Reasoning in Dialogue

Exploring the Inferential Articulation of Speech Acts

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UPF DOCTORAL THESIS / Year 2021

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Live the questions now.
Perhaps then, someday far in the future,
you will gradually, without even noticing it,
live your way into the answer.

Rainer Maria Rilke, *Letters to a Young Poet*

To my parents and grandparents
献给我的父母和祖父母

Acknowledgments

Some short period in one's life looks as if it will last for ever. Then at some unexpected moment, one is surprised to realize that that period has already become part of the past. It has been over five years since I first took Laia's and Enric's classes on semantics and pragmatics at Pompeu, not knowing that they soon would become my supervisors. I am grateful to both of them for giving me the opportunity to pursue my doctoral research at Pomepu, and moreover, for the freedom that they gave me to explore my research interests in this long course. If it were not for their encouragements and intellectual support, the completion of this dissertation would be definitely impossible.

I am indebted to many professors of the department, in particular, Pilar Prieto, my Master's supervisor, who taught me the first things about Linguistics and impressed me with her Catalan spirit. I learned a lot from Alex Alsina, Louise McNally, and Cristina Real Puigdollers when I worked for them as a seminar instructor. I must also express my thanks to my colleagues of the Formal Linguistics Research Group (GLiF), who unconsciously inspired me during my doctoral research.

My research stay at the University of Gothenburg during the winter trimester of 2018 was a wonderful experience. I am grateful to all the members of the Centre for Linguistic Theory and Studies in Probability (CLASP), who accommodated me warmly since the first day that I arrived at Gothenburg. In particular, I am deeply indebted to Stergios Chatzikyriakidis for offering me this opportunity to study at CLASP, and to Robin Cooper for having spent a lot of time with me discussing many basic but interesting questions.

The five years of my Ph.D journey were both sweet and sorrowful. It is a great pleasure to get to know all of my professors and my lovely friends, who made my stay in Europe bright and enjoyable. They are the most sweet part of this short period of my life! The long distance and the unexpected Covid-19 pandemic, however, deprived me of the opportunity to say a final farewell to two family members who passed away in 2020 and 2021. They clearly don't and will never understand what I have written in this dissertation, but they would be definitely happy if they could see the smile on my face for having returned home safely from this long journey.

The Covid-19 pandemic has changed everything that we have been accustomed to. The one-year stay at home really came unexpected. It allowed me more time to reflect on myself, thinking about the way of life that I truly desire. I would like to thank my friends, Zi Huang (in Barcelona), Wenyue Hua (in New Jersey), Tsy Yih (in Hangzhou) and Aaron Nianyi Qian (in Oxford) for their virtual accompany and encouragements. I am greatly indebted to Dr. Yiyang Cheng (in Shanghai), who kindly shared with me her life experience, helping me to get prepared for prospective challenges. I owe a lot to Jinsong Wang for taking care of my life during this year and for spending time with me walking almost everyday after lunch in the Natural Park of Collserola.

This research was supported by a grant BES-2016-077488 awarded by the Spanish Ministry of Economy and Competitiveness associated with Enric Vallduví's research project FFI2015-67991-P. This dissertation was prepared using LaTeX.

Abstract

English version:

This dissertation studies the inferential articulation of speech acts (in particular, assertions and questions) in dialogue, drawing upon two theoretical frameworks, a normative Question Under Discussion (qud) model of discourse and a type-theoretical framework for semantics. It is demonstrated that, under a normative inferentialist view of speech acts, the potential of reacting to a speech act can be characterized in terms of the existence of a proper question that bridges the two concerned speech acts, and furthermore, that the rhetorical relation that emerges from this one-turn dialogical interaction can be reduced to a family of qud-relations (i.e., question resolution and question implication). The analyses presented in this dissertation give rise to a more comprehensive qud-model of discourse called RiD (acronym for "Reasoning in Dialogue").

Catalan version:

Aquesta tesi estudia l'articulació inferencial dels actes de parla (en particular, assercions i preguntes) en diàleg, a partir de dos marcs teòrics, el model Question Under Discussion (qud) normatiu del discurs i la semàntica basada en la teoria de tipus. Es demostra que, sota una visió normativo-inferentialista dels actes de parla, és possible caracteritzar el potencial de respondre a un acte de parla en termes de l'existència d'una pregunta que relaciona els dos actes de parla en qües-

tió, i a més, que la relació retòrica que emergeix d'aquesta interacció dialògica d'un sol torn es pot reduir a una família de relacions qud (i.e., resolució de preguntes i implicació de preguntes). Les anàlisis presentades en aquesta tesi donen lloc a un model qud del discurs més complet anomenat RiD (acrònim de "raonament en el diàleg").

Spanish version:

Esta tesis estudia la articulación inferencial de los actos de habla (en particular, aserciones y preguntas) en diálogo, basándose en dos marcos teóricos, el modelo Question Under Discussion (qud) normativo del discurso y la semántica basada en la teoría de tipos. Se demuestra que, bajo una visión normativo-inferentialista de los actos de habla, es posible caracterizar el potencial de responder a un acto de habla en términos de la existencia de una pregunta que relaciona los dos actos de habla en cuestión, y además, que la relación retórica que emerge de esta interacción dialógica de un solo turno puede reducirse a una familia de relaciones qud (i.e., resolución de preguntas e implicación de preguntas). Los análisis presentados en esta tesis dan lugar a un modelo qud del discurso más completo llamado RiD (acrónimo de "razonamiento en el diálogo").

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Chapter 1

Introduction

The very idea that natural language can be studied in a formal manner grew out of Frege's and Russell's attempt to reconstruct mathematical reasoning using a restricted set of inference rules (see Hintikka (1984) for a historical note). Linguistic/ordinary reasoning is similar to mathematical reasoning: whilst mathematical reasoning is to reason with mathematical *judgments* (Bolzano, 1837; Martin-Löf, 1996), linguistic reasoning is to reason with *speech acts* (Austin, 1962; Searle, 1969; Sadock, 1974). In light of this, it is reasonable to wonder if linguistic reasoning can be reconstructed using a limited set of inference rules such that the relevance of a speech act to a linguistic discourse can be conceived as underpinned by some primitive logical-inferential relations. This is expounded in the following hypothesis:

> **Inferential Articulation Hypothesis** (**IAH**)
> In linguistic discourse, speech acts are *inferentially* articulated: a speech act is relevant to a discourse iff the former is connected to the latter by certain inferential relations.

Although IAH is not strictly followed in the research about discourse structure, some modified versions have been investigated in the literature. Instead of characterizing discourse structure in terms of logical-inferential relations, researchers have introduced two different formal approaches, both resorting to certain organizing principles that are not purely logical-inferential: one is based on the notion of *rhetorical relation* (i.e., a relation that maps two discourse units to a complex one) (Hobbs, 1979; Mann & Thompson, 1988; Taylor, 1994; Kehler, 2002; Asher & Lascarides, 2003), the other is based on a notion called *question-under-discussion* (*qud*) (i.e., a question accepted for discussion) (Carlson, 1983; Roberts, 1996/2012; Ginzburg, 1996b; Büring, 2003). The basic ideas of the two approaches are as follows:

(*a*) **Relation-based approach**:
A speech act is relevant to a discourse iff it is connected to the discourse by some rhetorical relation(s).

(*b*) **Qud-based approach**:
A speech act is relevant to a discourse iff it is connected to the discourse by some qud-relation(s).[1]

If both relation- and qud-based approaches are on the right track to the modeling of discourse structure, there must be a way to define a mapping between them, that is, to define an algorithm that reduces a rhetorical relation to a family of qud-relations. This algorithm is called a *qud-reduction algorithm*. Previous studies have revealed that a qud-reduction algorithm is available for certain rhetorical relations (Jasinskaja, 2006; Jasinskaja & Zeevat, 2008; Onea, 2019) but to our current knowledge, it remains unclear if there exists a generic qud-reduction algorithm that applies to all varieties of rhetorical relations (see Hunter and Abrusán (2015) for more discussion).

The primary goal of this dissertation is to develop a generic qud-reduction algorithm for rhetorical relations. To make this project feasible, we restrict our scope of investigation to only two types of speech acts, *assertions* and *questions*, and consider their occurrence in only *elementary one-turn dialogues*, i.e., dialogues that consist of only two speech acts, each containing only one eventuality description. In order

[1] Two types of rhetorical relations are regarded as qud-relations: *question resolution* (i.e., resolving a question with a full answer), and *question implication* (i.e., inferring a question from another). They are formally defined in Chapter 5.

to characterize the relevance between two speech acts in an elementary one-turn dialogue, one is supposed to answer the following two questions: first, a fundamental ontological question on the performability of speech acts (concretely, what does a speech act express and moreover, what entitles one to perform such a speech act); second, a question on the potential of reacting to a speech act being addressed (concretely, what are potential reactions to a speech act, how can the potential be characterized in terms of only qud-relations, and finally what types of rhetorical relations will emerge from the process of reacting to a speech act). Although the utterance expressed in a speech act is not necessarily sentential (see Schlangen and Lascarides (2003) and Ginzburg (2012, 2016) for related discussion), to simplify the investigation, we assume throughout that non-sentential utterances can be converted to corresponding sentential utterances as long as they are interpretable in the concerned discourse.

1.1 Theoretical Frameworks

This dissertation draws upon two major theoretical frameworks: (*i*) a normative qud-model of discourse and (*ii*) a type-theoretical semantic framework. The two frameworks are briefly introduced in this section.

1.1.1 The qud-model of discourse

The qud-model of discourse, drawing inspirations from logical studies of games (Hintikka, 1973; Lorenzen & Lorenz, 1978), presents a radical view of discourse. The standard qud-model of discourse is introduced by Roberts (1996/2012) but the primitive idea is traced back to Collingwood (1940) and Wittgenstein (1953). The fundamental ideas of standard qud-model of discourse are summarized as follows:[2]

[2]The qud-model of discourse introduced here is based on Roberts (1996/2012). It advocates a radical view, largely following Carlson (1983), that qud-relations are the only organizing principles of linguistic discourse. Ginzburg (1996b, 2012) introduces another qud-model of discourse, which is essentially hybrid in contrast

(*a*) The primary purpose of discourse is cooperative inquiry, that is, the attempt to discover the way things are in this world. The goal of discourse can itself be viewed as a question dubbed the Big Question: *What is the way things are?*. Since the main goal of discourse is to answer the Big Question, a reasonable strategy to achieve this main goal is to generate a series of sub-goals by introducing a series of easier questions that are implied by the Big Question. The main goal of discourse is achieved as long as all of the sub-goals generated from the main goal are achieved.

(*b*) The goal of a linguistic discourse, dubbed a domain goal, is usually more specific than the general goal of discourse. In standard qud-model of discourse, a specific question is called a *question-under-discussion* (or simply, *qud*) whenever the discourse participants commit to seeking a full answer to this question. There are many sequences of questions at a given point in a discourse and one is not obliged to accept them all. But whenever a question is accepted by all as a qud, the interlocutors pursue it until it is fully answered or it turns out to be unanswerable.

(*c*) In a linguistic discourse, at any given point, there is a qud called the *current qud*. The contribution of a speech act is relevant to the discourse iff it either provides at least a partial answer to the current qud or it is part of a strategy of inquiry (i.e., a question implied by the current qud) that facilitates the resolution of the current qud. The structure of a linguistic discourse is functionally organized by qud-relations, namely, question resolution and question implication, though in many cases, such questions are only implicit, and are inferred or accommodated on the basis of available grammatical or contextual cues.

(*d*) In a question-answer pair, the answer is said to be congruent to the question iff "substituting *wh*-phrases for the focused phrase (or phrases) in [the answer] and performing morpho-syntactic

with Roberts' (1996/2012): in addition to qud-relations, Ginzburg defines a series of rhetorical relations and conversational rules for discourse modeling.

adjustments such as *wh*-movement and *do*-support can result in [the question]" (Rooth, 2016, 20).[3] In a question-answer pair, if the answer is congruent to the question, the question provides the current qud for the answer; otherwise, the current qud for the answer differs from the question in the question-answer pair.

The qud-model of discourse is shown to be successful in the analysis of many perplexing linguistic phenomena such as the interpretation of focus accents (Roberts, 1996/2012; Büring, 2003; Beaver & Clark, 2009) and presupposition projection (Simons, Tonhauser, Beaver, & Roberts, 2010) (see Roberts' annotated Qud Bibliography).

The standard qud-model of discourse adopts a communicative/informational view of speech acts: to assert a proposition is to propose to add it to the *common ground* (i.e., a set of propositions accepted by interlocutors) (Stalnaker, 1978) and to ask a question is to propose to add it to the *qud-stack* (i.e., a set of questions accepted by interlocutors), seeking an answer from the interlocutor (Roberts, 1996/2012).[4] The communicative view of speech acts, however, is criticized for having neglected the impersonal character of speech acts: a speech act need not be addressed to any specific individual. In light of this, taking inspirations from the normative turn in recent semantic and pragmatic research (Brandom, 1994; Peregrin, 2005, 2012; Millson, 2014b; McKenna, 2014; Krifka, 2015; Antonsen, 2018; Geurts, 2019), we advocate a normative qud-model of discourse, wherein the meaning of speech acts are explained in terms of normative statuses rather than communicative functions. The main ideas are summarized as follows, largely due to Brandom (1994, 2008, 2009) and Millson (2014b):[5]

[3]Readers who are familiar with the property of congruence might dislike the quotation from Rooth (2016) because it is informal and imprecise. But since we have not defined notions relevant for the formal definition of congruence, we see Rooth's description as a proper characterization of this property.

[4]Portner (2004, 2007) offers a similar analysis for *commands*: to issue a command is to add it to the *to-do list*, a set of commands accepted by interlocutors.

[5]The normative view of speech acts introduced here is hybrid: the interpretation of assertion is based on Brandom (1994), whilst the interpretation of question

(*a*) Speech acts are first and foremost *normative*, underlain by two fundamental types of *normative statuses*: by performing an assertion, one *prima facie* acknowledges a (*doxastic*) *commitment* (equivalently, a belief) to the proposition therein expressed and assumes the responsibility of vindicating one's *entitlement* to endorse such a commitment whenever challenged; by performing a question, one *prima facie* acknowledges a (*practical*) *commitment* (equivalently, a goal) to seek a full answer to the question and assumes the responsibility of vindicating one's *entitlement* to endorse such a commitment whenever challenged.

(*b*) To vindicate one's entitlement to make a speech act is to give a reason (or justification) for one's performance of the speech act. To vindicate an assertion, one offers a reason for why the proposition therein expressed is true: according to Brandom (1994), one justifies a proposition by either providing an inferential argument, or deferring the justificatory responsibility to someone else, or referring to some reliable perceptual experience. In order to vindicate a question, one provides a reason for why one pursues a full answer to the question: a reason for a question consists of two parts, a practical commitment that one desires to seek a full answer, and a doxastic commitment that raising the question makes explicit one's intent to resolve it.

(*c*) To *acknowledge* a normative status is to make it appropriate for others to *attribute* it. This takes place in two ways: one acknowledges a normative status directly (by explicitly performing a speech act) or consequently (as a result of acknowledging other normative statuses). In addition to *acknowledging* and *attributing*, Millson (2014a, 2014b) propose to regard *addressing* as the third deontic attitude: to *address* an assertion, one addresses its entitlement to the interlocutor, accepting any challenge to the assertion, whilst to address a question, one addresses a practical commitment requesting a (full) answer from the interlocutor.

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and addressing takes inspirations from Millson (2014a, 2014b).

(*d*) Language use in a discourse is modeled by a game of scorekeeping: at every stage of a discourse, one acknowledges a constellation of normative statuses and attributes another constellation to the interlocutor. There are various different models of scorekeeping proposed in the literature (see Ginzburg (2012, 61-66) for an overview). In this dissertation, following Brandom (1994), we adopt a double-entry scorekeeping model: every participant (as a game player) in a discourse maintains a two-entry scoreboard, keeping track of normative statuses that he/she acknowledges both *intrapersonally* and *interpersonally*.[6]

The reinterpretation of the Stalnakerian common ground under a normative view of speech acts is explored in Nickel (2013) and Antonsen (2018): the Stalnakerian common ground can be considered as a set of shared doxastic commitments to a series of propositions. Generalizing this idea to the Robertsian qud-stack, we shall give the following reinterpretation: the Robertsian qud-stack can be considered as a set of shared practical commitments to (resolve) a series of questions.

1.1.2 Type-theoretical semantics

Ever since Ranta (1994), modern type theories have been applied to the study of linguistic semantics. Recent years have witnessed an increasing interest in this field (Cooper, 2005; Asher, 2011; Ginzburg, 2012; Luo, 2012; Bekki, 2014; McAdams & Sterling, 2016; Chatzikyriakidis & Luo, 2017, 2020). Type-theoretical semantics has many attractive features, some of which are not available from model-theoretical semantics (Montague, 1974; Dowty, Wall, & Peters, 1981). The two features that are important to us are the following:

[6] The *intrapersonal*/*interpersonal* distinction has its roots in medieval scholastic tradition. In Aquinas's theory of action, a similar distinction is made between *actus interioris* and *actus exterioris*: the former refers to the internal dispositions that accompany or motivate one's action whereas the latter refers to the state of affairs brought about by the external performance (Aquinas, 1981, I-II, 18-21). It is also equivalent to the *private*/*public* distinction in Ginzburg (2012).

(*a*) In type theory, there is an explicit *type-token* distinction, which is not always available in the traditional model-theoretical semantics: types are used to represent concepts, whose instances/-tokens are terms of corresponding types. For example, one can posit a type $[\![\text{man}]\!]$ for all male human individuals and a specific man called *John* (abbreviated as j) is an instance of $[\![\text{man}]\!]$. The availability of the type-token distinction in type theory will be shown to be useful in the representation of speech acts.

(*b*) Type-theoretical semantics is both *model-theoretical* and *proof-theoretical*: linguistic expressions are first represented in a model-theoretical way and then the representations are understood inferentially in a proof-theoretical manner (Luo, 2014; Chatzikyriakidis & Luo, 2020). The model- and proof-theoretical aspects of type-theoretical semantics is useful in this dissertation: speech acts are first formalized in a model-theoretical way, and then the inferential articulation of speech acts in linguistic discourse are uniformly analyzed in a proof-theoretical manner.

The type-theoretical framework for semantics, in contrast with model-theoretical semantics, is relatively new to linguists. In Chapter 3, we give a more detailed introduction to the type-theoretical framework.

1.2 Reasoning in Dialogue: Synopsis

The theory developed in this dissertation is called RiD (an acronym for *Reasoning in Dialogue*). It consists of three components, as shown in Figure 1.1: (*i*) a normative interpretation of speech acts, (*ii*) a type-theoretical formalism for speech act representation, and (*iii*) a type-theoretical formalism for reasoning with speech acts in dialogue.[7]

[7]This dissertation does not aim to offer a comprehensive account of discourse, but only provides an alternative unified approach to the formal analysis of relevance in discourse (or more concretely, in dialogue). Consequently, many intricate linguistic phenomena in dialogue, as surveyed in Schlangen (2015) and Ginzburg (2016), are not considered in this dissertation. These remain for future scrutiny.

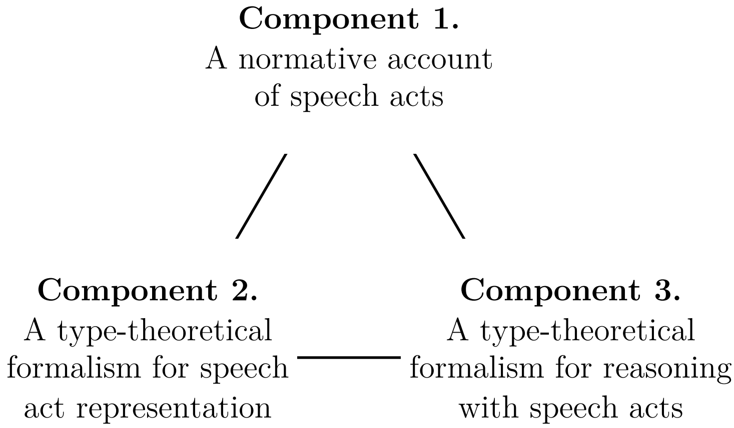

Figure 1.1: Three components of RiD

The first component of RiD is a normative account of speech acts. Brandom's (1994) and Millson's (2014b) normative accounts of speech acts, first introduced in Section 1.1.1, are originally intended for the analysis of *autonomous discursive practices* (i.e., an abstract and minimal form of discourse). In this dissertation, substantial revision and amendments are brought to them in order to make them suitable for the analysis of speech acts in *linguistic discourse*. The role of the first part among the three parts of RiD is evident: it is intended to provide a metaphysical and ontological basis for the other two parts of RiD.

The second component of RiD is a type-theoretical formalism for modeling assertions and questions. In RiD, both assertions and questions are represented by *typing judgments*. In contrast with previous approaches, an obvious advantage of formalizing speech acts by judgments is that they are directly apt for making inferences, with no need to resort to any mediator non-logical relation. In this sense, the formal representation of speech acts in RiD are not mere representations, but also reflect their inferential roles in linguistic reasoning.[8]

[8]This echos Brandom's (1994) pragmatist view that the meaning of linguistic

The third and also the final component of RiD is a type-theoretical formalism for reasoning with assertions and questions. It consists of four inter-related parts. The first part is a *plain logical system* formulated on the basis of a typed counterpart of natural deduction calculus (Martin-Löf, 1987; Nordström, Petersson, & Smith, 1990). It provides a logical basis for the other three parts. The second part is a system of *assertional reasoning* (i.e., reasoning with assertions). The third part is a system of *erotetic reasoning* (i.e., reasoning involving questions). The fourth part is a constrained non-logical reasoning mechanism developed on the basis of assertional and erotetic reasoning for modeling relevance (and coherence) in elementary one-turn dialogues.

1.3 Structure of the Dissertation

This dissertation is divided into four parts, each part containing two to three chapters. This section introduces the content of each chapter. Figure 1.2 provides a road-map for this dissertation.

The first part of this dissertation consists of Chapter 2 and Chapter 3. Chapter 2 briefly introduces problematic data and puzzles that are to be considered in detail in the subsequent chapters. Chapter 3 provides a brief introduction to the type-theoretical framework and adapts it for the study of linguistic semantics.

The second part consists of three chapters: Chapter 4 and Chapter 5 develop a normative account of assertion and question and a type-theoretical formalism for the representation of the two kinds of speech acts; Chapter 6 provides a normative analysis of the second-personal character of assertions and questions in linguistic discourse.

The third part, from Chapter 7 to Chapter 9, scrutinizes the rationale of the multiple ways in which one can respond to a speech act. Chapter 7 develops a new qud-based framework for discourse representation and defines related notions. Chapter 8 presents a tentative

expressions corresponds to their inferential roles in the Sellarian space of reasons. The reader is referred to Chapter 4 of Loeffler (2018) for an introduction.

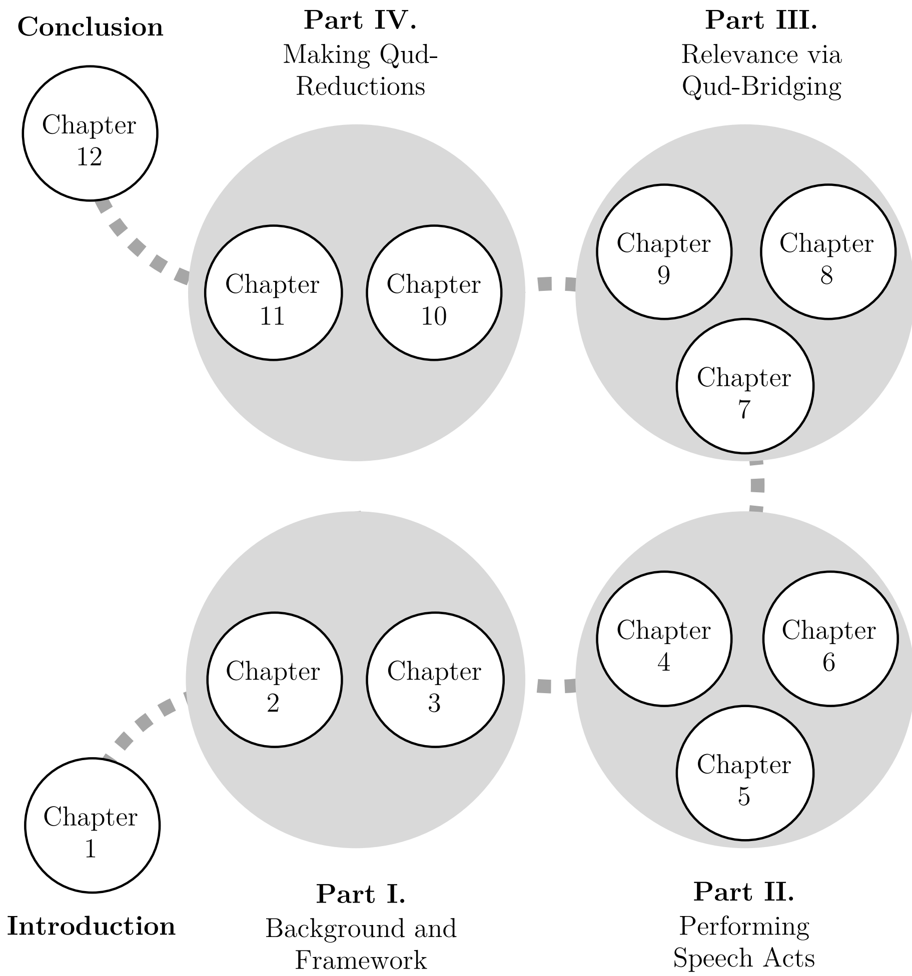

Figure 1.2: Road-map for this dissertation

definition of relevance, which is shown to be inadequate for the characterization of the potential of reactions. Chapter 9 is the nucleus of this part. This chapter develops a novel account of relevance on the basis of a mechanism called qud-bridging (that is, bridging two speech acts by a question) governed by a series of constraints.

The fourth part, consisting of Chapter 10 and Chapter 11, examines the possibility of reducing rhetorical relations to qud-relations. Chapter 10 considers the qud-reduction of logical relations, which do not impose a relevance requirement on the speech acts that they relate. Chapter 11 considers the qud-reduction of rhetorical relations (in linguistic discourse), which do impose a relevance requirement on the speech acts that they relate. The results confirm our hypothesis that if qud-relations are conceived as the minimal rhetorical relations, other rhetorical relations can be reduced to a family of qud-relations.

Chapter 12 provides some concluding remarks.

Part I

Background and Framework

Overview of Part I

This part sets the research background and the starting point of this dissertation. It consists of two chapters: Chapter 2 presents a series of research questions after a brief examination of problematic data and a comparison of previous approaches if any; Chapter 3 offers a brief introduction to the type-theoretical framework adopted in this dissertation and introduces the basics of type-theoretical semantics.

Chapter 2

Motivating Questions

This chapter introduces the research questions that will be tackled in the course of this dissertation. The goal of this chapter is to motivate these questions based on problematic linguistic data and existing research gaps, leaving an in-depth analysis to the subsequent chapters.

This chapter is organized as follows: Section 2.1 sets the frame for the linguistic phenomena to be considered in this chapter; Section 2.2 considers the first-personal and second-personal characters of speech acts in human communication; Section 2.3 examines the multiple potential ways to react to a speech act and compares two predominant approaches to the characterization of such potential; Section 2.4 looks into the way in which rhetorical relations emerge from dialogical interactions; Section 2.5 provides some concluding remarks.

2.1 Setting the Frame

The linguistic data to be considered in this chapter are all related to a particular kind of linguistic discourse, namely, *elementary one-turn dialogues* of the generic form shown in (1), in which ϕ and ψ are both elementary speech acts in the sense that they each contain only one eventuality description and moreover ψ is a reaction to ϕ:[1]

[1] The definition of an *elementary speech act* is largely inspired by Asher and Lascarides' (2003) *elementary discourse unit* (see Section 2.4 for more details).

(1) a. Speaker a: ϕ
b. Speaker b: ψ

For sake of convenience, (1) is henceforth abbreviated as:

$$\phi \oplus \psi$$

There are two reasons that we consider (only) elementary one-turn dialogues in this dissertation. First, an elementary one-turn dialogue represents the minimal form of interaction, and in contrast with more complicated discourse types, the interpretation of an elementary one-turn dialogue is much easier to pin down. Second, the results obtained form the analysis of elementary one-turn dialogues is expected to generalize to other types of linguistic discourse under the widespread conviction, dating back to Duke (1974) or even earlier, that a linguistic discourse, whether dialogical or not, is reducible to a sequence of one-turn dialogues (see Bergmann (2006) for more related discussion).

The successful completion of an elementary one-turn dialogue is a product of rational cooperation between two interlocutors: one performs a speech act and right afterwards the interlocutor reacts to it by another speech act. The linguistic data and phenomena to be considered in the remaining sections are closely related to this minimal process of communication: we seek to decipher the rationale behind one's performance of a speech act and the multiple ways in which the interlocutor can react to this speech act.

2.2 Rational Speech Acts

The rationality of human actions is a recurrent theme in philosophy. Since the linguistic/analytic turn of philosophy, there is a conviction shared by researchers that human communication provides a window for the understanding of rationality: humans communicate with each other by performing speech acts in a rational and cooperative way to achieve some common goals. The rationale of speech act performance, however, is controversial in the literature. This section compares two predominant approaches–the *non-communicative approach* and the *communicative approach*–that seek to answer the following question:

(Q1) What does one express by making a speech act and how is the performance of a speech act warranted?

The starting point is Brandom's (1994) (non-communicative) account of speech acts (anticipated in Section 1.1.1 of Chapter 1 and partially reintroduced in Section 2.2.1). To achieve a more comprehensive understanding of the rationale of speech act acts, we propose that Brandom's account must be enriched with a second-personal dimension in order to capture the communicative force of speech acts.

2.2.1 Non-communicative force

The first predominant approach to the rationality of speech act performance is what we call a non-communicative approach, best represented by Bach and Harnish (1979) and Brandom (1983, 1994), both concentrating more on the impersonal or first-personal character of speech acts: the primary illocutionary force of a speech act is not to communicate but to acknowledge some attitudes.[2] [3] Brandom's non-commutative account of speech acts is broadly acknowledged as the most comprehensive one and is taken as the starting point of this dissertation (see Section 1.1.1 of Chapter 1 for more details). However, it is not completely free of problems.

[2]It is unfair to say that the non-communicative approach *completely* neglects the communicative function of speech acts but they do not consider it the primary force of speech acts (see Witek (2013) and Antonsen (2018) for more dicussion).

[3]Bach and Harnish (1979) and Brandom (1994) differ, however, with respect to the nature of attitudes that one acknowledges by making a speech act: the former consider attitudes to be essentially *mental objects* whilst the latter considers attitudes to be *deontic normative statuses*. This represents a big bifurcation in contemporary analytic philosophy, one endorsing a mentalist view towards human rationality and the other endorsing a normativist view. The reader is referred to Chapter 1 in Loeffler (2018) and Geurts (2019) for more details.

To start with, consider Brandom's (1983) interpretation of *assertions* in human communication:

> "In asserting a [proposition] one both commits oneself to it and endorses it ... [The] commitment involved in asserting is [is taken to be] the undertaking of justificatory responsibility for what is [asserted]. In asserting a [proposition], one [...] licenses further assertions [by] others, [and] commits oneself to justifying the original [assertion]."
> (Brandom, 1983, 640-641)

This interpretation is complicated. Following Loeffler (2018), we divide it into two parts: first, to assert a proposition is to acknowledge a commitment to (the truth of) the asserted proposition; second, to assert a proposition, one is responsible for vindicating it whenever it is challenged and one authorizes anyone else to reassert it reflecting any challenge to oneself. The first part of Brandom's construal of assertions is relatively non-controversial (see also Krifka (2017) and Geurts (2019) for two similar accounts). The commitment that one acknowledges in making an assertion is called a *doxastic commitment*, which is tantamount to the notion of *belief* in Bach and Harnish (1979). In Brandom's analysis, that to assert a proposition is to commit to its truth is taken as a social deontic norm called the *commitment norm*.

The second part of Brandom's interpretation of assertions corresponds to what he calls the *entitlement norm*. In his original formulation, as quoted above, the entitlement norm of assertion consists of two subparts: first, in asserting a proposition, one undertakes the responsibility of vindicating one's entitlement to the assertion when it is challenged; second, in asserting a proposition, one entitles others to reassert it reflecting any challenge to oneself. The two subparts of the entitlement norm of assertion are closely related to each other: "it is only assertions one is entitled to make that can serve to entitle others to [reassert]" Brandom (1983, 641). It is a fact that whenever one asserts a proposition, the interlocutors are free to reassert it deferring the justificatory responsibility to the original asserter. In view of this, following Brandom's account of the entitlement norm, we would conclude that one is always entitled to what one asserts. This is, however, explicitly rejected by Brandom: one might be not entitled to what one asserts, or in other words, one might assert something that one fails to justify.[4] Brandom (1994) further argues that

> "... [M]aking [an assertion that] one is not entitled to [...] is a kind of impropriety, the violation of a norm. For the performance to have this sort of status or significance within or according to a set of practices–for this sort of norm to be implicit in or be instituted by those practices–requires that the practices include attitudes of taking, treating, or acknowledging performances as incorrect ..."
>
> (Brandom, 1983, 179)

.

Brandom's treatment of non-entitled assertions is not unacceptable. But it is not quite suitable for the analysis of linguistic discourse.

To illustrate, consider the following example:

(2) Amadís defeated Dardán.
#But I don't know why I think so.

The infelicity of the second sentence in (2) points to the reality that whenever one asserts the first sentence, one must be in possession of some evidence that justifies it.[5] That evidence exactly corresponds to what Brandom calls a *vindication*. The oddity stays if we transform (2) into a dialogue, as shown in the following example:

(3) a. **Lisuarte**: Amadís defeated Dardán.
b. **Oriana**: Why do you think so?

[4]Loeffler (2018) makes this idea more explicit: "being committed to a [proposition] does not imply being entitled to it [...] although very often [speakers] are both committed and entitled to a [proposition]" (p.67).

[5]The requirement of a justification reminds us of justification and knowledge accounts of assertions (Douven, 2006; Lackey, 2007; Kvanvig, 2009), which will be considered in more detail in Section 4.1 of Chapter 4.

c. **Lisuarte**: #I don't know.

The oddity of (3c) again confirms that whenever one asserts a proposition, one must have a reason that justifies it. However, it is worthwhile mentioning that the above observation is not essentially in contradiction with Brandom's account because for Brandom, entitlement is a social status, that is, a status attributed by the social community: one is judged as being entitled to an assertion iff the social community (or the interlocutors in a discourse) accepts one's vindication for the assertion; otherwise, one is deemed not entitled to this assertion. Therefore, for Brandom, the attribution of entitlements depends on a post-hoc analysis: it can be done only if one offers a vindication for one's assertion. However, note that in such a procedure, the presence of a vindication is in fact presupposed. This hints that whenever one makes an assertion, it is at least warranted from one's own perspective in the sense that one is necessarily in possession of a vindication, though it is unclear whether such a vindication would be accepted by the social community. This provides a better explanation for the observation in examples (2) and (3). The idea that one's assertion is necessarily warranted at least from one's own perspective will be further considered and developed in Chapter 4 of Part II.

The classical Brandomian model of discourse is purely assertional and no other speech acts are involved.[6] Millson (2014b) further extends the classical Brandomian model of discourse by questions. Leaving aside the communicative function of questions, Millson proposes to interpret the non-communicative force of questions as follows:

> "[In asking a question, the] querier [acknowledges] an erotetic commitment to [the question], that is, a responsibility to acknowledge an assertional commitment [to an answer to this question] to which the querier is entitled."
> (Millson, 2014b, 203)

.

[6]The reason that Brandom excludes non-assertional speech acts in his model of discourse is not because that he considers other types of speech acts insignificant but because that he considers assertions to be more essential.

In Millson's sense, an assertional commitment to an answer to a question is exactly "a commitment to the answerability of this question" (p.201), that is, that there exists a true answer that resolves this question. Having this made explicit, Millson's definition of *erotetic commitment* shall be reduced to a special type of doxastic commitment: in making a question, the querier acknowledges an erotetic commitment to the question, that is, a doxastic commitment to the existence of a true answer to this question. In linguistic discourse, however, acknowledging such a doxastic commitment need not lead one to raise the question. To illustrate, consider the following example:

(4) a. **Oriana**: A knight defeated Amadís.
b. **Lisuarte**: Yes.
c. **Oriana**: Guess which knight defeated him?
d. **Lisuarte**: i. I don't know. Which knight defeated him?
ii. Whichever. #Which knight defeated him?

By asserting (4b), Lisuarte acknowledges a doxastic commitment to the existence of a knight that defeated Amadís. On Millson's account, to acknowledge such a doxastic commitment amounts to the same as to acknowledge an erotetic commitment to such a question as (4di). But as shown in (4dii), acknowledging such a doxastic commitment need not evoke (4di): it is suppressed if Lisuarte has no interest in knowing a full answer to (4di). Millson's view of question as an act to acknowledge an erotetic commitment is therefore untenable. In fact, the Millsonian erotetic commitment to a question is not what one acknowledges but *presupposes* in asking the question (Keenan & Hull, 1973; Hintikka, 1974, 2007; Belnap & Steel, 1976; Wiśniewski, 1995).

In order to properly capture the non-communicative force of questions, we propose to turn back to Brandom's (1994) account of *shall-statements* (briefly introduced in Section 1.1.1 of Chapter 1):

> "The role of [shall-statements] can be understood in socre-keeping terms from their fundamental pragmatic significance as acknowledging a practical commitment [to fulfill

> some action] ... A primary reason [that justify a shall-statement is a] pair of a belief and [...] a pro-attitude."
> (Brandom, 1994, 246)

To illustrate, let us consider Brandom's example (p.246):

(5) I shall open my umbrella.

In terms of Brandom, to avow (5) is to acknowledge a practical commitment to the action that the speaker opens the umbrella. To provide a warranty for the avowal of (5), the speaker is expected to give a reason such as (6) (adapted from Brandom (1994, 163-164))

(6) a. Opening my umbrella will keep me dry.
    b. I want to stay dry.

(6a) and (6b) are both indispensable for the justification of the practical commitment that one acknowledges by performing (5): (6a) is a doxastic reason, whereas (6b) is what Brandom calls a pro-attitude (inherited from Davidson (1963, 1984)). In Searle's (1969) taxonomy of speech acts, questions and shall-statements are both classified as *directives* in the sense that they both aim at provoking some action: a shall-statement commits one to fulfill the action therein specified, whilst a question commits one to seek a (full) answer to the question.[7] In light of this, Brandom's analysis of shall-statements can be transposed to the analysis of questions: in asking a question, one acknowledges a practical commitment to seek a (full) answer to the question.

To make one's question warranted, one is supposed to give a reason that justifies the question. The justification of a question is similar to that of a shall-statement, consisting of two parts, as suggested by Brandom: a doxastic commitment and a pro-attitude. Let us consider again the following example (repeated from (4)):

(7) a. **Oriana**: A knight defeated Amadís.

[7] The notion of *full answer* is to be defined in Section 5.1 of Chapter 5.

b. **Lisuarte**: Yes.

c. **Oriana**: Guess which knight defeated him?

d. **Lisuarte**: i. I don't know. Which knight defeated him?
ii. Whichever. #Which knight defeated him?

The performance of the question *Which knight defeated him?* is justified by two reasons, as presented in (8):

(8) a. Raising a question helps me to seek a (full) answer to it.
b. I want to know which knight defeated Amadís.

(8a) and (8b) are both indispensable for the justification of the raising of *Which knight defeated him?*: (8a) is a doxastic reason whilst (8b) is what Brandom calls a pro-attitude. The infelicity of (7dii) can be now properly explained: although Lisuarte acknowledges a doxastic commitment (or erotetic commitment in Millson's terms) to the existence of a knight who defeated Amadís, he does not have such a pro-attitude as specified in (8b), and for this reason, the utterance of the question *Which knight defeated him?* is infelicitous in (7dii). It is pertinent to wonder if one is always entitled to what one asks. Following Brandom's (1994) account of the entitlement norm, the answer is negative: one might fail to vindicate a question that one raises. This, however, fails to capture the following observation (cf. (2) and (3)):

(9) Which knight defeated Amadís?
#I don't know why I ask this.

(10) a. **Lisuarte**: Which knight defeated Amadís?
b. **Oriana**: Why do you ask this?
c. **Lisuarte**: #I don't know.

The oddity of the second sentence in (9) and the oddity of (10c) signal that whenever one asks a question, one is *prima facie* entitled to it at least from one's own perspective, that is, that one is in possession of a reason (which might be invalidated by the community) that warrants one's performance of this question. Under this view, we can propose a tentative but more comprehensive definition of question (in parallel with Brandom's (1994) definition of assertion): in asking a question, one *prima facie* acknowledges a practical commitment to seek a (full) answer to resolve the question and undertakes the responsibility of justifying one's entitlement to acknowledge such a commitment. This view of questions will be further developed in Chapter 5.

This section considers some previous approaches to the rationale of speech act performance that seek to answer the following question:

(Q1.1) What does a speech act express if it is not addressed to any audience and what entitles one to perform such a speech act?

The starting point is Brandom's (1994) normative account of speech acts. It is appealing to us for at least two reasons: first, it develops a comprehensive commitment account of speech acts which faithfully captures many non-communicative aspects of speech act performance; second, in comparison with other non-communicative approaches, the entitlement norm proposed for speech act performance directly captures the inferential role of speech acts. Brandom's account of speech acts, however, is not free of problems. First, the notion of entitlement in Brandom's sense fails to capture many linguistic facts. In view of this, we propose a reinterpretation of this notion, which is to be further developed in Chapter 4. Second, the original Brandomian model of discourse is assertion-based, to adapt it for linguistic analysis, we propose to enrich it with more varieties of speech acts, in particular, questions. This extension will be carried out in Chapter 5.

2.2.2 Communicative force

The second predominant approach to deciphering the rationality of speech act performance is what we call a communicative approach.[8] This approach is best represented by Stalnaker (1978, 2002), Ginzburg (1996b), and Roberts (1996/2012, 2018), which pay more attention to

[8]This approach is called an *informational approach* in Antonsen (2018).

the communicative function of speech acts: to perform a speech act is to address it to the interlocutor calling upon the latter for a reaction.[9] In the literature, the communicative function of a speech act is also called the *second-personal character* of the speech act (Kukla & Lance, 2009; Millson, 2014b). The importance of the second-personal character of speech acts is beyond doubt, without which, human communication becomes completely impossible. Surprisingly, however, it is not considered in Brandom (1994). The reason for this neglect, as suggested by Kukla and Lance (2009), is the following:

> "It doesn't matter at all, for Brandom, whether the speech act was actually addressed to [...] the people it targets–it achieves its function and shifts the normative status of *everyone* in the community [...] simply by being uttered."
> (Kukla & Lance, 2009, 172)

This ideal picture is undoubtedly possible but in linguistic discourse, the pragmatic force of a speech act is conventionally directed at particular audience, namely, the addressee. There is a crucial difference between the addressee, i.e., the audience that a speech act is intended to target, and non-targeted audience: in the case that one is addressed a speech act, one is obliged to respond to it and shall never ignore it; in contrast, non-targeted audience need not incur such an obligation. To illustrate the difference, consider the following example (where $\mathcal{F}$ marks constituents that bear a narrow focus):

(11) a. **Oriana**: Eufemia, who told my secret to my father?
b. **Eufemia**: I don't know.
[*Two guardians standing aside whispering* ...]
c. **Guardian A**: It was [Galaor]$_{\mathcal{F}}$.
d. **Guardian B**: None of your business!

[9]The verb *address* in English can mean (*i*) to direct information to someone, or (*ii*) to deal with a matter or a problem. To avoid ambiguity, in this dissertation, unless otherwise noted, the first sense of *address* is adopted.

In this example, Oriana's question in (11a) targets only Eufemia and as a consequence, the two guardians who overhear it is free to ignore it. In contrast, Eufemia shall never ignore it and is obliged to respond to it. For this reason, (11d) is a felicitous reaction to only (11c) but not to (11b). This contrast points to the reality that the conflation of targeted and non-targeted audience in Brandom's account of speech acts is inappropriate in the sense that the performance of a speech act alters the normative statuses associated with the audience who are targeted by the speech act differently than it alters the normative statuses of non-targeted audience. To achieve a more comprehensive and complete understanding of speech acts, a non-communicative approach to the rationale of speech act performance such as Brandom's should be further enriched with a second-personal dimension.

This task is first systematically tackled in Kukla and Lance (2009). Drawing insights from Hinchman (2005), Moran (2006) and Darwall (2006) among others, Kukla and Lance (2009) make a distinction between *impersonal assertions* and *second-personal assertions*: in making a second-personal assertion, one does not merely assert a proposition (as in an impersonal assertion), but also makes a promise to the addressee that the asserted proposition is true (p.p.165-166).[10] Kukla and Lance argue that speech acts involved in communication between agents bound in specific relationships (cf. *genres* in Bakhtin (1986) and Ginzburg (2012)) including "doctors and patients, teachers and students, parents and children, and even political representatives and their constituents" (p.169) are all second-personal; whilst impersonal assertions are more frequently found in "newspaper reporting, formal expert testimony, and academic writing" (p.169). Nevertheless, Kukla and Lance remind that impersonal assertions *can* also have a second-personal character: the speaker speaks on behalf a group and the addressee speaks on behalf of another group. According to Kukla and Lance, the difference between second-personal assertions and the second-personal character of impersonal assertions is that the former

[10]In line with Moran (2006) and Hinchman (2005), second-personal assertions are called *tellings* in Kukla and Lance (2009).

is determined by the "intimacy of the speaker/audience relationship" whilst the latter is a "structural property" (p.170). Kukla and Lance's analysis of the second-personal character of speech acts is *ad hoc* in the sense that it inevitably increases the complexity of the interpretation of speech acts: on the one hand, it enforces a distinction between two kinds of speech acts–impersonal ones and second-personal ones–both of which are in fact addressable to others; on the other, it relates such a distinction to certain normative relationships but it provides no criteria for what amounts to a qualified relationship that triggers the performance of second-personal speech acts.

In view of the problems that Kukla and Lance (2009) encounter, Millson (2014b), taking inspirations from Wanderer (2010), proposes to maintain assertion as a single kind of speech act and attributes the difference between impersonal and second-personal interpretations of assertion in Kukla and Lance (2009) to whether the assertion targets particular audience or not: if an assertion targets particular audience (namely, the addressee), it has a second-personal interpretation; otherwise, it is conventionally interpreted as impersonal. Starting from this very idea, Millson proposes to consider *addressing* a deontic attitude, in parallel to the other two deontic attitudes–*acknowleging* and *attributing*–in standard Brandomian scorekeeping model (see Section 1.1.1 of Chapter 1 for details). To address a speech act, from Millson's perspective, is to address certain normative statuses, concretely:

- (*a*) To avow an *assertion*, one addresses its *entitlement* to the interlocutors, requesting them to recognize the address and to either acknowledge one's entitlement (to reassert the assertion) or to challenge it (by asking for a reason).
- (*b*) To ask a *question*, one addresses an *apokritic commitment* to the interlocutors, calling upon them to recognize the address and to either fulfill the commitment (by providing a full answer) or to reject acknowledging such a commitment (due to the ignorance of even a partial answer).

On Millson's account, the pragmatic force of a speech act is twofold:

an assertion requires that the speaker acknowledge a doxastic commitment to the proposition therein expressed, and address its entitlement to the targeted audience, calling upon the latter to provide appropriate uptake; in contrast, a question requires that the speaker acknowledge an erotetic commitment to the existence of a (full) answer to the question (see Section 2.2.1 for more details), and address an apokritic commitment to the targeted audience, calling upon the latter to provide appropriate uptake.

Millson's (2014b) treatment of *addressing* as an additional deontic attitude enhances our understanding of the second-personal character of speech acts. However, it is not completely free of problems. The most prominent problem is the lack of an account of the *conditions* of addressing. Since addressing is a deontic attitude towards others, the main contrast is with attributing: the former places a demand on the addressee to give recognition whilst the latter need not be recognized. In line with Brandom (1994), Millson proposes that the attribution of normative statuses to an agent is warranted directly or consequently by the speech acts performed by the agent. It is surprising, however, that Millson has said nothing about whether and how the addressing of normative statuses is warranted. From some loosely related discussion, Millson appears to endorse a view that addressing need not be warranted but is subject to the speaker's will:

> "We are not restricted to addressing [...] only those apokritic commitments to which the addressee is *entitled* to undertake [due to the possession of an answer]. If the responsible agent is lacking the authority to fulfill her duty, it is *her* failing, not the one who takes her to be responsible."
> (Millson, 2014b, 212)

This is very close to a *unidirectional* view of addressing: while speech acts can have a second-personal character, whether to realize it (i.e., whether to address a speech act) is entirely a personal issue. This view has been repeatedly criticized in the literature and is shown to be untenable for having ignored the role of *common ground* (i.e., a set of recognized shared propositions) (Stalnaker, 1978, 1998, 2002; Clark & Brennan, 1991) in constraining the possibility of addressing (Clark & Carlson, 1982; Krauss, 1987; Gibbs, Mueller, & Cox, 1988; Fussell & Krauss, 1989; Krauss & Fussell, 1990, 1991; Horton & Keysar, 1996). Consider first the conditions for the addressing of assertions:

(A1) If it is known that the addressee is committed to a proposition, there is no need to assert it to the addressee.

(12) You already know that Amadís defeated Dardán.
#Amadís defeated Dardán.

(A2) If it is known that the addressee does not want to talk about a proposition, there is no need to assert it to the addressee.

(13) You don't care if Amadís defeated Dardán.
#Amadís defeated Dardán.

(A1) is trivial: there is no need to assert a proposition if it is known to be part of the common ground (i.e., that both the speaker and the addressee are committed to it). (A1) is confirmed by the infelicity of the second sentence in (12). In the case of (A2), there are various reasons for one to have no interest in talking about a proposition, two of them being essential: (*i*) that one is unaware whether this proposition is true, or (*ii*) that one is not interested in the semantic content expressed in this proposition. (A2) is confirmed by the infelicity of the second sentence in (13). Let us now turn to questions. There are two similar conditions for the addressing of questions:

(E1) If it is known that the addressee is unaware of an answer to a question, there is no need to pose it to the addressee.

(14) You don't know which knight defeated Dardán.
#Which knight defeated Dardán?

(E2) If it is known that the addressee does not want talk about a question, there is no need to pose it to the addressee.

(15) You don't want to talk about which knight defeated Dardán. #Which knight defeated Dardán?

(E1) is trivial: there is no point to address a question to the interlocutor if it is known that the interlocutor is unaware of an answer to it. In the case of (E2), there are various reasons for one to show no interest in talking about a question, two of them being fundamental: (*i*) that one is unaware of an answer to the question, or (*ii*) that one is not interested at all in knowing an answer to the question. The two conditions for the addressing of questions are confimed respectively by the second sentences in examples (14) and (15).

On Antonsen's (2018) view, the Stalnakerian common ground can be seen as a constellation of mutually shared commitments (cf. Nickel (2013)). Combined with Antonsen's (2018) analysis, Millson's account of addressing *does* provide the resources to accommodate the above constraints: they can be checked *a priori* through the mutual scorekeeping of commitments between the speaker and the addressee. Nevertheless, (A1)-(A2) and (E1)-(E2) specify only the conditions that *preclude* the possibility of addressing a speech act but provide no explanation for how an address is *warranted*. The speaker's assumption about the addressee's commitments enters into the picture (Åqvist, 1965; Lakoff, 1972; Bellert, 1972; Hintikka, 1974; Wachowicz, 1978):

(H1) To address an assertion, one *assumes* that the addressee wants to talk about it and is not committed to it.[11]

(H2) To address a question, one *assumes* that the addressee wants to talk about it and is aware of an answer to it.

The above assumptions can be checked before addressing a speech act and thus can be easily captured by standard Brandomian socrekeeping model: as long as they are confirmed, the address of a speech act is warranted. In linguistic discourse, however, these assumptions need

[11] If one is not committed to a proposition, it is possible that one is committed to its negation or that one is committed to neither of them.

not be checked in advance: one might address a speech act, being unaware that it is infelicitous because the corresponding assumption is false. Consider the following example:

(16) a. **Lisuarte**: Which knight defeated Dardán?
b. **Oriana**: There $[\text{isn't}]_{\mathcal{F}}$ such a knight.

It is widely acknowledged that unary *which*-questions carry a uniqueness presupposition that there is a unique entity of the specified sort (Higginbotham & May, 1981; Dayal, 1996; Rullmann & Beck, 1998). For example, by raising (16a), Lisuarte is *prima facie* committed to the existence of a (unique) knight who defeated Dardán. But by addressing (16a) to Oriana, it is certain that Lisuarte is unaware that Oriana does not share this existential commitment. This implies that Lisuarte's address of (16a) to Oriana is unwarranted (cf. *vain questions* in terms of Driver (1988)): (16a) is addressed on the basis of the assumption that the interlocutor wants to talk about (16a) and is aware of an answer to (16a). However, notice that even the address of (16a) is unwarranted, we would normally not regard it as infelicitous in (16). The possibility of making unwarranted addresses signals that addressing differs from attributing not only in the (un)requirement of recognition but also in the fact that attributing is warranted whereas addressing need not be. It is unclear whether and in what way both warranted and unwarranted addresses can be systematically explained.

This section considers previous attempts to decipher the second-personal character of speech acts in human communication, aiming at answering the following question:

(Q1.2) What does a speech act express if it is addressed to specific audience and how it differs from a speech act that is not addressed to any audience?

It is shown that to achieve a comprehensive understanding of the rationale of speech act performance, an account of speech acts must take both the impersonal and the second-personal characters of speech acts into account. The route adopted in this dissertation is to extend Brandom's (1994)'s account of (impersonal) speech acts with an additional second-personal dimension. Millson's (2014b) proposal is shown to be more promising but it is shown to be incomplete due to the lack of an account for how the addressing of speech acts is warranted. Such an account will be developed in Chapter 6.

2.3 The Potential of Reacting

The performance of a speech act, as examined in the previous section represents only one side of human communication and the other side concerns the way to *react* to the performed speech act (if necessary). To ensure that the update with a reacting speech act is coherent with the preceding discourse, researchers appeal to the notion of *relevance* (Grice, 1975, 1989; Horn, 1984; Sperber & Wilson, 1986): in a nutshell, in a coherent discourse, the contribution of a speech act should be relevant to the goal of the discourse. In Grice's (1975) theory of conversation, for example, a speech act contributes to a discourse iff it complies with the cooperative principle, consisting of four maxims, the most important one probably being the *maxim of relevance*: make your contribution relevant. In Sperber and Wilson's (1986) relevance theory, the concept of *relevance* plays a more important role in organizing discourse: coherent discourse, or in general, human communication, is governed by two principles of relevance: (*i*) that "human cognition tends to be [geared to] the maximization of relevance" and (*ii*) that "every ostensive stimulus conveys a presumption of its own optimal relevance" (Wilson & Sperber, 2002, 610-612). The notion of relevance in these classics is terse and as Grice (1975) has admitted, "its formulation conceals a number of problems" (p.27) which are all difficult to deal with. Most of the subsequent works seek to concretize the opaque notion of relevance. Currently, there are two predominant (formal) approaches to this problem: the relation-based approach and the qud-based approach, first mentioned in Introduction.

The relation-based approach to relevance and discourse coherence, anticipated by Hobbs (1979), has its origins in Hume:

> "To me, there appear to be three principles of connection among ideas, namely, Resemblance, Contiguity in time or place, and Cause or Effect."
>
> (Hume, 2008, 16)

The fundamental assumption of the relation-based approach to discourse coherence is that in a coherent discourse, speech acts (or utterances) are connected by a series of *rhetorical relations* (also called *discourse relations*) (Thompson & Mann, 1987; Mann & Thompson, 1988; Taylor, 1994; Asher & Lascarides, 2003). The relevance of a speech act to a discourse is precisely characterized in terms of rhetorical relations: "the current utterance is relevant only if it is rhetorically connected to something in the context" (Asher & Lascarides, 2003, 20). To illustrate, consider the following examples:

(17) a. **Lisuarte**: Did Amadís defeat Dardán?
 b. **Oriana**: Yes.

(18) a. **Lisuarte**: Amadís defeated Dardán.
 b. **Oriana**: Yes.

On relation-based accounts, such as Asher and Lascarides (2003), Oriana's assertions in (17) and (18) are relevant to the discourse as they are connected to Lisuarte's speech acts by distinct rhetorical relations, concretely, *QAP* (*Question Answer Pair*) for (17) and *Acknowledgement* for (18) (in terms of Asher and Lascarides), respectively: (17b) provides an affirmative answer to Lisuarte's question whereas (18b) acknowledges that Lisuarte is right in uttering (18a). At a given point in a discourse, there could be many possible updates relevant to the discourse context. In Asher and Lascarides (2003), for example, the selection of a preferred update that can maximize discourse coherence is governed by a principle dubbed *maximize discourse coherence* (MDC): "maximizing coherence amounts to preferring discourse structures with the smallest number of nodes, the fewest semantic and pragmatic clashes, the largest number of rhetorical relations and the fewest number of underspecifications" (p.234). Consider (19):

(19) a. **Lisuarte**: Amadís defeated Dardán.
b. **Oriana**: He defeated [Patin]$_{\mathcal{F}}$ as well.

The rhetorical relations posited for (19) are *Background* and *Parallel* (in terms of Asher and Lascarides): (19a) provides background information for (19b), whereas (19b) adds parallel information to (19a). In (19b), the pronoun *he* might be anaphoric to Amadís or Dardán in Lisuarte's assertion. In order to maximize discourse coherence, MDC prefers the interpretation that *he* refers to Amadís instead of Dardán. This, on the one hand, maximizes the coherence between Lisuarte's and Oriana's assertions; on the other, helps to determine the exact rhetorical relations that connect Lisuarte's assertion to Oriana's.

The origins of the qud-based approach to discourse coherence are traced back to at least Collingwood and Wittgenstein:

> "Every statement [...] is made in answer to a question."
> (Collingwood, 1940, 23)

> "We might very well also write every statement in the form of a question followed by a *Yes*; for instance, *Is it raining? Yes* Would this show that every statement contained a question? Of course."
> (Wittgenstein, 1953, par.22)

Informally, a *question-under-discussion* (or *qud* in abbreviated fashion) is a question accepted by interlocutors as the immediate topic of discussion. The qud-based approach, anticipated by Carlson (1983), conceives linguistic discourse as functionally organized by question-answer pairs, although the relevant questions are not always explicitly given, but can be inferred based on available contextual information. The notion of *relevance* is defined as follows: a speech act is relevant to the current qud iff it is either a partial answer (if it is an assertion) or is part of a strategy to answer the current qud (if it is a question) (Roberts, 1996/2012, 21-22).[12] A question is a *strategy* to resolve another question iff the former is implied by the latter.[13] To illustrate, consider the following examples (repeated from (17) and (18)):

(20) a. **Lisuarte**: Did Amadís defeat Dardán?
b. **Oriana**: Yes.

(21) a. **Lisuarte**: Amadís defeat Dardán.
b. **Oriana**: Yes.

On Roberts's account, in the case that (20a) is accepted, it becomes the current qud for both interlocutors. (20b) is relevant to the context as it introduces an answer to the current qud. In (21), the addressing of (21a) introduces a question, requesting a response from Oriana on whether the asserted proposition is true or not. This is dubbed the *question-incrementation* effect of asserting in Ginzburg (2012). (21b) is relevant to the context as it answers the qud introduced by (21a).

In both relation- and qud-based approaches, relevance is a relationship between a speech act (or an utterance) and discourse context. This is both desired and undesired: it is desired because it takes into account available contextual information which is important for the interpretation of speech acts expressed in a discourse; it is undesired because if no additional contextual information is available, it might fail to capture the relevance between a speech act and its reaction. In

[12] A hybrid qud-based approach is proposed by Ginzburg (2012): "an utterance u is relevant to an information state I just in case there is a [series of conversational rules that] successfully update I with u" (p.292). In comparison with the (radical) qud-based approach introduced above (due to Roberts (1996/2012)), Ginzburg's approach is hybrid in the sense that qud-relations are no longer regarded as the only organizing principles of discourse; instead, Ginzburg defines a series of operators, rhetorical relations, and conversational rules that are useful in the maintenance of discourse coherence.

[13] The notion of *question implication* in Roberts (1996/2012) is inherited from Groenendijk and Stokhof (1984). The Robertsian notion of question implication corresponds to what Wiśniewski (2013) calls *pure erotetic implication*, which is a subtype of question implication. For more details, see Section 5.5 of Chapter 5.

this dissertation, as stated earlier, we focus on only *elementary one-turn dialogues* of the following generic setting:

$$\phi \oplus \psi$$

$\phi \oplus \psi$ is a coherent discourse just in case that ψ is relevant to ϕ. If one is addressed ϕ, there is a wide range of possibilities of reacting to ϕ_i. Call it the *potential of reactions* (cf. *discursive potential* in Ginzburg (1996a), *attachment possibilities* in Asher (2000), *space of responses* in Millson (2014a, 2014b)). To characterize the potential of reacting to ϕ amounts to the same as to define under what circumstances ψ is a relevant reaction to ϕ. On relation-based account, ψ is a relevant reaction iff ψ is connected to ϕ by certain rhetorical relation(s). To illustrate, consider the following example, repeated from (19):

(22) a. **Lisuarte**: Amadís defeated Dardán.
b. **Oriana**: He defeated $[\text{Patin}]_{\mathcal{F}}$ too.

In terms of rhetorical relations, (22b) is a relevant reaction to (22a) because they are connected by two rhetorical relations, namely, *Background* and *Parallel* (in terms of Asher and Lascarides (2003)). However, the positing of *Background* and *Parallel* does not give a proper characterization for why ψ can be uttered because they are obtained from post-hoc analyses. The relation-based approach inevitably encounters such a problem of circularity: a rhetorical relation abstracted from a coherent elementary one-turn dialogue $\phi \oplus \psi$ (and perhaps with the help of available contextual information) is later again applied to the explanation of why ψ counts as a relevant reaction to ϕ. Clearly, it is not the case that one reacts to ϕ with ψ with the purpose to satisfy a presumed rhetorical relation for ϕ and ψ; instead, the rhetorical relation is what one abstracts from a post-hoc analysis of $\phi \oplus \psi$ (see Section 2.4 for more related discussion).

Let us now consider how a qud-based approach, such as Roberts (1996/2012), accounts for the relevance of ψ to the context in $\phi \oplus \psi$. On Roberts's account, since ϕ is an initiating move, there is no specific qud hanging over ϕ but simply the Big Question. Given the way the notion of relevance is defined by Roberts, to determine whether ψ is relevant, one must first identify what amounts to the (potential) qud that ϕ elaborates on. There are two possibilities:

(a) The qud of ψ is introduced by ϕ.
(b) The qud of ψ is accommodated/inferred.

First of all, consider situation (a). Let ϕ denote a question, as long as ϕ is accepted, it becomes the current qud of this elementary one-turn dialogue. Then by Roberts' (1996/2012) definition of relevance, ψ is relevant to the qud introduced by ϕ iff ψ is either a partial answer to ϕ (if ψ is an assertion) or a question implied by ϕ (if ψ is a question). To illustrate, consider the following example: (23bi) is a partial answer to (23a) whereas (23bii) is a subquestion implied by (23a).

(23) a. **Lisuarte**: Who defeated Dardán?
b. **Oriana**: i. [Amadís]$_{\mathcal{F}}$ (defeated Dardán).
ii. Did [Amadís]$_{\mathcal{F}}$ defeat Dardán?

Consider situation (b): to account for the relevance of ψ to the context, one needs to resort to some implicit qud(s). Consider (24):

(24) a. **Lisuarte**: Amadís defeated Dardán.
b. **Oriana**: i. He didn't defeat [Galaor]$_{\mathcal{F}}$.
ii. Whom did [Galaor]$_{\mathcal{F}}$ defeat?

For Roberts (1996/2012), the current qud of a speech act is accommodated/inferred based on the fact that every speech act is *congruent* to the qud that it elaborates on (see Section 1.1.1 of Chapter 1 for an informal definition of congruence, due to Rooth (2016)):[14] the current qud of a speech act is obtained by replacing every $\mathcal{F}$-marked constituent by a wh-constituent of the same semantic type, and in the case

[14]The definition of congruence, in its current state, is shown to be inadequate for the analysis of linguistic discourse in Section 7.3 of Chapter 7.

that a speech act does not contain any $\mathcal{F}$-marked constituents, then the current qud is simply the Big Question. Accordingly, the current quds for (24bi) and (24bii) are respectively (25a) and (25b):

(25) a. Whom did Amadís defeat?
 b. Who did whom defeat?

Let us now go back to the generic setting $\phi \oplus \psi$. The mere inference of a qud (i.e., the current qud) for ψ does not suffice to characterize the relevance of ψ to the discourse context, because it does not give an explanation for why ψ is a relevant reaction to ϕ but not to any other speech act. This implies that in order to account for the relevance of ψ to the discourse context in an elementary one-turn dialogue $\phi \oplus \psi$, one is supposed to find a proper way to build a more *direct* link between ϕ and ψ. This gives rise to the following hypothesis:

> **Relevance via Qud-Bridging (RQB)**
> In an elementary one-turn dialogue $\phi \oplus \psi$ where ϕ or ψ is either an assertion or a question, ψ is a relevant reaction to ϕ iff there is a proper bridging qud for ϕ and ψ.

The notion of *qud-bridging* will be defined later in a precise way. For current purposes, it is sufficient to give an informal definition: a question can serve as a bridging qud for ϕ and ψ iff ϕ and ψ are both elaborations on this question, that is, ϕ/ψ either introduces at least a partial answer to this question (if ϕ/ψ is an assertion), or ϕ/ψ is implied by this question (if ϕ/ψ is a question). RQB appears to work well for example (24): for (24a-24bi), a bridging qud might be (25a) such that both (24a) and (24bi) are partial answers to (25a); in contrast, for (24a-24bii), a bridging qud might be (25b) such that (24a) partially answers (25b) and (24bii) is a subquestion of (25b). However, notice that according to Roberts (1996/2012), the Big Question implies every question and is partially answered by every assertion. This implies that the Big Question can function as a bridging qud for any two speech acts, and as a consequence, every two speech acts are wrongly predicted to be relevant reactions to each other. This is clearly undesired. For this reason, in RQB, we further require that the inferred bridging qud for an elementary one-turn dialogue must be *proper*. To maintain RQB, one is supposed to specify what amounts to a proper bridging qud for an elementary one-turn dialogue.

There is a widespread view, tracing back to at least Duke (1974), that a linguistic discourse, whether dialogical or not, is reducible to a sequence of elementary one-turn dialogues. Under this assumption, in order to explain the coherence between speech acts (or utterances) in a linguistic discourse, one is first and foremost supposed to account for the potential of reacting to a speech act in an elementary one-turn dialogue. This leads to the following research question:

(Q2) How can the relevance of a reaction to a speech act in an elementary one-turn dialogue be properly characterized?

The hypothesis proposed for (Q2) is exactly the qud-based RQB hypothesis. Consequently, to answer (Q2), from our point of view, is to answer the following refined research question:

(Q2') Is it possible to define the relevance of a reaction to a speech act in an elementary one-turn dialogue in terms of the existence of a proper bridging qud for the two concerned speech acts?

RQB will be tested in Part III of this dissertation. To anticipate the analysis, it will be shown in Part III that RQB provides a simpler and more powerful definition of relevance, which is useful in characterizing the potential of reacting in elementary one-turn dialogues.

2.4 Emerging Rhetorical Relations

The relationship between a speech act and its reactions is extensively discussed in the literature of discourse analysis, in particular, in studies of the rhetorical structure of discourse (Mann & Thompson, 1988;

Taylor, 1994; Asher & Lascarides, 2003). Among studies of this type, Asher and Lascarides (2003) is a milestone, in which the influential *segmented discourse representation theory* (SDRT, henceforth) is put forward. The working mechanism of SDRT is briefly summarized as follows (see an extended summary in Schlangen (2015)):

(*a*) A discourse is segmented into a series of elementary discourse units (EDUs), each containing at least one eventuality description (and often only one). Complex discourse units (CDUs) are built out of a series of EDUs, organized by rhetorical relations.

(*b*) A series of non-logical axioms are posited for inferring rhetorical relations. They form part of glue logic which allows one to glue new discourse units, together with certain rhetorical relations, to discourse units already given in the discourse context.

In all of the examples considered so far, every elementary speech act can be seen as an EDU, and the whole elementary one-turn dialogue constitutes a CDU. In such a CDU, the reacting speech act is related to the preceding speech act by a rhetorical relation (and usually only one). To illustrate, consider the following example:

(26) a. **Lisuarte**: Amadís defeated Dardán.
b. **Oriana**: Then he returned to London.

In SDRT, (26b) is connected to (26a) via a rhetorical relation dubbed *Narration*, defined as follows, where α and β are two discourse units, λ labels the attachment site (Asher & Lascarides, 2003, 473):[15]

(27) $(?(\alpha, \beta, \lambda) \wedge \textit{and-then}(\alpha, \beta)) > \textit{Narration}(\alpha, \beta, \lambda)$.

The defining axiom for *Narration* stipulates that if β is to be attached to α and this attachment point is labeled by λ, and there is a temporal order between α and β such that $\textit{and-then}(\alpha, \beta)$, then normally $\textit{Narration}(\alpha, \beta, \lambda)$ holds (Asher & Lascarides, 2003, 202).

[15] For a complete definition of *Narration*, see Asher and Lascarides (2003, 462).

The analysis provided by SDRT for discourse coherence is by and large elegant and successful. However, as pointed out in the previous section, it encounters a problem of circularity: in a dialogue such as (26), *Narration* emerges as a *result* from addressing and reacting to Lisuarte's assertion and it is inappropriate to (re)use this *result* to explain the relevance between Lisuarte's assertion and Oriana's reaction. This is clearly reflected in the working mechanism of SDRT (see (*b*)): the rhetorical relation connecting two discourse units is inferable only if the two discourse units are already given. The glue-logic axiom given above for *Narration* only works when both discourse units α and β are (at least partially) known.[16] The rhetorical relation is therefore abstracted away from a post-hoc analysis. For this reason, rhetorical relations in SDRT are useful for the description of the connection between speech acts and their reactions, but it is unlikely that one can offer a proper characterization of the potential of reacting in terms of (only) rhetorical relations. The qud-based approach, pioneered by Roberts (1996/2012), van Kuppevelt (1995a) and Ginzburg (1996b), provides an alternative, which views a coherent discourse as underlain by a hierarchy of question-answer pairs and question-subquestion pairs arranged in a tree structure (dubbed *qud-tree*, to be defined in Section 7.4 of Chapter 7). Though the qud-based tree structure for a discourse is also obtained from a post-hoc analysis, it presents a more attractive idea that one can reduce a complex discourse to only two primitive qud-relations (i.e., question resolution and question implication), rather than to a bundle of complex rhetorical relations. Now that both relation- and qud-based approaches are intended to model discourse coherence, it is natural to wonder whether it is possible to define a mapping between the two approaches, or more concretely, between rhetorical relations and qud-relations. In its early days, it is not a goal–at least not explicitly stated–of qud-based approaches to discourse to (re)analyze rhetorical relations in terms of qud-relations.[17]

[16] Asher and Lascarides (2003) allow the semantic representations of discourse units to be at least partially unspecified. For more discussion, see Irmer (2011).

[17] Ginzburg (2012) makes use of both qud and rhetorical relations in his the-

Recent years, however, this idea has drawn more and more attention from researchers (Jasinskaja, 2006; Clifton & Frazier, 2012; Onea, 2013, 2019; Hunter & Abrusán, 2015; Benz & Jasinskaja, 2017; Riester, 2019; Hesse, Benz, Langner, Theodor, & Klabunde, 2020; Hesse, Langner, Benz, & Klabunde, 2021; Riester, Canes, & Hoek, 2021).

Hunter and Abrusán's (2015) discussion on the possibility of relating relation- and qud-based models is most inspiring from our perspective. The following two hypotheses are considered:[18]

(28) a. **Relation-Qud Correspondence** (**RQC**):
Let π_i and π_j be two discourse units, if π_j is attached to π_i via a rhetorical relation $\mathfrak{R}$, there is a question $\mathsf{q}(\pi_i)$ that π_i raises and that π_j at least partially answers.

b. **CDU-Qud Correspondence** (**CQC**):
Every CDU π_i fully answers a question qud_i.

The two hypotheses are carefully examined in Hunter and Abrusán (2015). The first is strongly rejected whereas the second is shown by the authors to be more promising.

To start with, let us consider RQC. RQC is strongly rejected by Hunter and Abrusán because it leads to both information loss and the abandonment of basic principles of qud-based theories. To illustrate, consider (29) adapted from Hunter and Abrusán (2015, 48):

(29) a. [Sam is being punished]$_{\pi_1}$. [She took her parents' car without permission]$_{\pi_2}$, [so they've grounded her for 2 weeks]$_{\pi_3}$.

b. *Explanation*(π_1, π_2),
Result(π_2, π_3),
Elaboration(π_1, π_3).

---

ory of discourse (see Ginzburg (2012, 57-58)). Roberts (1996/2012) also predicts that relation- and qud-based approaches are compatible with each other and the understanding of how they work together gives us an elaborate pragmatic theory.

[18] The formulation of Hunter and Abrusán's (2015) two hypotheses are slightly modified to adapt to the notations used in this dissertation.

The rhetorical relations between the EDUs in (29a) are presented in (29b). Since π_2 explains π_1, it answers *Why is Sam being punished?*$_{q(\pi_1)}$ raised by π_1; in the meantime, since π_3 is a result of π_2, π_3 answers *What happened then as a result?*$_{q(\pi_2)}$ raised by π_2. SDRT construes π_3 as an elaboration of π_1. In this case, π_3 answers *How is Sam being punished?*$_{q(\pi_3)}$. It is unclear how the three quds mentioned above should be ordered. The different orderings of the three quds make a significant impact on the structure and interpretation of (29). But RQC makes no prediction about what amounts to a correct ordering of the three quds. Consequently, there is a loss of information.[19]

Besides information loss, the adoption of RQC forces one to abandon certain important principles of the qud-based approach. In Roberts' (1996/2012) qud-model of discourse, *subquestion relation* (or more generally, *question implication*) is important because it keeps a conversation on topic by splitting a qud into a series of subquds. However, RQC excludes the possibility of quds being ordered by implicational relations. To illustrate, consider the following example, adapated from Hunter and Abrusán (2015, 48):

(30) a. [We had so much fun in London]$_{\pi_1}$! [We got to see the Lion King]$_{\pi_2}$! [I've been wanting to go for a really long time]$_{\pi_3}$ and [my mom finally gave me tickets for my birthday]$_{\pi_4}$! [We also got to ride on the big Ferris wheel]$_{\pi_5}$...

b. *Elaboration*(π_1, π_2),
Background$(\pi_2, [\pi_3, \pi_4])$,
Continuation(π_3, π_4),
Elaboration(π_1, π_5),
Continuation(π_2, π_5).

The rhetorical relations between the discourse units in (30a) are given in (30b). π_2 and π_5 are both elaborations of π_1. The qud that π_1 raises

[19] The problem with the analysis of (29) shows that in order to predict a proper ordering of different utterances in (29), RQC is supposed to be further amended. If such amendments are not available, Hunter and Abrusán (2015) are right in claiming that the implementation of RQC leads to a loss of information.

and that π_2 and π_5 answer could be *What did you do?*$_{\mathsf{q}(\pi_1)}$. The qud raised by π_2 for $[\pi_3, \pi_4]$ could be *What makes that so exciting?*$_{\mathsf{q}(\pi_2)}$. Since $\mathsf{q}(\pi_2)$ is more discourse-recent, it is on top of $\mathsf{q}(\pi_1)$. The fact that π_5 elaborates on π_1 shows that $\mathsf{q}(\pi_1)$ is not fully answered when π_3 and π_4 are uttered. However, notice that in this case, $\mathsf{q}(\pi_2)$ is not a subquestion of $\mathsf{q}(\pi_1)$. This indicates that the set of quds for (30a) is not ordered by implications between questions.[20]

The second hypothesis CQC is demonstrated to be more promising in Hunter and Abrusán (2015) and is further developed in Riester (2019). To show how CQC relates SDRT and the qud-based approach, let us consider (31), taken from Hunter and Abrusán (2015, 62):

(31) a. [John had a great evening]$_{\pi_1}$. [He had a great meal]$_{\pi_2}$. [He ate salmon]$_{\pi_3}$. [He devoured lots of cheese]$_{\pi_4}$. [Then he won a dancing competition]$_{\pi_5}$.

b. *Elaboration*(π_1,[π_2,π_5]),
Elaboration(π_2,[π_3,π_4]),
Narration(π_2,π_5),
Narration(π_3,π_4).

The rhetorical relations between the discourse units in (31a) are presented in (31b). From the first two rhetorical relations, CQC yields the following quds for two CDUs: *What did John do in the evening?* ($\mathsf{qud}(\pi_1)$) for [π_2,π_5] and *What did he eat?* ($\mathsf{qud}(\pi_2)$) for [π_3,π_4]. If the whole discourse is treated as a CDU π_i, the qud that π_i answers could be *What was John's evening like?* (qud_i). The implicational relationship between questions is preserved in this example: an assertion that fully answers qud_i answers $\mathsf{qud}(\pi_1)$ and an assertion that fully answers $\mathsf{qud}(\pi_1)$ fully answers $\mathsf{qud}(\pi_2)$ as well.

[20] The problem that inferred quds for discourse units are not ordered by implications between questions *is* a problem if one strictly follows Roberts' (1996/2012) qud-based approach to discourse. However, it need not be a problem for some other qud-based approaches such as Larsson (2002) and Ginzburg (2012), which allow a more flexible mechanism of the management of (pending) quds in a discourse. Thanks for my supervisor Enric Vallduví for pointing out this to me.

Hunter and Abrusán's (2015) analysis of example (31) by appealing to CQC is in general attractive. However, it is worthwhile noticing that in the analysis of almost all of the examples–cited or not in this section–considered by Hunter and Abrusán, the authors *seem* to endorse a view that apart from the very initiating move π_1, to explain $\mathfrak{R}(\pi_i, \pi_j)$ in terms of qud-relations, the qud that π_j answers must be raised by π_i. This is possible but it is problematic in some cases. To illustrate, consider the following example:

(32) a. **Lisuarte**: Amadís defeated Dardán.
  b. **Oriana**: He didn't defeat $[\text{Galaor}]_{\mathcal{F}}$.

According to Asher and Lascarides (2003), (32a) and (32b) are connected by two rhetorical relations, namely, *Background* and *Parallel*: (32a) provides background information for (32b) whereas (32b) adds parallel information to (32a). Following Hunter and Abrusán's (2015) analysis, one expects that in both *Background* and *Contrast* relations, (32a) raises a qud that (32b) answers. However, for either *Background* or *Contrast*, we find it difficult to pose such a qud that (32a) raises and that (32b) answers. The qud that (32b) is congruent to, as mentioned earlier in our analysis for example (24), is *Whom did Amadís defeat?*. However, this qud is not raised but is partially resolved by (32a).

Inspired by Hunter and Abrusán's (2015) second hypothesis CQC, a possible route to solve the abovementioned problem is to propose a higher-level bridging qud such as *Who did Amadís defeat?* for (32). In Hunter and Abrusán's analysis of (31), they also introduce a bridging qud: conceiving the whole discourse in (31) as a CDU π_i, it answers a bridging qud, namely, qud_i. The status of the bridging qud in (31), however, is quite different from that in (32): in (31), even if the bridging qud is not posited, for every discourse unit except the initial one, there is a qud raised by the preceding discourse unit; in contrast, in the case of (32), if the bridging qud is not introduced, neither of the two EDUs in (32) has a qud. Interestingly, by introducing a bridging qud in the analysis of (32), a complete CDU appears and the possibility of analyzing it in terms of qud-relations also confirms Hunter and Abrusán's CQC. The necessity of introducing a bridging qud in the analysis of (32) indicates that some rhetorical relations do not merely connect two discourse units, but allude to some implicit discourse units which are necessary for the construal of the concerned rhetorical relations. It also suggests that the inference of *Background* and *Contrast* in (32) is not solely based on the two given EDUs but resorts to an inferred bridging qud.[21] If this also generalizes to other rhetorical relations, then we expect that every rhetorical relation is abstracted from a CDU, which often contains only two discourse units but can also contain additional implicit discourse units in some cases (as shown in example (32)). Since a CDU, as demonstrated by Hunter and Abrusán, answers a question, it is reasonable to surmise that the emergence of a rhetorical relation between two discourses units has an underpinning qud-driven layer, or more radically, that every rhetorical relation can be reduced to a family of qud-relations:

> **Relation-to-Qud Hypothesis** (**RQH**)
> A rhetorical relation is reducible to a family of qud-relations.

It is clear from the above analysis that RQH generalizes CQC. Indeed, RQH is more attractive than CQC because it opens the possibility of unifying both relation- and qud-based approaches to discourse.

Elementary one-turn dialogues provide a good testing ground for RQH. Let $\phi \oplus \psi$ denote an elementary one-turn dialogue, SDRT predicts that ϕ and ψ are connected by at least one rhetorical relation $\mathfrak{R}$. Putting it in another way, $\mathfrak{R}$ can be considered as emerging from addressing and reacting to ϕ in $\phi \oplus \psi$. Under this view, to reduce $\mathfrak{R}$ to

[21] The necessity of resorting to a bridging qud/topic/theme in the inference of some rhetorical relations such as *Background*, *Contrast* and *Parallel* is also endorsed in Asher and Lascarides (2003), according to which, to infer such rhetorical relations between two discourse units, there must exist a *discourse topic* (for *Background*), *contrasting theme* (for *Contrast*) or *common theme* (for *Parallel*) between them. For *Backgound*, Asher and Lascarides argue that such a discourse topic must be salient from available contextual information or world knowledge. For *Contrast* and *Parallel*, they advocate that the contrasting or common theme is obtained on the basis of the partial isomorphism between two discourse units.

a family of qud-relations amounts to the same as to characterize the relevance of ψ to ϕ in terms of qud-relations. The latter is exactly the goal of the RQB hypothesis proposed in the previous section. Therefore, if RQB is sound, then RQH is predicted to hold at least for elementary one-turn dialogues. This leads to the following question:

(Q3) Under the view that rhetorical relations emerge from addressing and reacting to speech acts in elementary one-turn dialogues, is it possible to reduce rhetorical relations that occur in elementary one-turn dialogues to qud-relations?

(Q3) is examined in Part IV of this dissertation. Under RQH, the answer to this research question is positive. To anticipate the analysis, it will be shown that every rhetorical relation that occurs in an elementary one-turn dialogue is reducible to a family of qud-relations and moreover, some important characterizing properties of rhetorical relations can be more directly and intuitively interpreted when these rhetorical relations are reduced to qud-relations.

2.5 Summary

In this chapter, we have considered a series of linguistic phenomena that are related to a particular type of discourse, i.e., elementary one-turn dialogues. The examination has led us to put forward three research questions, which are to be tackled in the course of this study:

(Q1) What does one express by performing a speech act and how is the performance of a speech act warranted?

- (Q1.1) What does a speech act express if it is not meant to be addressed to any audience and what entitles one to perform such a speech act?
- (Q1.2) What does a speech act express if it is addressed to specific audience and how it differs from a speech act that is not addressed to any audience?

(Q2) How can the relevance of a reaction to a speech act in an elementary one-turn dialogue be properly characterized? Is it possible to define the relevance of a reaction to a speech act in an elementary one-turn dialogue in terms of the existence of a proper bridging qud for the two concerned speech acts?

(Q3) Under the view that rhetorical relations emerge from addressing and reacting to speech acts in elementary one-turn dialogues, is it possible to reduce rhetorical relations that occur in elementary one-turn dialogues to qud-relations?

For (Q1), no specific hypothesis is introduced. The general conviction is that a successful account of speech acts must take both the impersonal and the second-personal characters of speech acts into account. This idea will be explored in detail in Part II. For (Q2), we propose that the relevance of a reaction to a speech act in an elementary one-turn dialogue can be characterized in terms of the possibility of inferring a proper bridging qud for the two concerned speech acts. This hypothesis, called *relevance via qud-bridging* (RQB), is to be examined in Part III. For (Q3), we point out that to reduce a rhetorical relation that connects two speech acts that form a coherent elementary one-turn dialogue amounts to the same as to characterize to the relevance between the two speech acts in terms of qud-relations. Therefore, as long as RQB is shown to be sound, we predict that rhetorical relations that occur in elementary one-turn dialogues can be reduced to qud-relations. This hypothesis, which forms part of the more general *relation-to-qud hypothesis* (RQH), is to be empirically tested in Part IV of this dissertation.

Chapter 3

Type-Theoretical Framework

This chapter introduces the type-theoretical framework–a variant of Martin-Löf's (1984) type theory–adopted in this dissertation.

This chapter consists of six sections: Section 3.1 introduces basic concepts in type theory; Section 3.2 defines useful types; Section 3.3 considers subtyping relations; Section 3.4 shows how classical logic is embedded in type theory; Section 3.5 adapts type theory for linguistic semantics; Section 3.6 offers some concluding remarks. The reader is referred to Appendix A for more technical details.

3.1 Basic Concepts

As a formal system, type theory consists of a series of formal expressions that fall under various syntactic categories. This section offers a brief introduction to the main syntactic categories in type theory.

3.1.1 Types and terms

Types represent concepts. *Terms* are instances of types: for example, *Amadís* is classified a term/instance of *knight* (modeled as a type). A term is either a *constant* or a *variable*: for example, *Amadís* is clearly a constant term of *knight*, but it is also possible that one talks about some x (a variable term) that is a *knight*.

A type whose terms are themselves types is called a (*typing*) *universe*. In type theory, there is a hierarchical chain of universes:

$$\mathsf{U}_0, \mathsf{U}_1, ..., \mathsf{U}_i, ...$$

Each universe is contained in a higher one but not in itself; otherwise, a type-level version of Russell's paradox, discovered by Girard (1971), appears. For convenience, we write U to denote a generic universe.

3.1.2 Judgments and contexts

The fundamental unit in type theory is a (*typing*) *judgment*

$$\Gamma \vdash a : A, \qquad (*)$$

where $\vdash$ a symbol for *consequence* or *derivability*, and the judgment as a whole reads as: a is a term of type A under context Γ.

To start with, let us consider the right side of $\vdash$ in $(*)$:

$$a : A.$$

This is called a context-free judgment. If $a : A$ is correctly made, A is said to be *inhabited* (by a). If a occurs in other judgments, we write a :: A to annotate the type A of a (Tanaka, Mineshima, & Bekki, 2017). If A is inhabited but the inhabitant is not given, we write A true or use $@_i$ :: A to denote the underspecified inhabitant of type A (Bekki, 2014). There are four basic kinds of context-free judgments in type theory (see Nordström et al. (1990) for more details):

$$A : \mathsf{U}, \qquad A = B : \mathsf{U}, \qquad a : A, \qquad a = b : A.$$

The first two declare respectively that (*i*) A is a type and that (*ii*) A and B are equal types. The latter two state respectively that (*i*) a is a term of A and that (*ii*) a and b are equal terms of A.

Let us now turn to the left side of $\vdash$ in $(*)$:

$$\Gamma,$$

which intuitively denotes a context, i.e., a sequence of *assumptions* required for judging that a is a term of type A:

$$\Gamma = \langle x_1 : C_1, ..., x_n : C_n \rangle : \mathsf{ctx},$$

where $i, n : \mathbb{N}^+$ and $1 \leq i \leq n$. $\langle x_1 : C_1, ..., x_n : C_n \rangle$ is occasionally abbreviated as $\langle \overrightarrow{x_i} : \overrightarrow{C_i} \rangle$. If Γ is empty, we notate it as $\langle - \rangle$.

3.2 Type Formers

This section introduces a series of types and their formers. The formal rules for type formers are given in Section B of Appendix A.

3.2.1 Function types

Given $A : \mathsf{U}$ and $B : A \to \mathsf{U}$, there is a *dependent function type* $\Pi x : A. B(x)$, whose terms are functions from A to $B(x)$ (for $x : A$):

$$\Pi x : A.B(x) : \mathsf{U}, \qquad (\lambda x)b(x) : \Pi x : A.B(x).$$

Let $f : \Pi x : A.B(x)$ and $a : A$, we shall define an elimination operator app such that $\mathsf{app}(f, a) : B$, where $\mathsf{app}((\lambda x)b(x), a) = b(a/x)$.

Let $B : A \to \mathsf{U}$ be a constant function (i.e., $B : \mathsf{U}$), $\Pi x : A.B(x)$ degenerates into an ordinary *function type* $A \to B$:

$$A \to B : \mathsf{U}, \qquad (\lambda x)b(x) : A \to B.$$

app also applies to $A \to B$: let $f : A \to B$ and $a : A$, then $\mathsf{app}(f, a) : B$ where $\mathsf{app}((\lambda x)b(x), a) = b(a)$. $\neg A$ is defined as $A \to \mathbf{0}$.

If A follows from B, then $A \to B$ is also inhabited. This is called *deduction theorem* in traditional logic:

$$\text{If } \langle x : A \rangle \vdash B \ \mathsf{true}, \text{ then } \vdash A \to B \ \mathsf{true}. \qquad (\text{DT})$$

The converse of deduction theorem also holds.

3.2.2 Product types

Given $A:\mathsf{U}$ and $B:A\to\mathsf{U}$, there is a *dependent product type* $\Sigma x : A. B(x)$, whose terms are pairs (a,b) such that $a : A$ and $b : B(a)$.

$$\Sigma x : A.B(x) : \mathsf{U}, \qquad (a,b) : \Sigma x : A.B(x).$$

Let $c : \Sigma x : A.B(x)$ and $c = (a,b)$, we shall define two elimination operators π_l and π_r (called *left* and *right projections*) such that $\pi_l(c) : A$ and $\pi_r(c) : B(\pi_l(c))$, where $\pi_l((a,b)) = a$ and $\pi_r((a,b)) = b$.

Let $B : A \to \mathsf{U}$ be a constant function (i.e., $B : \mathsf{U}$), $\Sigma x : A.B(x)$ degenerates into an ordinary *product type* $A \times B$:

$$A \times B : \mathsf{U}, \qquad (a,b) : A \times B.$$

The two elimination operators π_l and π_r defined above also apply to the product type $A\times B$: let $c : A\times B$ and $c = (a,b)$, we have $\pi_l(c) : A$ and $\pi_r(c) : B$, where $\pi_l((a,b)) = a$ and $\pi_r((a,b)) = b$.

3.2.3 Other types

Finite types

Finite sets are represented as finite types. Given a finite set A, there is a corresponding finite type whose terms are members of set A:

$$A : \mathsf{U}, \qquad a : A.$$

There are two special finite types: *unit type* $\mathbf{1}$ (corresponding to $\top$ in logic), that is inhabited by default, and *void type* $\mathbf{0}$ (corresponding to $\bot$ in logic), that is never inhabited.

Sum types

Given $A, B : \mathsf{U}$, there is a *sum type* $A + B$ whose terms are obtained from either a term $a : A$ or alternatively a term $b : B$:

$$A + B : \mathsf{U}, \qquad \iota_l(a) : A + B, \qquad \iota_r(b) : A + B.$$

If both A and B imply C and given $p : A + B$, then no matter p is obtained from a term of either A or B, there is always a proof of C.

$A + B$ is convertible to a logically equivalent dependent product type $\Sigma x{:}\{A, B\}.\tau(x)$, where τ is an identity function such that

$$\tau(T) = T \textit{ for } T : \mathsf{U}.$$

Identity types

Given $A : \mathsf{U}$, if $a, b : A$, then we obtain an *identity type* $a =_A b$, whose term $\mathsf{id}(a)$ is obtained whenever $a = b : A$ holds constructively.

$$a =_A b : \mathsf{U}, \qquad \mathsf{id}(a) : a =_A b.$$

Provided $p : a =_A b$ and $f : A \to C(x, y, z)$ (where $z : x =_A y$), we shall define κ such that $\kappa(f, p) : C(a, b, p)$ and $\kappa(f, \mathsf{id}(a)) = f(a)$.

Replacing b in $a =_A b$ by a, we obtain a membership type $a =_A a$, conveniently written as $a \triangleright A$, inhabited by $\mathsf{id}(a)$:

$$a \triangleright A : \mathsf{U}, \qquad \mathsf{id}(a) : a \triangleright A.$$

Membership types are a special kind of identity types.

3.3 Coercive Subtyping

Subtyping is a semantic relation that relates a datatype called *subtype* to another datatype called *supertype* via some notion of substitutability. In this dissertation, following Luo, Soloviev, and Xue (2013), we conceive subtyping as an abbreviation mechanism: A is a proper subtype of B, written as $A \prec_c B$ iff there is a unique coercion $c : A \to B$ such that for $a : A$ and $f : B \to C$, $f(a) = f(c(b)) : C$. For notational convenience, we adopt the following abbreviations:

- $A \subset B$ denotes "$A \prec_c B : \mathsf{U}$ where $c : A \to B$";
- $A \subseteq B$ denotes "$A \prec_c B : \mathsf{U}$ or $A = B : \mathsf{U}$".

3.3.1 Subset types

The terms of $A : \mathsf{U}$ that satisfy $P : A \to B$ form a dependent product type $\Sigma x : A.P(x)$. However, it is inconvenient to use $\Sigma x : A.P(x)$ to denote a subset: in set theory, a term of a subset of A is a term of A, but in type theory, a term of $\Sigma x : A.P(x)$ is a pair (a, p) and to get a, one applies π_l such that $\pi_l((a, p)) = a : A$. To avoid the inconvenience, by appealing to coercive subtyping, we introduce a new definition of subset type: the terms of A that satisfy P form a subset type

$$\{A|P\} : \mathsf{U},$$

such that $\{A|P\}$ satisfies the following two requirements:

(*a*) $\{A|P\} \subseteq A$ and $\Pi x : \{A|P\}.P(x)$.

(*b*) There is a unique bijective coercion c that satisfies: $c : \{A|P\} \to \Sigma x : A.\ P(x)$ and $c^{-1} : \Sigma x : A.P(x) \to \{A|P\}$.[1]

The first rule requires that $\{A|P\}$ be a subtype of A and every term x of $\{A|P\}$ satisfies $P(x)$ (where $x : \{A|P\}$). The second rule requires that there be a one-to-one bijective mapping from $\{A|P\}$ to $\Sigma x : A.\ P(x)$ such that a term of $\Sigma x : A.P(x)$ (or $\{A|P\}$) can be used whenever a term of $\{A|P\}$ (or $\Sigma x : A.P(x)$, respectively) is required.

3.4 Logic in Type Theory

Logic is formalized in type theory under the so-called Curry-Howard isomorphism: propositions are viewed as types, whose terms are proofs of corresponding propositions (Curry & Feys, 1958; Howard, 1980). This section provides a proper formalization of propositions and shows how classical logic is embedded in type theory.

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[1] Let f denote a function, f^{-1} denotes the *inverse* of f such that f^{-1} satisfies the following: $f^{-1}(f(x)) = x$ and $f(f^{-1}(x)) = x$.

3.4.1 Relevant properties

Before we consider how classical logic can be embedded in type theory, we introduce three relevant properties. The first property is called *proof-irrelevance*: a type A is proof-irrelevant iff the information contained in the terms of A is irrelevant to the inhabitedness of A. Formally, this is captured by the following definition:

$$\mathcal{I}(A) := \Pi x, y : A. x =_A y.$$

The second property is called $\neg\neg$-*stability* or simply *stability* henceforth: a type A is stable iff a proof of $\neg\neg A$ returns a proof of A.

$$\mathcal{S}(A) := \neg\neg A \to A.$$

The third property is called *decidability*. Roughly, a type A is decidable iff there exists a constructive proof of A or $\neg A$:

$$\mathcal{D}(A) := A + \neg A.$$

3.4.2 Embedding classical logic

The internal logic of type theory is proof-relevant constructive logic: it is *proof-relevant* in the sense that propositions are directly identified with types such that a proposition might have various different proofs; it is *constructive* in the sense that both $\neg\neg$-stability and decidability are not valid properties for propositions. This, however, is unwanted for the analysis of linguistic propositions. To a first approximation, let us consider the following two examples:

(1) a. Someone defeated Dardán.
    b. It is not the case that no one defeated Dardán.

In a constructive setting, a proof for (1a) consists of two parts: a specific human individual a, and a proof b that justifies the proposition that a defeated Dardán. However, notice that to establish the truth of (1a), one does not care which human individual defeated Dardán, nor does one care how this claim is proved. This signals that linguistic propositions are *proof-irrelevant*. Turn to (1b), the double negated form of (1a). Cooper and Ginzburg (2011) observe that in linguistic discourse, one tends to conceive (1b) as truth-functionally equivalent to (1a). This amounts to saying that linguistic propositions are stable. To recover proof-irrelevance and stability in type theory amounts to the same as to recover classical logic, which has long been considered as more appropriate for the analysis of linguistic propositions.

To recover classical logic in type theory, we propose to represent classical propositions by stable proof-irrelevant types. The property of being stable and proof-irrelevant is written as isProp, and the universe of stable proof-irrelevant types is written as Prop.

$$\mathsf{isProp}(A) := \mathcal{I}(A) \times \mathcal{S}(A), \qquad \mathsf{Prop} := \{\mathsf{U}|\mathsf{isProp}\}.$$

Every type A can have a stable proof-irrelevant counterpart, written as $\mathcal{P}(A)$, where P is a composition of two relevant operations: *double negation* ($\neg\neg$-) and *truncation* ($||$-$||$) (Awodey & Bauer, 2004; Univalent Foundations Program, 2013; Luo, 2019). $\neg\neg$ converts a type into a stable one and $||$-$||$ converts a type into a proof-irrelevant one.

$$\mathcal{P}(A) := \neg\neg||A||.$$

Under the identification of propositions as stable proof-irrelevant types, classical logic is successfully recovered, as shown in Figure 3.1.[2] $\mathcal{P}$ is applied to only disjunction, existential quantification, and identity because they do not preserve the property of being stable proof-irrelevant. The stable proof-irrelevant counterpart of $\mathcal{D}(A)$ is written as $\widetilde{\mathcal{D}}(A)$, defined as follows (where $\pm A$ abbreviates $\{A, \neg A\}$):

$$\widetilde{\mathcal{D}}(A) := \exists x : \pm A.\tau(x).$$

[2]Since $||$-$||$ returns a traditional intuitionistic proposition, there is no essential difference between the translation method provided here and the Gödel-Gentzen's double-negation translation (Gödel, 1933; Gentzen, 1936). For more related discussion about double-negation translation, see Ferreira and Oliva (2012).

Propositions		Types	Notations
$A \wedge B$	:=	$A \times B$	$A, B : \mathsf{Prop}$
$A \vee B$	:=	$\mathcal{P}(A + B)$	$A, B : \mathsf{Prop}$
$A \to B$	:=	$A \to B$	$A, B : \mathsf{Prop}$
$\neg A$	:=	$A \to \mathbf{0}$ or $\neg A$	$A : \mathsf{Prop}$
$\forall x : A.B(x)$	:=	$\Pi x : A.B(x)$	$A : \mathsf{U}$ and $B : A \to \mathsf{Prop}$
$\exists x : A.B(x)$	:=	$\mathcal{P}(\Sigma x : A.B(x))$	$A : \mathsf{U}$ and $B : A \to \mathsf{Prop}$
$a = b \in A$	:=	$\mathcal{P}(a =_A b)$	$A : \mathsf{U}$ and $a, b : A$

Table 3.1: Propositions as proof-irrelevant stable types

3.5 Linguistic Semantics

Ever since Ranta (1994), modern type theories have been applied to the study of linguistic semantics (see Chatzikyriakidis and Luo (2017) for recent trends). This section introduces the type-theoretical semantic analysis of basic linguistic items.

3.5.1 Linguistic types

Linguistic expressions (e.g., words, phrases, sentences) fall under different linguistic types. In this dissertation, we write $\mathcal{L}$ to denote the universe of type-indexed linguistic expressions, defined as follows:

$$\mathcal{L} := \Sigma X : \{\mathsf{CN}, \mathsf{PN}, ..., \mathsf{Prop}\}.X.$$

In this definition, CN and PN denote the universes of common nouns and proper nouns respectively. Prop is the universe of propositions. By the definition of Σ, a term of $\mathcal{L}$ is a pair

$$(T, \epsilon)$$

such that T is a linguistic type and ϵ is an expression of type T.

Following Bekki and colleagues (Bekki, 2014; Bekki & Mineshima, 2017), lexical items are interpreted *à la* Montague (Montague, 1974;

Dowty et al., 1981). But there are a few exceptions, such as the interpretation of common and proper nouns. In Montagovian semantics, common nouns are analyzed as predicates whilst proper nouns/names are seen as referential expressions. There is a long-standing debate in the literature on whether the two kinds of nouns are completely different from a semantic perspective. Inspired by Bach (2015), we conceive proper nouns as no different from common nouns: they are used both to *predicate* and to *refer* (cf. Retoré (2014)). In this dissertation, we write N to denote the universe of nouns, defined as follows:

$$\mathsf{N} := \mathsf{CN} + \mathsf{PN}.$$

The interpretation of a noun ϵ is subject to the following two rules (where we write $[\![\epsilon]\!]$ for the semantic denotation of ϵ):

(a) $\forall \epsilon : \mathsf{N}.\mathsf{is}(\epsilon) \in \mathsf{E} \to \mathsf{Prop}.$

(b) $\forall \epsilon : \mathsf{N}.[\![\epsilon]\!] = \{\mathsf{E}|\mathsf{is}(\epsilon)\} \in \mathsf{U}.$

The first rule specifies that for every noun ϵ, $\mathsf{is}(\epsilon)$ is a property predicate of type $\mathsf{E} \to \mathsf{Prop}$. The second rule specifies that for every noun ϵ, there is a corresponding type $[\![\epsilon]\!]$ of entities that satisfies $\mathsf{is}(\epsilon)$.

3.5.2 Proposition and reason

In this dissertation, linguistic propositions are viewed as stable proof-irrelevant types (see Section 3.4.2). Under this identification, the following principle is trivial (Primiero, 2007, 144-145):

> **Verificationist Principle of Truth (VPT)**
> Let $A : \mathsf{Prop}$, A is true iff there exists a proof of A.

The concept of a proof can be interpreted as either a demonstration process or an object abstracted from the demonstration (see Sundholm (1986) for details). The proof-as-object view is implemented in type theory. In linguistic discourse, a proof of a linguistic proposition refers to an *event/situation* (Ranta, 1994; Cooper, 2005) that it describes.

In linguistic discourse, to request a proof of a proposition, one asks for a reason of that proposition, rather than an abstract proof object. The notion of reason is defined as follows:

Definition 1 (Reason). *Let* $P, E_0 : \mathsf{Prop}$*, we write* $P\text{-}\mathsf{isR}(E_0)$ *to denote that* E_0 *is a reason of* P*, formally defined as follows:*

$$P\text{-}\mathsf{isR}(E_0) := P\text{-}\mathsf{isSR}(E_0) \times P\text{-}\mathsf{isCR}(E_0).$$

$P\text{-}\mathsf{isSR}(E_0)$ *and* $P\text{-}\mathsf{isCR}(E_0)$ *are respectively defined as follows:*

(a) $P\text{-}\mathsf{isSR}(E_0) := E_0 \to P$;

(b) $P\text{-}\mathsf{isCR}(E_0) := \Sigma\overrightarrow{E_{i+1}} : \mathsf{SR}(\overrightarrow{E_i}).E_n \wedge \mathsf{self\text{-}evident}(E_n)$

where $i : \mathbb{N}, n : \mathbb{N}^+, 0 \leq i \leq n,$ *and* $\mathsf{SR}(E_i) := \{\mathsf{Prop} | E_i\text{-}\mathsf{isSR}\}$.

The two clauses are respectively interpreted as follows:

(a) $P\text{-}\mathsf{isSR}(E_0)$ defines E_0 as a *simple* reason of P: E_0 implies P.[3]

(b) $P\text{-}\mathsf{isCR}(E_0)$ defines E_0 as a *complete* reason of P: (i) there exists a simple reason E_{i+1} for every E_i, and (ii) ultimately, there is a *self-evident* reason E_n for $E_{n\text{-}1}$.[4]

The type of reasons of P, written as $\mathsf{R}(P)$, is defined as follows:

$$\mathsf{R}(P) := \Sigma E_0 : \mathsf{Prop}.P\text{-}\mathsf{isR}(E_0).$$

Let $p : \mathsf{R}(P)$, we easily obtain the following:

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[3]In the literature, a simple reason of a proposition is required to satisfy more constraints (see Aliseda (1997, 2006)), which are not considered here.

[4]To say that a proposition is *self-evident* is to say that it is justified by itself. In addition to logical tautologies, there are many propositions that are self-evident in linguistic discourse: for example, if one observes a bravery, the proposition that one observes it is self-evident. For Brandom (1994), self-evident propositions are those that one is entitled to by default and they effectively avoid the regress of interpersonal inheritance of entitlement to a proposition.

$$\pi_l(p) = E_0 : \mathsf{Prop},$$
$$\pi_r(p) : P\text{-}\mathsf{isR}(E_0),$$
$$\pi_l(\pi_r(p)) : P\text{-}\mathsf{isSR}(E_0),$$
$$\pi_r(\pi_r(p)) : P\text{-}\mathsf{isCR}(E_0).$$

Let $q = \pi_r(\pi_r(p)) : P\text{-}\mathsf{isCR}(E_0)$, we easily obtain the following:

$$\mathsf{lef}_0(q) = \pi_l(q) = E_1 : \mathsf{SR}(E_0),$$
$$\mathsf{rig}_0(q) = \pi_r(q) : E_0\text{-}\mathsf{isCR}(E_1),$$
$$\ldots$$
$$\mathsf{lef}_i(q) = \pi_l(\mathsf{rig}_{i\text{-}1}(q)) = E_{i+1} : \mathsf{SR}(E_i),$$
$$\mathsf{rig}_i(q) = \pi_r(\mathsf{rig}_{i\text{-}1}(q)) : E_i\text{-}\mathsf{isCR}(E_{i+1}),$$
$$\ldots$$
$$\mathsf{lef}_n(q) = \pi_l(\mathsf{rig}_{n\text{-}1}(q)) : E_n,$$
$$\mathsf{rig}_n(q) = \pi_r(\mathsf{rig}_{n\text{-}1}(q)) : \mathsf{self\text{-}evident}(E_n).$$

For convenience, we abuse lef and rig instead of π_l and π_r henceforth. The proof object of $\mathsf{R}(E_i)$ is the following (where $i : \mathbb{N}, n : \mathbb{N}^+, 0 \leq i \leq n$ and $c : \mathsf{SR}(E_i) \to \Sigma E_i : \mathsf{Prop}.E_i\text{-}\mathsf{isSR}(E_i)$):

$$\mathsf{r}_i(p) = (\mathsf{lef}_i(\pi_r(\pi_r(p))), (\pi_r(c(\mathsf{lef}_i(\pi_r(\pi_r(p))))), \mathsf{rig}_i(\pi_r(\pi_r(p))))) : \mathsf{R}(E_i)$$

3.5.3 Speech acts

The most fundamental unit in a linguistic discourse is a speech act. In this dissertation, we consider two basic kinds of speech acts: *assertions* and *questions*. Central to our analysis of speech acts is a notion called *characteristic term of propositional content* (*p-term*, in short). To start with, we consider what amounts to a p-term of an assertion:

Definition 2 (P-term of Assertion)**.** *The p-term of an assertion refers to the proposition expressed in that assertion. The universe of p-terms of assertions is written as $\mathcal{A}$:*

$$\mathcal{A} := \mathsf{Prop}.$$

To define what amounts to a p-term of a question, we appeal to a classical view, due to Roland Hausser and Jonathan Ginzburg (Hausser & Zaefferer, 1978; Hausser, 1983; Ginzburg & Sag, 2000; Ginzburg, 2005, 2012), that the sentence expressed in a question is a λ-*abstract*, or equivalently, a *function* (Yuan, 2018). To distinguish it from other functions, we call it an *e-function* hence. For example, a *polar question* on whether P (for $P : \mathsf{Prop}$) expresses the following e-function:

$$\tau(X) : \pm P \to \mathsf{Prop}.$$

In contrast, a unary *wh-question* requesting a term x of type B (for $B : \mathsf{U}$) that satisfies $A(x)$ expresses the following e-function:

$$A(x) : B \to \mathsf{Prop}.$$

Generically, the sentence expressed in a question is an n-ary e-function, written as follows (where $D_i : \mathsf{U}$, $x_i : D_i$, $i, n : \mathbb{N}^+$ and $1 \leq i \leq n$):

$$P(\overrightarrow{x_i}) : \overrightarrow{D_i} \to \mathsf{Prop}.$$

The p-term of a question is defined as follows:

Definition 3 (P-term of Question)**.** *The p-term of a question is a nested pair* $(n, (\overrightarrow{D_i}, P))$ *collecting the information contained in the e-function* $P(\overrightarrow{x_i}) : \overrightarrow{D_i} \to \mathsf{Prop}$ *expressed in that question. The universe of p-terms of questions is written as* $\mathcal{E}$*:*

$$\mathcal{E} := \mathbb{N}^+ \times (\Sigma \overrightarrow{D_i} : \mathsf{U}.\overrightarrow{D_i} \to \mathsf{Prop}).$$

Let $f = (n, (\overrightarrow{D_i}, P)) : \mathcal{E}$, by appealing to lef introduced in the previous section, the set of the domain types P is written as:

$$\underset{1\to n}{\mathsf{domain}}(f) := \{\mathsf{lef}_1(f), ..., \mathsf{lef}_n(f)\}.$$

The function P is trivially equivalent to $\mathsf{rig}_n(f)$:

$$\mathsf{rig}_n(f) : \bigwedge \underset{1\to n}{\mathsf{domain}}(f) \to \mathsf{Prop}.$$

The sentence expressed in a speech act has a complex information structure. In this dissertation, we consider only the *focus-background* dimension of information structure, largely because it is closely related to discourse update (McNally, 1998; Roberts, 1996/2012; Vallduví, 2016). In English, if a constituent in a sentence bears a focus, it is marked by a focus accent and the sentence is said to contain a narrow focus (see Büring (2016) for more details). If, however, a sentence does not contain any salient focus accent, it is said to contain a wide focus.[5] To describe the focal structure of a sentence, we introduce a new characteristic term called *r-term*, defined as follows: [6]

Definition 4 (R-term)**.** *The r-term of a speech act whose p-term is* f *is a nested pair* $((m, n), (\overrightarrow{D_i}, (\overrightarrow{C_j}, F)))$ *where* $m : \mathbb{N}$, n, $i, j : \mathbb{N}^+$, $1 \leq i \leq m$, *and* $1 \leq j \leq n$. *The three different variables* D_i, C_j *and* F *are interpreted as follows, depending on the focal interpretation of the speech act under consideration:*

(*a*) *If* $f : \mathcal{A}$ *and the speech act bears a wide focus, then*

- $m = 0$;
- $n = 1$ *and* $C_1 = \mathsf{Prop} : \mathsf{U}$;
- $F = \tau : \mathsf{Prop} \rightarrow \mathsf{Prop}$.

(*b*) *If* $f : \mathcal{A}$ *and the speech act bears some narrow foci, then*

- $m = 0$;
- C_j *denotes the semantic type of a focused constituent in* α *and* $\overrightarrow{C_j}$ *exhausts the semantic types of a series of* n *focused constituents in* α;

[5] Recall that the utterance expressed in a speech act is not necessarily sentential. However, in this dissertation, we assume that a non-sentential utterance can be converted to a sentential one as long as it is interpretable.

[6] The information structure of a sentence is much more complicated than what we have considered here. There are many other dimensions of information structure relevant for the interpretation of a sentence such as the *theme-rheme* layer and the *topic-comment* layer among others (see Vallduví (2016) for a review). The incorporation of these layers of information structure remains for future research.

- *F denotes the e-function obtained after substituting every focused constituent with a corresponding* wh-*expression of the same semantic type.*

(*c*) *If $f : \mathcal{E}$ and the speech act bears a wide focus, then*

- $m = \pi_l(f)$ *and* $\overrightarrow{D_i} = \overrightarrow{\mathsf{lef}_i(f)} : \mathsf{U}$;
- $n = 1$ *and* $C_1 = \overrightarrow{D_i} \to \mathsf{Prop} : \mathsf{U}$,
- $F : (\overrightarrow{D_i} \times \overrightarrow{C_j}) \to \mathsf{Prop}$ *and* $F(a, f) = f(a) : \mathsf{Prop}$.

(*d*) *If $f : \mathcal{E}$ and the speech act bears some narrow foci, then*

- – $m = 0$ (*if* $\mathsf{rig}_n(f) = \tau$) *or*
  – $m = \pi_l(f)$ *and* $\overrightarrow{D_i} = \overrightarrow{\mathsf{lef}_i(f)} : \mathsf{U}$ (*if* $\mathsf{rig}_n(f) \neq \tau$);
- *C_j denotes the semantic type of a focused constituent in α and $\overrightarrow{C_j}$ exhausts the semantic types of a series of n focused constituents in α;*
- *F denotes the e-function obtained after substituting every focused constituent with a corresponding* wh-*expression of the same semantic type.*

The universe of r-terms is written as $\mathcal{R}$, defined as follows:

$$\mathcal{R} := (\mathbb{N}_{D_i} \times \mathbb{N}^+_{C_j}) \times (\Sigma\overrightarrow{D_i} : \mathsf{U}.\Sigma\overrightarrow{C_j} : \mathsf{U}.(\overrightarrow{D_i} \times \overrightarrow{C_j}) \to \mathsf{Prop}).$$

Two remarks have to be made here. First, D_i and C_j intuitively denote respectively the semantic type of an interrogative *wh*-expression and the semantic type of a focused constituent contained in a speech act. Second, if an assertion bears a wide focus, the whole proposition expressed therein is focused and as a consequence, the semantic type of the focused constituent therein contained is Prop; in contrast, if a question bears a wide focus, the whole e-function expressed therein is focused and as a consequence, the semantic type of the focused constituent therein contained is simply $\overrightarrow{D_i} \to \mathsf{Prop}$.

To illustrate, consider the following examples (where $\mathcal{F}$ highlights constituents that bear a narrow focus):

(2) a. Amadís defeated Dardán.
   b. Amadís defeated [Dardán]$_{\mathcal{F}}$.
   c. Who defeated Dardán?
   d. Who defeated [Dardán]$_{\mathcal{F}}$?

Consider (2a) and (2b). They express the same propositional content and for this reason, the p-terms for the two assertions are exactly the same (where a and d denote respectively *Amadís* and *Dardán*):

$$\mathsf{defeat}(\mathsf{a}, \mathsf{d}).$$

Nevertheless, (2a) and (2b) differ with respect to the way of information packaging: (2a) bears a wide focus whereas (2b) bears a narrow focus. The r-terms for (2a) and (2b) are respectively the following (where ind denotes the type of human individuals):[7]

$$((0,1), (\{\}, (\mathsf{Prop}, \tau))), \qquad ((0,1)(\{\}, (\mathsf{ind}, \mathsf{defeat}(\mathsf{a}, x)))).$$

Consider (2c) and (2d). They express the same propositional content and for this reason, the p-terms for them are exactly the same:

$$(1, (\mathsf{ind}, \mathsf{defeat}(x, \mathsf{d})).$$

However, as in the previous pair, (2c) and (2d) differ with respect to the way of information packaging: (2c) bears a wide focus whereas (2d) bears a narrow focus. The r-term for (2c) is the following:

$$((1,1), (\mathsf{ind}, (\mathsf{ind} \to \mathsf{Prop}, F))),$$

[7] *Dardán* might be assigned many different types depending on the role that he assumes. For example, Dardán might be classified as a *man*, a *warrior*, a *knight* among many others. It is pertinent to wonder what type, if not clearly mentioned, should be assigned to *Dardán* in this example. This will be considered in detail in Section 7.3 of Chapter 7. For the time being, let us assume that *Dardán* refers to a human individual of type ind.

where F, by definition, is defined as follows:

$$F : (\mathsf{ind} \times (\mathsf{ind} \to \mathsf{Prop})) \to \mathsf{Prop}.$$

The r-term for (2d) is the following:

$$((1, 1), (\mathsf{ind}, (\mathsf{ind}, \mathsf{defeat}(x, y)))).$$

From the two characteristic terms of a speech act, one can more or less recover the content therein expressed. To collect the characteristic terms of speech acts, we introduce a notion dubbed the *typed universe of characteristic terms*, or alternatively, the *universe of speech acts*:

Definition 5 (Universe of Speech Acts)**.** *The typed universe of characteristic terms of speech acts, more commonly called the universe of speech acts, is written as* Ψ*, defined as follows:*

$$\Psi := \mathsf{Label} \times \Sigma T : \{\mathcal{A}, \mathcal{E}\}.T \times \mathcal{R}.$$

Label denotes the type of labels for speech acts. In this dissertation, we distinguish between two types of labels: simple Greek letters such as $\alpha, \beta, ...$ and labeled Greek letters such as $\pi_1, \pi_2, \pi_{2.1}, ...$ The latter are used when many speech acts are under consideration. For current purposes, let us use simple Greek letters. By the definitions of $\times$ and Σ, a term of Ψ is a (nested) quaternary pair:[8]

$$(\alpha, ((T, f), g)) : \Psi,$$

where $\alpha : \mathsf{Label}$, $T : \{\mathcal{A}, \mathcal{E}\}$, $f : T$, and $g : \mathcal{R}$. For sake of notational convenience, in this dissertation, we write simply:

$$\alpha[T]^g_f : \Psi \quad \text{instead of} \quad (\alpha, ((T, f), g)) : \Psi.$$

[8] $(\alpha, ((T, f), g))$ collects the characteristic terms of a speech act characterized by f and g but it is not a logical representation of this speech act. In Chapters 4 and 5, we consider what amounts to a logical representation of such a speech act.

The introduction of α is useful as it facilitates our discussion: if T, f, and g are irrelevant to discussion, we simply refer to the speech act characterized by f and g as α. In this dissertation, we write Ψ_X (for $X : \{\mathcal{A}, \mathcal{E}\}$) to denote a sub-universe of Ψ:

$$\Psi_X := \mathsf{Label} \times \Sigma T : \{X\}.T \times \mathcal{R}.$$

Let $X = \mathcal{A}$, $\Psi_\mathcal{A}$ intuitively denotes the universe of assertions, and let $X = \mathcal{E}$, $\Psi_\mathcal{E}$ denotes the universe of questions.

3.5.4 Information states

The *information state* of an agent a refers to the collection of information at a's disposal. It is modeled by a typing context:

Definition 6 (Information State)**.** *The information state of an agent is modeled by a typing context. The universe of agent-indexed information states is written as* $\mathsf{ctx} \times \mathsf{ind}$. *By the definition of* $\times$, *a term of* $\mathsf{ctx} \times \mathsf{ind}$ *is a pair* $(\Gamma, a) : \mathsf{ctx} \times \mathsf{ind}$ *such that* $\Gamma : \mathsf{ctx}$ *and* $a : \mathsf{ind}$. *For sake of notational convenience, we write* Γ_a *to denote* a*'s information state:*

$$\Gamma_a : \mathsf{ctx}.$$

The information state of a is divided into two parts: the intrapersonal part, which collects information that a believes that a him-/herself holds, and the interpersonal part, which collects information that a believes that others (i.e., relevant discourse participants) are in possession of. In this dissertation, an information state collecting information that a believes that b holds (for $a, b : \mathsf{ind}$) is called a *mirroring information state* of b from a's perspective. The notion of mirroring information state is formally defined as follows:

Definition 7 (Mirroring Information State)**.** *Let* $a, b : \mathsf{ind}$, *the mirroring information state of* b *from* a*'s perspective collects*

> *information that a believes that b holds. The universe of agent-indexed mirroring information states is written as* $(\mathsf{ctx} \times \mathsf{ind}) \times \mathsf{ind}$*. By the definition of* $\times$*, a term of* $(\mathsf{ctx} \times \mathsf{ind}) \times \mathsf{ind}$ *is a ternary pair* $((\Delta, b), a) : (\mathsf{ctx} \times \mathsf{ind}) \times \mathsf{ind}$ *such that* $\Delta : \mathsf{ctx}$ *and* $a, b : \mathsf{ind}$*. For notational convenience, we write* $[\Delta_b]_a$ *to denote the mirroring information state of b from a's perspective:*
>
> $$[\Delta_b]_a : \mathsf{ctx}.$$

In terms of mirroring information states, the information state of a, written as Γ_a, is alternatively defined as a sequence of mirroring information states of a and other relevant discourse participants:

$$\Gamma_a := [\Gamma_a]_a; [\Delta_b]_a; [\Xi_c]_a; ...$$

where $[\Gamma_a]_a$ denotes the mirroring information state of a from a's perspective, or alternatively, the intrapersonal part of a's information state. $[\Delta_b]_a$ and $[\Xi_c]_a$ denote respectively the mirroring information states of b and c from a's perspective.

If a confesses that A derives from a's (complete) information state Γ_a, A derives from the mirroring of a's information state in x's (written as $[\Gamma_a]_x$). This is because there is a mapping f from Γ_a to $[\Gamma_a]_x$:

$$f : \Gamma_a \to [\Gamma_a]_x.$$

f is usually irreversible: Γ_a is conventionally more informative than $[\Gamma_a]_x$. Γ_a intuitively represents what a knows about the information that a has whilst $[\Gamma_a])x$ represents what x knows about the information that a holds. The former is undoubtedly more informative than the latter: one knows more about oneself than anyone else.

3.5.5 Composite judgments

Two or more typing judgments can be concatenated if they are made against different mirroring information states of the *same* agent (e.g.,

$[\Gamma_a]_a$, $[\Delta_b]_a$, ...). The outcome is called a *composite judgment*.[9]

Definition 8 (Composite Judgment). *A composite judgment is a concatenation of at least two judgments that are made against different mirroring information states of an agent.*

Let J_1, ..., J_n (where $n : \mathbb{N}^+$) be judgments made on the basis of different mirroring information states of an agent, then by concatenating J_1, ..., J_n, we obtain a composite judgment J, written as follows:[10]

$$\mathsf{J} := \begin{bmatrix} J_1 \\ ... \\ J_n \end{bmatrix}$$

To abstract the component judgments from J, we define a deconcatenation operator μ_i (for $i : \mathbb{N}^+$ and $1 \leq i \leq n$) such that:

$$\mu_i(\mathsf{J}) = J_i.$$

3.6 Summary

This chapter introduces the fundamentals of type theory and shows how linguistic semantics is studied using type-theoretical tools:

- Basics of type theory:
  - Basic syntactic categories
  - Useful type formers/constructors
  - Coercive subtyping
  - Logic in type theory
- Type-theoretical semantics:

[9] Please note that a composite judgment is not a judgment by itself but a series of judgments that are concatenated!

[10] The use of the matrix symbol should not be confused with that in Tanaka et al. (2017) and Bekki and Mineshima (2017).

- Lexical categories
- Linguistic propositions
- Justificatory reasons
- Speech acts
- Information states

The techniques introduced in this chapter offers a formal basis for the analysis of the inferential articulation of speech acts in the remaining chapters of this dissertation. A formal presentation of type theory is given in Appendix A. For more about type theory and its applications to linguistic semantics, see Chatzikyriakidis and Luo (2020).

Part II

Performing Speech Acts

Overview Part II

In linguistic discourse, a speech act often has two different characters: on the one hand, it is a speech act avowed by the speaker; and on the other, it is conventionally though not necessarily addressed to another speaker. This part examines in detail the two different characters of a speech act in linguistic discourse. Specifically, this part is intended to answer the following research question:

(Q1) What does one express by performing a speech act and how is the performance of a speech act warranted?

- (Q1.1) What does a speech act express if it is not meant to be addressed to any audience and what entitles one to perform such a speech act?
- (Q1.2) What does a speech act express if it is addressed to specific audience and how it differs from a speech act that is not addressed to any audience?

To spell out the analysis in a precise and unambiguous way, this part develops a type-theoretical formalism for both speech act representation and reasoning with speech acts.

This part consists of three chapters: Chapter 4 offers a normative account of assertion, mainly on the basis of Brandom (1994); Chapter 5 generalizes the normative analysis to question; Chapter 6 examines the second-personal character of speech acts in linguistic discourse.

Chapter 4

Assertion: From Proof to Truth

This chapter offers a normative account of assertion, the central claim being that by performing an assertion, one is *prima facie* committed to the proposition therein expressed as one is in possession of a proof (conceived as a demonstration/justification process) of it.

This chapter is structured as follows: Section 4.1 introduces the norms of assertion; Section 4.2 defines the notions of (doxastic) commitment and (propositional) knowledge; Section 4.3 develops a type-theoretical formalism for assertion representation; Section 4.4 examines the different ways to vindicate one's entitlement to an assertion; Section 4.5 considers the peculiarities of reasoning with (only) assertions; Section 4.6 provides some concluding remarks

4.1 Norms of Assertion

The definition of assertion, first introduced in Section 1.1.1 of Chapter 1, is mainly inherited from Brandom (1983, 1994):

Definition 9 (Assertion)**.** *To perform an assertion, one prima facie* (*a*) *acknowledges a* (*doxastic*) *commitment to the asserted proposition, and* (*b*) *assumes the responsibility of demonstrating one's entitlement to endorse such a commitment.*

In Brandom's sense, assertion is first and foremost a normative kind, underlain by two normative statuses: *commitment* and *entitlement*.[1] The two normative statuses are essentially social statuses, exhibiting the corresponding constituting social norms: *commitment norm* and *entitlement norm*. In discursive practices, participants comply their assertional behavior with the two norms and evaluate others' likewise. For Brandom, however, one's commitment to a proposition need not be entitled (see Section 2.2 of Chapter 2 for more details), but in Definition 9, we impose the requirement that one is *prima facie* entitled to what one asserts. This seems to make our definition stronger than Brandom's. In fact, however, there is no essential difference between our conception of assertion and Brandom's as we interpret the notion of entitlement in a slightly different way: for Brandom, one is entitled to an assertion iff one is acknowledged by the social community that one's proof for the asserted proposition *does* provide a warranty; but in our definition, entitlement is understood as a self-ascribed status– one is entitled iff one regards oneself as being in possession of a proof. Brandom's notion of entitlement can be recovered from ours as follows: if one's self-ascribed entitlement to a commitment is rebutted by the social community, one is not in the epistemic position to acknowledge such a commitment; but that does not exclude the possibility that one still regards oneself as being entitled. The conception of entitlement advocated in this dissertation is partially supported by the justification account of assertion, according to which, a proposition can be asserted iff one holds a justification of it (Douven, 2006; Lackey, 2007; Kvanvig, 2009).[2] If we follow Brandom viewing a doxas-

[1]For a detailed interpretation of the two types of normative statuses, see Chapter 3 in Loeffler (2018). The commitment norm of assertion is extensively considered in the literature (e.g., Krifka (2015) and Geurts (2019)). The entitlement norm is sometimes called a justification norm (e.g., Douven (2006), Lackey (2007), and Kvanvig (2009)). For an extensive overview of different norms of assertion, see MacFarlane (2011) and van der Schaar (2011).

[2]The main supportive evidence for a justification account of assertion is that one has no problem in making *selfless assertions*. The textbook example for this argument is Lackey's (1999, 2007) *creationist teacher*: as a biology teacher, one

tic commitment as a belief, the entitlement norm of assertion implies that the belief that one expresses by asserting is not a *mere belief* but is necessarily justified. However, this does not amount to saying that a belief conveyed by an assertion is an instance of knowledge: according to the standard JTB definition of knowledge (as *justified true beliefs*), a justified belief is an instance of knowledge iff it is true in the actual world, but the belief conveyed by an assertion is justified to be true with respect to the speaker's information state and need not be true in actuality. Since information states are modeled by contexts, such a set of justified true beliefs is more appropriately dubbed *contextually-dependent knowledge* in terms of Rahman and Clerbout (2013).

In type theory, assertion and judgment are usually synonyms (see Martin-Löf (1996) for a historical note). Supposing that the terminological equivalence also holds for linguistic discourse, we shall formalize *assertions* as *judgments*. The two constitutive norms of assertion are accordingly each endowed with a type-theoretical reading:

(*a*) To perform an assertion, one *prima facie* acknowledges a (doxastic) commitment to the proposition therein expressed as it is *true* relative to one's information state (*qua* context).

(*b*) To perform an assertion, one is *prima facie* responsible of vindicating one's entitlement to endorse such a (doxastic) commitment as one possesses a *proof* of the asserted proposition.

---

may assert the theses of evolutionary theory and provide justifications (following textbooks), though one might indeed believe otherwise because of one's personal belief in creationism. For defenders of justification norm of assertion, the felicity of such assertions indicates that what is crucial to one's assertion is justification and there is no need to impose a belief condition. Milić (2015) shows that these assertions do not actually constitute a challenge to the belief account of assertion, as they are not assertions but *presentations* (of others' claims). In line with Milić (2015), we do not accept Lackey's *creationist teacher* as a counterexample for the belief account of assertion; but counter to Milić (2015), we maintain that selfless assertions *are* assertions but they differ from regular assertions in that by making a regular assertion, one is both publicly and privately committed to the asserted proposition but in avowing a selfless assertion, one's private commitment diverges from one's public commitment. This will be further considered in Section 6.3.

The type-theoretical interpretation of the two constitutive norms of assertion makes it explicit that asserting should be understood as an act of claiming the truth of a proposition with the support of a proof. However, notice that a proof of a type in type theory is an abstract object whilst a proof for a proposition in linguistic discourse refers to a *reason* (see Section 3.5.2 of Chapter 3 for the definition of reason).

4.2 Commitment and Knowledge

In light of the above analysis, we shall further summarize Definition 9 as follows: to assert a proposition, one *prima facie* commits oneself to knowing the proposition. Based on this simplified definition of assertion, to properly represent assertions, it is necessary to formally define two different propositional attitudes: *commitment* and *knowledge*.[3]

4.2.1 Commitment/Belief

For Brandom (1994, 1997), to acknowledge a (doxastic) commitment is to express a *belief*. In this dissertation, belief is treated as a modal operator, defined as follows in type-theoretical terms:

$$\mathsf{B} : \mathsf{ind} \to \mathsf{Prop} \to \mathsf{Prop}.$$

Let $a : \mathsf{ind}$ and $A : \mathsf{Prop}$, $\mathsf{B}(a, A)$, abbreviated as $\mathsf{B}_a(A)$, denotes that a commits to A or equivalently, that a believes A. Ranta (1994) offers a type-theoretical analysis of belief: one believes a proposition iff it derives from one's information state. Inspired by Ranta's interpretation, we characterize B by the following rules:

$$\text{If } [\Gamma_a]_x \vdash A \ \mathsf{true}, \ \text{then } Y_x \vdash \mathsf{B}_a(A) \ \mathsf{true}. \qquad (\text{I}_\mathsf{B})$$

$$\mathsf{B}_a(A \to B) \to \mathsf{B}_a(A) \to \mathsf{B}_a(B). \qquad (\text{DB})$$

$$\mathsf{B}_a\mathsf{B}_a(A) \to \mathsf{B}_a(A). \qquad (\text{BB})$$

[3]Please notice that the two attitudes are both meta-level attitudes as neither of them is explicitly expressed in asserting a proposition.

($\textsc{i}_{\mathsf{B}}$) is formulated in a multi-context style. It intuitively shows that from x's perspective, if A is true for a, then a believes A.[4]

4.2.2 *Knowing-that*

The relationship between *commitment/belief* and *knowledge*, by the classical JTB definition, is the following: one knows a proposition iff one commits to the proposition and one is in possession of a proof of it. In order to represent one's knowledge, more specifically, *propositional knowledge*, we encounter two challenges: (i) how to enrich the lexical meaning of *know* with the requirement of a proof; (ii) how to capture the factive inferences associated with knowledge assertions as shown in Table 4.1. The solutions to the two challenges are related to each other. To start with, consider the first challenge. In their pioneer analysis of *know*, Tanaka et al. (2017) propose that the proof required in one's expression of propositional knowledge is an abstract object. They define the knowledge operator K as follows:

$$\text{(Tanaka et al.'s) } \mathsf{K} : \mathsf{ind} \to A : \mathsf{Prop} \to A \to \mathsf{Prop}.$$

Let $a : \mathsf{ind}$ and $p : A$, $\mathsf{K}(a, A, p)$ denotes that a knows A (whose proof object is p). In linguistic discourse, to ask for a proof is to request a *reason*, not a proof object. In light of this, by appealing to the notion of reason defined in Section 3.5.2, Tanaka et al.'s K is amended:

$$\mathsf{K} : \mathsf{ind} \to A : \mathsf{Prop} \to \mathsf{R}(A) \to \mathsf{Prop}.$$

Let $a : \mathsf{ind}$ and $p : \mathsf{R}(A)$, $\mathsf{K}(a, A, p)$, abbreviated as $\mathsf{K}_a(A, p)$, denotes that a knows A (whose reason is $\pi_l(p)$). The new operator for knowledge is defined by the following two rules:

$$\text{If } \Gamma_a \vdash p : \mathsf{R}(A), \text{ then } \Gamma_a \vdash \mathsf{K}_a(A, p) \ \mathsf{true}. \qquad (\textsc{i}_{\mathsf{K}})$$

$$\forall f : \mathsf{R}(A) \to \mathsf{R}(B).(\mathsf{K}_a(A, p) \to \mathsf{K}_a(B, f(p))). \qquad (\textsc{dk}_1)$$

[4] Let $Y_x = \Gamma_a : \mathsf{ctx}$, B defined by the first two rules is equivalent to intuitionistic belief first axiomatized in Artemov and Protopopescu (2016).

Let a be different from the speaker				
K1	a knows A	$\rightsquigarrow$	(presupposes)	A
K2	a doesn't know A	$\rightsquigarrow$		A
Let a be identical with the speaker				
K3	a knows A	$\rightsquigarrow$		A
K4	a doesn't know A	$\not\rightsquigarrow$		A

*In this table, *the speaker* denotes the one who asserts/asserted the proposition on the left side of $\rightsquigarrow/\not\rightsquigarrow$.

Table 4.1: Inference patterns of *know-that*

In our definition of K, by replacing A with $\mathsf{R}(A)$, the first challenge is successfully solved. There is, however, a problem with the new definition of K: since $\mathsf{R}(A)$ is proof-relevant, the new definition of K fails to capture the intuition that the truth of $\mathsf{K}_a(A,p)$ is irrelevant to what amounts to a proof of $\mathsf{R}(A)$. To illustrate, let $p,q : \mathsf{R}(A)$ where p and q are not identical, $\mathsf{K}_a(A,p)$ and $\mathsf{K}_a(A,q)$ are by definition different. This is undoubtedly undesired as we expect that both $\mathsf{K}_a(A,p)$ and $\mathsf{K}_a(A,q)$ express the same meaning that a knows A. In order to avoid this problem, we propose the following axiom for K:[5]

$$\forall p,q : \mathsf{R}(A).\mathsf{K}_a(A,p) \leftrightarrow \mathsf{K}_a(A,q). \tag{PK}$$

The second challenge is extensively discussed in the literature. In epistemic logic research, the factive inference associated with *know* in (K1)/(K3) is conceived as an entailment, but this fails to explicate

[5]The relationship between K and B is extensively discussed in the literature. For example, to capture the classical view that (propositional) knowledge implies belief, we propose the following axiom for K and B:

$$\mathsf{K}_a(A,p) \rightarrow \mathsf{B}_a(A). \tag{KB}$$

For more on the relationship between K and B, see Stalnaker (2006).

(K2)/(K4). In linguistic research, the factive inference associated with *know* is analyzed as a presupposition. The felicity of (K4) indicates that such a presupposition is cancelable (see Beaver (2010) for more details). Following the dynamic semantic approach (Karttunen, 1974; Stalnaker, 1974; Heim, 1983), we conceive this cancelable presupposition as one that is satisfied locally but not globally.[6] In connection with our definition of K, this amounts to saying that $\mathsf{R}(A)$ is inhabited locally but not globally. To illustrate, consider $\mathsf{K}_a(A, p)$. In the case that a is different from the asserter of $\mathsf{K}_a(A, p)$ (or $\neg\mathsf{K}_a(A, p)$), $\mathsf{R}(A)$ is inhabited both locally and globally. Since $\mathsf{R}(A)$ implies A, the factive presupposition carried by $\mathsf{K}_a(A, p)$ projects. Let a be identical with the asserter of $\neg\mathsf{K}_a(A, p)$, $\mathsf{R}(A)$ is inhabited locally but not necessarily globally. The factive presupposition carried by $\neg\mathsf{K}_a(A, p)$ is thus cancelable in this case. (K1-K4) are successfully captured.

4.3 Simple Assertion

Let us turn back to the simplified definition of assertion given at the beginning of Section 4.2: to perform an assertion, one is committed to knowing the asserted proposition. Under this view, a's assertion of A is written as follows (where $A : \mathsf{Prop}$ and $\Gamma_a \vdash p : \mathsf{R}(A)$):

$$\Gamma_a \vdash \mathsf{K}_a(A, p)\ \mathsf{true}. \tag{$*$}$$

$(*)$ says that a is committed to knowing A. In $(*)$, K is not intended to formalize *know* but to capture the normative statuses underpinning *asserting*, i.e., that by asserting A, a is committed and entitled to A. By the definition of K, by asserting A, it is presupposed that a is in

[6] The general idea of the global/local distinction is the following: for a complex proposition such as $A \to B$, the context for $A \to B$ is dubbed the global context and if the global context is incremented with A, it provides a local context for the interpretation of B. In a nutshell, any context can serve as a global context, whereas a local context for a linguistic expression refers to "the smallest domain of objects that the interpreter needs to consider when he assesses the contribution of [the expression] to the meaning of the discourse" (Schlenker, 2009, 2).

possession of a reason of A. In contrast, a's assertion that a knows A is represented as follows (where $\Gamma_a \vdash q : \mathsf{R}(\mathsf{K}_a(A, p)))$:

$$\Gamma_a \vdash \mathsf{K}_a(\mathsf{K}_a(A, p), q) \text{ true}. \qquad (**)$$

By the definition of K, by asserting that a knows A, it is presupposed that a is in possession of a reason of A and a reason of $\mathsf{K}_a(A, p)$.

$(*)$ is taken as the semantic representation of a's assertion of A. In Section 3.5.3, we introduce two characteristic terms for a speech act: *p-term*, which encodes information about the semantics of a speech act, and *r-term*, which encodes information about the rhematic structure of a speech act. The p-term of a's assertion of A is A itself. Let g denote the r-term of this assertion. Then, if the performer a is irrelevant to discussion, the assertion of A is abbreviated as follows:

$$\alpha[\mathcal{A}]^g_A : \Psi_{\mathcal{A}}. \qquad (*')$$

4.4 Three Types of Reasons

Brandom (1994) identifies three kinds of reasons: *referential reason*, *deferential reason*, and *inferential reason* (see Section 1.1.1 of Chapter 1): to offer a referential reason is to refer to some perceptual experience; to offer a deferential reason is to defer the justificatory responsibility to the authority of someone else; to offer an inferential reason is to justify a proposition by making deductive or inductive inferences.[7]

To illustrate, consider the following example:

(1) a. [**Context**: Oriana, daughter of Lisuarte and beloved of Amadís, visited her father this morning and asserted to him ...]

b. **Oriana**: Amadís defeated Dardán.

[7]Brandom's trictonomy of reasons is anticipated by Willett (1988), who makes a distinction between three kinds of *evidence*: referential reason corresponds to *direct/referential evidence*; deferential reason corresponds to *indirect/reportative evidence*; inferential reason corresponds to *inferential evidence*.

c. **Lisuarte**: Why do you think so?
d. **Oriana**: i. I saw it with my own eyes.
ii. I heard it from a damsel.
ii. He brought back Dardán's sword.

(1c) challenges (1b) for a reason. The reasons that Oriana provides in (1d) differ: (1di) indicates that Oriana's entitlement to (1b) is epistemically grounded by a referential reason; (1dii) shows that Oriana's entitlement to (1b) is based on a deferential reason; (1diii) suggests that Oriana's entitlement to (1b) is justified by an inferential reason.

4.4.1 Inferential reason

In Brandom's trictonomy of reasons, the notion of *inferential reason* is easy to capture: to justify a proposition by an inferential reason is to expand the proof that demonstrates the truth of the proposition. To illustrate, consider (2) (repeated from (1b) and (1diii)):

(2) **Oriana**: i. Amadís defeated Dardán.
ii. He brought back Dardán's sword.

The justification provided by Oriana in (2ii) is an *enthymeme* (i.e., an incomplete syllogism): the observation that Amadís brought back Dardán's sword cannot properly justify the proposition that Amadís defeated Dardán unless (3) is implicitly endorsed as a premise.

(3) A knight defeats another iff the former takes the latter's sword.

In terms of Breitholtz and Cooper (2011) and Breitholtz (2014, ms.), (3) is considered a *topoi* (i.e., an implicit premise), a term originally attributed to Aristotle (1954).

4.4.2 Referential reason

To justify a proposition with a referential reason, one resorts to some *event/situation* that one has experienced (Austin, 1961; Perry & Bar-

W	a witnesses/witnessed A	$\rightarrow$	A
L1	a's assertion of A is reliable	$\rightarrow$	A
L2	a's assertion of A is reliable	$\rightsquigarrow$	a asserted A
L3	a's assertion of A isn't reliable	$\rightsquigarrow$	a asserted A

Table 4.2: Inference patterns of *witness* and *reliable*

wise, 1983; Ranta, 1994; Cooper, 2005, 2012). In (4) (repeated from (1b-1di)), (4ii) implies that she has a referential reason for (4i).

(4) **Oriana**: i. Amadís defeated Dardán.
ii. I saw it with my own eyes.

To represent the referential reason, we introduce an operator W that intuitively formalizes the verb *witness*, defined as follows:

$$\mathsf{W} : \mathsf{ind} \rightarrow \mathsf{Prop} \rightarrow \mathsf{Prop}.$$

Let a : ind and A : Prop, $\mathsf{W}(a, A)$, conveniently abbreviated as $\mathsf{W}_a(A)$, means that a witnesses A. Following Montague (1969), Willett (1988), and Brandom (1994), we endorse the idea that the observation of an event/situation described by A establishes the truth of A. To capture this very idea, we propose the following axiom for W:

$$\mathsf{W}_a(A) \rightarrow A. \qquad \text{(RF)}$$

(RF) correctly predicts the inference pattern (W) in Table 4.2.

4.4.3 Deferential reason

To vindicate one's entitlement to an assertion by deferring the responsibility is different from the other two ways of justification because it involves the reference to another agent. In (5) (repeated from (1b) and (1dii)), to vindicate (5i), Oriana defers the justificatory responsibility to the damsel who first told her that Amadís defeated Dardán.

(5) **Oriana**: i. Amadís defeated Dardán.
ii. I heard it from a damsel.

For Brandom, if one witnesses the act of an assertion, one is entitled to reassert it by deferring the justificatory responsibility to the original asserter. This view, however, is repeated criticized:

> "If witnessing the act is sufficient grounds for acceptance [of an assertion], the utterance does not count as an assertion for [...] assertion is characterized by certain cognitive and social safeguards that come into play when there is a possibility of the hearer being misled or deceived."
> (Jary, 2010, 4)

Brandom's view of deference is faced with a more severe problem, as pointed out by Millson (2014a, 2014b), that under Brandom's view of deference, one is never allowed to challenge an assertion because the assertion itself provides a deferential reason for one's reassertion of it. In this dissertation, we advocate a more natural view of deference: it is not the act of asserting A but one's *trust* on it that entitles one to reassert A. To capture this idea, we introduce an operator isL:

$$\mathsf{isL} : a : \mathsf{ind} \to A : \mathsf{Prop} \to \mathsf{assert}(a, A) \to \mathsf{Prop}.$$

Let $a : \mathsf{ind}$ and $p : \mathsf{assert}(a, A)$, $\mathsf{isL}(a, A, p)$ denotes that a's assertion of A is reliable. The definition of isL captures ($\mathsf{L2}$-$\mathsf{L3}$) in Table 4.2. To capture the idea that A can be justified deferentially, we posit (DF):

$$\mathsf{isL}(a, A, p) \to A. \qquad \text{(DF)}$$

(DF) correctly predicts the inference pattern ($\mathsf{L1}$) in Table 4.2.

4.5 Assertional Reasoning

To justify one's (doxastic commitment to an) assertion by a series of justificatory assertions is an inferential process called *assertion rea-*

soning (or $\mathcal{A}$-*reasoning*, henceforth). Since assertions are represented by typing judgments, the inference rules for $\mathcal{A}$-reasoning are instances of inference rules for type formers (defined in Section 3.2 of Chapter 3).[8] Since what are expressed in assertions are propositions (*qua* stable proof-irrelevant types) (see Section 3.4.2 of Chapter 3 for more details), the logic underlying $\mathcal{A}$-reasoning is essentially classical (first-order) logic. The complete set of inference rules for $\mathcal{A}$-reasoning is laid out in Section C of Appendix B.

4.6 Summary

This chapter develops a normative analysis of assertions, further extending Brandom's (1994) account of assertions, first introduced in Section 1.1.1 of Chapter 1, in the following two directions: first, we conceive both *commitment* and *entitlement* as self-ascribed normative attitudes (i.e., attitudes ascribed to the speech act performer in discursive practices) and under this view, by making an assertion, one is *prima facie* both committed and entitled to the proposition therein expressed, or equivalently, one is *prima facie* committed to knowing (the truth of) the asserted proposition; second, we advocate a more natural view of deference, that is, that it is not someone's mere act of asserting a proposition but one's trust on this act that provides a warranty for one to reassert this proposition, thus avoiding the problems that Brandom's conception of deference encounters. Under the view that to assert is to commit to knowing, we develop a knowledge-based formalism for assertion representation, according to which, an assertion is no different from a propositional knowledge judgment. This faithfully captures the inferential role and the epistemic background of asserting, and furthermore, the modeling of assertions as judgments lends us a straightforward way to formalize assertional reasoning (i.e., reasoning with (only) assertions) by the inference rules for judgments in type theory.

[8] See Section B of Appendix A for the full set of inference rules for type formers.

Chapter 5

Question: Proof Deanonymization

This chapter generalizes the normative analysis of assertions (given in the previous chapter) to questions, the central claims being as follows: (i) every question carries a resolvability presupposition that there is a full answer to the question; and (ii) by asking a question, one acknowledges a practical commitment to seek a full answer to the question, or alternatively, to seek a constructive proof for the resolvability presupposition carried by this question.

This chapter consists of six sections: Section 5.1 introduces various notions of answers and the important notion of resolvability presupposition; Section 5.2 introduces the constitutive norms of questions; Section 5.3 considers the ascription of identificatory knowledge; Section 5.4 develops a type-theoretical formalism for representing questions; Section 5.5 proposes inferences rules for erotetic reasoning; Section 5.6 provides some concluding remarks.

5.1 Answerhood and Resolvability

It is widely acknowledged that a question is askable iff it is *prima facie* resolvable from the speaker's perspective (Hamblin, 1958; Belnap & Steel, 1976; Wiśniewski, 1995; Piwek, 1998; Fitzpatrick, 2005; Hintikka, 2007; Peliš & Majer, 2011). This indicates that every question, as long as it is askable from the speaker's point of view, carries a *re-*

solvability presupposition.[1] It is not clear, for the time being, what is a proper way to resolve a question. This alludes to another question: what is an answer to a question? The purpose of this section is to introduce various notions of answerhood and define what amounts to the resolvability presupposition of a question.

5.1.1 Various notions of answers

The notion of *answer* is elusive in the literature. The simplest notion of answerhood is what we call a *simple answer* in this dissertation.[2] To define the notion of simple answer, it is worthwhile recalling that the sentence *prima facie* expressed in a question is an n-ary e-function (see Section 3.5.3 of Chapter 3 for more related discussion):

$$P(\overrightarrow{x_i}) : \overrightarrow{D_i} \to \mathsf{Prop},$$

where $D_i : \mathsf{U}, x_i : D_i, i, n : \mathbb{N}^+$ and $1 \leq i \leq n$. Let $f = (n, (\overrightarrow{D_i}, P)) : \mathcal{E}$, by appealing to lef and rig defined in Section 3.5.2 of Chapter 3, the above e-function is trivially equivalent to the following:

$$\mathsf{rig}_n(f) : \bigwedge_{1 \to n} \mathsf{domain}(f) \to \mathsf{Prop}.$$

In a nutshell, a simple answer to a question provides an instantiation of the e-function expressed in the question or a negation of such an instantiation. The notion of simple answer is defined as follows:

Definition 10 (Simple Answer)**.** *Let* $A : \mathsf{Prop}$ *and* $f : \mathcal{E}$*, we write* $f\text{-}\mathsf{sans}(A)$ *to denote that* A *is a simple answer to a ques-*

[1] The notion of *resolvability commitment/presupposition* (aka. "presupposition of answers" in Hintikka (2007, ch.5)) should not be confused with the linguistic notion of *existential presupposition* of questions. The latter refers to a cancelable commitment to the existence of an entity of some semantic type specified by some *wh*-expression (see Dayal (2016, 51) for a useful overview).

[2] The notion of *simple answer* (aka. *direct answer* in Wiśniewski (1995, 2013)) is borrowed from Jonathan Ginzburg (Ginzburg & Sag, 2000; Ginzburg, 2012).

tion characterized by f. $f\text{-}\mathsf{sans}(A)$ *is defined as follows:*

$$f\text{-}\mathsf{sans}(A) := \exists x : \bigwedge_{1\to n}\mathsf{domain}(f).\exists y : \pm\mathsf{rig}_n(f)(x).y = A \in \mathsf{Prop}.$$

The set/universe of simple answers to a question characterized by f*, conveniently written as* $\mathsf{sans}(f)$*, is defined as follows:*

$$\mathsf{sans}(f) := \{\mathsf{Prop}|f\text{-}\mathsf{sans}\}.$$

In terms of simple answers, two auxiliary notions of answerhood are defined: if an assertion exhausts true simple answers to a question, it is dubbed an *exhaustive answer*; otherwise, it is *non-exhaustive*. If a question is resolved by an exhaustive answer, it is called an exhaustive question; otherwise, it is non-exhaustive. In this dissertation, what is more useful is a notion called *full answer*, defined as follows:

Definition 11 (Full Answer)**.** *An assertion is a full answer to a question iff it fully resolves the question, concretely:* (*a*) *a full answer to an exhaustive question is exhaustive; and* (*b*) *a full answer to a non-exhaustive question is non-exhaustive.*

Though the presence of some grammatical, lexical, or prosodic markings signal the (non-)exhaustive reading of a question, in many cases, the (non-)exhaustiveness of a question can only be inferred from available contextual information. It is not a goal of this dissertation to decide when a question is exhaustively or non-exhaustively interpreted.

By contrast to *full answer*, we introduce another useful notion of answerhood dubbed *partial answer*: a partial answer to a question is a conjunction of some (but not necessarily all) of the simple answers to the question. The notion of partial answer is defined as follows:

Definition 12 (Partial Answer)**.** *Let* $A : \mathsf{Prop}$ *and* $f : \mathcal{E}$*, we write* $f\text{-}\mathsf{pans}(A)$ *to denote that* A *partially answers a question* *characterized by* f. $f\text{-}\mathsf{pans}(A)$ *is defined as follows:*[a]

$$f\text{-}\mathsf{pans}(A) := \exists x : \mathbb{P}^+(\mathsf{sans}(f)).(A = \bigwedge x \in \mathsf{Prop}).$$

[a] The powerset of a set A, written as $\mathbb{P}(A)$, is a set of all subsets of A. Under the view of sets as types, $\mathbb{P}(A)$ is interpreted as a type of subtypes of A. $\mathbb{P}^+(A)$ is obtained from $\mathbb{P}(A)$ by excluding the empty set.

5.1.2 Resolvability presupposition

The resolvability presupposition associated with a question β characterized $f : \mathcal{E}$, written as $\hat{\varsigma}(f)$, is defined as follows:

Definition 13 (Resolvability Presupposition)**.** *The resolvability presupposition associated with a question* β *characterized* $f : \mathcal{E}$ *is written as* $\hat{\varsigma}(f)$, *defined as follows (see Section 3.5.2 of Chapter 3 for the definition of the operation* $\mathcal{P}$*):*

$$\hat{\varsigma}(f) := \mathcal{P}(\varsigma(f)),$$

where $\varsigma(f)$ *denotes the proof-relevant counterpart of* β*'s resolvability presupposition.* ς *is a piece-wise function:*

$$\varsigma(f) = \begin{cases} \forall x : \bigwedge_{1\to n} \mathsf{domain}(f).\mathcal{D}(\mathsf{rig}_n(f)(x)) & \textit{for } \mathsf{exh}(\beta), \\ \Sigma x : \bigwedge_{1\to n} \mathsf{domain}(f).\mathsf{rig}_n(f)(x) & \textit{for } \mathsf{non\text{-}exh}(\beta). \end{cases}$$

where $\mathsf{exh}(\beta)$ *denotes that* β *is exhaustive and* $\mathsf{non\text{-}exh}(\beta)$ *denotes that* β *is non-exhaustive.*

To resolve β is to construct a proof for $\varsigma(f)$. If β is exhaustive, to resolve β, one provides a proof v for $\forall x : \bigwedge_{1\to n} \mathsf{domain}(f).\mathcal{D}(\mathsf{rig}_n(f)(x))$, but one is not obliged to mention all the information contained in v: it suffices to mention whether $\mathsf{rig}_n(f)(x)$ holds for every $x : \bigwedge_{1\to n} \mathsf{domain}(f)$.

Likewise, for β non-exhaustive, to resolve β, one is supposed to construct a proof v for $\Sigma x : \bigwedge \underset{1\to n}{\mathsf{domain}}(f).\mathsf{rig}_n(f)(x)$, but one is not obliged to mention all the information contained in v: it suffices to specify which $x : \bigwedge \underset{1\to n}{\mathsf{domain}}(f)$ satisfies $\mathsf{rig}_n(f)(x)$. Let $\underset{1\to n}{\mathsf{domain}}(f)$ be a finite type such that $\underset{1\to n}{\mathsf{domain}}(f)$ can be equivalently written as:

$$\underset{1\to n}{\mathsf{domain}}(f) = \{c_1, ..., c_m\} : \mathsf{U},$$

where $m : \mathbb{N}^+$. Let $v : \varsigma(f)$, a full answer to β is written as $\vartheta(f, v) : \mathsf{Prop}$, defined as follows (where $1 \leq j \leq m$ and $j, m : \mathbb{N}^+$):

$$\vartheta(f,v)=\begin{cases}\bigwedge \pi_l(v(c_j)) & \textit{for } \mathsf{exh}(\beta),\\ \mathsf{rig}(f)(\pi_l(v)) & \textit{for } \mathsf{non\text{-}exh}(\beta).\end{cases}$$

In terms of ϑ, the notion of full answer can be now formally defined:

Definition 14 (Full Answer, formalized)**.** *Let $A : \mathsf{Prop}$ and $f : \mathcal{E}$, we write f-$\mathsf{fans}(A)$ to denote that A fully answers a question characterized by f. f-$\mathsf{fans}(A)$ is defined as follows:*

$$f\text{-}\mathsf{fans}(A) := \exists x : \varsigma(f).(\vartheta(f, x) = A \in \mathsf{Prop}).$$

5.2 Norms of Question

The definition of questions as a normative specie, first introduced in Section 1.1.1 of Chapter 1 and repeated here, is inspired by Brandom's (1994, 1997, 2000) analysis of shall-statements:[3] [4]

[3]For Millson (2014b), to perform a question is to acknowledge a commitment to the existence of a full answer to the question. However, the acknowledgment of such a commitment need not lead one to raise the question: one can commit to the existence of a full answer to a question but shows no interest in knowing it.

[4]Brandom (1994) views the utterance of a shall-statement as the most typical way to express a practical commitment. For example, the statement *I shall open*

Definition 15 (Question)**.** *To perform a question, one prima facie* (*a*) *acknowledges a* (*practical*) *commitment to seek a full answer to the question, and* (*b*) *assumes the responsibility of vindicating one's entitlement to endorse such a commitment.*

Questions, as assertions, are conceived first and foremost as a normative kind, underlain by two types of normative statuses: *commitment* and *entitlement*. The two types of normative statuses are essentially social statuses, exhibiting the corresponding constituting social norms (i.e., *commitment* and *entitlement norms*). In discursive practices, participants comply their behavior with the two constitutive norms when performing a question and evaluate others' in a similar fashion.

In virtue of the fact that every question is associated with a resolvability presupposition (as long as it is considered askable), to fully answer a question, from a type-theoretical perspective, is to construct a proof for the proof-relevant counterpart of the resolvability presupposition carried by the question (cf. Ranta (1994, 137)). In other words, in uttering a question, one is doxastically committed to the existence of a full answer to the question and one seeks to *deanonymize* (or to search for) a constructive proof of the resolvability presupposition associated with the question. The view of question as proof deanonymization is reminiscent of the inquisitive analysis of question: "the logic of questions has a constructive flavor [as] proofs involving questions have [a] constructive interpretation" (Ciardelli, 2016, 84-85). A similar idea is also expressed in Hintikka (2002): "the logic of identificatory knowledge [= knowledge of a full answer to a question] is a realization of the correctly interpreted intuitions of the intuitionists"(p.244) (see Chapter 2 in Hintikka (2007) for related discussion).

The practical commitment that one acknowledges by performing

the umbrella expresses a practical commitment to an action. It is obvious that the expression of a shall-statement is closely related to what we usually call a *command* in linguistic discourse. For a detailed account of normative statuses underpinning the performance of shall-statements and the way to justify one's entitlement to a shall-statement, see Chapter 4 in Brandom (1994).

a question is first and foremost impersonal: it is a normative status that one acknowledges by oneself or alternatively that one attributes to oneself.[5] To vindicate one's entitlement to endorse such a practical commitment, one provides a reason consisting of two parts: a practical commitment, also called a *pro-attitude* in Davidson (1963, 1984), that one has a goal to know a full answer to the question, and a doxastic commitment that if one wants to know a full answer to a question, one shall ask the question. The two justificatory commitments for the performance of a question are trivial in linguistic discourse and most often there is no need to explicitly mention them (unless necessary). This does not amount to saying that they are useless: as long as they are made explicit, the interlocutor is free to challenge for further reasons. For example, whenever the pro-attitude of making a question is made explicit, one shall interrogate why the speaker wants to know a full answer to the question. In consonance with our definition of assertion, the above analysis justifies our interpretation of questions as a normative specie underlain by two fundamental sorts of normative statuses: to raise a question, one *prima facie* acknowledges a practical commitment to seek a full answer to the question and meanwhile one assumes the responsibility of vindicating one's entitlement to acknowledge such a practical commitment.

5.3 *Knowing-wh*

To resolve a question by providing a full answer, one is first and foremost (doxastically) committed to the fact that one knows the answer. The knowledge of a (full) answer to a question, also known as *identificatory knowledge* in Hintikka (1962, 2002), is different from propo-

[5]In linguistic discourse, in particular, in interaction contexts, the performance of a question usually has a second-personal character, that is, that the question is addressed to the interlocutor. This implies that in such contexts, by performing a question, one expresses an additional practical commitment that is essentially second-personal, i.e., that one commits to seeking a full answer to the question from the interlocutor. This is considered in detail in Chapter 6.

Let a be different from the speaker			
K5	a knows $_{\beta}[wh\text{-}...]$	$\rightsquigarrow$	β is resolvable
K6	a doesn't know $_{\beta}[wh\text{-}...]$	$\rightsquigarrow$	β is resolvable
Let a be identical with the speaker			
K7	a knows $_{\beta}[wh\text{-}...]$	$\rightsquigarrow$	β is resolvable
K8	a doesn't know $_{\beta}[wh\text{-}...]$	$\not\rightsquigarrow$	β is resolvable

*In this table, *the speaker* denotes the one who asserts/asserted the proposition on the left side of $\rightsquigarrow/\not\rightsquigarrow$.

Table 5.1: Inference patterns of *know-wh*

sitional knowledge considered in Section 4.2 of Chapter 4. In English, identificatory knowledge is usually expressed by *know-wh* (e.g., know whether/what/why/how ...), whereas propositional knowledge is expressed by *know-that*. Traditionally, it is believed that identificatory knowledge can be reduced to propositional knowledge: one knows an answer to a question iff one knows the proposition therein expressed.[6]

To formally represent one's identificatory knowledge expressed by *know-wh*, we confront two challenges. First, similar to the assertions of propositional knowledge, to assert that one possesses certain identificatory knowledge usually exhibits certain factive inferences, as shown in Table 5.1. It is worthwhile noticing that such factive inferences are cancelable in certain contexts such as in (K8). An adequate analysis of identificatory knowledge must account for the associated factive inferences. Second, there is a crucial difference between self- and other-ascribed identificatory knowledge: if one accredits to oneself certain

[6]In the traditional logical analysis of knowledge, three kinds of knowledge are distinguished: propositional knowledge, identificatory knowledge, and knowledge of entities. Since Hintikka (1962), it is widely assumed that propositional knowledge is primitive among the three kinds of knowledge whilst the other two kinds of knowledge are both reducible to propositional knowledge.

identificatory knowledge, i.e., knowledge of a (full) answer to a question, one entitles the interlocutor to address to oneself the concerned question; but such an address is certainly unfair if the concerned identificatory knowledge is ascribed to one by someone else but not by oneself.[7] For example, when a claims to know a (full) answer to a question, b shall address this question to a asking for the answer (that a knows); in contrast, when b claims that a knows a (full) answer to a question, it is unfair to address the question to a because a might be completely ignorant of such an answer. The above observation indicates that a proper analysis of identificatory knowledge should take into account the relationship between the *ascriber* (i.e., usually the speaker), who ascribes certain identificatory knowledge to someone, and the *ascribee*, who is attributed certain identificatory knowledge. The solutions to abovementioned two challenges are closely related.

To start with, consider the first problem. To represent one's identificatory knowledge, we introduce a knowledge-*wh* operator Kh:

$$\mathsf{Kh} : \mathsf{ind} \to f : \mathcal{E} \to \mathsf{R}(\hat{\varsigma}(f)) \to \mathsf{Prop}.$$

Let β be characterized by f and let $a : \mathsf{ind}$ and $p : \mathsf{R}(\hat{\varsigma}(f))$, $\mathsf{Kh}(a, f, p)$, conveniently abbreviated as $\mathsf{Kh}_a(f, q)$, intuitively expresses that a is aware of a full answer to β. Kh is defined by the following rules:

$$\text{If } \Gamma_a \vdash p : \mathsf{R}(\hat{\varsigma}(f)) \text{ and } \Gamma_a \vdash f\text{-}\mathsf{fans}(\pi_l(p)) \ \mathsf{true}, \text{ then } \Gamma_a \vdash \mathsf{Kh}_a(f, p) \ \mathsf{true}. \qquad (\mathrm{I}_{\mathsf{Kh}})$$

$$\text{If } \Gamma_a \vdash \mathsf{Kh}_a(f, p) \ \mathsf{true}, \Gamma_a \vdash h : \mathsf{R}(\hat{\varsigma}(f)) \to \mathsf{R}(\hat{\varsigma}(g)), \text{ and } \Gamma_a \vdash g\text{-}\mathsf{fans}(\pi_l(h(p))) \ \mathsf{true}, \text{ then } \Gamma_a \vdash \mathsf{Kh}_a(g, h(p)) \ \mathsf{true}. \qquad (\mathrm{E}_{\mathsf{Kh}})$$

$$\forall h : \mathsf{R}(\hat{\varsigma}(f)) \to \mathsf{R}(\hat{\varsigma}(g)).(\mathsf{Kh}_a(f, p) \to \mathsf{Kh}_a(g, h(p))). \qquad (\mathrm{DK}_2)$$

[7] Lemmon (1959) has observed that one might claim to know a (full) answer to a question but happens to forget it. However, notice that if one has a feeling of forgetting, one also has a strong feeling of knowing (Wiggins, 1979; Frise, 2018). Therefore, if an agent claims to know a (full) answer to a question, the address of the question to the agent is necessarily warranted regardless of whether the agent still remembers or happens to forget the concerned answer.

The rationale of having $\mathsf{R}(\hat{\varsigma}(f))$ in the definition of Kh is very similar to the inclusion of $\mathsf{R}(A)$ in our definition of K: the well-formedness of $\mathsf{Kh}_a(f,p)$ presupposes $p : \mathsf{R}(\hat{\varsigma}(f))$ (that is, that a is in possession of a reason of the resolvability presupposition of β and consequently, that a is committed to the resolvability of β), which is satisfied locally but not necessarily globally. Due to the inclusion of $\mathsf{R}(\hat{\varsigma}(f))$ in the definition of Kh, (K5-K8) are successfully captured: let a differ from the asserter of $\mathsf{Kh}_a(f,p)$ (or $\neg\mathsf{Kh}_a(f,p)$), $\mathsf{R}(\hat{\varsigma}(f))$ is satisfied/inhabited both locally and globally; by contrast, let a be identical with the asserter of $\neg\mathsf{Kh}_a(f,p)$, the factive presupposition $\mathsf{R}(\hat{\varsigma}(f))$ holds locally but not necessarily globally. The first challenge is thus solved. Please note that since $\mathsf{R}(\hat{\varsigma}(f))$ is proof-relevant, the definition of Kh fails to capture the fact that the truth of a *know-wh*-proposition is irrelevant to the content contained in the proofs of $\mathsf{R}(\hat{\varsigma}(f))$. To illustrate, let $p, q : \mathsf{R}(\hat{\varsigma}(f))$ where p and q are not identical, by definition, $\mathsf{Kh}_a(f,p)$ and $\mathsf{Kh}_a(f,q)$ are different propositions. This is clearly unwanted because $\mathsf{Kh}_a(f,p)$ and $\mathsf{Kh}_a(f,q)$ should express the same meaning that a knows a full answer to β. To handle this problem, we posit the following axiom:

$$\forall p, q : \mathsf{R}(\hat{\varsigma}(f)).\mathsf{Kh}_a(f,p) \leftrightarrow \mathsf{Kh}_a(f,q). \tag{QK}$$

The second challenge is trickier. Representing a first-person assertion of identificatory knowledge using Kh correctly captures the inference that such an assertion presupposes that the speaker commits to the resolvability of the concerned question. However, notice that such an assertion has a stronger inference, i.e., that the speaker commits to not only the resolvability of the concerned question, but also to knowing a full answer to it. This is captured by the following axiom:

$$\begin{aligned}\forall x : \mathsf{R}(\hat{\varsigma}(f)).(\mathsf{Kh}_a(f,x) \rightarrow \mathsf{B}_a(f\text{-}\mathsf{fans}(\pi_l(x))) \rightarrow \\ \Sigma y : \varsigma(f).\mathsf{K}_a(\vartheta(f,y), \mathsf{r}_0(x))).\end{aligned} \tag{CA}$$

(CA) intuitively reads as follows: for every reason x of the resolvability presupposition carried by a question, if a is aware of a full answer to this question and if a believes that $\pi_l(x)$ is exactly such a full answer, then a knows this answer.[8] This axiom is useful in the formalization of questions, as will be immediately shown in the next section.

5.4 Simple Question

Let β denote a question characterized by $f : \mathcal{E}$. In linguistic discourse, a question that one performs is addressed to another. In the simplest scenario, one is unaware if the latter knows a full answer to β. In light of this, an assumption of the addressee's knowledge of a full answer to β is added to the semantic representation of β:[9]

$$\begin{bmatrix} [\Delta_b]_a & \vdash \forall x : \mathsf{R}(\hat{\varsigma}(f)).\forall y : (\mathsf{Kh}_b(f,x) \wedge \mathsf{B}_b(f\text{-}\mathsf{fans}(\pi_l(x)))). \\ & \quad \mathsf{K}_b(\vartheta(f, \pi_l(@_i(x,y))), \mathsf{r}_0(x)) \ \mathsf{true} \\ \Gamma_a & \vdash \mathsf{K}_a(\hat{\varsigma}(f), p) \wedge \mathsf{K}_a(\mathsf{G}_a(f), q) \ \mathsf{true} \end{bmatrix} \qquad (\star)$$

where a and b denote respectively the speaker and the addressee, $@_i$: (CA), $\Gamma_a \vdash p : \mathsf{R}(\hat{\varsigma}(f))$, and $\Gamma_a \vdash q : \mathsf{R}(\mathsf{G}_a(f))$. $\mathsf{G}_a(f)$ intuitively denotes that a desires to know a full answer to a question characterized by f (i.e., β). ($\star$) is a composite judgment, consisting of two compo-

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[8] (QA) and (AQ) further characterize the connection between Kh and K:

$$\mathsf{Kh}_a(f,p) \to \exists x : \mathsf{R}(\hat{\varsigma}(f)).f\text{-}\mathsf{fans}(\pi_l(x)) \wedge \mathsf{K}_a(\pi_l(x), \mathsf{r}_0(x)). \qquad \text{(QA)}$$

$$\forall x : \mathsf{R}(\hat{\varsigma}(f)).(f\text{-}\mathsf{fans}(\pi_l(x)) \to \mathsf{K}_a(\pi_l(x), \mathsf{r}_0(x)) \to \mathsf{Kh}_a(f,x)). \qquad \text{(AQ)}$$

(QA) intuitively shows that if a knows what amounts to a full answer to a question β (characterized by $f : \mathcal{E}$), then there exists a full answer to β such that a knows it. (AQ) intuitively shows that for any full answer to β, if a knows it, then a knows what amounts to a full answer to β.

[9] In Ginzburg and Sag (2000) and Ginzburg (2005, 2012), questions are directly represented as functions (or λ-abstracts). But this cannot offer a proper epistemic explanation for question evocation: it lacks an account of the knowledge required for evoking a question. This does not amount to saying that a theory of question under the view of questions as functions cannot offer an account for the way how a question is used. But in order to develop such an account, a question-as-function theory of question appeals to the introduction of additional concepts (e.g., preconditions of inquiry in Ginzburg (2012)), which are somewhat *ad hoc*.

nent judgments. The first component judgment of $(\star)$ is $(\star')$.

$$[\Delta_b]_a \vdash \forall x : \mathsf{R}(\hat{\varsigma}(f)).\forall y : (\mathsf{Kh}_b(f,x) \wedge \mathsf{B}_b(f\text{-}\mathsf{fans}(\pi_l(x)))). \\ \mathsf{K}_b(\vartheta(f, \pi_l(@_i(x,y))), \mathsf{r}_0(x)) \ \mathsf{true} \tag{$\star'$}$$

$(\star')$ expresses that from a's perspective, if b knows amounts to a full answer to β, b knows this answer. The second part of $(\star)$ is $(\star'')$:

$$\Gamma_a \vdash \mathsf{K}_a(\hat{\varsigma}(f), p) \wedge \mathsf{K}_a(\mathsf{G}_a(f), q) \ \mathsf{true} \tag{$\star''$}$$

$(\star'')$ expresses that a knows that there exists a full answer to β and a desires to know such a full answer to β. The addition of $(\star'')$ allows the possibility for challenges to the question β: the interlocutor can challenge $\mathsf{K}_a(\hat{\varsigma}(f), p)$ for a reason for the speaker's doxastic commitment to $\hat{\varsigma}(f)$, or challenge $\mathsf{K}_a(\mathsf{G}_a(f), q)$ for a reason for the speaker's practical commitment (or *pro-attitude* in Davidson (1963)) to $\mathsf{G}_a(f)$.

In this dissertation, $(\star)$ is taken as the semantic representation of β. In Section 3.5.3, we define two characteristic terms for a speech act: *p-term*, which encodes information about the semantics of a speech act, and *r-term*, which encodes information about the rhematic structure of a speech act. The p-term of β is exactly f. Let g denote the r-term of β. If the performer a and the addressee b are both irrelevant to discussion, $(\star)$ is conveniently abbreviated as follows:

$$\beta[\mathcal{E}]_f^g : \Psi_{\mathcal{E}}. \tag{$\star'''$}$$

5.5 Erotetic Reasoning

Erotetic reasoning (i.e., *$\mathcal{E}$-reasoning*, henceforth) extends $\mathcal{A}$-reasoning by taking *questions* into consideration. This section introduces three kinds of erotetic inferences: *question implication*, *question resolution* and *question evocation*. In this dissertation, question implication and question resolution are deemed primitive, whilst question evocation is shown to be reducible to question implication. The complete derivations for erotetic inferences are given in Section D of Appendix B.

5.5.1 Question implication

To infer a question from another is an erotetic inference dubbed *question implication*, formally defined as follows:

Definition 16 (Question Implication). *Let* $\alpha[\mathcal{A}]_u^v : \Psi_{\mathcal{A}}$, $\rho[\mathcal{E}]_p^q : \Psi_{\mathcal{E}}$, *and* $\beta[\mathcal{E}]_f^g : \Psi_{\mathcal{E}}$, $\mathsf{imp}(\alpha[\mathcal{A}]_u^v, \rho[\mathcal{E}]_p^q, \beta[\mathcal{E}]_f^g)$ *denotes that* ρ *implies* β *on the basis of* α, *formally defined as follows:*

$$\mathsf{imp}(\alpha[\mathcal{A}]_u^v, \rho[\mathcal{E}]_p^q, \beta[\mathcal{E}]_f^g) := u \to \forall A, B : \mathsf{Prop}.(p\text{-}\mathsf{fans}(A) \to f\text{-}\mathsf{fans}(B) \to ((A \to B) \wedge p\text{-}\mathsf{pans}(B)).$$

$\mathsf{imp}(\alpha[\mathcal{A}]_u^v, \rho[\mathcal{E}]_p^q, \beta[\mathcal{E}]_f^g)$ *is often abbreviated as* $\mathsf{imp}(\alpha, \rho, \beta)$.

The fundamental idea of question implication is the following: ρ implies β on the basis of α iff (i) a full answer to ρ fully answers β on the basis of α and (ii) a full answer to β at least partially answers ρ on the basis of α (see Wiśniewski (2013, 71) for a comparison of various definitions of question implication). The definition of question implication looks very similar to that of Roberts (1996/2012) (see Section 1.1.1 of Chapter 1) but there are two minor differences: first, drawing inspirations from Wiśniewski (2013), we allow question implication to take an assertion as a premise (called *assertional premise* henceforth); second, in Roberts (1996/2012), the notion of question implication is defined on the basis of the exhaustive interpretation of questions but this is no longer required in our definition.

5.5.2 Question resolution

To resolve/answer a question with an assertion is an erotetic inference dubbed *question resolution*, formally defined as follows:

Definition 17 (Question Resolution). *Let* $\alpha[\mathcal{A}]_p^q : \Psi_{\mathcal{A}}$, $\beta[\mathcal{E}]_f^g : \Psi_{\mathcal{E}}$, $\mathsf{rsl}(\alpha[\mathcal{A}]_p^q, \beta[\mathcal{E}]_f^g)$ *denotes that* α *resolves* β. $\mathsf{rsl}(\alpha[\mathcal{A}]_p^q, \beta[\mathcal{E}]_f^g)$

is formally defined as follows:

$$\mathsf{rsl}(\alpha[\mathcal{A}]^q_p, \beta[\mathcal{E}]^g_f) := f\text{-}\mathsf{fans}(p).$$

$\mathsf{rsl}(\alpha[\mathcal{A}]^q_p, \beta[\mathcal{E}]^g_f)$ *is often abbreviated as* $\mathsf{rsl}(\alpha, \beta)$.

The intuitive idea underlying this definition is as follows: α resolves β iff α fully answers β. In linguistic discourse, however, an answer to a question could be only partial. For Roberts (1996/2012), it suffices to define *question resolution* based on partial resolution. However, it is worth mentioning that partial resolution is reducible to full resolution: to partially resolve a question is to fully resolve a question implied by the original question. This motivates the following definition:

Definition 18 (Partial Question Resolution)**.** *Let* $\alpha[\mathcal{A}]^q_p : \Psi_\mathcal{A}$ *and* $\beta[\mathcal{E}]^g_f : \Psi_\mathcal{E}$, $\mathsf{prsl}(\alpha[\mathcal{A}]^q_p,\ \beta[\mathcal{E}]^g_f)$ *denotes that* α *partially resolves* β*, formally defined as follows:*

$$\mathsf{prsl}(\alpha[\mathcal{A}]^q_p, \beta[\mathcal{E}]^g_f) := f\text{-}\mathsf{pans}(p).$$

$\mathsf{prsl}(\alpha[\mathcal{A}]^q_p, \beta[\mathcal{E}]^g_f)$ *is often abbreviated as* $\mathsf{prsl}(\alpha, \beta)$.

To avoid terminological ambiguity, in the dissertation, the term *question resolution* refers exclusively to full question resolution (*à la* Definition 17) but not partial question resolution.

5.5.3 Question evocation

In many qud-based studies such as Onea (2013) and Riester (2019), researchers appeal to a structural relation dubbed *question evocation*, i.e., to evoke/infer a question from an assertion.[10] The extensive use

[10] To illustrate, consider Riester's (2019) example:

(1) a. A_0: Max had a lovely evening.
    b. $Q_{0.1}$: What did Max do on that lovely evening?

of question evocation in these works seems improper as it is inconsistent with the fundamental assumption of qud-based approaches to discourse, i.e., that question resolution and question implication are the only two organizing principles of discourse. This is no longer a problem in this dissertation because our definition of question implication (but not Roberts' (1996/2012)) provides the possibility of defining question evocation as a special case of question implication.

Let ρ stand for the Big Question (in Roberts' (1996/2012) sense) in $\mathsf{imp}(\alpha, \rho, \beta)$. In this case, ρ is contentless and the information required for the implication of β is provided by α only. This very special type of question implication is dubbed *question evocation*:[11]

> **Definition 19** (Question Evocation). *Let α denote an assertion and β denote a question.* $\mathsf{evk}(\alpha, \beta)$ *denotes that α evokes β, formally defined as follows:*
>
> $$\mathsf{evk}(\alpha, \beta) := \mathsf{imp}(\alpha, \mathrm{BQ}, \beta).$$

In light of the close connection between question evocation and question implication, i.e., that question evocation is reducible to question implication (from the Big Question), we consider question implication a primitive erotetic inference in this dissertation.

---

c. $A_{0.1}$: He had a great meal.

d. $Q_{0.1.1}$: What did Max eat during his meal?

In terms of Riester, $Q_{0.1}$ is *anaphorically dependent* on A_0, or in our words, $Q_{0.1}$ is *evoked* by A_0. This analysis can be traced back at least to van Kuppevelt (1995a, 1995b), who considers A_0 a *feeder* for $Q_{0.1}$. The same analysis also generalizes to $A_{0.1}$ and $Q_{0.1.1}$: the latter is evoked by the former. In terms of Onea (2013, 2016), a question evoked by an assertion (under a set of contextual assumptions) is called a *potential question*.

[11]In Wiśniewski (2013, 84), erotetic evocation is seen as erotetic implication by *non-factual questions*. The notion of a non-factual question is defined as follows: a question is non-factual iff every simple answer to this question is necessarily true. This notion is by and large useless for the analysis of linguistic discourse because a natural language does not contain any non-factual questions. The relationship between Wiśniewski's view of erotetic evocation and ours is left for future work.

5.6 Summary

This chapter generalizes the normative analysis of assertions (given in Chapter 4) to questions, conceiving questions as a normative kind, underlain by two types of normative statuses: commitment and entitlement. The normative analysis of questions takes inspirations from Brandom's (1994) analysis of shall-statements, but despite many similarities that they share, there is a fundamental difference between questions and shall-statements: the former carry a resolvability presupposition, which is not part of the semantics of the latter. From a type-theoretical perspective, fully answering a question is tantamount to giving a constructive proof for the resolvability presupposition associated with the question. Under this view of question, we propose to represent a question by a knowledge-based composite judgment consisting of two component judgments: one showing that the questioner commits to knowing the resolvability (i.e., the existence of a full answer) of this question and that the questioner desires to know a full answer to this question; the other requesting such a full answer from the interlocutor under the assumption that the interlocutor is aware of it. The modeling of questions as knowledge-based composite judgments faithfully captures the inferential role and the epistemic background of querying, and moreover, it lends us a straightforward way to formalize erotetic reasoning (i.e., reasoning involving questions) in terms of the inference rules for judgments in type theory.

Chapter 6

Addressing Speech Acts

This chapter develops an account of addressing as a normative attitude, the main theses being the following: (*i*) to address a speech act, one addresses a practical commitment under the assumption that the interlocutor will accept and fulfill it; (*ii*) addressing is a normative attitude pertaining to the speaker but not the addressee.[1]

This chapter is structured as follows: Section 6.1 defines addressing as a normative attitude and compares our account of addressing with Millson's (2014a, 2014b); Section 6.2 explores the inner structure of the address of a speech act; Section 6.3 examines the relevance of addressing to the intrapersonal/interpersonal distinction in discursive scorekeeping; Section 6.4 offers some concluding remarks.

6.1 Addressing: The Third Attitude

The main insight that we draw from Millson's (2014a, 2014b) account of addressing (see Section 2.2.2 of Chapter 2 for more details) is that *addressing* should be considered a normative attitude, in parallel with

[1] It is worthwhile reminding that the verb *address* is used in a technical way (in line with Millson (2014a, 2014b)) throughout this dissertation: to address a speech act is to attract one's attention to the speech act, usually calling for a response. This substantially differs from the more popular and colloquial use of this verb as a synonym for *handle* and *deal with*.

acknowledging and *attributing*. However, as pointed out in Section 2.2.2 of Chapter 2, Millson's account of addressing lacks a proper explanation of the warranty of addressing: it is unclear under what conditions one is *entitled* to address a speech act. In this section, to handle this problem, we advocate a conditional interpretation of addressing: by addressing a speech act, one addresses a practical commitment under the assumption that the interlocutor will accept and fulfill it.

To start with, consider the addressing of questions. In Chapter 5, we define that in making a question, one *prima facie* acknowledges a practical commitment to seek a full answer to the question. In a conversation, such a commitment is addressed to the interlocutor (that is, the addressee): to perform a question, one requests the interlocutor to provide a full answer to the question. However, as first mentioned in Section 2.2.2 of Chapter 2, the address of a question need not be accepted by the interlocutor, and even if it is accepted, it does not guarantee that the interlocutor is aware of a full answer to the question. This amounts to saying that the address of a question is associated with two assumptions (first mentioned in Section 2.2.2 of Chapter 2): (*i*) that the interlocutor will accept the address and (*ii*) that the interlocutor is aware of a full answer to the question. The two assumptions can be either affirmed or rejected by the interlocutor. This indicates that to address a question, what one *prima facie* addresses is a practical commitment requesting the interlocutor to give a full answer to the question, but in the meantime, one also addresses two auxiliary practical commitments, one requesting the interlocutor to either affirm or reject the acceptance of the question being addressed, and the other requesting the interlocutor to either affirm or reject the possession of a full answer to the question.

In line with Ginzburg (1996a) and Farkas and Bruce (2010) among others, we propose that to make an assertion, one introduces to the discourse a polar question about whether the proposition expressed in the assertion is true.[2] In connection with the second-personal char-

[2]The idea that asserting a proposition introduces a polar question on whether the proposition is true is due to Ginzburg (1996a). It is occasionally dubbed the

acter of assertion, this implies that by addressing an assertion, one addresses a practical commitment requesting the interlocutor to answer whether the asserted proposition is true. Having made explicit the role of the polar question generated from the address of an assertion, the analysis provided above for the addressing of questions can be directly transposed to the analysis of the addressing of assertions. Similar to the practical commitment that one addresses by making a question, the practical commitment that one addresses by asserting need not be accepted by the interlocutor, and even it is accepted, it is not guaranteed that the interlocutor is able to fulfill it. This amounts to saying that the address of an assertion, similar to the address of a question, is associated with two assumptions (already introduced in Section 2.2.2 of Chapter 2): (*i*) that the interlocutor will accept the address, and moreover, (*ii*) that the interlocutor is aware of a full answer to the polar question generated from the address. The fact that the two assumptions can be either either affirmed or rejected points to the reality that in making an assertion, what one *prima facie* addresses is a practical commitment to resolve the polar question generated from the address, but in the meantime, one also addresses two auxiliary practical commitments: one requesting the interlocutor to either affirm or reject the acceptance of the generated polar question, whilst the other requesting the interlocutor to either affirm or reject the possession of a full answer to the generated polar question. However, notice that although the addressing of an assertion is similar to the addressing of a question in various aspects, they differ in that by addressing an assertion, one already provides a full answer–the assertion itself–to the polar question generated from the address, whereas by addressing a question, it is unknown whether one is committed to any possible full answer to the question.[3] In virtue of this distinction,

question-incrementation effect of asserting in this dissertation. The generation of a polar question from the address of an assertion is essentially a pragmatic inference. Undoubtedly, this generated polar question is not part of the semantics of the assertion being addressed but is inferred on the basis of the assumption that the speaker complies with the cooperative principle.

[3]In linguistic discourse, it is possible that a question is not purely information-

to fulfill a practical commitment introduced by the address of an assertion, one not only answers the polar question generated from the address, but also either affirms or rejects the addressed assertion. This triggers Stalnaker's (1978) interpretation: to assert a proposition is to propose that the interlocutor accept it. But this interpretation, as made clear above, is an epiphenomenon of reacting to the the polar question generated from the address of an assertion.

The account of addressing offered above substantially differs from Millson's (2014b). To start with, consider first the addressing of questions. For Millson (2014b), what is addressed to the interlocutor by making a question is an apokritic commitment, i.e., a commitment to resolve the question. The addressing of apokritic commitments in Millson's account can be unwarranted–one is free to reject the address or even reject the interlocutor's entitlement to address such an apokritic commitment. In our account of addressing, we stick to use of the traditional term *practical commitment* introduced by Brandom, which differs from the Millsonian *apokritic commitment* in an important aspect: under the conditional interpretation, one is free to reject an address of a practical commitment by rejecting one of the two assumptions therein involved but one can never reject the interlocutor's entitlement to make such an address.[4] The unwarranted addressing of questions is consequentially avoided. The addressing of assertions is relatively more complicated than the addressing of questions. For Millson (2014b), to address an assertion, one addresses its entitlement, calling upon the interlocutor to recognize the address and to either acknowledge one's entitlement (by making an reassertion) or to chal-

seeking but also encodes one's epistemic bias towards one of the alternative answers to the question. In the literature, such a question is called a *biased question* (see Dayal (2016) for an overview). To not to complicate the discussion, biased questions are not considered in this dissertation but remain for future research.

[4]Let ϕ denote a question. Under the conditional interpretation, an address of ϕ is paraphrased as follows: "if you accept my address of ϕ and if you knows a full answer to ϕ, then answer ϕ". Undoubtedly, one shall never reject the whole sentence because affirming the two assumptions commits one to answer ϕ, but one shall reject either of the two assumptions so as to get rid of the duty to answer ϕ.

lenge it (by requesting a reason) (pp.198-199). However, observe that even in the case that one is not the addressee of an assertion, one is still free to reassert or challenge it whenever one (over)hears it. This amounts to saying that what is important in addressing an assertion is not one's entitlement but something else, concretely, an invitation for an affirmation or a rejection. This motivates our account of the addressing of assertions, mainly inspired by Ginzburg's proposal of the *question-incrementation effect* of asserting: in asserting a proposition, one introduces a polar question on whether the asserted proposition is true. Furthermore, the address of an assertion, similar to that of a question, is made under two assumptions, i.e., that the interlocutor will accept the address and that the interlocutor is aware of a full answer to the generated polar question. The addition of the two assumptions successfully captures the fact that by asserting a proposition, one could be unaware of whether the interlocutor commits to it, and thus ensures that the addressing of an assertion is warranted.

6.2 The Address Structure

The address of a speech act in linguistic discourse, according to the account of addressing developed in the previous section, has a complex structure, dubbed *address structure*, defined as follows:

Definition 20 (Address Structure)**.** *Let* $\alpha[T]^g_f : \Psi$*, the address of* α *has a quaternary structure, defined as follows:*

$$\langle I_c(\alpha), I_k(\alpha), I(\alpha), \alpha \rangle,$$

where $I(\alpha)$*,* $I_c(\alpha)$*, and* $I_k(\alpha)$ *are defined as follows:*

$$I(\alpha) := \begin{cases} \alpha & \textit{if } \alpha \textit{ is a question} \\ \textit{Is } f \textit{ true?} & \textit{if } \alpha \textit{ is an assertion} \end{cases}$$

$$I_c(\alpha) := \textit{Do you commit to answering } I(\alpha)?$$

$$I_k(\alpha) := \textit{Do you know a full answer to } I(\alpha)?$$

$I(\alpha)$, $I_c(\alpha)$, $I_k(\alpha)$ are questions associated with the address of α. $I(\alpha)$ is called the *immediate question* (cf. *attitude locus* in Walker (1996)): as specified in the above definition, if α is a question, $I(\alpha)$ is identified with α; if α is an assertion, then $I(\alpha)$ stands for a polar question on whether the proposition asserted in α is true or not. $I_c(\alpha)$ is dubbed the *acceptance question*. It intuitively reads as follows: *Do you accept the address of* $I_c(\alpha)$? Following Roberts (1996/2012), we understand one's acceptance of a question as equivalent to the acknowledgment of a (practical) commitment to resolve this question. $I_k(\alpha)$ is dubbed the *knowability question*. It intuitively reads as follows: *Do you* (= *the interlocutor*) *know a full answer to* $I(\alpha)$?

The relationship between $I_c(\alpha)$, $I_k(\alpha)$, and $I(\alpha)$ is interesting. If one provides a full answer to $I(\alpha)$, then one must answer both $I_c(\alpha)$ and $I_k(\alpha)$ affirmatively, though such affirmations usually need not be made explicit. However, if one cannot provide a full answer to $I(\alpha)$, it is usually because that one provides a rejective answer to either $I_c(\alpha)$ or $I_k(\alpha)$, that is, that one either does not commit to answering $I(\alpha)$ or one is unaware of a full answer to $I(\alpha)$. It is worthwhile mentioning that while answering rejectively either $I_c(\alpha)$ or $I_k(\alpha)$ implies that one would not be able to answer $I(\alpha)$, there is not such a similar overlap between $I_c(\alpha)$ and $I_k(\alpha)$: one can resolve either of them affirmatively and answers the other with a rejective answer. The relationship between $I_c(\alpha)$, $I_k(\alpha)$, and $I(\alpha)$ is schematically represented by Figure 6.1 (where rsl denotes *question resolution*). The relationship between the three phases, marked by the question marker ?, is underspecified and will be considered in detail in Chapter 8.

6.3 Scorekeeping and Beyond

In line with Brandom (1994, 2000), human communication is modeled by a scorekeeping game. Against Lewis (1979), Brandom argues that there is no need for an official scorekeeper, but instead, that everyone keeps a two-entry scoreboard: on the one hand, one maintains a con-

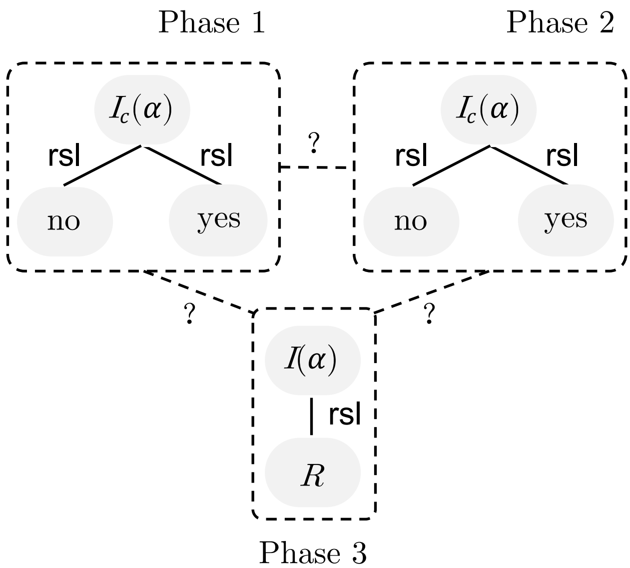


Figure 6.1: Relationship between $I_c(\alpha)$, $I_k(\alpha)$, and $I(\alpha)$

versation with oneself, which is kept track by the interpersonal part of the scoreboard; on the other, one maintains a conversation with the interlocutors(s), which is kept track by the interpersonal part of the scoreboard (see Section 1.1.1 of Chapter 1 for related discussion). In a monologue, the intrapersonal-interpersonal distinction collapses as the speaker and the addressee are the same one. In contrast, in a dialogue or a multi-person conversation, the intrapersonal part and the interpersonal part in a scoreboard need not always go together.[5] This section extends standard Brandomian scorekeeping model with addressing (as an additional deontic attitude) and briefly considers the importance of meta-discursive reasoning in linguistic discourse.

6.3.1 Addressing in scorekeeping

Following Millson (2014a, 2014b), we propose to consider *addressing* as a deontic attitude, in parallel with *acknowledging* and *attributing.* The role and the structure of an address of a speech act is considered in detail in Sections 6.1 and 6.2. In a two-entry scorekeeping model of discourse, the role of addressing is two-fold: by performing a speech act, one addresses it to the interlocutor and in the meantime, one also addresses it to oneself. Schematically, this is illustrated by Figure 6.2, where $\bullet$ denotes a communicating agent and $\circ$ denotes a speech act. The arrows in solid line represent the acknowledgment/self-attribution of normative statuses whereas the arrows in dotted line represent the address of normative statuses. In Figure 6.2, we have three speech acts labeled by 1, 2, and 3: the 1- and 3-labeled circles correspond to the performed and perceived speech acts whereas the 2-labeled circle, linked to 1-labeled speech act by an ellipse, represents a's actual attitude towards the content expressed in the 1-labeled speech act.

[5]The intrapersonal-interpersonal distinction helps to account for a variety of intriguing linguistic phenomena such as the performability of *insincere speech acts* (see Lackey (2007), Wall (2012), and Meibauer (2014) for details) and *clarificatory questions* (i.e., questions that request a clarification about a previously performed speech act) (see Chapter 6 of Ginzburg (2012) for details).

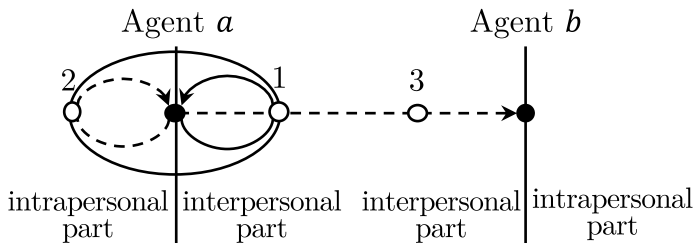


Figure 6.2: Two-entry scorekeeping

The distinction between 1- and 3-labeled nodes in Figure 6.2 is necessary because one's speech act is not necessarily fully retrieved by the interlocutor: the interlocutor might miss something contained in the speech act due to various reasons (e.g., overhearing or being distracted) (see Section 1.1.1 of Chapter 1 for related discussion).

6.3.2 Meta-discursive reasoning

In discourse analysis, a *meta-discourse* is a discourse about another discourse, usually dubbed the *object discourse*. Linguistic discourse is a mixture: though there is a clear boundary between meta-discourse and object discourse, discourse participants shall feel free to fluctuate between the two very different layers. To model reasoning activities in the meta-discourse, the basic idea is to view meta-discourse as an object discourse–though at a different level–such that the inferential relationship between meta-discursive speech acts can be characterized by formal rules for $\mathcal{A}$- and $\mathcal{E}$-reasoning. The primary meta-discursive speech act associated with an object-level speech act α is an assertion, conveniently written as $\mathsf{meta}(\alpha)$. The performance of a speech act α consists of two parts: the object-level speech act α and the meta-level speech act $\mathsf{meta}(\alpha)$. This is called the *two-fold performance thesis*:

Two-Fold Performance Thesis:
The performance of a speech act consists of two parts: the

object-level speech act and the meta-level speech act.

Please observe that the content of the meta-level speech act $\mathsf{meta}(\alpha)$ is not fixed but is dependent on how the interlocutor perceives α: for example, it could be the case that the interlocutor has missed some information in α. This allows for multiple types of clarificatory questions. Consider (1), inspired by Ginzburg (2012, 23):

(1) a. Speaker *a*: Whom does Jon admire?
    b. Speaker *b*: Jon? i. (= Are you mentioning Jon?)
       ii. (= Who is Jon?)

The first reading of *Jon?* signals that *b* is unclear whether *a* mentions Jon, whilst the second reading of *Jon?* signals that *b* is unaware of who Jon is.[6] In both cases, (1a) is not fully interpreted in the sense that some constituent or the meaning of some constituent is underspecified. From the two different readings of *b*'s reaction, we can retrieve what *b* has perceived from *a*'s utterance:

(2) a. $\mathsf{meta}(1a)_1$: *a* performed a question asking whom does someone, probably called Jon admires.
    b. $\mathsf{meta}(1a)_2$: *a* performed a question asking whom does someone called Jon admires.

Taking meta-level reasoning activities into account, we further extend standard Brandomian scorekeeping model of discourse. It is not only two-entry but also, at the same time, two-tier: on the one hand, the scoreboard keeps track of scores associated with speech acts in the object-level discourse; on the other hand, the scoreboard also keeps track of scores associated with corresponding meta-discursive speech

[6] Thanks to Enric Vallduví (p.c.), who reminded me that there is an alternative interpretation of the non-sentential utterance *Jon?*, that is, that *b* fully interprets *a*'s utterance but *b* wonders if *a* really desires to talk about whom Jon admires but not others. It is still a meta-discursive clarificatory question but it does not seek a clarification about the content expressed in (1a) but about *a*'s certitude of acknowledging such a practical commitment (to seek an answer to (1a)).

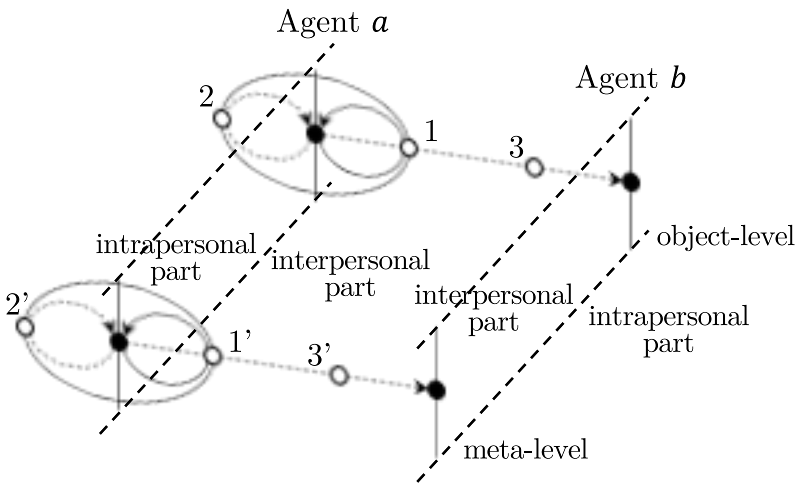


Figure 6.3: Two-entry and two-tier scorekeeping

acts. Schematically, this is intuitively illustrated by Figure 6.3, which consists of two parallel diagrams of two-entry scorekeeping model of discourse, one at the object-level and the other at the meta-level.

6.4 Summary

This chapter develops a normative account of addressing. Following Millson (2014a, 2014b), we propose to conceive addressing as a normative deontic attitude, in parallel with acknowledging and attributing in Brandom (1994, 2000). But unlike Millson, we propose to conceive the essential import of addressing as an invitation for a reaction: to address a speech act α, one address a question $I(\alpha)$ to the interlocutor together with two auxiliary questions $I_c(\alpha)$ (i.e., whether the interlocutor accepts $I(\alpha)$) and $I_k(\alpha)$ (i.e., whether the interlocutor is aware of a full answer to $I(\alpha)$). The addition of $I_c(\alpha)$ and $I_k(\alpha)$ as part of the interpretation of the address of α ensures that the act of addressing α is always epistemically warranted. This effectively avoids many problems encountered by Millson. The view that linguistic discourse can be modeled as a two-entry scorekeeping game open new possibilities for the interpretation of addressing: in a multi-agent discourse, by making a speech act, one addresses it to not only the interlocutor but also oneself; and scaling down to a monologue, it is also plausible to say that the performance of a speech act has a second-personal character, that is, that one at least addresses the speech act to oneself. The practical goal of a discourse, whether monological or multilogical, is the exchange of information: in the case of a multilogue, one exchanges information with the interlocutors; and in the case of a monologue, one exchanges information with oneself. The addressing of a speech act is therefore only one side of the story and the other side is about how the interlocutor will react to the speech act being addressed. This is the main topic for Part III.

Part III

Reacting to Speech Acts

Overview Part III

There is a widespread view, dating back to at least Duke (1974), that a linguistic discourse can be reduced to a sequence of *elementary one-turn dialogues* of the following generic setting (in which ϕ and ψ are both elementary speech acts, and ψ is a reaction to ϕ):[7]

$$\phi \oplus \psi$$

The coherence between ϕ and ψ is explained in terms of the notion of relevance: ψ is coherent with ϕ iff ψ is a relevant reaction to ϕ. This part adopts a qud-based perspective, pursuing a proper way to characterize the potential of reactions in an elementary one-turn dialogue, or equivalently, to define the relevance of a reaction to a speech act in an elementary one-turn dialogue. To be more concrete, this part is intended to answer the following research question:

(Q2) How can the relevance of a reaction to a speech act in an elementary one-turn dialogue be properly characterized? Is it possible to define the relevance of a reaction to a speech act in an elementary one-turn dialogue in terms of the existence of a proper bridging qud for the two concerned speech acts?

To answer this question, we propose a mechanism dubbed *qud-bridging* (i.e., bridging two speech acts by a question), together with a series of five constraints for the inference of a proper bridging qud that establishes the relevance of a reaction to a speech act. For convenience, we assume throughout that speech acts are all sincere and as a consequence, the intrapersonal/interpersonal distinction (see Section 6.3

[7] Under this view, a monologue is conceived as a dialogue between two agents that are identical to each other. In order to make such a *monologue-to-dialogue transformation* (or *dialogical transformation* in our terminology, to be considered in detail in Section 11.1 of Chapter 11), a series of constraints must be introduced (see van Deemter et al. (2008), Stoyanchev and Piwek (2011), Bowden, Lin, Reed, Tree, and Walker (2016), and Xu, Hargood, Tang, and Charles (2018) for recent inspiring attempts).

of Chapter 6 for more details) need not be considered.[8]

This part consists of three chapters: Chapter 7 defines a series of useful structural relations between speech acts; Chapter 8 presents an attempt to implement a revised version of Roberts' (1996/2012) definition of qud-based relevance to characterize the potential of reactions and points out several problems that it encounters; Chapter 9 introduces the constrained mechanism of qud-bridging and examines in detail the possibility of defining the relevance of a reaction to a speech act (in an elementary one-turn dialogue) in terms of the existence of a proper bridging qud for both of them.

[8]This does not amount to saying that the interpersonal/intrapersonal distinction is irrelevant to the potential of reactions. It is intentionally left out here in order not to make the picture too complicated.

Chapter 7

Qud-Relations and Qud-Tree

This chapter introduces a series of structural relations between assertions and questions, and a useful convenient method dubbed *qud-tree* for discourse representation. This chapter lays a necessary foundation for the remaining two chapters of Part III.

This chapter is structured as follows: Section 7.1 introduces two primitive types of qud-relations (inherited from Section 5.5 of Chapter 5); Section 7.2 defines two secondary structural relations between speech acts; Section 7.3 considers the information-structural congruence of a speech act to a question; Section 7.4 introduces qud-tree as a framework for discourse representation; Section 7.5 considers (a)symmetries in qud-trees; Section 7.6 provides some concluding remarks.

7.1 Qud-Relations

Since Roberts (1996/2012), most qud-theorists endorse a fundamental working hypothesis that qud-relations are the most basic organizing principles of linguistic discourse (see Section 2.3 of Chapter 2 for more discussion).[1] There is a general consensus among qud-theorists that there are two types of qud-relations, namely, *question resolution*

[1] This working hypothesis is not explicitly argued in Roberts (1996/2012) but is gradually made clear in many subsequent works such as Jasinskaja (2006), Hunter and Abrusán (2015), and Benz and Jasinskaja (2017).

and *question implication*. The two qud-relations are formally defined as follows (repeated from Section 5.5 of Chapter 5):[2]

Definition 21 (Question Implication). *Let* $\alpha[\mathcal{A}]^v_u : \Psi_{\mathcal{A}}$, $\rho[\mathcal{E}]^q_p : \Psi_{\mathcal{E}}$, *and* $\beta[\mathcal{E}]^g_f : \Psi_{\mathcal{E}}$, $\mathsf{imp}(\alpha[\mathcal{A}]^v_u, \rho[\mathcal{E}]^q_p, \beta[\mathcal{E}]^g_f)$ *denotes that* ρ *implies* β *on the basis of* α*, formally defined as follows:*

$$\mathsf{imp}(\alpha[\mathcal{A}]^v_u, \rho[\mathcal{E}]^q_p, \beta[\mathcal{E}]^g_f) := u \to \forall A, B : \mathsf{Prop}.(p\text{-}\mathsf{fans}(A) \to f\text{-}\mathsf{fans}(B) \to ((A \to B) \wedge p\text{-}\mathsf{pans}(B)).$$

$\mathsf{imp}(\alpha[\mathcal{A}]^v_u, \rho[\mathcal{E}]^q_p, \beta[\mathcal{E}]^g_f)$ *is often abbreviated as* $\mathsf{imp}(\alpha, \rho, \beta)$.

Definition 22 (Question Resolution). *Let* $\alpha[\mathcal{A}]^q_p : \Psi_{\mathcal{A}}$, $\beta[\mathcal{E}]^g_f : \Psi_{\mathcal{E}}$, $\mathsf{rsl}(\alpha[\mathcal{A}]^q_p, \beta[\mathcal{E}]^g_f)$ *denotes that* α *resolves* β. $\mathsf{rsl}(\alpha[\mathcal{A}]^q_p, \beta[\mathcal{E}]^g_f)$ *is formally defined as follows:*

$$\mathsf{rsl}(\alpha[\mathcal{A}]^q_p, \beta[\mathcal{E}]^g_f) := f\text{-}\mathsf{fans}(p).$$

$\mathsf{rsl}(\alpha[\mathcal{A}]^q_p, \beta[\mathcal{E}]^g_f)$ *is often abbreviated as* $\mathsf{rsl}(\alpha, \beta)$.

In the vast literature of qud-based approaches to pragmatics and discourse (see Roberts' annotated Qud Bibliography), researchers have introduced many auxiliary qud-based relations, among which, *partial question resolution* (Roberts, 1996/2012; Ginzburg, 2012) and *question evocation* (van Kuppevelt, 1995a; Onea, 2013, 2016; Riester, 2019) are most commonly found. The formal definitions of the two auxiliary qud-based relations are presented in Section 5.5 of Chapter 5, and it is further shown both can be reduced to the two primitive qud-relations: question evocation is reducible to question implication (from the Big Question), whilst partial question resolution is reducible to question resolution of a subquestion. The observation that auxiliary qud-based

[2]The reader is referred to Section 5.5 of Chapter 5 for the basic intuitive idea underlying the definitions of the two primitive qud-relations.

relations are reducible to primitive qud-relations partially supports the fundamental assumption that only question resolution and question implication are primitive qud-relations.

7.2 Secondary Relations

This section introduces two secondary relations between speech acts, *domination* and *promotion*, which are defined on the basis of the two primitive qud-relations. The two secondary relations, as will be shown in Section 7.4, are extremely useful in the construction of qud-trees.

7.2.1 Domination

Domination is a binary relation, defined as follows:[3]

> **Definition 23** (Domination). *Let β denote a question and α denote an assertion or a question, we write* $\mathsf{dom}(\beta, \alpha)$ *to denote that β dominates α, defined as follows:*
>
> $$\mathsf{dom}(\beta, \alpha) := \begin{cases} \mathsf{rsl}(\alpha, \beta) & \textit{if } \alpha \textit{ is an assertion,} \\ \exists x : \Psi_{\mathcal{A}}.\mathsf{imp}(x, \beta, \alpha) & \textit{if } \alpha \textit{ is a question.} \end{cases}$$

The notion of domination can be seen as a cover term for both question resolution and question implication: β dominates α iff either β implies α (if α is a question) or α resolves β (if α is an assertion).

Domination is transitive: if β dominates α and α dominates ρ, β dominates ρ as well. This is captured by the following proposition:

$$\mathsf{dom}(\beta, \alpha) \to \mathsf{dom}(\alpha, \rho) \to \mathsf{dom}(\beta, \rho). \qquad \text{(DT)}$$

If β dominates α but not vice versa, we say that β *properly* dominates α. The notion of *proper domination* is defined as follows:

[3]The notion of *domination* introduced here should not be confused with *syntactic domination* in generative syntax research.

Definition 24 (Proper Domination)**.** *Let β denote a question and α denote an assertion or a question, we write $\mathsf{pdom}(\beta, \alpha)$ to denote that β properly dominates α, defined as follows:*

$$\mathsf{pdom}(\beta, \alpha) := \mathsf{dom}(\beta, \alpha) \wedge \neg\mathsf{dom}(\alpha, \beta).$$

7.2.2 Promotion

The concept of *promotion* is introduced to capture the role of assertional premises in the process of question implication:

Definition 25 (Promotion)**.** *Let α denote an assertion, ρ and β denote two questions, we write $\mathsf{pro}(\alpha, \rho, \beta)$ to denote that α promotes the implication of β from ρ, defined as follows:*

$$\mathsf{pro}(\alpha, \rho, \beta) := \mathsf{imp}(\alpha, \rho, \beta) \wedge \neg\forall y : \Psi_{\mathcal{A}}.\mathsf{imp}(y, \rho, \beta).$$

It is worthwhile mentioning that promotion is not necessary in question implication. If a question ρ implies another question β without the need to appeal to any assertional premise, the implication is said to be *promotion-free*. Consider the following example:

(1) a. **Lisuarte**: Between Amadís or Galaor, who defeated Dardán?
    b. **Oriana**: Did [Amadís]$_{\mathcal{F}}$ defeat Dardán?

The implication of (1b) from (1a) is promotion-free.

7.3 Congruence

The notion of congruence, originally due to von Stechow (1991), is not a logical property but describes the information-structural relationship between a speech act and a question. This section considers how this notion shall be properly defined.

7.3.1 The traditional approach

The traditional approach to the definition of congruence is best represented by Rooth (2016) (first introduced in Section 1.1.1): a speech act is congruent to a question only if "substituting *wh*-phrases for the focused phrase (or phrases) in [the speech act] and then performing morphosyntactic adjustments such as *wh*-movement and do-support can result in [the question]" (p.20). Consider (2) and (3):

(2) a. **Lisuarte**: Who defeated Dardán?
  b. **Oriana**: i. [Amadís]$_{\mathcal{F}}$ defeated Dardán.
    ii. Amadís defeated [Dardán]$_{\mathcal{F}}$.

(3) a. **Lisuarte**: Who defeated Dardán?
  b. **Oriana**: i. Did [Amadís]$_{\mathcal{F}}$ defeat Dardán?
    ii. Did Amadís defeat [Dardán]$_{\mathcal{F}}$?

(2bi) is congruent to (2a) in virtue of the fact that substituting the focused item *Amadís* in (2bi) with *who*, we obtain exactly (2a). This, however, does not work for (2bii). Similarly, in (3), (3bi) is congruent to (3a) in virtue of the fact that substituting the focused item *Amadís* in (3bi) with *who*, we obtain exactly the question (3a). This, however, does not work for (3bii). Roberts (1996/2012) examines in detail the role of qud in licensing prosodic foci and proposes that a speech act is congruent to a question iff the latter provides the current qud for the former.[4] This is indeed equivalent to Rooth's (2016) characterization and is confirmed by the above observations.[5]

[4]In Roberts (1996/2012), the notion of congruence is defined in terms of the relationship between the set of focal alternatives of a speech act and the set of simple answers to a question. In a nutshell, an assertion is congruent to a question iff the set of focal alternative of the assertion is identified with the set of simple answers to the question. This definition will not be considered in detail (largely because the notion of focal alternative is not formally defined in this dissertation) but it is sufficient to mention that it is equivalent to Rooth's (2016).

[5]Rooth's definition of congruence (as well as Roberts') is originally proposed to capture the congruence between an assertion and a question. But this straightforwardly generalizes to characterizing the congruence between two questions.

Rooth's (2016) definition of congruence is not free of problems. It is problematic in at least three aspects. First, Rooth has not specified what type of *wh*-expression can be used to substitute a focused constituent, and consequently, the definition of congruence *à la* Rooth is hard to be implemented. Consider the following example:

(4) a. **Lisuarte**: Which knight defeated Dardán?
    b. **Oriana**: [Amadís]$_{\mathcal{F}}$ defeated Dardán.

Following Rooth's definition, to determine whether (4b) is congruent to (4a), the first step is to replace the focused constituent *Amadís* in (4b) by a *wh*-expression of the same semantic type. But it is unclear what type underlies *Amadís*. There are many possibilities: for example, Amadís is undoubtedly a human, and from contextual knowledge, it is also known that Amadís is a knight. Now the question is: what semantic type should one assign to *Amadís*? If one classifies *Amadís* as an instance of *knight*, one could probably obtain (4a) and conclude that (4b) is congruent to (4a). However, if one opts for another route, one might conclude that (4b) is not congruent to (4a).

Now consider the second problem: Rooth's definition of congruence undergenerates. Consider the following example:

(5) a. **Lisuarte**: Between Amadís and Galaor, who defeated Dardán?
    b. **Oriana**: [Amadís]$_{\mathcal{F}}$ defeated Dardán.

Let us assume that the semantic type assigned to *Amadís* in (5b) is *human*. Then following the operation suggested by Rooth, one obtains the following question: *Who defeated Dardán?*, which is different from (5a). However, there is no doubt that (5b) is congruent to (5a). This intuition cannot be captured by Rooth's definition of congruence.

Finally, observe that Rooth's (2016) informal characterization of congruence works only when the concerned speech act contains narrowly focused constituents but does not directly generalize to speech acts with a wide focus. Roberts (1996/2012) advocates a rather simple view that if a speech act contains a wide focus, it is congruent to the

Big Question (BQ). This view, however, is still problematic: it confronts a problem similar to what we meet in (5). Consider (6):

(6) a. **Lisuarte**: What happened this morning?
b. **Oriana**: A knight defeated Dardán.
c. **Lisuarte**: Which knight (defeated Dardán)?

(6a) implies (6c) on the basis of (6b). Since (6c) contains a wide focus, following Roberts, we predict that (6c) is congruent to BQ. This is odd here because intuitively, it is more appropriate to consider (6c) as being congruent to (6a) rather than to BQ in this example.

7.3.2 Defining congruence

To cope with the abovementioned problems, we advocate a more restrictive view on the congruence between a speech act and a question. Let us start from the very initial question: what semantic types are to be assigned to focused constituents in a speech act? Please note that although a constituent such as *Amadís* in (4b) can be assigned many semantic types, the assignment is not arbitrary. The most trivial restriction is that the verb *defeat* in (4b) selects for at least a human individual.[6] However, whenever the semantic type *human* is inferred, many subtypes of *human* can serve as semantic types of *Amadís* such as *noble*, *knight*, *warrior*. The availability of multiple semantic types for a focused constituent makes Rooth's definition of congruence inapplicable. To avoid this problem, we advocate that the default semantic type to be assigned to a constituent is the maximal type of this constituent. The notion of *maximal type* is defined as follows:

Definition 26 (Maximal Type)**.** *Let ϵ stand for a constituent and $T(\llbracket\epsilon\rrbracket)$ denote the set/universe of possible semantic types of ϵ. Let $C : T(\llbracket\epsilon\rrbracket)$, C is said to be the maximal semantic type*

[6]For more on *selection criterion*, see Chatzikyriakidis and Luo (2014, 2018).

of ϵ iff for every $x : T([\![\epsilon]\!])$, x satisfies the following:

$$x \subseteq C.$$

Intuitively, the definition says that C is a maximal semantic type of ϵ iff C is the supertype of every possible semantic type of ϵ. In connection with (4b), the maximal semantic type of *Amadís* is *human*. Under the assumption that every focused constituent is assigned the maximal type, by applying the operation proposed by Rooth, we obtain a question, called *maximal qud*, that (4b) is congruent to.[7]

Definition 27 (Maximal Qud). *Let $\alpha[T]^g_f : \Psi$ and $\beta[\mathcal{E}]^q_p : \Psi_{\mathcal{E}}$, we write $\mathsf{max}(\alpha[T]^g_f, \beta[\mathcal{E}]^q_p)$ to denote that β is the maximal qud of α, defined as follows (where $\pi_l(\pi_l(g)) = i$, $\pi_r(\pi_l(g)) = j$):*

$$\mathsf{max}(\alpha[T]^g_f, \beta[\mathcal{E}]^q_p) :=$$
$$(i + j, (\underset{1\to i}{\mathsf{domain}}(g) \times \underset{i+1\to i+j}{\mathsf{domain}}(g), \mathsf{rig}_{i+j}(g))) = p \in \mathcal{E}.$$

$\mathsf{max}(\alpha[T]^g_f, \beta[\mathcal{E}]^q_p)$ *is often abbreviated as* $\mathsf{max}(\alpha, \beta)$*. For sake of convenience, we write* $\mathsf{qud}_m(\alpha)$ *for the maximal qud of* α*.*

Let us take a second look at the following two examples (repeated from examples (5) and (6) respectively):

(7) a. **Lisuarte**: Between Amadís and Galaor, who defeated Dardán?
b. **Oriana**: [Amadís]$_{\mathcal{F}}$ defeated Dardán.

(8) a. **Lisuarte**: What happened this morning?
b. **Oriana**: A knight defeated Dardán.

[7] The notion of *maximal qud* is adopted in Vallduví (2016) to refer to a question that a speech act is congruent to. However, note that the notion of maximal qud in Vallduví's sense is more similar to *current qud* in our account. The notion of *maximal qud* in our sense is broader than Vallduví's: the current qud of a speech act might be identified with the maximal qud but in most cases, the current qud of a speech act is a subquestion of its maximal qud.

c. **Lisuarte**: Which knight (defeated Dardán)?

The maximal quds for (7b) and (8c) are respectively (9) and BQ:

(9) Who defeated Dardán?

The relationship between (7a) and (9) is obvious: (9) implies (7a). The relationship between (8a) and BQ is very similar. Is it sufficient to define that α is congruent to β only if the maximal qud of α implies β? The answer is negative. Consider the following example:[8]

(10) a. **Lisuarte**: Between Amadís and Galaor, who defeated Dardán?
b. **Oriana**: i. ?[Endriago]$_{\mathcal{F}}$ defeated Dardán.
ii. #Did [Endriago]$_{\mathcal{F}}$ defeat Dardán?

The maximal qud of (10bi) is exactly (9). (10a) satisfies the following requirement: (9) implies (10a). However, (10bi) is undoubtedly not congruent to (10a). Likewise, the maximal qud of (10bii) is (9) and moreover, (10a) satisfies the following requirement: (9) implies (10bii). However, (10bii) is definitely not congruent to (10a). It is pertinent to wonder why (7b) and (8c) are congruent reactions and why (10bi) and (10bii) are not. The observation is as follows: in the case of (7b) and (10bi), (7b) partially answers (7a), but (10bi) is not a partial answer to (10a); and in the case of (8c) and (10bii), a partial answer to (8c) partially answers (8a) but this does not hold for (10a-10bii).

To summarize, α is congruent to β iff α satisfies: (a) the maximal qud of α implies β; and (b) α is either a partial answer to β (if α is an assertion) or a partial answer to α is also a partial answer to β (if α is a question). The notion of congruence is defined as follows:

[8] (10bi), though decidedly odd, is much better than (10bii). (10bi) is congruent to a higher-level question, *Who defeated Dardán?*. The utterance of (10bi) manifests, to some extent, the speaker's intentional ignorance of the two entities *Amadís* and *Galaor* introduced by Lisuarte for discussion. This conversationally implicates that the speaker is either unaware of an answer to (10a) or that she is clear that neither Amadís nor Galaor defeated Dardán.

Definition 28 (Congruence)**.** *Let α denote an assertion or a question and β denote a question.* $\mathsf{cgr}(\alpha, \beta)$ *denotes that α is congruent to β, formally defined as follows:*

$$\mathsf{cgr}(\alpha, \beta) :=$$
$$\begin{cases} \exists x : \Psi_{\mathcal{A}}.\mathsf{imp}(x, \mathsf{qud}_m(\alpha), \beta) & \\ \quad \wedge\ \mathsf{prsl}(\alpha, \beta) & \text{if } \alpha \text{ is an assertion,} \\ \exists x : \Psi_{\mathcal{A}}.\mathsf{imp}(x, \mathsf{qud}_m(\alpha), \beta) & \\ \quad \wedge\ \forall y : \Psi_{\mathcal{A}}.\mathsf{prsl}(y, \alpha) \rightarrow \mathsf{prsl}(y, \beta) & \text{if } \alpha \text{ is a question.} \end{cases}$$

Let $x_1, ..., x_n$ denote a series of questions. If there is a string $\alpha, x_1, ...,$ x_n, β such that every speech act in this string, except β, is congruent to its successor, we say that there is a *congruence path* from α to β.

Definition 29 (Congruence Path)**.** *Let α denote an assertion or a question and β denote a question, we write* $\mathsf{c\text{-}path}(\alpha, \beta)$ *to denote that there is a congruence path from α to β, formally defined as follows (where $i, n : \mathbb{N}$ and $0 \leq i \leq n$):*

$$\mathsf{c\text{-}path}(\alpha, \beta) := \exists \overrightarrow{x_i} : \Psi_{\mathcal{E}}.\mathsf{cgr}(\alpha, x_1) \wedge \overrightarrow{\mathsf{cgr}(x_i, x_{i+1})} \wedge \mathsf{cgr}(x_n, \beta).$$

The notion of congruence path will be extensively used in Chapter 9.

7.4 Qud-Tree

Inspired by Büring (2003), Asher and Lascarides (2003), and Riester (2019) among others, this section develops a convenient method called *qud-tree* to visualize the structure of a discourse. In a nutshell, a qud-tree consists of four kinds of components: *branches*, *nodes*, *agents*, and *congruence arrows*, the first two being fundamental.[9]

[9]The notion of *qud-tree* is borrowed from Riester (2019). However, the guidelines that Riester offers for drawing a well-formed qud-tree are much looser than

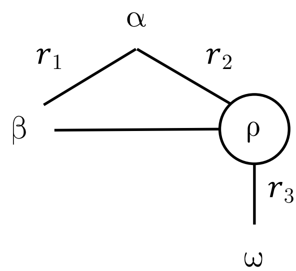


Figure 7.1: Qud-tree: an example

7.4.1 Linking branches

Branches in qud-trees stand for structural relations. There are two kinds of branches: *horizontal branches* and *non-horizontal branches.*

- **Horizontal branch**: A horizontal branch in a qud-tree denotes the promoting relation (pro) between an assertion and a question, the former promoting the latter. Since promoting relations are not primitive relations, horizontal branches are auxiliary in a qud-tree, usually not labeled.
- **Non-horizontal branch**: A non-horizontal branch in a qud-tree denotes a qud-relation: either question resolution (rsl) or question implication (imp). Since qud-relations are considered as primitive relations, non-horizontal branches are fundamental in a qud-tree. They are labeled by corresponding qud-relations.

---

ours. For current purposes, it suffices to highlight two crucial differences. First, a qud-tree *à la* Riester allows not only for *question implication* and *question resolution* but also *question evocation* as primitive qud-relations; in contrast, a qud-tree containing a branch denoting *question evocation* is not well-formed from our point of view because it is not regarded as a primitive qud-relation (see Section 7.1). Second, *promotion* is an important auxiliary structural relation between speech acts and is the only auxiliary structural relation that we allow to appear in a qud-tree; in contrast, while promoting relations are present in Riester's examples, it is not available from his guidelines for drawing a well-formed qud-tree.

Take Figure 7.1 as an example. The horizontal branch relating β and ρ denotes a promoting relation. The non-horizontal branches, labeled by r_1, r_2, and r_3, denote underspecified qud-relations.

7.4.2 Nodes for speech acts

Nodes in qud-trees are filled by speech acts. There are three types of nodes: *root nodes*, *terminal nodes* and *intermediate nodes*.

- **Root node**: A node that dominates every node in a qud-tree is called a root note. The root node of a qud-tree is necessarily filled by a question. Every qud-tree has a root node.
- **Terminal node**: A node that neither dominates nor promotes any other nodes in a qud-tree is dubbed a terminal node. Every qud-tree has at least one terminal node, which is filled by either a question or an assertion.
- **Intermediate node**: A node that is neither a root node nor a terminal node is called an intermediate node.

In Figure 7.1, the root node is filled by α. There is only one terminal node, filled by ω. β and ρ occupy two intermediate nodes. The node filled by ρ is different from other nodes because it is encircled. In this dissertation, we make a further distinction between *bare nodes* and *encircled nodes*: bare nodes are filled by speech acts that are actually performed whereas encircled nodes are filled by speech act that are not actually performed but are inferred/accommodated on the basis of contextual available resources. In Figure 7.1, since ρ is encircled, it indicates that ρ is inferred but not actually performed.

7.4.3 Labels for agents

In the qud-tree presented in Figure 7.1, speech acts are anonymous: it is underspecified who performed them and whom they are addressed to. To make it suitable for the analysis of multi-agent interaction, a

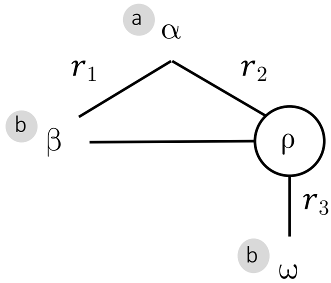


Figure 7.2: Agent-indexed qud-tree: an example

qud-tree must be extended by taking into account the roles of communicating agents.[10] In a dialogue, since there are only two communicating agents, the speaker-addressee role-shifting is automatic: whenever an agent is identified as the speaker, the other is automatically identified as the addressee. Consequently, we notate only the speaker (or performer) of a speech act, leaving the identification of the addressee to default contextual inferences. The qud-tree presented in Figure 7.2 extends Figure 7.1 by taking into account the roles of communicating agents: every node filled by a performed speech act is assigned a label denoting the performer of the speech act, whilst inferred speech acts are not labeled as they are not performed by any agent.[11]

[10]There are two methods to make this extension: (*i*) assign a qud-tree to each agent such that one keeps track of turning-taking on one's own; or (*ii*) maintain a single qud-tree, in which every speech act is assigned two labels denoting the speaker and the addressee respectively. The first method is more promising as it echos the view expressed earlier that every participant maintains a scoreboard (see Sections 1.1.1 and 6.3). But for current purposes, since we are dealing with very simple discourses, there is no significant difference between the two methods. To simplify discussion, we adopt method (*ii*), leaving (*i*) for future scrutiny.

[11]It is a controversial issue where such inferred speech acts come from: are they speaker-oriented or addressee-oriented? In some discourse contexts, the source of inferred speech acts is quite clear but in some others, it turns out to be ambiguous. For an interesting experimental study, see Holtgraves (2005). This question is not tackled in this dissertation but remains for future scrutiny.

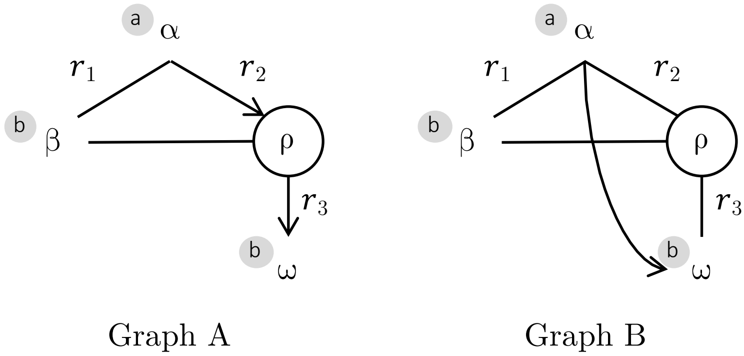
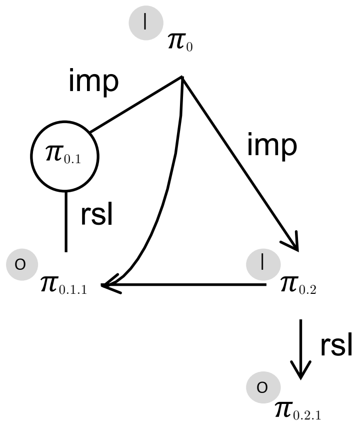


Figure 7.3: Qud-tree with congruence arrows: an example

7.4.4 Congruence arrows

In a qud-tree, if a speech act is dominated by a question and is also congruent to the question, they are connected by a *congruence arrow* (simply *arrow* henceforth) (from the dominating question to the dominated speech act). It is worthwhile mentioning that while congruence implies domination, domination does not imply congruence. For this reason, it is possible that a speech act is congruent to a question but the question does not immediately dominate the speech act (see (11) in the next section for an illustrating example of this situation). Figure 7.3 illustrates two possibilities: the arrow in Graph A shows that ρ is congruent to α and ω is congruent to ρ (that is, that there is a congruence path from ω through ρ to α), whereas the arrow in Graph B shows that ω is congruent to α. In Graph A, the arrow overlaps with the branches linking α, ρ and ω, whereas in Graph B, the arrow does not overlap with any branch in the qud-tree.

Arrows are not mandatory in qud-trees because the well-formedness of a qud-tree does not require that a speech act be congruent to some question that immediately or remotely dominates it. However, whenever there is a such requirement, for example, that there be a congruence path from the root node to a fixed terminal node, the inclusion of congruence arrows is mandatory (see Chapter 9 for details).



- π_0 = Who defeated Dardán?
- $\pi_{0.1}$ = Did Amadís defeat Dardán?
- $\pi_{0.1.1}$ = $[\text{Amadís}]_{\mathcal{F}}$ (defeated Dardán).
- $\pi_{0.2}$ = Who else?
- $\pi_{0.2.1}$ = $[\text{Amadís}]_{\mathcal{F}}$ (defeated Dardán).

Figure 7.4: Qud-tree for (11)

7.4.5 A worked example

This section presents a worked example (11) to show how a discourse fragment can be represented as a qud-tree.

(11) a. **Lisuarte**: Who defeated Dardán?
b. **Oriana**: $[\text{Amadís}]_{\mathcal{F}}$ (defeated Dardán).
c. **Lisuarte**: Who else (defeated Dardán)?
d. **Oriana**: $[\text{Galaor}]_{\mathcal{F}}$ (also defeated Dardán).

To start with, now consider the relationship between every two speech acts (or utterances) in the above example:

(*a*) (11a) is partially resolved by (11b), and moreover, (11b) is congruent to (11a).

(*b*) (11a) implies (11c) on the basis of (11b), and moreover, (11c) is congruent to (11a).

(*c*) (11c) is (fully) resolved by (11d). (11d) is congruent to (11c).

The relationship between every two speech acts in (11) can be captured by primitive qud-relations except the (11a)-(11b) pair: (11a) is partially resolved by (11b). To reduce partial question resolution to (full) question resolution, it is necessary to introduce an auxiliary intermediate question, namely, (12), which is implied by (11a): (11b) (fully) resolves (12) and (12) is implied by (11a).

(12) Did Amadís defeat Dardán?

The qud-tree for (11) is presented in Figure 7.4.

7.5 Symmetries in Qud-Trees

This section considers an important property called *symmetry* in qud-trees. This property is rarely discussed in the literature but is important for capturing some important aspects of discourse structure (as will be shown in Section 11.5 of Chapter 11).

7.5.1 Trunks and loci

This section introduces two notions, *trunk* and *locus*, that are relevant for defining symmetries in qud-trees:

- **Trunk**: A trunk in a qud-tree is a path that starts from the root node of the qud-tree and ends in a terminal node. The length of a trunk refers to the number of nodes therein contained.
- **Locus**: The locus of a node in a trunk of a qud-tree is a natural number $i : \mathbb{N}$ for counting the quantity of nodes that appear before this node (not included) in this trunk. The locus of the root node in a qud-tree is 0 (as no other nodes appear before it).

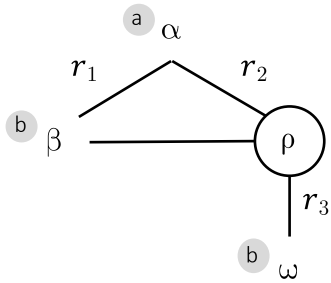


Figure 7.5: Agent-indexed qud-tree: an example (repeated)

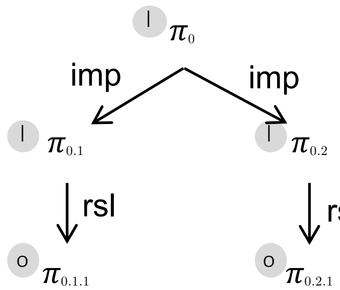
To illustrate, consider again Figure 7.5 (repeated from Figure 7.2 in Section 7.4). By the definition of trunk, there are two trunks in this qud-tree: one starting from α to β, and the other starting from α through ρ to ω. The qud-tree in Figure 7.5 is binary: it has only two trunks. In an n-ary qud-tree, there are n trucks. Finally, consider the loci of nodes in Figure 7.5: the locus of α is 0, the loci of β and ρ are both 1, and the locus of w is 2.

7.5.2 Defining symmetry

Before we define what amounts to a symmetric qud-tree, consider the following example as an illustration:

(13) a. **Lisuarte**: Who defeated Dardán? [Amadís]$_{\mathcal{F}}$?
b. **Oriana**: Yes.
c. **Lisuarte**: Did [Galaor]$_{\mathcal{F}}$ defeat Dardán?
d. **Oriana**: No.

The qud-tree for (13) is presented in Figure 7.6. Let us now consider how this qud-tree differs from the qud-tree for (11) (in Figure 7.4). First, observe that both qud-trees contain two trunks, each consisting of three nodes. In both trunks of the qud-tree for (13), there is a congruence relation between every two adjacent nodes therein contained,



- π_0 = Who defeated Dardán?
- $\pi_{0.1}$ = [Amadís]$_\mathcal{F}$ (= Did [Amadís]$_\mathcal{F}$ defeat Dardán?)
- $\pi_{0.1.1}$ = Yes (= Amadís defeated Dardán.)
- $\pi_{0.2}$ = Did [Galaor]$_\mathcal{F}$ defeat Dardán?
- $\pi_{0.2.1}$ = No (= Galaor didn't defeat Dardán.)

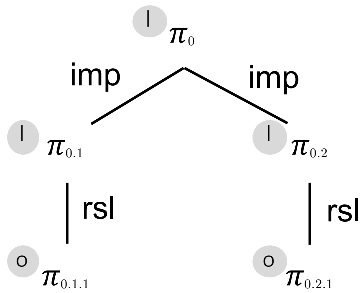
Figure 7.6: Qud-tree for (13)

but this is not the case of the qud-tree for (11), which contains a node (i.e., $\pi_{0.1}$ in Figure 7.4) that is not congruent to any other nodes. In addition, observe that every two nodes of the same locus in the qud-tree for (13) are inhabited by speech acts that are characterized by the same r-term (that is, that they share the same focal structure). This is clearly not the case of the qud-tree for (11). Finally, note that no promoting relation is involved in the qud-tree for (13) but there is a promoting relation in the qud-tree for (11). In this dissertation, the qud-tree for (13) is called a *strictly symmetric qud-tree.*

Definition 30 (Strict Symmetry)**.** *A qud-tree* $\mathbb{Q}$ *is strict symmetric iff* $\mathbb{Q}$ *satisfies the following requirements:*

(*a*) $\mathbb{Q}$ *contains only two trunks* $\mathbb{T}_1$ *and* $\mathbb{T}_2$ *of the same length.*

(*b*) *Every two adjacent nodes in any trunk of* $\mathbb{Q}$ *are inhabited by speech acts that form a congruent pair* (*in which one is congruent to another*)*. This is dubbed congruent trunk*



- π_0 = Who defeated Dardán?
- $\pi_{0.1}$ = Amadís (= Did Amadís defeat Dardán?)
- $\pi_{0.1.1}$ = Yes (= Amadís defeated Dardán.)
- $\pi_{0.2}$ = Did Galaor defeat Dardán?
- $\pi_{0.2.1}$ = Yes (= Galaor defeated Dardán.)

Figure 7.7: Qud-tree for (14)

requirement (CTR, *henceforth*).

(*c*) *Every two nodes of the same locus in* $\mathbb{Q}$ *are inhabited by speech acts characterized by the same r-term* (*that is, that they have the same focal structure*).

(*d*) $\mathbb{Q}$ *does not contain any promoting relation.*[a]

[a]Note that clause (*c*) already implies clause (*d*): clause (*c*) implies that every two nodes of the same locus in $\mathbb{Q}$ must be assigned the same speech act type, and as a consequence, they can never stand in a promoting relation (because promotion is a relation between an assertion and a question).

Let us now consider the following example:

(14) a. **Lisuarte**: Who defeated Dardán? Amadís?
b. **Oriana**: Yes.
c. **Lisuarte**: Did Galaor defeat Dardán?
d. **Oriana**: Yes.

This example is almost the same as (13) except that the utterances (or speech acts) in (14) do not contain any focus accents, thus encoding no information regarding the potential congruence relations between the utterances in (14). The qud-tree for (14), presented in Figure 7.7, is almost the same as the qud-tree for (13) expect that the former no longer contains any congruence arrows as no congruence relations are retrievable from (14). Intuitively, we would also want to consider the qud-tree for (14) as symmetric but it is clearly not strictly symmetric.

To characterize this non-strict symmetric property, we introduce a notion called *force-congruence* mapping, defined as follows:

Definition 31 (Force-Congruence). *Let* $\mathbb{Q}$ *denote a qud-tree, the force-congruence mapping* forcgr *maps* $\mathbb{Q}$ *to another qud-tree* $\mathbb{Q}'$ *such that* $\mathbb{Q}'$ *is an unfaithful copy of* $\mathbb{Q}$ *in the sense that* $\mathbb{Q}'$ *is required to satisfy* CTR (*see clause* (*b*) *in Definition 30*).

$$\mathsf{forcgr} : \mathbb{Q} \to \mathbb{Q}'.$$

In connection with examples (13) and (14), the qud-tree of (13) can be seen as obtained from the application of the force-congruence mapping forcgr to the qud-tree of (14). In terms of forcgr, we can define what amounts to a non-strict symmetric qud-tree now. In this dissertation, a non-strict symmetric qud-tree is simply called a *symmetric qud-tree* for sake of convenience, defined as follows:

Definition 32 (Symmetric Qud-Tree). *Let* $\mathbb{Q}$ *denote a qud-tree,* $\mathbb{Q}$ *is said to be symmetric iff there exists another* $\mathbb{Q}'$ *that is strictly symmetric such that* $\mathsf{forcgr} : \mathbb{Q} \to \mathbb{Q}'$.

7.6 Summary

This chapter introduces the qud-tree model as a convenient method for discourse representation and defines a series of qud-related structural relations that are relevant for the interpretation of a qud-tree. In the remaining two chapters of Part III, qud-trees will be extensively used to represent fragments of discourse. It is worthwhile mentioning that there are different proposals for representing discourse structure using qud-oriented trees such as Onea (2013, 2016), Riester, Brunetti, and de Kuthy (2018), de Kuthy, Reiter, and Riester (2018), Riester (2019), Hesse et al. (2020), and Hesse et al. (2021). The similarities and dissimilarities between our proposal and these related proposals remain for future scrutiny.

Chapter 8

Relevance: A Tentative Definition

This chapter proposes a revision to Roberts' (1996/2012) definition of qud-based relevance and applies it to the characterization of the potential of reactions. Such a characterization, however, is shown to be inadequate finally: it both overgenerates and undergenerates.

This chapter consists of four sections: Section 8.1 introduces the notion of *strategy* (*of inquiry*) and proposes a revision to this notion; Section 8.2 proposes a tentative definition of relevance to characterize the potential of reactions; Section 8.3 outlines three problems for the notion of relevance proposed in Section 8.2; Section 8.4 provides some concluding remarks and alludes to the necessity of an alternative way to define the notion of relevance.

8.1 Strategy and Facilitation

This section considers the inadequacy of Roberts' (1996/2012) definition of strategy (of inquiry) and proposes to replace it by a more comprehensive notion called *facilitation*.

8.1.1 Strategy and beyond

The notion of strategy (of inquiry) is important in Roberts' (1996/2012) qud-model of discourse, informally defined as follows:

> "The interlocutors' strategy [...] may include the decision to pursue answers to subquestions, i.e., a series of related questions may realize a strategy to get the answer to the most general [...] question among them."
>
> (Roberts, 1996/2012, 7)

For Roberts, a speech act α counts as a strategy to the resolution of β iff α is a question and α is implied by β (p.21). Consider (1):

(1) a. **Lisuarte**: Which knight defeated Darán?
    b. **Oriana**: Did $[\text{Amadís}]_{\mathcal{F}}$ defeat Dardán?

Following Roberts' definition of strategy, (1b) is a strategy to answer (1a) in the sense that (1b) is implied by (1a).

The intuitive idea underlying the notion of strategy is impeccable: to develop a strategy to resolve a question is to introduce a subquestion. However, there are many different ways to trigger a subquestion, not limiting to the (only) way proposed by Roberts. Consider (2):

(2) a. **Lisuarte**: Which knight defeated Dardán?
    b. **Oriana**: i. Who is a knight?
        ii. $[\text{Amadís}]_{\mathcal{F}}$ is a knight.
        iii. Did $[\text{Amadís}]_{\mathcal{F}}$ defeat Dardán?

Following Roberts' definition, only (2biii) is considered a strategy to answer (2a). However, it is unfair to say that (2bi) and (2bii) are both irrelevant to the implementation of a strategy to answer (2a): an answer to (2bi) either specifies some entity/entities in the domain specified in (2a) or narrows down this domain by excluding some entity/entities; in contrast, the availability of (2bii) provides information that is indispensable for the implication of (2aiii) from (2a).

8.1.2 Facilitation

Taking (2) into account, we introduce a more general notion called *facilitation*, extending Roberts' notion of strategy: a speech act facilities the resolution of a question iff it contributes to the implementation of a strategy. The analysis of (1-2) shows that there are at least three ways to implement a strategy to answer a question β: (i) to give an assertion that is indispensable for the implication of a subquestion from β; (ii) to give a subquestion of β; and (iii) to give a question y such that a partial answer to y is indispensable for the implication of a subquestion of β. The notion of facilitation is defined as follows:

Definition 33 (Facilitation)**.** *Let α denote an assertion or a question and β denote a question, we write* $\mathsf{facil}(\alpha, \beta)$ *to denote that α facilitates the resolution of β, defined as follows:*

$$\mathsf{facil}(\alpha,\beta) :=$$
$$\begin{cases} \exists x : \Psi_{\mathcal{E}}.\mathsf{pro}(\alpha,\beta,x) & \textit{if } \alpha \textit{ is an assertion,} \\ \exists x : \Psi_{\mathcal{A}}.(\mathsf{imp}(x,\beta,\alpha) \vee & \\ \qquad \exists y : \Psi_{\mathcal{E}}.\mathsf{prsl}(x,\alpha) \wedge \mathsf{imp}(x,\beta,y)) & \textit{if } \alpha \textit{ is a question.} \end{cases}$$

In linguistic discourse, whenever one issues a question, one is unaware of whether the interlocutor is aware of a full answer to this question, it is much more fair to say that what one seeks by making a question is not necessarily a full or partial answer to the question but simply information relevant to the resolution of the question. Undoubtedly, one will be satisfied if the interlocutor can (either fully or partially) answer one's question, but one will also be satisfied if the interlocutor provides some information that facilitates the resolution of one's question. In light of this, we introduce a new auxiliary type of question dubbed *info-question*, defined as follows:

Definition 34 (Info-Question)**.** *Let α denote a question, we write $F(\alpha)$ to denote the info-question associated with α. $F(\alpha)$ is defined by the following two rules:*

$$\forall x : \Psi_{\mathcal{A}}.\mathsf{facil}(x,\alpha) \leftarrow \mathsf{rsl}(x, F(\alpha)). \qquad (\text{FC}_1)$$
$$\forall x : \Psi_{\mathcal{E}}.\mathsf{facil}(x,\alpha) \leftrightarrow \exists y : \Psi_{\mathcal{A}}.\mathsf{imp}(y, F(\alpha), x). \qquad (\text{FC}_2)$$

(FC_1) intuitively shows that if an assertion fully answers $F(\alpha)$, then it facilitates the resolution of α. (FC_2) intuitively shows that if a question x facilitates the resolution of α, there is some assertion y that is indispensable for the implication of x from $F(\alpha)$ (i.e., $F(\alpha)$ implies x on the basis of y). $F(\alpha)$ intuitively reads as follows:

$$F(\alpha) := \textit{What do you know about } \alpha\textit{?}$$

Let α and β denote two questions, (FQ) and (FD) are trivial:

$$\forall x : \Psi_{\mathcal{A}}.\mathsf{imp}(x, F(\alpha), \alpha). \tag{FQ}$$

$$\forall x : \Psi_{\mathcal{A}}.\mathsf{imp}(x, \alpha, \beta) \rightarrow \mathsf{imp}(x, F(\alpha), F(\beta)). \tag{FD}$$

(FQ) intuitively shows that $F(\alpha)$ implies α. (FQ) implies that a (full/partial) answer to a question α is a full answer to the corresponding info-question $F(\alpha)$. (FD) shows that if α implies β based on an assertional premise, then based on the same premise, $F(\alpha)$ implies $F(\beta)$.

8.2 Relevance under Q-Assumption

To characterize the relevance of a speech act to the discourse context, Roberts (1996/2012) introduces a qud-based notion of relevance:[1]

> **Qud-Relevance** (Roberts, 1996/2012)
> A speech act α is relevant to a qud β iff α either introduces a partial answer to β (if α is an assertion) or is part of a strategy to answer β (if α is a question).

In Section 2.3 of Chapter 2, we argue that in an elementary one-turn dialogue $\phi \oplus \psi$, the qud for ψ must be established by ϕ. In connection with our account of addressing, the qud for ψ could be one the following three questions generated from the address of ϕ: $I_c(\phi)$, $I_k(\phi)$,

[1] The notion of relevance defined by Roberts (1996/2012) is a property of a speech act relative to a qud but not to another speech act. For this reason, we call it *qud-relevance* (i.e., relevance relative to a qud).

and $I(\phi)$ (see Section 6.2 of Chapter 6). Having this explained, now we introduce the following assumption:

> **Q-Assumption (Q-Asm)**
> In a one-turn dialogue $\phi \oplus \psi$, ψ is a reaction to ϕ iff ψ is a reaction to one of the three questions generated from the address of ϕ: $I_c(\phi)$, $I_k(\phi)$, and $I(\phi)$.

Under Q-Assumption, we shall characterize the potential of reacting to ϕ in an elementary one-turn dialogue $\phi \oplus \psi$ as follows:

> **Relevance under Q-Asm (Q-Relevance)**
> In a one-turn dialogue $\phi \oplus \psi$, ψ is relevant to ϕ iff
> (*a*) ψ is relevant (*à la* Roberts) to $F(q)$
> (where $q : \{I_c(\phi), I_k(\phi), I(\phi)\}$).
> (*b*) ψ is as informative as is required.

In this definition, (*a*) is a straightforward generalization of standard Robertsian qud-relevance, whilst (*b*) is due to Grice (1975). To a first approximation, consider the following example:

(3) a. **Lisuarte**: Which knight defeated Dardán?
b. **Oriana**: i. ?I want to talk about it.
ii. ?I know which knight defeated Dardán.

If (*a*) is the only requirement for the definition of Q-Relevance, (3bi) and (3bii) are both predicted to be relevant reactions to (3a), but they are in fact infelicitous in this example.[2] Clause (*b*) comes into rescue. (3bi) is infelicitous because it violates (*b*): if one wants to talk about

[2]Please observe that (3bi) and (3bii) are not completely impossible reactions. In the case that (3bi) and (3bii) are used as reactions to (3a), since they both fail to observe clause (*b*), as suggested by Grice (1975), some conversational implicatures would arise: the assertion of (3bi) implicates that Oriana could be ignorant of which knight defeated Dardán though she is willing to talk about it, whereas the assertion of (3bii) implicates that Oriana could be unwilling to answer Lisuarte's question even though she is aware of the answer.

(3a), there is no necessity to mention it but shall proceed immediately by tackling (3a). Likewise, (3bii) also violates (*b*): if one is aware of an answer to (3a), there is no necessity to mention it but shall proceed immediately by giving the answer.

In the previous two sections, we have pointed out that the notion of strategy in Roberts' (1996/2012) qud-model of discourse is incomplete. By appealing to the concept of *info-question* defined in Section 8.1, we shall further extend the notion of Q-Relevance:

Relevance under Q-Asm, extended (EQR)
In a one-turn dialogue $\phi \oplus \psi$, ψ is relevant to ϕ iff

(*a*) ψ is either a full answer to $F(q)$ or a strategy to answer $F(q)$ (where $q : \{I_c(F(I(\phi)), I_k(F(I(\phi))), I(\phi)\}$).
(*b*) ψ is as informative as is required.

The multiple potential ways to react to ϕ in an elementary one-turn dialogue predicted by EQR are schematically summarized in Figure 8.1 (where R_i denotes an underspecified reaction, and r_i denotes an underspecified qud-relation), a generalization of Figure 6.1.

The relationship between the three phases in Figure 8.1 is underspecified. Note that $F(I(\alpha))$ is askable iff $I_c(F(I(\alpha)))$ and $I_k(F(I(\alpha)))$ are both affirmatively answered. This indicates that affirmative answers to $I_c(F(I(\alpha)))$ and $I_k(F(I(\alpha)))$ are mandatory premises for the implication of $F(I(\alpha))$ from a higher level question $V(I(\alpha))$, as represented in Figure 8.2. Leaving aside the denotation of $V(I(\alpha))$, consider the structure of the qud-tree in Figure 8.2. This qud-tree represents a strategy to resolve $V(I(\alpha))$: to seek an answer to this question, one asks for information on whether the interlocutor commits to answering $F(I(\alpha))$, and meanwhile, one asks for information on whether the interlocutor knows a (full) answer to $F(I(\alpha))$; if both questions are affirmatively answered, one is entitled to raise $F(I(\alpha))$. $V(I(\alpha))$ is a question formally defined as follows:

$$V(I(\alpha)) := F(v(F(I(\alpha)))),$$

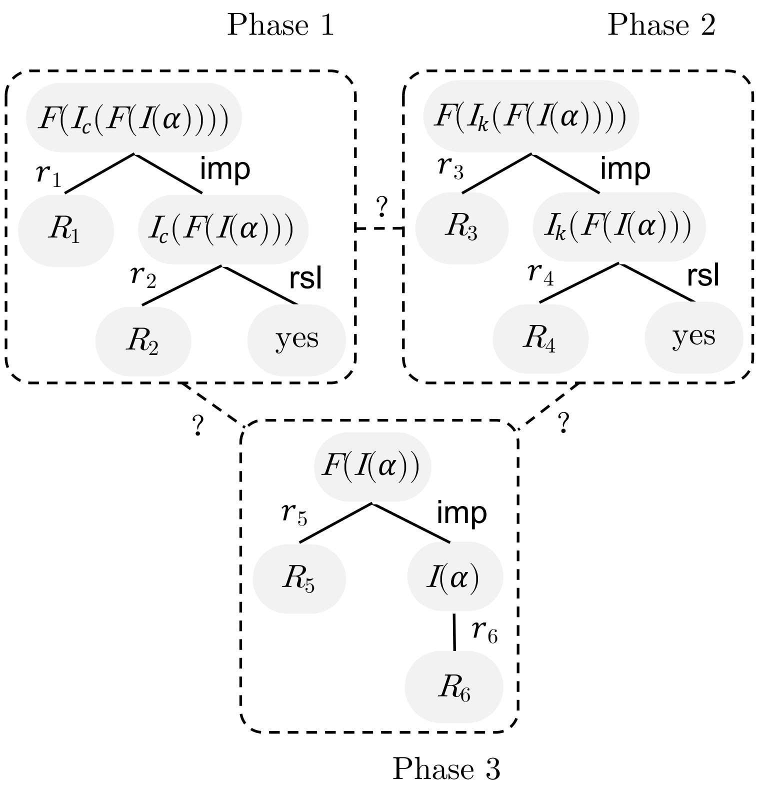


Figure 8.1: Potential of reactions *à la* EQR

where $v(x)$ (for $x : \Psi_{\mathcal{E}}$) intuitively reads as:

$$v(x) := \textit{If you want to talk about } x, \textit{ and if you know a full answer to } x, \textit{ then what is the answer that you know?}$$

The above analysis suggests that the resolution of the three auxiliary questions $I_c(\alpha)$, $I_k(\alpha)$ and $I(\alpha)$ generated from the address of α undergoes a process depicted by Figure 8.2.[3] [4]

8.3 Three Problems

Can EQR offer a faithful characterization of the potential of reactions in elementary one-turn dialogues? The answer is negative. This section outlines three problems, showing that not only EQR is inadequate, even the Q-Assumption that EQR depends on is untenable.

8.3.1 Reacting by challenging

The notion of *challenge* is central to Brandom's (1994, 2000) deontic scorekeeping model of discourse. For Brandom, one of the most important ingredients of the deontic force of a speech act is that it allows for *challenges*: by making a speech act, one assumes the responsibility of demonstrating one's entitlement to it whenever it is challenged (see Section 5.2 of Chapter 5 for details). Following Millson (2014b),

[3] The semantics of conditional questions is subject to much controversy. Following Groenendijk and Stokhof (1997) and Hulstijn (1997) among others, we suggest that besides answering the matrix question, the denial of the antecedent of a conditional question is a full answer to this question. In accordance with this, it is easy to see that $v(I(\alpha))$ implies $I_c(\alpha)$ and $I_k(\alpha)$, and if $I_c(\alpha)$ and $I_k(\alpha)$ are affirmatively answered, $v(I(\alpha))$ implies $I(\alpha)$. Under (FD), this generalizes to $V(I(\alpha))$: $V(I(\alpha))$ implies $F(I_c(F(I(\alpha))))$ and $F(I_k(F(I(\alpha))))$, and whenever $I_c(F(I(\alpha)))$ and $I_k(F(I(\alpha)))$ are affirmatively answered, $V(I(\alpha))$ implies $F(I(\alpha))$.

[4] The analysis presented here also generalizes to the analysis of the relationship between the three phases in Figure 6.1. Details are spared here.

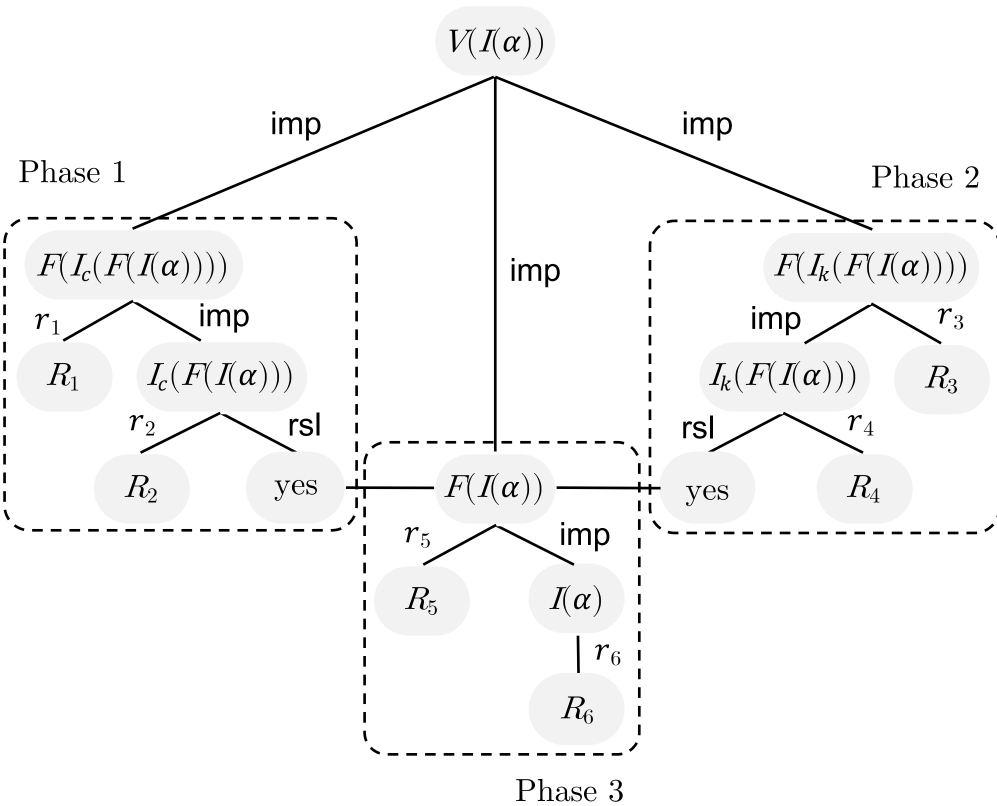


Figure 8.2: Qud-tree: Potential of reactions *à la* EQR

we propose that the most natural way to challenge the performance of a speech act is to make a query. There are two types of challenges:[5]

- Reason-seeking Questions:
  A *reason-seeking question* requests a reason that justifies one's entitlement to a speech act.
- Clarificatory Questions:
  A *clarificatory question* requests a clarification about the utterance of some constituent(s) or the semantic denotation of some constituent(s) in a speech act.

To illustrate, consider the following two examples:

(5) a. **Lisuarte**: Which knight defeated Dardán?
b. **Oriana**: Why do you ask this?
c. **Lisuarte**: (Because) Everyone desires to know it.
d. **Oriana**: Why do you think so?

(6) a. Speaker a: Whom does Jon admire?
b. Speaker b: Jon? i. (= Are you mentioning Jon?)
ii. (= Who is Jon?)

(5b) and (5d) are both reason-seeking questions: (5b) challenges (5a) for a reason for the speaker's (practical) commitment to (5a); (5d) challenges (5c) for a reason for the speaker's (doxastic) commitment to (5c). (6bi) and (6bii) are both clarificatory questions: (6bi) requests a clarification about the utterance of *Jon* (i.e., whether a really uttered

[5] In linguistic discourse, challenges are usually but not necessarily made in the form of a *why-question*, but that does not mean that why-questions are all challenges. To illustrate, consider the following example:

(4) a. **Lisuarte**: Amadís took Dardán sword.
b. **Oriana**: Why? (= Why did he do this?)

(4b) is a why-question but not a challenge to (4a); instead, the performance of (4b) presupposes the truth of (4a).

this constituent); (6bii) asks for a clarification about the denotation of *Jon* (i.e., whom did a refer to by uttering *Jon*).[6]

There is no doubt that reason-seeking questions and clarificatory questions are both relevant reactions, but they are not predicted by EQR: a challenge to ϕ is neither a full answer to $F(q)$ nor a strategy to answer $F(q)$ (where $q : \{I_c(F(I(\phi))), I_k(F(I(\phi))), I(\phi)\}$).

8.3.2 Default acceptance

The validity of EQR depends on Q-Assumption. Under Q-Assumption, the potential of reacting to an assertion of P is equivalent to that of reacting to a polar question on whether P, in virtue of the fact that the three questions generated from the address of the assertion of P are identified with those generated from the polar question on whether P. This treatment works in many cases but there is still a huge difference between reacting to an assertion and reacting to a question (see Farkas and Bruce (2010) for more details). Consider (7) and (8):

(7) a. **Lisuarte**: Did Amadís defeat Dardán?
  b. **Oriana**: #Okay, I see.

(8) a. **Lisuarte**: Amadís defeated Dardán.
  b. **Oriana**: Okay, I see.

The contrast between (7b) and (8b) refutes EQR's predication that the potential of reacting to an assertion of P is identified with that of reacting to a question on whether P. In terms of Ginzburg (2012), an assertion like (7b) is called an assertion of *acceptance*. The contrast between (7b) and (8b) shows that an assertion of acceptance can only be used as a reaction to an assertion but never to a question.

The use of an assertion of acceptance (e.g., *Okay, I see*) represents the most typical and explicit way to accept an assertion. In linguistic discourse, however, the acceptance of an assertion is usually done in a

[6]The utterance *Jon?* could be interpreted in another way: by uttering *Jon?*, b intends to confirm if a wants to talk about whom Jon admires but not others.

more implicit way and is not easy to detect. To a first approximation, let us consider the following two examples:

(9) a. **Lisuarte**: Amadís defeated Dardán.
b. **Oriana**: I am so happy to hear about this.

(10) a. **Lisuarte**: Amadís defeated Dardán.
b. **Oriana**: Will you give him an award?

(9b) and (10b) are relevant reactions and moreover, from both (9b) and (10b), one can infer that Oriana accepts Lisuarte's assertion: the reason that Oriana feels so happy is that she accepts that Amadís defeated Dardán and the reason that Oriana wonders whether Lisuarte will give Amadís an award or not is that she accepts that Amadís defeated Dardán. The phenomenon of implicitly accepting an assertion by making another speech act is widely discussed in the literature (Schegloff, 1982; Walker, 1996; Asher & Lascarides, 2003). In order to account for this, Walker (1996) argues that "conversants can make default inferences of acceptance from the fact that [the interlocutor] has provided no evidence of rejection or evidence that there is a need for a clarification in the [speech act being addressed]" (p. 268). This proposal is insightful but still problematic. Consider (11):[7]

(11) a. **Lisuarte**: Amadís defeated Dardán.
b. **Oriana**: ?Galaor was robbed.

If we strictly follow Walker's proposal, we would predict that (11b) is a relevant reaction to (11a) because it neither rejects nor challenges (11a), and thus contextually implies the default acceptance of (11a). The intuition goes the other way: though it is unfair to regard (11b) as necessarily unacceptable, it is still an odd reaction to (11a).

[7]The reason that we place a question marker ? in front of (11b) is that in some situations, one would regard (11b) as a relevant reaction: for example, if it is contextually inferable that both (11a) and (11b) answers the question *What happened this morning*, then (11b) can be taken as a relevant reaction to (11a). A very similar example is considered in Asher and Lascarides (2003, 237).

There is no doubt that an assertion of acceptance or an assertion that implies default acceptance is a relevant reaction to an assertion. Q-Assumption is thus untenable. It is intriguing why some assertions imply default acceptance whilst some others, though provide no evidence of rejection or a need for a clarification, lack this inference.

8.3.3 Accenting in reactions

In predicting whether a speech act counts as a relevant reaction, EQR cares about only the semantic content therein expressed, in particular, on how it contributes to the resolution of questions introduced by the address of the preceding speech act. However, speech acts are not mere semantic objects but may bear accents indicating their connections with the preceding discourse, more concretely, the questions that they are congruent to. This is all neglected in EQR.

To a first approximation, consider the following example:

(12) a. **Lisuarte**: Did Amadís visit London yesterday?
b. **Oriana**: i. The boat he planned to catch was broken.
ii. Amadís visited $[\text{Paris}]_{\mathcal{F}}$.

(12bi) and (12bii) are *indirect answers* to (12a): they do not directly give a rejective answer but provide information that is incompatible with the nuclear proposition in (12a). EQR predicts that both (12bi) and (12bii) are relevant reactions to (12a) because they provide information that facilitates the resolution of (12a). This analysis might be sound for (12bi) but is definitely not for (12bii). The problem is related to the fact that (12bii) contains a focus accent, which indicates that it is intended to answer (13), not $F(12a)$.

(13) Where did Amadís visit?

Therefore, if one wishes to take into account the presence of the focus accent in (12bii), the EQR-based analysis is untenable, though it does correctly predict that (12b) is a relevant reaction to (12a).

8.4 Summary

This chapter is an interlude in this part. EQR, a tentative definition of relevance is introduced but is later shown to be unable to give an adequate characterization of the potential of reactions in elementary one-turn dialogues. The biggest problem with EQR, as shown in the previous section, is concerned with the fundamental Q-Assumption that EQR is dependent on: Q-Assumption is too restrictive. But if one tries to loosen it, for example, by appealing to Walker's (1996) proposal of default acceptance, the whole theory overgenerates. Nevertheless, this does not amount to saying that EQR is a total failure. The multiple possibilities of reacting to a speech act predicted by EQR, as depicted by Figure 8.2, is still attractive. Some part of EQR will be retained in the new definition of relevance to be introduced in the next chapter.

Chapter 9

Relevance via Qud-Bridging

This chapter develops a new definition of relevance dubbed *relevance via qud-bridging* (RQB) (first introduced in Section 2.3 of Chapter 2), to characterize the potential of reactions in elementary one-turn dialogues, the central idea being the following: in an elementary one-turn dialogue, a speech act is a relevant reaction to the other iff there is a proper bridging qud that hangs over the two speech acts.

This chapter consists of six sections: Section 9.1 defines the mechanism of qud-bridging; Section 9.2 motivates and revisits the hypothesis of relevance via qud-bridging; Section 9.3 proposes five constraints for the inference of a proper bridging qud; Section 9.4 briefly considers issues related to underspecification; Section 9.5 introduces an alternative (quasi-)top-down approach to the characterization of the potential of reactions; Section 9.6 offers some concluding remarks.

9.1 Qud-Bridging

The mechanism of *qud-bridging* is central to RQB.[1] Qud-bridging is a relation between a question and two other speech acts: a question bridges two speech acts iff the former dominates the latter. The notion of qud-bridging is formally defined as follows:

[1]The concept of *bridging* in *qud-bridging* should not be confused with that in *bridging antecedent* (see Asher and Lascarides (1998) and Umbach (2003)).

Definition 35 (Qud-Bridging)**.** *Let ρ denote a question and α/ β denote either an assertion or a question.* $\mathsf{bri}(\rho, \alpha, \beta)$ *denotes that ρ bridges α and β, defined as follows:*

$$\mathsf{bri}(\rho, \alpha, \beta) := \mathsf{dom}(\rho, \alpha) \wedge \mathsf{dom}(\rho, \beta).$$

The notion of *qud-bridging* can be intuitively understood as a ternary counterpart of *domination*. Since domination is transitive, the following rule applies to qud-bridging (where α and β are questions):

$$\mathsf{bri}(\rho, \alpha, \beta) \rightarrow \mathsf{dom}(\alpha, \alpha') \rightarrow \mathsf{dom}(\beta, \beta') \rightarrow \mathsf{bri}(\rho, \alpha', \beta'). \qquad (\text{QT}_1)$$

(QT_1) intuitively reads as: if ρ bridges α and β, and if α and β dominate α' and β' respectively, then ρ bridges α' and β' as well. If ρ is a bridging qud for α and β, and if ρ' dominates ρ, by the transitivity of domination, ρ' bridges α and β as well. This is captured by (QT_2):

$$\mathsf{dom}(\rho', \rho) \rightarrow \mathsf{bri}(\rho, \alpha, \beta) \rightarrow\rightarrow \mathsf{bri}(\rho', \alpha, \beta). \qquad (\text{QT}_2)$$

9.2 RQB: Intuition and Revision

This sections explains the intuitive idea that underlies RQB and introduces a revision to the original formulation of RQB by taking into account the meta-discursive aspect of speech acts.

9.2.1 The intuitive idea

The hypothesis/definition of relevance via qud-bridging is first introduced in Section 2.3 of Chapter 2, repeated here:

> **Relevance via Qud-Bridging** (**RQB**)
> In an elementary one-turn dialogue $\phi \oplus \psi$ where ϕ or ψ is either an assertion or a question, ψ is a relevant reaction to ϕ iff there is a proper bridging qud for ϕ and ψ.

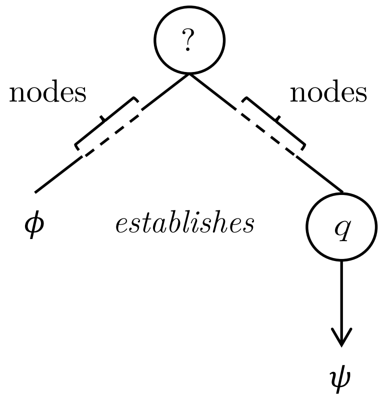


Figure 9.1: ϕ establishes q for ψ

The intuitive idea underlying RQB is that in an elementary one-turn dialogue $\phi \oplus \psi$, if ψ is a relevant reaction to ϕ, the current qud q for ψ (i.e., a question that ψ is congruent to) must be *established* by ϕ, as shown in Figure 9.1 (where dotted lines indicate possibly infinite nodes).[2] If q is established by ϕ, there must be a way to relate them. This motivates the hypothesis of a proper bridging qud, i.e., ? in Figure 9.1, for ϕ and q. This hypothesis is inspired by the idea advocated in Asher and Lascarides (2003) and Asher (2004) that two speech acts connected by certain rhetorical relation must have a *thematic link* or a *common theme/topic*. For Asher and Lascarides, only some specific rhetorical relations, such as *Narration* and *Continuation*, impose such a requirement. This dissertation further generalizes this very idea to every pair of speech acts in a coherent elementary one-turn dialogue. Following Roberts (1996/2012) and McNally (1998), we propose that the thematic link or common theme/topic for a pair of speech acts is exactly established by a question. In an elementary one-turn dialogue, it is a question that bridges the two concerned speech acts.

[2]The way how ϕ establishes q for ψ is intentionally left underspecified here. To determine what amounts to a proper way in which ϕ establishes q is part of the task to infer a proper bridging qud for ϕ and ψ. This is tackled in Section 9.3.

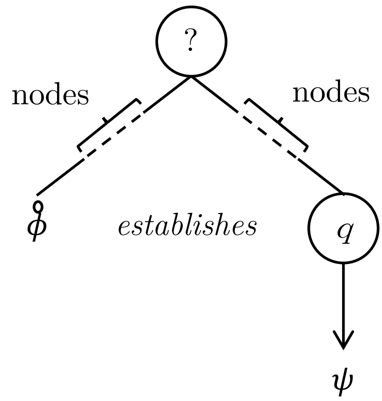


Figure 9.2: $\mathring{\phi}$ establishes q for ψ

9.2.2 The revised hypothesis

In virtue of the *two-fold performance thesis* (see Section 6.3 of Chapter 6.3), the original formulation of RQB is further extended, taking into account the potential of responding to speech acts at the meta-level. In the following revisited formulation of RQB, we write $\mathring{\phi}$ to denote either ϕ or $\mathsf{meta}(\phi)$ but not both of them.

> **Relevance via Qud-Bridging** (**RQB**, revised)
> In a one-turn dialogue $\phi \oplus \psi$ where ϕ or ψ is either an assertion or a question, ψ is a relevant reaction to ϕ iff there is a proper bridging qud for $\mathring{\phi}$ and ψ.

Under the revised RQB, the current qud q for ψ can be established by not only ϕ, but also $\mathsf{meta}(\phi)$. This leads to a revision of Figure 9.1, giving rise to Figure 9.2: ϕ in Figure 9.1 is replaced by $\mathring{\phi}$ in Figure 9.2.

9.3 Inferring Proper Bridging Quds

RQB defines the relevance of a reaction to a speech act in terms of the existence of a proper bridging qud. The *properness* of such a bridging qud is important: it cannot be any arbitary bridging qud for the two concerned speech act but a *proper* one. Let $\phi \oplus \psi$ denote an elementary one-turn dialogue, ρ denote a question, and CG denote the common ground between interlocutors prior to the utterance of ϕ, then if ρ is a proper bridging qud for ϕ and ψ, we conveniently notate it as

$$\mathsf{proper\text{-}bri}(\rho, \mathring{\phi}, \psi, \mathsf{CG})$$

The properness of ρ is defined in terms of five constraints: *accessibility constraint*, *concordance constraint*, *minimality constraint*, *optimality constraint*, and *informativity constraint*. ρ is a proper bridging qud for ϕ and ψ iff ρ satisfies the above five constraints. The remainder of this section introduces the five constraints and considers their relevance to the inference of a proper bridging qud.

9.3.1 Accessibility constraint

To start with, consider *accessibility constraint*.

> **Accessibility Constraint** (acc)
> Let $\phi \oplus \psi$ denote an elementary one-turn dialogue and CG denote the common ground between interlocutors prior to the utterance of ϕ. ρ an *accessible* bridging qud for $\mathring{\phi}$ and ψ relative to $\langle \mathsf{CG}, \phi \rangle$, written as $\mathsf{acc}(\rho, \mathring{\phi}, \psi, \mathsf{CG})$, iff ρ bridges $\mathring{\phi}$ and ψ relative to $\langle \mathsf{CG}, \mathring{\phi} \rangle$.[3]
>
> $$\mathsf{acc}(\rho, \mathring{\phi}, \psi, \mathsf{CG}) := \bigwedge \langle \mathsf{CG}, \mathring{\phi} \rangle \rightarrow \mathsf{bri}(\rho, \mathring{\phi}, \psi).$$

The importance of accessibility constraint is beyond doubt: it ensures that ρ is a bridging qud for $\mathring{\phi}$ and ψ with respect to $\langle \mathsf{CG}, \mathring{\phi} \rangle$. This constraint requires, first and foremost, that ρ is inferable from $\langle \mathsf{CG}, \mathring{\phi} \rangle$,

[3] $\bigwedge$ denotes generalized conjunction (to be considered in detail in Chapter 10). In the definition of $\mathsf{acc}(\rho, \mathring{\phi}, \psi, \mathsf{CG})$, $\bigwedge \langle \mathsf{CG}, \mathring{\phi} \rangle$ denotes the conjunction of all assumptions contained in $\langle \mathsf{CG}, \mathring{\phi} \rangle$.

that is, that the materials in ρ must be *given* in the sense that they are anaphoric to some contextually available antecedents. Consequently, it imposes a requirement similar to Givenness in Schwarzschild (1999) and Q-Givenness in Riester (2019).

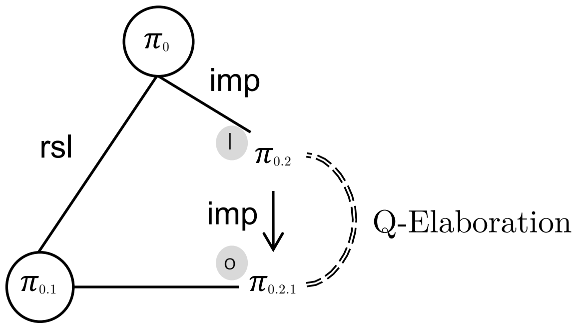
To a first approximation, consider the following two examples:

(1) a. **Lisuarte**: Which knight defeated Dardán?
 b. **Oriana**: #Which knight took Dardán's sword?

(2) a. [**Context**: It is a rule in medieval times that a knight defeats another iff the former takes the latter's sword.]
 b. **Lisuarte**: Which knight defeated Dardán?
 c. **Oriana**: Which knight took Dardán's sword?

(1b) is not a relevant reaction to (1a): if no clarification is made, it is unclear why Oriana reacts to (1a) by (1b). In contrast, (2c) is a relevant reaction to (2b). In (2), one may infer that (2b) is a bridging qud for (2b) and (2c): (2c) is a question implied by (2b) based on the contextual information that a knight defeats another iff the former brings back the latter's sword. This, however, is impossible for (1) because that (1a) implies (1b) is not inferable from the common ground. The qud-tree for (2) is presented in Figure 9.3, in which arrows indicate congruence relations and dotted double-lines indicate rhetorical relations.[4] The rationale of including congruence paths in Figure 9.3 will be made explicit immediately. Provided Figure 9.3, the infelicity of (1b) can be accounted in a more intuitive way: due to the lack of the necessary contextual information provided by $\pi_{0.1}$, the branches linking π_0-$\pi_{0.1}$, $\pi_{0.1}$-$\pi_{0.2.1}$, and $\pi_{0.2}$-$\pi_{0.2.1}$ are all impossible. Please note that while π_0 is the root node of the qud-tree presented in Figure 9.3, the proper bridging qud for establishing the relevance of $\pi_{0.2.1}$ to $\pi_{0.2}$

[4] *Q-elaboration* stands for question elaboration in Asher and Lascarides (2003). RQB lays a foundation for the qud-reduction of rhetorical relations. In all of the examples considered in this chapter, rhetorical relations emerging from addressing and reacting to speech acts in elementary one-turn dialogues are all made explicit (i.e., marked by dotted double-lines) in their qud-trees.



- π_0:= F(Which knight defeated Dardán?)
- $\pi_{0.1}$:= A knight defeats another iff the former takes the latter's sword.
- $\pi_{0.2}$:= Which knight defeated Dardán?
- $\pi_{0.2.1}$:= Which knight took Dardán's sword?

Figure 9.3: Qud-tree for (2): Q-Elaboration

is exactly $\pi_{0.2}$ itself but not π_0. The requirement for the presence of π_0 and $\pi_{0.1}$ in this figure indicates that the relevance of $\pi_{0.2.1}$ to $\pi_{0.2}$ can only be established when π_0 and $\pi_{0.1}$ are contextually available.

The reason that we require that $\mathsf{bri}(\rho, \mathring{\phi}, \psi)$ be inferable relative to $\langle \mathsf{CG}, \mathring{\phi} \rangle$ instead of CG is that to determine how to react in a relevant way or how to tell whether a reaction is relevant takes the addressee's perspective, presuming that the preceding speech act ϕ is given. The addition of ϕ, however, is not useless. Consider (3) and (4):

(3) a. **Lisuarte**: Amadís defeated Dardán.
   b. **Oriana**: I am so happy with this.

(4) a. **Lisuarte**: Amadís defeated Dardán.
   b. **Oriana**: Who do you refer to by *Amadís*?

The use of the demonstrative pronoun *this* indicates that (3b) cannot be performed unless (3a) is available. The fact that Amadís defeated Dardán provides a motive that makes Oriana happy. In traditional terminology, we call (3b) a *result* of (3a). From a different angle, however, we can say that (3a) provides information that facilitates the resolution of the question about whether Oriana is happy or not. In (4), (4b) requests a clarification on the semantic content associated with *Amadís*. The utterability of (4b) is dependent on the availability of (4a): if (4a) is unavailable, there seems no point to raise the question (4b). Intuitively, it is the meta-level speech act associated with (4a) that guarantees that by asserting (4a), Lisuarte refers to someone called *Amadís*. The qud-trees for (3) and (4) are presented in Figure 9.4.[5] The analysis for example (4) partially shows how challenges (which are difficult to handle under EQR) are dealt with under RQB (see Section 8.3 of Chapter 8.3 for related discussion).

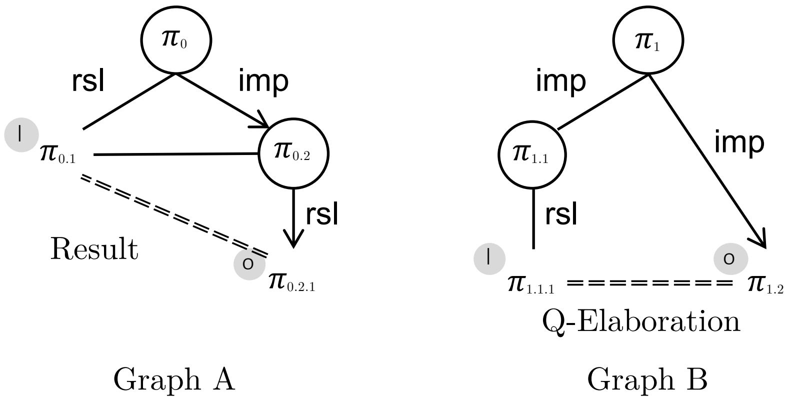
9.3.2 Concordance constraint

The second constraint is called *concordance constraint*.

> **Concordance Constraint** (con)
> Let $\phi \oplus \psi$ denote an elementary one-turn dialogue and let ρ denote a bridging qud for $\mathring{\phi}$ and ψ. ρ is concordant with $\mathring{\phi}$ and ψ, written as $\mathsf{con}(\rho, \mathring{\phi}, \psi)$, iff there is a congruence path from the reacting speech act ψ to ρ.
>
> $$\mathsf{con}(\rho, \mathring{\phi}, \psi) := \mathsf{c\text{-}path}(\psi, \rho).$$

This constraint requires that there be a congruence path from ψ to ρ. The significance of this condition is less evident. To explain why it is important, one should answer the following two questions: (i) why the congruence path from ψ to ρ is necessary and (ii) why the congruence path from $\mathring{\phi}$ to ρ is not. Let us start from the first question. Recall that the property of being congruent describes the relationship between a speech act and its current qud. In an elementary one-turn dialogue

[5]The rhetorical relation that appears in Graph B of Figure 9.4 is considered a subtype of *question elaboration* in Asher and Lascarides (2003). However, it is different from what we meet in Figure 9.3: in Figure 9.3, Q-elaboration connects an implying question and an implied question; in contrast, in Graph B of Figure 9.4 connects an assertion by a clarificatory question.



- Notations for (3) (Graph A):
  - π_0:= F(Are you happy?)
  - $\pi_{0.1}$:= Amadís defeated Dardán.
  - $\pi_{0.2}$:= Given $\pi_{0.1}$, are you happy?
  - $\pi_{0.2.1}$:= Yes (= I am so happy with this.)
- Notations for (4) (Graph B):
  - π_1:= What did you say?
  - $\pi_{1.1}$:= Did you say that someone called Amadís defeated Dardán?
  - $\pi_{1.1.1}$:= Yes (= Amadís defeated Dardán.)
  - $\pi_{1.2}$:= Who do you refer to by *Amadís*?

Figure 9.4: Qud-trees for (3)-(4): Result and Q-Elaboration

$\phi \oplus \psi$, to explain why ψ can be uttered is to explain why the current qud of ψ is inferable. In light of this, a proper bridging qud ρ for $\mathring{\phi}$ and ψ must provide such a possibility that the current qud for ψ is derivable from ρ. Turning to the second question: why the congruence path from $\mathring{\phi}$ to ρ is not necessary for the definition of a bridging qud? This is quite obvious: in an elementary one-turn dialogue $\phi \oplus \psi$, the interlocutor abstracts information that is interesting and useful (or more generally, information that attracts the interlocutor's *attention*) and need not be interested in what $\mathring{\phi}$ is congruent to.[6] Correspondingly, in reacting to $\mathring{\phi}$, the current qud for ψ is what the interlocutor is interested in and need not be identical with the current qud for $\mathring{\phi}$. Consequently, to determine whether ρ is proper, there is no reason to care about whether there is a congruence path from $\mathring{\phi}$ to ρ.

To illustrate, consider the following example:

(5) a. **Lisuarte**: Amadís defeated [Dardán]$_{\mathcal{F}}$.
    b. **Oriana**: [Galaor]$_{\mathcal{F}}$ defeated Dardán as well.

Though it appears odd to let *Dardán* in (5a) bear a narrow focus, it is not impossible. Consider the following context: Lisuarte and Oriana were both aware that Amadís defeated someone but were unaware whom he had defeated, and finally Lisuarte got to know that Amadís defeated Dardán, and asserted (5a) to Oriana. From the focus marking, one infers that (5a) is intended to answer (6a). In contrast, the focus marking in (5b) indicates that (5b) is intended to answer (6b) instead of (6a) or any question dominated by (6a). The reason could be that (6b), instead of (6a), attracts more attention from Oriana.

(6) a. Whom did Amadís defeat?
    b. Who defeated Dardán as well?

[6]The importance of *attention* in discourse is widely acknowledged in the literature (Grosz & Sidner, 1986; Brennan, 1995; Walker, 1996; Grosz & Gordon, 1999; Stojnić, Stone, & Lepore, 2017). For a comprehensive attention-based approach to semantics/pragmatics, see Westera (2017).

This provides supportive evidence for our claim that the presence of a congruence path between a bridging qud and the initiating move is not necessary for determining whether the bridging qud is proper. The qud-tree for (5) is presented in Figure 9.5.

9.3.3 Minimality constraint

This third constraint is called *minimality constraint.*

> **Minimality Constraint** (min):
> Let $\phi \oplus \psi$ denote an elementary one-turn dialogue and let ρ denote a bridging qud for $\mathring{\phi}$ and ψ. ρ is *minimal* relative to ϕ and ψ, written as $\mathsf{min}(\rho, \mathring{\phi}, \psi)$ iff no question properly dominated by ρ bridges $\mathring{\phi}$ and ψ.
>
> $$\mathsf{min}(\rho, \mathring{\phi}, \psi) := \forall x : \Psi_{\mathcal{E}}.\mathsf{pdom}(\rho, x) \rightarrow \neg\mathsf{bri}(x, \mathring{\phi}, \psi).$$

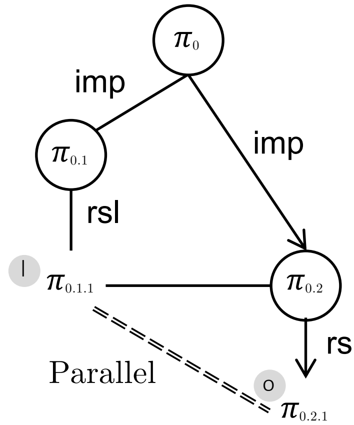
The importance of this constraint is trivial. For an elementary one-turn dialogue $\phi \oplus \psi$, there could be infinitely many bridging quds for $\mathring{\phi}$ and ψ, but what is most relevant to us is one ρ that is *minimal* in the sense that no question properly dominated by ρ bridges $\mathring{\phi}$ and ψ. This is intuitively illustrate by Figure 9.6: there could be possibly infinite questions that can serve as a bridging qud for $\mathring{\phi}$ and ψ but what is relevant to us is the one ρ that is minimal. It is trivial that if ρ is a bridging qud for $\mathring{\phi}$ and ψ, then ρ_x is a bridging qud for $\mathring{\phi}$ and ψ (as captured by ($\textsc{qt}_2$)), but not the other way around.

To show how minimality constraint works, consider (7):

(7) a. **Lisuarte**: Amadís defeated Dardán.
b. **Oriana**: (But) He didn't defeat Endriago.

There is clearly no doubt that (7b) is a relevant reaction to (7a). Here are some possible bridging quds for (7a) and (7b):

(8) a. Who defeated whom?



- π_0:= Between Amadís and Galaor, who defeated Dardán
- $\pi_{0.1}$:= Did Amadís defeat Dardán?
- $\pi_{0.1.1}$:= Yes (= Amadís defeated Dardán.)
- $\pi_{0.2}$:= Did Galaor defeat Dardán as well?
- $\pi_{0.2.1}$:= Yes (= Galaor defeated Dardán as well.)

Figure 9.5: Qud-tree for (5): Parallel

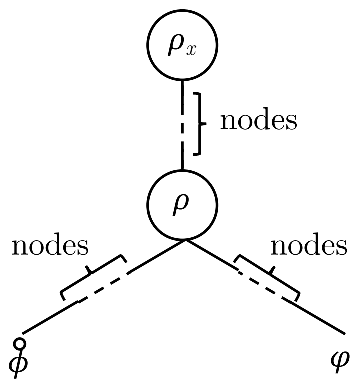


Figure 9.6: ρ is minimal relative to $\mathring{\phi}$ and ψ

b. Whom did Amadís defeat?

c. Whom did Amadís defeat, Dardán or Endriago?

The three candidate questions given in (8) comply with both *accessibility* and *concordance constraints*, but undoubtedly (8c) is more proper than the other two candidate questions because the fact that (8c) bridges (7a) and (7b) implies that (8b) and (8c) are both bridging quds for (7a) and (7b) but not the other way around, and more importantly, no question dominated by (8c) is a bridging qud for (7a) and (7b). The possible qud-trees for (7) is presented in Figure 9.7.[7] [8] Graph A and Graph B differ with respect to whether (7a) promotes the implication of the current qud for (7b). If the answer is negative, we obtain Graph A and if the answer is positive, we obtain Graph B. The contrastive interpretation seems to be stronger in Graph B, in which the use of the particle *but* in (7b) is more proper (see also Asher and Lascarides (2003, 168), Umbach (2005), Jasinskaja (2012, 2013) and Toosarvandani (2014) for related discussion on *but*).

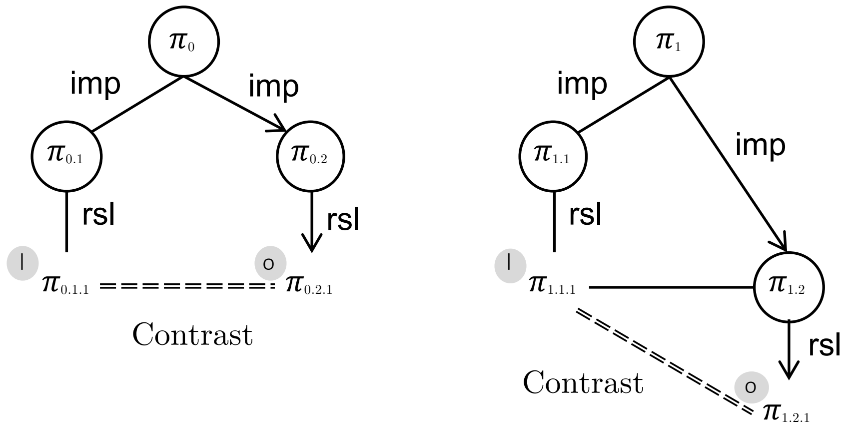
9.3.4 Optimality constraint

The fourth constraint is called *optimality constraint.*

Optimality Constraint (opt):
Let $\phi \oplus \psi$ denote an elementary one-turn dialogue and let ρ denote a bridging qud for $\mathring{\phi}$ and ψ. ρ is *optimal* relative to ϕ and ψ, written as $\mathsf{opt}(\rho, \mathring{\phi}, \psi)$ iff either (a), (b) or (c) is satisfied (where $q : \{I_c(F(I(\mathring{\phi}))), I_k(F(I(\mathring{\phi}))), I(\mathring{\phi})\}$):

[7] Since only (*full*) *question resolution* and *question implication* are notated in qud-trees, *partial question resolution* must be reduced to (*full*) *question resolution.* For this reason, some intermediate nodes (i.e., $\pi_{0.1}$ and $\pi_{1.1}$) are introduced in Figure 9.7. In Roberts' (1996/2012) framework, these nodes are unnecessary.

[8] Please notice that although (8b) is not minimal, it seems plausible to consider it as a proper bridging qud for (7a) and (7b). This shows that minimality is not categorical but scalar in some cases.



Graph A Graph B

- Notations for (7) ((7b) does not contain *but*) (Graph A):
  - π_0:= Whom did Amadís defeat, Dardán or Endriago?
  - $\pi_{0.1}$:= Did Amadís deafeat Dardán?
  - $\pi_{0.1.1}$:= Yes (= Amadís defeated Dardán.)
  - $\pi_{0.2}$:= Did Amadís defeat Endriago?
  - $\pi_{0.2.1}$:= No (= Amadís didn't defeat Endriago.)
- Notations for (7) ((7b) contains *but*) (Graph B):
  - π_1:= Whom did Amadís defeat, Dardán or Endriago?
  - $\pi_{1.1}$:= Did Amadís deafeat Dardán?
  - $\pi_{1.1.1}$:= Yes (= Amadís defeated Dardán.)
  - $\pi_{1.2}$:= Did Amadís defeat Endriago as well?
  - $\pi_{1.2.1}$:= No (= Amadís didn't defeat Endriago.)

Figure 9.7: Qud-tree for (7): Contrast

(a) If $\mathring{\phi}$ is a question, then $F(q)$ dominates ψ;[9]

$$\mathsf{opt}(\rho, \mathring{\phi}, \psi) := \mathsf{dom}(F(q), \psi).$$

(b) If $\mathring{\phi}$ is an assertion, then either (i) $F(q)$ dominates ψ, or (ii) $\mathring{\phi}$ promotes the implication of ψ from ρ (if ψ is a question) or $\mathring{\phi}$ promotes the implication of the current qud for ψ from ρ.

$$\mathsf{opt}(\rho, \mathring{\phi}, \psi) := \mathsf{dom}(F(q), \psi) \vee \mathsf{pro}(\mathring{\phi}, \rho, \psi) \vee \exists x : \Psi_{\mathcal{E}}.\mathsf{cgr}(\psi, x) \wedge \mathsf{pro}(\mathring{\phi}, \rho, x).$$

(c) If $\mathring{\phi}$ is an assertion and (b) is not satisfied, then ρ is the current qud for ψ and ρ contains materials that are commonly shared by both $\mathring{\phi}$ and ψ.

$$\mathsf{opt}(\rho, \mathring{\phi}, \psi) := \mathsf{cgr}(\psi, \rho) \wedge \mathsf{anaph}(\rho, \mathring{\phi}, \psi).$$

The importance of this constraint is less obvious, but it is in fact central to RQB as it introduces stringent requirements on the structural relationship between a proper bridging qud and the pair of speech acts (in an elementary one-turn dialogue) that it bridges.

To start with, let us consider clause (a) of optimality constraint. It reminds us of the first clause of EQR (see Section 8.2 of Chapter 8 for details). However, (a) is not a mere retention of EQR but allows for a finer-grained two-way distinction: $F(q)$ might merely dominate ψ or $F(q)$ not only dominates ψ but is situated in the congruence path from ψ to ρ. To illustrate why this two-way distinction is important, consider again the following example (repeated from (12) in Chapter 8):

(9) a. **Lisuarte**: Did Amadís visit London yesterday?

[9] $\mathsf{meta}(\phi)$ is an assertion that the speaker performed ϕ and addressed it to the interlocutor. For this reason, this clause does not apply to $\mathsf{meta}(\phi)$.

b. **Oriana**: i. The boat he planned to catch was broken.
ii. Amadís visited $[\text{Paris}]_{\mathcal{F}}$.

In Section 8.3 of Chapter 8, we point out that although EQR successfully predicts that (9bi) and (9bii) are both relevant reactions to (9a) (in virtue of the fact that they both answer $F(I(9a)))$, it fails to capture the fact that (9bii) is not intended to answer $F(I(9a))$ but to answer (10), as signaled by the focus accent in (9bii).

(10) Where did Amadís visit?

Under RQB, the analysis for (9bii) is completely different: (9bii) answers (10), a question dominating (9a), and provided (9bii), one infers (11) from (9a) and the answer to (11) is rejective.

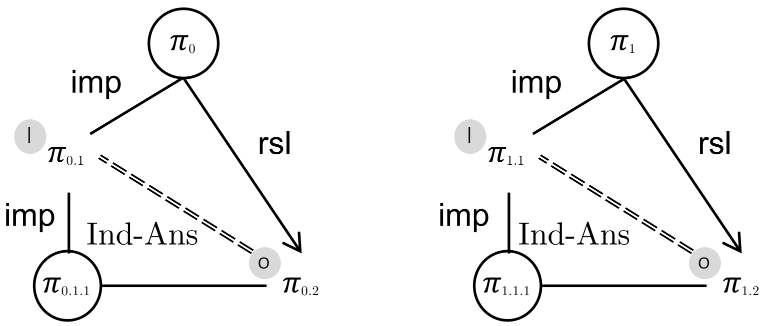
(11) Since Amadís visited Paris yesterday, did he visit London?

Under RQB, the qud-trees for (9a-9bi) and (9a-9bii) are different, as shown respectively in Graph A and Graph B in Figure 9.8.[10]

Let us move to clause (b) of optimality constraint. This clause consists of two alternative conditions. The first condition, as clause (a) of this constraint, is inherited from the first condition of EQR, requiring that ψ contribute to the resolution of $F(q)$. The second condition in clause (b) is novel: it specifies that if ψ does not contribute to the resolution of $F(q)$, it should promote the implication of ψ (if it is a question) or the current qud of ψ (regardless of whether ψ is an assertion or a question). The significance of the first condition of clause (b) is beyond doubt, as made clear in Section 8.2 of Chapter 8. Let us now consider the second condition of (b). Consider (12):

(12) a. **Lisuarte**: Amadís defeated a monster.
b. **Oriana**: i. I don't want to talk about this.
ii. The monster was $[\text{Endriago}]_{\mathcal{F}}$.

[10]The rhetorical relation *Ind-Ans* in both Graph A and Graph B corresponds to *Indirect Question Answer Pair* (*IQAP*) in Asher and Lascarides (2003).



Graph A

Graph B

- Notations for (9a-9bi) (Graph A):
  - π_0:= F(Did Amadís visit London yesterday?)
  - $\pi_{0.1}$:= Did Amadís visit London yesterday?
  - $\pi_{0.1.1}$:= Since $\pi_{0.2}$, then $\pi_{0.1}$?
  - $\pi_{0.2}$:= The boat he planned to catch was broken.
- Notations for (9a-9bii) (Graph B):
  - π_1:= Where did Amadís visit?
  - $\pi_{1.1}$:= Did Amadís visit London yesterday?
  - $\pi_{1.1.1}$:= Since $\pi_{1.2}$, then $\pi_{1.1}$?
  - $\pi_{1.2}$:= Amadís visited [Paris]$_{\mathcal{F}}$.

Figure 9.8: Qud-trees for (9a-9bi) and (9a-9bii): Indirect Answer

iii. Okay, I see.
iv. But he is $[\text{unhappy}]_{\mathcal{F}}$.

There is no doubt that (12bi)-(12biv) are relevant reactions to (12a), but they differ in the way they are connected to (12a). Consider first (12bi): it is an answer to $F(I_k(F(I(12a))))$ and thus satisfies the first condition of clause (*b*). (12bii) does not satisfy the first condition of clause (*b*). The focus marking in (12bii) signals that it answers (13):

(13) Who was the monster (that Amadís defeated)?

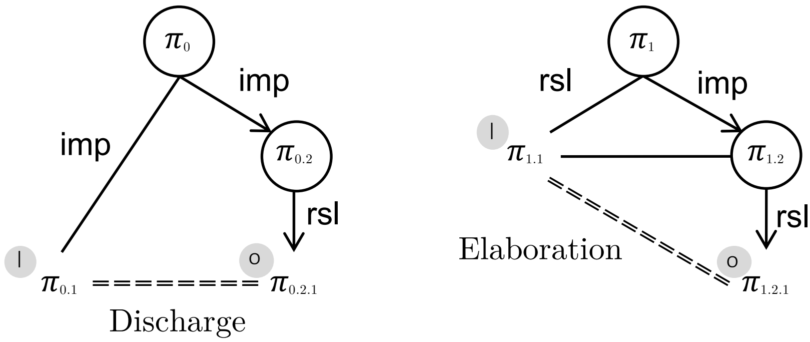
The raising of (13) is impossible unless (12a) is available (or at least contextually salient). In other words, (12a) promotes the implication of (13) from a higher-level question (i.e., a bridging qud for (12a) and (12bii). The qud-trees for (12a-12bi) and (12a-12bii) are presented in Graph A and Graph B in Figure 9.9.[11]

The rationale of reacting to (12a) by (12biii) or (12biv) is different from that of reacting to (12a) by (12bi) or (12bii). Let us now consider (12biii). Intuitively, (12biii) is intended to answer (14):

(14) Do you accept/believe that Amadís defeated a monster.

(14) contributes to the resolution of I(12a) in the sense that whenever one affirmatively or rejectively answers (14), one also (indirectly) answers I(12a): if one answers (14) affirmatively, one gives an affirmative answer to I(12a); and if one answers (12a) rejectively, it could be the case that one provides a rejective answer to I(12a) or at least that one decommits to (12a). However, notice that while one can infer an affirmative answer to I(12a) from an affirmative answer to (14), it is pragmatically different from directly answering (14) by an affirmation. The former conveys a conversational implicature that is usually unavailable from the latter: the utterance of (12biii) as a reaction to

[11] The rhetorical relation dubbed *Discharge* in Graph A loosely corresponds to *Plan-Correction* in Asher and Lascarides (2003).



Graph A Graph B

- Notations for (12a-12bi) (Graph A):
  - $\pi_0 := v(I(\text{Amadís defeated a monster}))$.
  - $\pi_{0.1}$:= Amadís defeated a monster.
  - $\pi_{0.2}$:= Do you want to talk about $\pi_{0.1}$?
  - $\pi_{0.2.1}$:= No (= I don't want to talk about this.)
- Notations for (12a-12bii) (Graph B):
  - π_1:= What happened to Amadís?
  - $\pi_{1.1}$:= Amadís defeated a monster.
  - $\pi_{1.2}$:= Who was the monster (that Amadís defeated)?
  - $\pi_{1.2.1}$:= The monster was Endriago.

Figure 9.9: Qud-trees for (12a-12bi) and (12a-12bii): Discharge and Elaboration

I(12a) implicates that Oriana was unaware of whether Amadís defeated a monster before Lisuarte asserted (12a) to her.[12]

Finally, consider (12biv).(12biv) answers the following question:

(16) What does Amadís feel after that he defeated Dardán?

Nevertheless, the occurrence of the connective *but* in (12biv) indicates that (12biv) is counter-expectation: Oriana expects that Amadís would be happy for having defeated Dardán but the reality goes the opposite. The qud-trees for (12a-12biii) and (12a-12biv) are presented respectively in Graph A and Graph B in Figure 9.10.[13]

Let us now move on to consider clause (c) of optimality constraint. Clause (b) captures the majority of relevant reactions to an assertion. The purpose of introducing clause (c) is to handle some extreme but actually frequently found cases in linguistic discourse. To show how clause (c) works, consider again (17) (repeated from (11)):

(17) a. **Lisuarte**: Amadís defeated Dardán.
b. **Oriana**: ?Galaor was robbed.

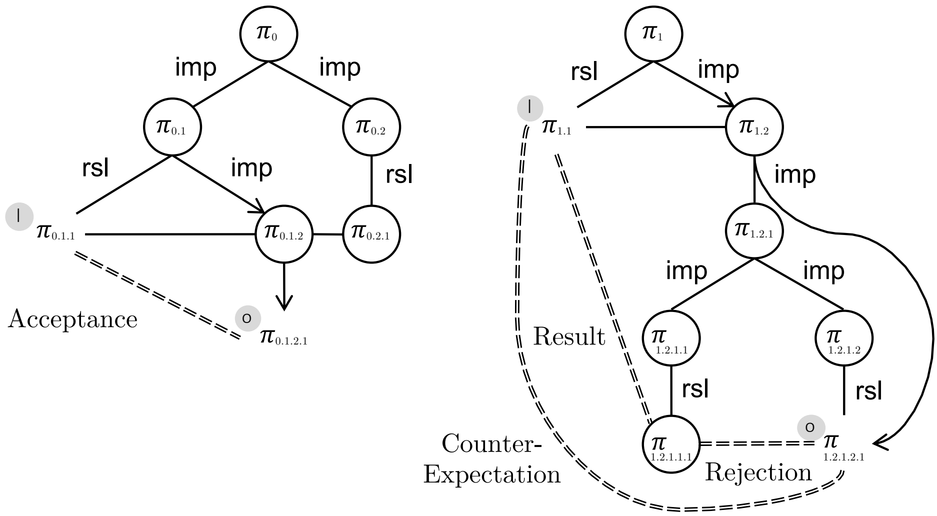
It is obvious that (17b) does not satisfy clause (b) of optimality constraint. For this reason, to infer a proper bridging qud for (17a) and (17b), one should consider clause (c). Can one infer a bridging qud for

[12] This implicature cannot be easily canceled unless the speaker confesses that the reacting speech act (12biii) fails to observe Grice's (1975) maxim of *manner*. To illustrate, consider the following example:

(15) a. **Lisuarte**: Amadís defeated a monster.
b. **Oriana**: Okay, I see.
#I know it already.

The infelicity of the utterance *I know it already* in (15b) indicates that the inference that the mere acceptance of (15a) by Oriana conversationally implicates that Oriana was unaware of the truth of (15a) cannot be easily canceled.

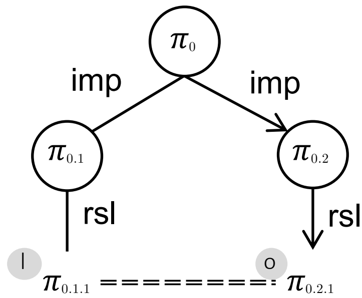
[13] The rhetorical relations *acceptance* in Graph A of Figure 9.10 and *counter-expectation* in Graph B of the same figure loosely correspond to *acknowledgment* and *counterevidence* respectively in Asher and Lascarides (2003).



Graph A Graph B

- Notations for (12a-12biii) (Graph A):
  - π_0:= $v(I$(Amadís defeated Dardán)).
  - $\pi_{0.1}$:= Did Amadís defeat Dardán?
  - $\pi_{0.1.1}$:= Amadís defeated Dardán.
  - $\pi_{0.1.2}$:= Do you accept that Amadís defeated Dardán?
  - $\pi_{0.1.2.1}$:= Yes (= Okay, I see.)
  - $\pi_{0.2}$:= $I_k(I$(Amadís defeated Dardán)).
  - $\pi_{0.2.1}$:= No (= I don't want to talk about this.)
- Notations for (12a-12biv) (Graph B):
  - π_1:= What happened to Amadís?
  - $\pi_{1.1}$:= Amadís defeated Dardán.
  - $\pi_{1.2}$:= What does Amadís feel after $\pi_{1.1}$?
  - $\pi_{1.2.1}$:= Is Amadís happy after $\pi_{1.1}$?
  - $\pi_{1.2.1.1}$:= Is Amadís supposed to be happy after $\pi_{1.1}$?
  - $\pi_{1.2.1.1.1}$:= Yes (= Amadís is supposed to be happy after $\pi_{1.1}$.)
  - $\pi_{1.2.1.2}$:= Is Amadís actually happy after $\pi_{1.1}$?
  - $\pi_{1.2.1.2.1}$:= No (= Amadís is actually unhappy after $\pi_{1.1}$.)

Figure 9.10: Qud-trees for (12a-12biii) and (12a-12biv): Acceptance and Couner-Expectation



- π_0:= What happened to Amadís and Galaor yesterday?
- $\pi_{0.1}$:= What happened to Amadís (yesterday)?
- $\pi_{0.1.1}$:= Amadís defeated Dardán (yesterday).
- $\pi_{0.2}$:= What happened to Galaor (yesterday)?
- $\pi_{0.2.1}$:= Galaor was robbed (yesterday).

Figure 9.11: Qud-tree for (18): Continuation

(17) that satisfy clause (c)? The answer is negative, because (17a) and (17b) do not contain any materials in common.[14] In contrast, let us now consider the following example:

(18) a. **Lisuarte**: Amadís defeated Dardán yesterday.
b. **Oriana**: Galaor was robbed yesterday.

The only difference between (17) and (18) is that in the latter, a new constituent *yesterday* is added to both speech acts. It is exactly this addition that enables one to find materials shared by (18a) and (18b) and to infer (19) as a proper bridging qud for (18a) and (18b):

[14]It is unfair to claim that (17a) and (17b) have nothing shared in common: for example, the past tense used in both (17a) and (17b) indicate that (17a) and (17b) are both about things that happened in the past (relative to the utterance time). This, however, is intuitively not enough for the inference of a proper bridging qud for (17a) and (17b). In view of this, there is a necessity to amend clause (c) by specifying what materials in $\mathring{\phi}$ and ψ are relevant for the inference of a proper bridging qud ρ and what are not. This remains for future research.

(19) What happened to Amadís and Galaor yesterday?

The qud-tree for (18) is offered in Figure 9.11. In terms of Asher and Lascarides (2003), (19) establishes the *common topic/theme* for (18a) and (18b). The above analysis for (17) and (18) partially shows how the phenomenon of default acceptance (which is difficult to deal with under EQR), is dealt with under RQB (see Section 8.3 of Chapter 8 for more related discussion).

9.3.5 Informativity constraint

The last constraint is called *informativity constraint*, which requires that if ρ is a proper bridging qud for an elementary one-turn dialogue $\phi \oplus \psi$, ψ is as informative as possible relative to ρ. Similar to the second condition in EQR (see Section 8.2 of Chapter 8 for more details), this constraint derives from Grice's (1975) maxim of *quantity*.

> **Informativity constraint** (inf):
> Let $\phi \oplus \psi$ denote an elementary one-turn dialogue and ρ denote a bridging qud for $\mathring{\phi}$ and ψ. ρ satisfies informativity constraint iff ψ is as informative as is required relative to both ρ and $\mathring{\phi}$, written as follows:[15]
>
> $$\mathsf{inf}(\rho, \mathring{\phi}, \psi).$$

The significance of informativity constraint has already been considered in Section 8.2 of Chapter 8 (when we justify the necessity of introducing the second condition of EQR). Consider (20):[16]

---

[15] The informativity constraint has long been considered to be essentially pragmatic. Westera (2017) proposes a potential formalization of this constraint, which however does not work well for our purposes. The formalization of this constraint is beyond the scope of this dissertation and we leave it for future research.

[16] Informativity constraint sometimes need not be strictly followed, but whenever it is not observed, as suggested by Grice (1975), some conversational implicature(s) would emerge. In connection with (20bi), as first argued in Section 8.2 of

(20) a. **Lisuarte**: Which knight defeated Dardán?
b. **Oriana**: i. ?I want to talk about this.
ii. I don't want to talk about this.

(20bi) appears odd as a reaction to (20a), as it violates informativity constraint: if Oriana wants to talk about the question introduced by Lisuarte, there is no need to explicitly mention it, but shall proceed immediately by tackling this question. In contrast, (20bii) is undoubtedly a felicitous reaction: (20bii) discharges Oriana's commitment to answer (20a). The qud-trees for (20a-20bi) (Graph A) and (20a-20bii) (Graph B) are presented in Figure 9.12. The well-formedness of the qud-tree in Graph A indicates that even though (20bi) is odd in (20), it *can* in principle be used as a reaction to (20a).

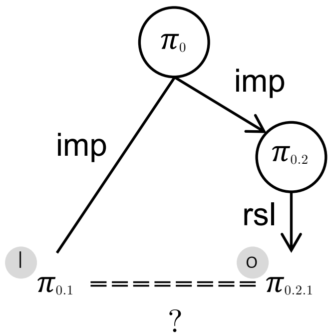
9.4 Remarks on Underspecification

The procedure of inferring a proper bridging qud for a pair of speech acts that forms an elementary one-turn dialogue appears to take for granted that the two concerned speech acts are both fully interpreted. This is in fact not the case. Consider the following example:

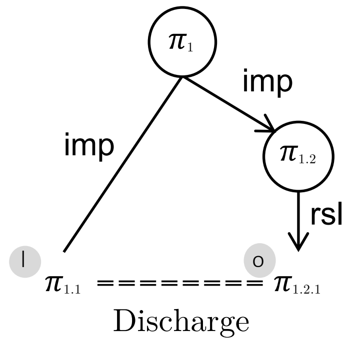
(21) a. Speaker *a*: John pushed Bill.
b. Speaker *b*: He $[\text{fell}]_{\mathcal{F}}$.

In (21b), it is *underspecified* whom the pronoun *he* refers to. (21a) provides two possibilities: *he* might refer to *John* or *Bill*. There is no doubt that (21b) is a relevant reaction to (21a). Let us now consider how to account for the relevance of (21b) to (21a) under RQB. There are two possibilities to interpret the pronoun *he*. Let *he* refer to *John*, then from the focus marking in (21b), it is very easy to infer that (21b) answers (22a). Let *he* refer to *Bill*, then (21b) answers (22b).

Chapter 8, though (20bi) appears odd, it is not completely impossible. But whenever (20bi) is uttered as a reaction to (20a), it conversationally implicates that the speaker is unaware of an answer to (20a).



Graph A



Graph B

- Notations for (20a-20bi) (Graph A):
  - π_0:= v(Which knight defeated Dardán?)
  - $\pi_{0.1}$:= Which knight defeated Dardán?
  - $\pi_{0.2}$:= I_c(Which knight defeated Dardán?).
  - $\pi_{0.2.1}$:= I want to talk about this.
- Notations for (20a-20bii) (Graph B):
  - π_0:= v(Which knight defeated Dardán?)
  - $\pi_{0.1}$:= Which knight defeated Dardán?
  - $\pi_{0.2}$:= I_c(Which knight defeated Dardán?).
  - $\pi_{0.2.1}$:= I don't want to talk about this.

Figure 9.12: Qud-trees for (20a-20bi) and (20a-20bii)

(22) a. What happened to John?
  b. What happened to Bill?

If (21b) answers (22a), (21b) is counter-expectation in the discourse: on the basis of commonsense knowledge, if one pushed another, the latter would fall, but this contradicts the interpretation of (21b) when it answers (22a).[17] In contrast, if (21b) answers (22b), the interpretation of (21b) is pro-expectation and is therefore more consistent with commonsense knowledge. The above analysis suggests that the resolution of *he* in (21b) depends on both the discourse structure of (21) and world knowledge. This echos Asher and Lascarides' (2003) view that discourse structure plays a role in anaphora and presupposition resolution. The qud-tree for (21) is presented in Figure 9.13.

The analysis for the resolution of *he* in (21b) shows how underspecified semantic values contained in a speech act are resolved in a discourse. A detailed formal mechanism for resolving underspecification under RQB is beyond the scope of this dissertation and remains for future scrutiny (see Chapters 4-5 in Asher and Lascarides (2003), Irmer (2011), and Ginzburg (2012, 316-348) for previous attempts).

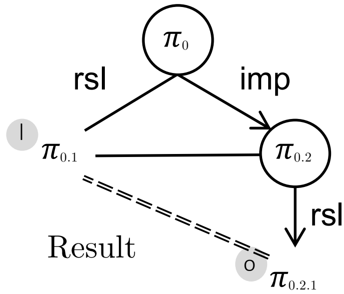
9.5 A (Quasi-)Top-Down Approach

RQB endorses a bottom-up approach to the characterization of the potential of reactions: it presumes the availability of a speech act and a reaction candidate and what one needs to do is to decide whether the latter is relevant to the former (that is, to check whether there is a proper bridging qud for the two concerned speech acts). There is a

[17] Kehler (2005) proposes that in this case, one might put a narrow focus on *he*, instead of *fell*, as shown in the following example:

(23) a. Speaker *a*: John pushed Bill.
  b. Speaker *b*: $[\text{He}]_{\mathcal{F}}$ fell.

The reader is referred to Onea (2013, 188-192) for an recent inspiring attempt to account for the distinction between (21) and (23) from a qud-based approach.



- π_0:= What happened to Bill?
- $\pi_{0.1}$:= John pushed Bill.
- $\pi_{0.2}$:= How did Bill react to $\pi_{0.1}$?
- $\pi_{0.2.1}$:= He (= Bill) fell.

Figure 9.13: Qud-trees for (21): Result

problem with the bottom-up approach to the potential of reactions: it fails to predict how a reaction to a speech act comes up and how the information therein contained is properly packaged (i.e., where to place a narrow focus, if any, in a reacting speech act). In order to handle this problem, we propose a tentative (quasi-)top-down approach to the characterization of the potential of reactions. The essential idea is the following: to determine what amounts to a relevant reaction to a speech act, one first infers the current qud for this reaction and then provides this reaction in compliance with the congruence requirement (i.e., that a speech act is congruent to its current qud). The inference of the current qud for a (relevant) reaction to a given speech act is a procedure called *current qud inference*, defined as follows:

Definition 36 (Current Qud Inference)**.** *Let ϕ denote a speech act, β denote a question, and* CG *denote the common ground between interlocutors prior to the utterance of ϕ. β establishes the current qud for a relevant reaction to ϕ, conveniently written as* $\mathsf{current}(\phi, \beta, \mathsf{CG})$*, iff (a) there is a bridging qud x for $\mathring{\phi}$*

and β such that x is accessible from $\langle \mathsf{CG}, \phi \rangle$ and x is concordant with $\mathring{\phi}$ and β, and (b) for every speech act y that is either an assertion (if the reaction to $\mathring{\phi}$ is an assertion) or a question (if the reaction to $\mathring{\phi}$ is a question) but not both, if y is congruent to β and if y is as informative as is required relative to $\mathring{\phi}$ and x, x is a proper bridging qud for $\mathring{\phi}$ and y.

$$\begin{aligned}&\mathsf{current}(\phi, \beta, \mathsf{CG}) := \\ &\exists x : \Psi_{\mathcal{E}}.\forall y : \Psi_X.(\mathsf{acc}(x, \mathring{\phi}, \beta, \mathsf{CG}) \wedge \mathsf{con}(x, \mathring{\phi}, \beta) \wedge \\ &(\mathsf{cgr}(y, \beta) \rightarrow \mathsf{inf}(x, \mathring{\phi}, y) \rightarrow \mathsf{proper\text{-}bri}(x, \mathring{\phi}, y, \mathsf{CG}))),\end{aligned}$$

where $X = \mathcal{A}$ if the reaction to ϕ is known to be an assertion and $X = \mathcal{E}$ if the reaction to ϕ is known to be a question.

The goal of inferring β is that whenever β is inferred, one shall react to ϕ by reacting to β with a speech act y that is congruent to β. This provides a top-down approach to the characterization of the potential of reactions. However, it is assuredly unfair to conceive it as a complete top-down approach due to the following two reasons: first, observe that in order to initiate the procedure of current qud inference, there is a prerequisite that one must be aware of the speech act type X of the reaction to ϕ; second, whereas reacting to ϕ by reacting to β with a speech act y that is congruent to β represents a top-down perspective, the inference of the current qud β for y still endorses a bottom-up perspective. In light of the above discussion, it seems more appropriate to call this approach a *quasi*-top-down approach to the characterization of the potential of reactions.[18] The potential of this quasi-top-down approach will be further explored in the future.

[18]The introduction of this quasi-top-down approach to the potential of reactions on the basis of the mechanism of current qud inference is by and large tentative. It remains unclear to what extent it differs essentially from the bottom-up approach developed in the previous sections of this chapter, nor do we know much about what advantages or disadvantages this quasi-top-down approach could have over the bottom-up approach. All these questions remain for future research.

9.6 Summary

The notion of relevance is central to pragmatic research (Grice, 1975, 1989; Wilson & Sperber, 2002). In an elementary one-turn dialogue $\phi \oplus \psi$, the coherence between ϕ and ψ is characterized in terms of the notion of relevance: ψ is coherent with ϕ iff ψ is a relevant reaction to ϕ. This chapter develops a novel qud-based definition of relevance (in contrast with Roberts' (1996/2012)) called *relevance via qud-bridging* (RQB) which characterizes the relevance of ψ to ϕ in terms of the existence of a proper bridging qud ρ for ϕ and ψ. The relevance between ψ and ϕ is therefore not a simple binary relation but a ternary relation between ψ, ϕ, and a proper bridging qud ρ for them. The inference of a proper bridging qud is subject to a series of five constraints, which are core to RQB. RQB is more powerful than EQR introduced in the previous chapter: on the one hand, except the fundamental Q-Assumption, EQR is by and large retained in RQB (concretely, in the *optimality constraint*), and on the other, it is revealed in our analysis that the three problems that EQR encounters can be easily handled under RQB (see our analyses for examples (4), (9), and (17) in Section 9.3 of this chapter). In contrast with EQR, which can be seen as a plain and perhaps superficial generalization of Roberts' (1996/2012) definition of (qud-)relevance, RQB introduces a freshly new qud-based approach to the characterization of relevance.

Part IV

Making Qud-Reductions

Overview of Part IV

In an elementary one-turn dialogue

$$\phi \oplus \psi,$$

the relevance of ψ to ϕ can be characterized in two different manners: the relation-based approach views the relevance of ψ to ϕ as mediated by certain rhetorical relation(s), and the qud-based approach explains the relevance of ψ to ϕ in terms of underlying qud-relation(s) (see Sections 2.3 and 2.4 of Chapter 2 for more relevant discussion). If relation- and qud-based approaches are both on the right track to the relevance of ψ to ϕ (or more generally, to the modeling of the discourse structure of $\phi \oplus \psi$), there must be a way to define a mapping between them. Since qud-relations are (assumed to be) more primitive than other rhetorical relations, it is reasonable to wonder if one can reduce non-qud rhetorical relations to qud-relations. This task is handled in this part. Specifically, this part answers the following research question (motivated in Section 2.4 of Chapter 2):

(Q3) Under the view that rhetorical relations emerge from addressing and reacting to speech acts in elementary one-turn dialogues, is it possible to reduce rhetorical relations that occur in elementary one-turn dialogues to qud-relations?

The working hypothesis for this research question, first introduced in Section 2.4 of Chapter 2, is repeated here:

> **Relation-to-Qud Hypothesis** (**RQH**)
> A rhetorical relation is reducible to a family of qud-relations.

Though not explicitly mentioned, the analyses of examples in Section 9.3 of Chapter 9 provide supportive evidence for RQH. The purpose of this part is to examine in a more systematic way how rhetorical relations are reduced to qud-relations. Two general kinds of rhetorical relations are considered: rhetorical relations in logical discourse and rhetorical relations in linguistic discourse. Unless otherwise specified, we call the former simply *logical relations* and reserve the name *rhetorical relations* for the latter henceforth.

This part consists of two chapters: Chapter 10 shifts the focus of research from linguistic discourse to logical discourse and considers in detail the way in which logical relations are reduced to qud-relations, taking inspirations from Wiśniewski (1995, 2013); Chapter 11 considers systematically the qud-reduction of rhetorical relations defined *à la* Asher and Lascarides (2003) via a thorough examination of the possibility of recovering certain important properties of rhetorical relations in a qud-model of discourse under RQB. The overall results provide supportive evidence for RQH and more generally, for the enterprise of unifying relation- and qud-based approaches to discourse.

Chapter 10

Qud-Reduction: Logical Relations

This chapter considers the qud-reduction of logical relations and reformulates $\mathcal{A}$-reasoning in an erotetic style.

This chapter consists of four sections: Section 10.1 introduces logical relations in classical first-order logic; Section 10.2 outlines inference rules called *qud-decomposition rules* for reducing logical relations to qud-relations; Section 10.3 represents qud-decomposition rules by qud-trees; Section 10.4 provides some concluding remarks.

10.1 Logical Relations

In this dissertation, logical relations are understood as a special type of rhetorical relations expressed by logical connectives. The logic underlying $\mathcal{A}$-reasoning (and $\mathcal{E}$-reasoning) is classical logic (see Section 4.5 of Chapter 4 and Section 5.5 of Chapter 5 for more details). There are five primitive logical relations in classical (first-order) logic:

- conjunction ($\wedge$)
- disjunction ($\vee$)
- implication ($\rightarrow$)
- universal quantification ($\forall$)
- existential quantification ($\exists$)

Three remarks are to be made here. First, *negation* ($\neg$) is an instance of implication ($\rightarrow$): $\neg A$ is equivalent to $A \rightarrow \mathbf{0}$. Second, in a fixed finite domain, universal and existential quantification can be seen respectively as generalized conjunction ($\bigwedge$) and generalized disjunction ($\bigvee$).[1] Third, it is important to notice that the propositions connected by a logical relation need not be relevant to each other.[2] Take $A \wedge B$ as an example. Let A denote (1a) and B denote (1b):

(1) a. Amadís defeated Dardán.
    b. Galaor was robbed.

In linguistic discourse, if no contextual information is given, A and B, as defined above, are apparently irrelevant to each other. In logic, however, it is plausible to conjoin A and B returning a conjunctive proposition $A \wedge B$. In light of this, the purpose of reducing a logical relation $\mathfrak{R}$ to a series of qud-relations is definitely not to capture the relevance between the propositions that $\mathfrak{R}$ connects–they need not be relevant to each other at all. It is pertinent then to wonder what the qud-reduction of logical relations aims at. Taking inspirations from dialogical and inquisitive approaches to logic (Lorenzen, 1955; Hintikka, 1973; Lorenzen & Lorenz, 1978; Wiśniewski, 1995, 2013; Ciardelli, 2016), we propose that the goal of reducing a logical relation $\mathfrak{R}$ to a family of qud-relations is to depict an alternative way to the

---

[1]Let A denote a finite domain $\{t_1, ..., t_i, ...t_n\}$ (where $i, n : \mathbb{N}^+$ and $1 \leq i \leq n$), $\forall x : A.B(x)$ is logically equivalent to $\bigwedge\{B(t_i)\}$, defined as follows:

$$\bigwedge\{B(t_i)\} := B(t_1) \wedge ... \wedge B(t_i) \wedge ... \wedge B(t_n).$$

$\exists x : A.B(x)$ is logically equivalent to $\bigvee\{B(t_i)\}$, defined as follows:

$$\bigvee\{B(t_i)\} := B(t_1) \vee ... \vee B(t_i) \vee ... \vee B(t_n).$$

The correspondence between quantifiers and generalized conjunction/disjunction is shown to be important in the next section.

[2]For an extensive comparison of logical/mathematical discourse and linguistic discourse, see Chapter 4 in Trafford (2017).

characterization of the assertibility of propositions constructed on the basis of (only) $\mathfrak{R}$. For example, to reduce logical conjunction ($\wedge$) to qud-relations is to offer an alternative way to understand under what circumstances a conjunctive proposition $A \wedge B$ is assertible/true.

10.2 Qud-Decomposition

This section proposes a series of rules called qud-decomposition rules for the qud-reduction of logical relations. The resulting system of reasoning is called $\mathcal{Q}$-*reasoning*, an erotetic counterpart of $\mathcal{A}$-reasoning.

10.2.1 Truth of atoms

To check whether an atomic proposition P is true is to demand an answer to the question on whether P is true. This question is conveniently written as follows (where $\mathcal{D}(P) := P + \neg P$):

$$?\mathcal{D}(P).$$

The assertion that P is true is written as follows:

$$!P.$$

If the answer to $?\mathcal{D}(P)$ is $!P$, one concludes that P is true; otherwise, if the answer to $?\mathcal{D}(P)$ is $!\neg P$, one concludes that P is false.

10.2.2 Binary logical relations

The procedure of checking the truth of a compound proposition is a generalization of the procedure of checking the truth of an atom. In proposition logic, a compound proposition can be written as follows in a generic way (where $*$ denote either $\wedge$, $\vee$, or $\rightarrow$):

$$A * B.$$

To illustrate, we shall let $* = \wedge$. To check whether $A \wedge B$ is true, one introduces the following question:

$$?\mathcal{D}(A \wedge B).$$

Recall that $A \wedge B$ is true iff A and B are both true. This implies that to check the truth of $A \wedge B$, one has to check in turn the truth of A and the truth of B. This amounts to saying that in order to answer $?\mathcal{D}(A \wedge B)$, one has to answer the following two subquestions:

$$?\mathcal{D}(A), \qquad ?\mathcal{D}(B).$$

There is not a fixed order between the two subquestions: one is free to start with either $?\mathcal{D}(A)$ or $?\mathcal{D}(B)$. If the answers to both $?\mathcal{D}(A)$ and $?\mathcal{D}(B)$ are affirmative, concretely, $!A$, and $!B$, then one shall conclude that $A \wedge B$ is true; otherwise, $A \wedge B$ is false. The procedure of checking the truth/falsity of $A \wedge B$ can be summarized as the following rule, called the *qud-decomposition rule for conjunction* $(\wedge_q)$:

$(\wedge_q)$ $?\mathcal{D}(A \wedge B)$ is decomposed in two steps: for $X \neq Y : \{A, B\}$,
(a) generate $?\mathcal{D}(X)$ from $?\mathcal{D}(A \wedge B)$;
(b) if $!X$, generate $?\mathcal{D}(Y)$ from $?\mathcal{D}(A \wedge B)$.

The qud-decomposition rules for other logical relations ($\vee$ and $\rightarrow$) in propositional logic are as follows:

$(\vee_q)$ $\mathcal{D}(A \vee B)$ is decomposed in two steps: for $X \neq Y : \{A, B\}$,
(a) generate $?\mathcal{D}(X)$ from $?\mathcal{D}(A \vee B)$;
(b) if $!\neg X$, generate $?\mathcal{D}(Y)$ from $?\mathcal{D}(A \vee B)$.

$(\rightarrow_q)$ $?\mathcal{D}(A \rightarrow B)$ is decomposed in two steps:
(a) generate $?\mathcal{D}(A)$ from $?\mathcal{D}(A \rightarrow B)$;
(b) if $!A$, generate $?\mathcal{D}(B)$ from $?\mathcal{D}(A \rightarrow B)$.

The formulation of the above qud-decomposition rules draws insights from Wiśniewski's (2013) *erotetic decomposition principle*:

> **Erotetic Decomposition Principle (EDP)**
> Transform a principal question into auxiliary questions in such a way that (*a*) consecutive auxiliary questions are dependent upon previous questions and possibly, answers to previous auxiliary questions, and (*b*) once auxiliary questions are resolved, the principle question is resolved.
> (Wiśniewski, 2013, 103)

The notion of *dependence* between two questions in EDP more or less corresponds to what we call question implication in this dissertation.[3] It is obvious that the qud-decomposition rules for $\wedge$, $\vee$, and $\rightarrow$ satisfy EDP. It is worthwhile mentioning that the qud-decomposition rules for propositional-level logical relations have their counterparts (called *pure e-scenarios*) in Wiśniewski (2013, 129-130).[4]

10.2.3 Logical quantifiers

In first-order logic, two quantifiers are added: universal quantifier ($\forall$) and existential quantifier ($\exists$). In accordance with EDP, Wiśniewski (2013, 130) proposes the following qud-decomposition rules (aka *pure e-scenarios* in his terminology) for $\forall$ and $\exists$ (where the superscript w

[3]The converse of *dependence* (between questions) is dubbed *influence* in terms of Ginzburg (2012). Ginzburg attributes the distinction between dependence and influence to Carlson (1983). For more about the two notions (and their relationship with question implication), see Ginzburg (2012, 56-58).

[4]The notion of *erotetic scenario* (*e-scenario*, for short) is an important part of Wiśniewski's (2013) logic of questions. In a nutshell, an e-scenario is a family of "interconnected e-derivations [=qud-relations]" (p.110). From a pragmatic perspective, an e-scenario "provides us with conditional instructions which tell what auxiliary questions should be asked and when they should be asked" (p.117). It is worthwhile mentioning that an e-scenario can be represented by a "labeled tree" (p.110), which is quite similar to a qud-tree in our account. Wiśniewski makes a distinction between various particular forms of e-scenarios, among which, a pure e-scenario, which he employs to represent logical relations, is "an e-scenario which does not involve any initial [assertional] premise" (p.128). For more related discussion, see Wiśniewski (2003) and Leszczyńska-Jasion (2018).

indicates that marked rule belongs to Wiśniewski):

($\forall_q^w$) $?\mathcal{D}(\forall x : A.B(x))$ is decomposed in two steps:
(a) generate $?\mathcal{D}(\exists x : A.B(x))$ from $?\mathcal{D}(\forall x : A.B(x))$;
(b) if $!\exists x : A.B(x)$, generate $?\mathcal{D}(\exists x : A.\neg B(x))$.

($\exists_q^w$) $?\mathcal{D}(\exists x : A.B(x))$ is decomposed in two steps:
(a) generate $?\mathcal{D}(\forall x : A.B(x))$ from $?\mathcal{D}(\exists x : A.B(x))$;
(b) if $!\neg\forall x : A.B(x)$, generate $?\mathcal{D}(\forall x : A.\neg B(x))$.

To illustrate, consider ($\forall_q^w$). This rule specifies that to check whether $\forall x : A.B(x)$ is true, one first checks whether $\exists x : A.B(x)$ is true, and if $\exists x : A.B(x)$ is true, then one shall check whether $\exists x : A.\neg B(x)$ is true. Let $\forall x : A.B(x)$ stand for the following sentence:

(2) Amadís defeated every knight.

To check whether (2) is true, following ($\forall_q^w$), one first checks whether Amadís defeated *a* knight and if this turns out to be true, then one proceeds by checking whether there is any knight that is *not* defeated by Amadís. It is worthwhile pointing out that in order to apply ($\forall_q^w$), the qud-decomposition rule ($\exists_q^w$) for $\exists$ must be known already. However, please note that in Wiśniewski's proposal, ($\exists_q^w$) presupposes the availability of ($\forall_q^w$). The qud-decomposition rules for quantifiers *à la* Wiśniewski therefore inevitably run into a circularity problem.

To avoid this problem, we introduce an alternative way to define the qud-decomposition rules for quantifiers, taking into account their connections with generalized conjunction and generalized disjunction (see Section 10.1 for details). The new qud-decomposition rules for $\forall$ and $\exists$ are formulated as follows (where $A = \{t_1, ..., t_i, ...t_n\} : \mathsf{U}$):

($\forall_q$) $?\mathcal{D}(\forall x : A.B(x))$ is decomposed in two steps:
(a) generate $?\mathcal{D}(A)$ from $?\mathcal{D}(\forall x : A.B(x))$;
(b) if $!A$, generate $?\mathcal{D}(\bigwedge\{B(t_i)\})$ from $?\mathcal{D}(\forall x : A.B(x))$.

($\exists_q$) $?\mathcal{D}(\exists x : A.B(x))$ is decomposed in two steps:
(a) generate $?\mathcal{D}(A)$ from $?\mathcal{D}(\exists x : A.B(x))$;
(b) if $!A$, generate $?\mathcal{D}(\bigwedge\{\neg B(t_i)\})$ from $?\mathcal{D}(\exists x : A.B(x))$.

To illustrate, consider ($\forall_q$). This rule specifies that to check whether $\forall x : A.B(x)$ is true, one first checks whether A is inhabited, and if A is inhabited, one checks whether $B(t_i)$ is true for every term t_i of A. Please note that the inhabitedness of A could be intensional but not necessarily extensional: it is possible that A is empty (or not inhabited) in the actual world, but is inhabited in some possible worlds.

10.3 Qud-Trees for $\mathcal{Q}$-Reasoning

The qud-decomposition rules for logical relations can be visually represented by qud-trees. To a first approximation, consider the qud-tree for $\wedge$ presented in Figure 10.1. To interpret this qud-tree, let us start from the root node $?\mathcal{D}(A \wedge B)$. Following ($\wedge_q$), one first generates $?\mathcal{D}(X)$ from $?\mathcal{D}(A \wedge B)$. To illustrate, we shall let $X = A$ and $Y = B$. $?\mathcal{D}(A)$ is answered by a rejection $!\neg A$ or an affirmation $!A$. If the answer is $!\neg A$, one concludes that $!\neg(A \wedge B)$. If the answer is $!A$, according to ($\wedge_q$), one proceeds by asking $?\mathcal{D}(B)$, which is answered by an affirmation $!B$ or a rejection $!\neg B$. In the former case, one concludes that $!A \wedge B$ whereas in the latter, one concludes that $!\neg(A \wedge B)$.[5] Figure 10.1 shows that $A \wedge B$ is true only under the circumstance that $?\mathcal{D}(A)$ and $?\mathcal{D}(B)$ are both affirmatively answered. This shows that logical conjunction, as a rhetorical relation between two propositions, emerges as a result of affirming both propositions. This provides supportive evidence for *relation-to-qud hypothesis* (RQH).

The above analysis for logical conjunction $\wedge$ generalizes to other logical relations, as shown in Figures 10.2.

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[5] In Figure 10.1, a conclusion is drawn only when the qud-tree terminates. The addition of *conclusion bars* (i.e., horizontal lines below terminal nodes in Figure 10.1) to a qud-tree is inspired by Wiśniewski (2003, 2013).

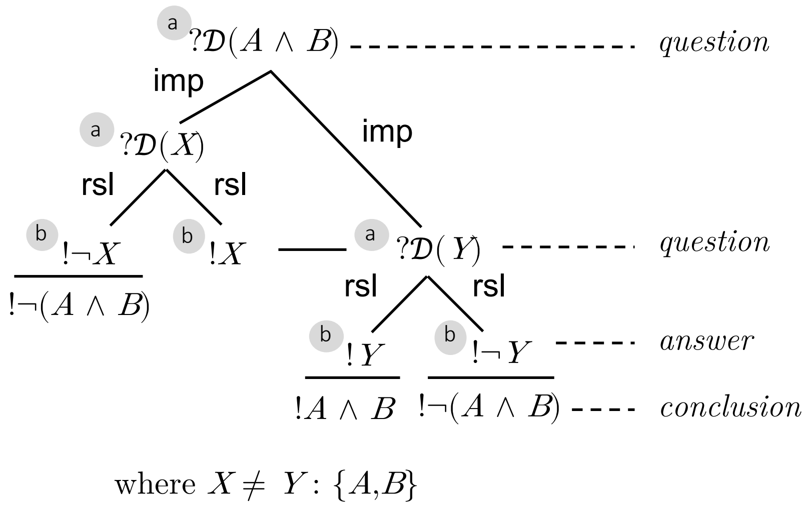


Figure 10.1: Qud-tree for logical conjunction

10.4 Summary

Chapter 10 examines in a systematic way how logical relations can be reduced to qud-relations. There is a crucial distinction between logical relations and rhetorical relations: the latter impose a relevance requirement (i.e., that the two speech acts connected by a rhetorical relation must be relevant to each other), which is not mandatory for the former. In line with dialogical and inquisitive approaches to logical, we advocate that the qud-reduction of a logical relation $\mathfrak{R}$ should offer an alternative way to determine the assertibility of a proposition constructed on the basis of $\mathfrak{R}$ and no other logical relations. For every logical relation $\mathfrak{R}$, we propose a qud-decomposition rule, which is tantamount to a qud-reduction algorithm for $\mathfrak{R}$. The overall results confirm that logical relations can be reduced to qud-relations, thus offering supportive evidence for the working hypothesis RQH.

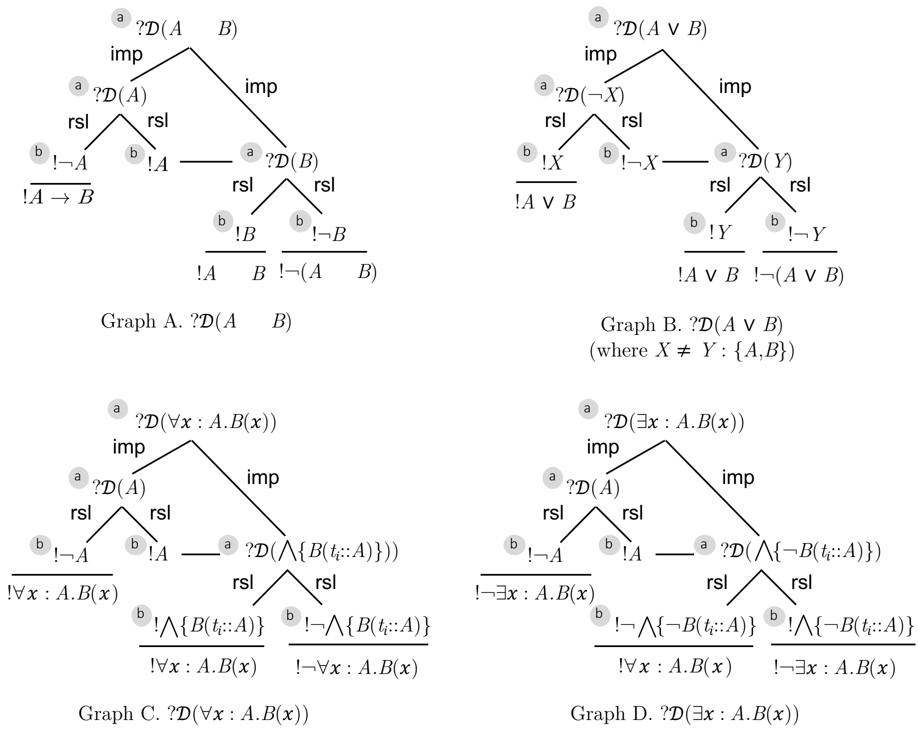


Figure 10.2: Qud-trees for other logical relations

Chapter 11

Qud-Reduction: Rhetorical Relations

The analyses provided in Section 9.3 of Chapter 9 (indirectly) shows that qud-reduction is possible for rhetorical relations.[1] This chapter considers in a more systematic way how the qud-reduction of rhetorical relations is done through a thorough examination of the possibility of recovering a series of important properties of rhetorical relations, defined *à la* Asher and Lascarides (2003), under RQB.

This chapter is organized as follows: Section 11.1 briefly considers the possibility of transforming a non-dialogical discourse to a family of elementary one-turn dialogues; Section 11.2 presents two different desiderata for the qud-reduction of rhetorical relations; Section 11.3 considers the qud-reduction of veridical and non-veridical rhetorical relations; Section 11.4 examines the way to recover the temporal consequence requirements imposed by some rhetorical relations; Section 11.5 aims at reducing coordinating and subordinating rhetorical relations to qud-relations; Section 11.6 offers some concluding remarks.

11.1 The Dialogical Transformation

The starting point of the qud-reduction of rhetorical relations is RQB developed in Chapter 9. However, observe that RQB originally applies

[1]The rhetorical relations involved in the examples considered in Section 9.3 of Chapter 9 are not explicitly discussed but are marked by dotted double-lines.

to elementary one-turn dialogues only but not to other types of discourse. In order to implement RQB to the qud-reduction of rhetorical relations, the first step is to consider whether a linguistic discourse, dialogical or non-dialogical, can be transformed into a family of elementary one-turn dialogues. In this dissertation, we call it a procedure of *dialogical transformation* (*DiaT*, for short) (see van Deemter et al. (2008), Stoyanchev and Piwek (2011), Bowden et al. (2016), and Xu et al. (2018) for recent studies). This chapter considers the simplest scenario: can the simplest *complex discourse unit* (*à la* Asher and Lascarides (2003)) $\mathfrak{R}(\phi, \psi)$ (where ϕ and ψ are both elementary speech acts and $\mathfrak{R}$ denotes a rhetorical relation) be transformed into an elementary one-turn dialogue in which ψ is a reaction to ϕ? If $\mathfrak{R}(\phi, \psi)$ can be transformed into an elementary one-turn dialogue $\phi \oplus \psi$, then under RQB, one shall precede by reducing $\mathfrak{R}$ to a set of qud-relations (or equivalently, to represent $\phi \oplus \psi$ by a qud-tree that satisfies RQB). The qud-reduction procedure of $\mathfrak{R}$ is represented in Figure 11.1.

Let us now consider in detail whether $\mathfrak{R}(\phi, \psi)$ can be transformed into an elementary one-turn dialogue $\phi \oplus \psi$. Consider (1):

(1) a. Amadís defeated Dardán.
    b. He is very happy.

(1a) and (1b) form a coherent monologue: (1b) is intuitively a result of (1a). It is pertinent to wonder if (1a) and (1b) form a coherent one-turn dialogue, in particular, if (1b) can be used as a reaction to (1a). The answer is undoubtedly positive. In contrast, consider (2):

(2) a. What happened this morning?
    b. Amadís defeated Dardán.
    c. Galaor was robbed.

(2) is a coherent monologue. The rhetorical relations connecting (2a), (2b), and (2c) are the following: both (2b) and (2c) answer (2a) whilst (2c) is a continuation of (2b). There is no question that (2a-2b) and (2a-2c) are both coherent one-turn dialogues, but it is controversial

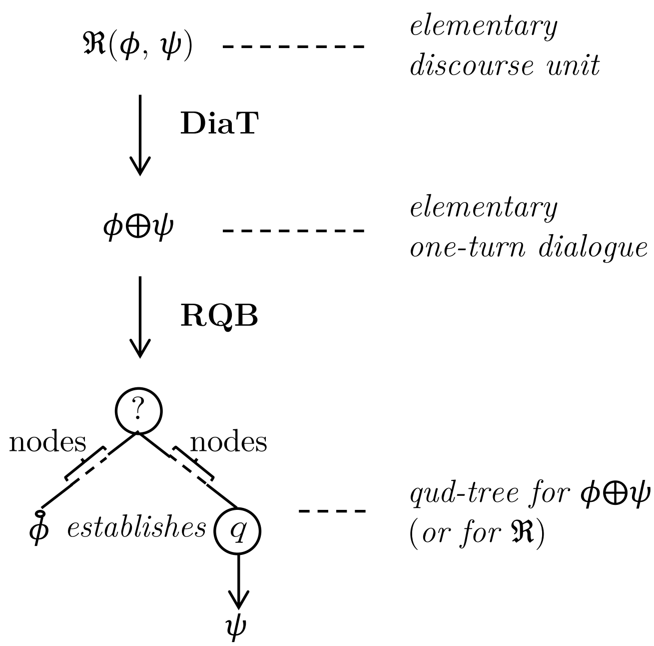


Figure 11.1: Procedure of qud-reduction

whether (2b-2c) is a coherent one-turn dialogue. The problem of treating (2b-2c) as a coherent dialogue is considered in detail in Section 8.3 of Chapter 8: if (2a) is available from discourse context, (2b-2c) is a coherent dialogue; otherwise, (2b-2c) is not. This implies that the dialogical transformation of some discourse fragments such as (2b-2c), unlike that of (1), resorts to another speech act, i.e., (2a). It is worthwhile mentioning that even in Asher and Lascarides (2003), the inference of the rhetorical relation (i.e., *Continuation*) for (2b-2c) appeals to (2a), which establishes the *topic*, in terms of Asher and Lascarides, for (2b-2c) (see Asher (2004) for related discussion).

In view of the contrast between (1) and (2), we argue that $\mathfrak{R}(\phi, \psi)$ can be transformed into an elementary one-turn dialogue $\phi \oplus \psi$ iff the inference of the rhetorical relation $\mathfrak{R}$ for ϕ and ψ (in the way as suggested by Asher and Lascarides) need not refer to a third explicitly given speech act.[2] This is called *dialogical transformation hypothesis*:

> **Dialogical Transformation Hypothesis (DTH)**
> Let $\mathfrak{R}(\phi, \psi)$ denote a complex discourse unit (*à la* Asher and Lascarides (2003)) in which $\mathfrak{R}$ is a rhetorical relation and ϕ and ψ are both elementary speech acts. $\mathfrak{R}(\phi, \psi)$ can be transformed into an elementary one-turn dialogue $\phi \oplus \psi$ iff the inference of the rhetorical relation $\mathfrak{R}$ (in the way as suggested by Asher and Lascarides) do not have to refer to a third explicitly given speech act.

Though the examples considered so far (in particular, those discussed in Section 9.3 of Chapter 9) provide supportive evidence for DTH, it needs to be scrutinized in a more systematic way.[3] This is, however,

[2] In Asher and Lascarides (2003), the inference of $\mathfrak{R}$ for ϕ and ψ makes use of a series of resources including non-logical axioms for rhetorical relations, contextual information, and world knowledge (see Section 2.4 of Chapter 2 for details).

[3] Some recent data-driven studies provide indirect empirical evidence for DTH (Stoyanchev & Piwek, 2011; Bowden et al., 2016; Xu et al., 2018; Petac, Bosser, Charles, de Loor, & Cavazza, 2020). However, they are exclusively inconclusive. More research is called for to test DTH in a more conclusive way.

beyond the scope of this dissertation and remains for future research. In the remainder of this chapter, we will skip the phase of dialogical transformation and consider only those pairs of speech acts that are convertible to elementary one-turn dialogues.

11.2 Qud-Reduction: Desiderata

Asher and Lascarides (2003) propose a plenty of rhetorical relations for linguistic discourse (see Appendix D in their book for definitions). To make the qud-reduction of rhetorical relations, the ideal way is to check one by one whether every rhetorical relation in their list can be reduced to a set of qud-relations. However, there is in fact no need to do so because rhetorical relations in Asher and Lascarides (2003) are grouped under different categories according to whether they exhibit certain properties, and as long as such a property is demonstrated to be recoverable from qud-reduction, then a group of rhetorical relations can in principle be reduced to qud-relations. In the remainder of this chapter, we consider three representative properties:

(a) whether a rhetorical relation is *veridical*;

(b) whether a rhetorical relation imposes a *temporal consequence requirement*;

(c) whether a rhetorical relation is *coordinating* or *subordinating.*

The goal of this chapter is to examine whether all of the three properties listed above are recoverable from the qud-reduction of (corresponding) rhetorical relations and in particular, to examine how these properties are manifested in the qud-trees for rhetorical relations.

11.3 (Non-)Veridicality

The concept of *veridicality* is very important for Asher and Lascarides (2003): a rhetorical relation is either veridical or non-veridical. This section considers the property of being (non)veridical and shows how it is captured/recovered in the qud-reduction of rhetorical relations.

11.3.1 (Non-)veridical relations

The notion of *veridicality* is widely discussed in linguistics literature. In Asher and Lascarides (2003), a rhetorical relation $\mathfrak{R}$ is veridical iff when α and β are assertions, the proposition expressed in $\mathfrak{R}(\alpha, \beta)$ implies both the proposition expressed in α and that expressed in β. Formally, the property of veridicality is defined as follows:[4]

Definition 37 (Veridicality)**.** *Let $\mathfrak{R}$ denote a rhetorical relation, α and β stand for two speech acts, and $K(x)$ denote the proposition expressed in x (x is an assertion). $\mathfrak{R}$ is veridical iff $\mathfrak{R}$ satisfies the following requirement:*

$$K(\mathfrak{R}(\alpha, \beta)) \mapsto (K(\alpha) \wedge K(\beta)),$$

where $\mapsto$ denotes defeasible implication.[a]

[a]Let A, B : Prop, $A \mapsto B$ intuitively reads as: A normally implies B. In Asher and Lascarides (2003), B is called a *defeasible consequence* of A. For more related discussion, see Koons (2021).

Typical veridical rhetorical relations include *Elaboration*, *Background*, *Narration*, *Continuation*, *Explanation*, *Result*, *Parallel* and *Contrast*, some of which have already been considered in Section 9.3 of Chapter 9. Typical non-veridical rhetorical relations include *Correction*, *Alternation*, *Consequence*, and those that take non-assertional speech acts as arguments. In Asher and Lascarides (2003), whether a rhetorical relation is veridical depends on a post-hoc analysis but is not directly reflected in the way how this rhetorical relation is established.

[4]In Asher and Lascarides (2003), whether a rhetorical relation is veridical or not depends on whether it satisfies the *Satisfaction Schema*. This schema is not repeated here largely because it is too complicated but the essential idea of this schema is already captured by the definition of veridicality.

11.3.2 Strong non-veridicality

Under RQB and RQH, if every rhetorical relation can be reduced to a set of qud-relations, or alternatively, be analytically depicted by a qud-tree, it is pertinent to wonder how the property of being (non-) veridical is manifested in the qud-trees for rhetorical relations. From the analysis of examples that contain veridical rhetorical relations in Section 9.3 of Chapter 9, we can hardly find any characteristic feature that they share in common. But we do notice that the qud-trees for a particular subtype of non-veridical rhetorical relations, called *strong non-veridical rhetorical relations*, have some features in common. The notion of strong non-veridicality is defined as follows:

> **Definition 38** (Strong Non-Veridicality)**.** *Let* $\mathfrak{R}$ *denote a rhetorical relation,* α *and* β *stand for two speech acts, and* $K(x)$ *denote the proposition expressed in* x *(*x *is an assertion).* $\mathfrak{R}$ *is strong non-veridical iff* $\mathfrak{R}$ *satisfies the following requirement:*
>
> $$K(\beta) \mapsto \neg K(\alpha).$$

Intuitively, $\mathfrak{R}$ is strongly non-veridical iff the two speech acts that $\mathfrak{R}$ connects are incompatible. Strongly non-veridical rhetorical relations are dubbed *divergent relations* in Asher and Lascarides (2003). Asher and Lascarides identify two typical strongly non-veridical rhetorical relations in linguistic discourse: *Correction* and *Counterevidence*. The latter is now called *Counter-Expectation* in our terminology.

Counter-Expectation has already been examined in Section 9.3 of Chapter 9.[5] In this section, we consider *Correction* as a representative

[5]Laia Mayol (p.c.) pointed out to me that *Counter-Expectation* is not necessarily non-veridical. Consider the following pair of speech acts:

(3) a. It was raining.
    b. But John went our for a walk.

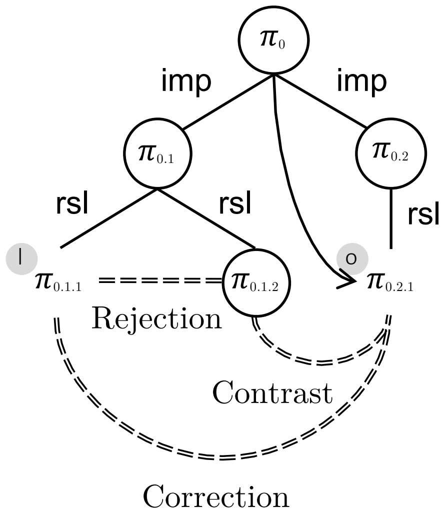
(3a) and (3b) are connected by *Counter-Expectation.* Laia Mayol pointed out that (3b) seems not incompatible with (3a), and for this reason, *Counter-Expectation* is not non-veridical. However, observe that while (3b) is not logically incompatible strong non-veridical rhetorical relation. Consider (4):

(4) a. **Lisuarte**: Amadís defeated Dardán.
b. **Oriana**: i. (But) he didn't defeat Endriago.
ii. It was $[\text{Galaor}]_{\mathcal{F}}$ who defeated Dardán.

In terms of Asher and Lascarides, (4bi) is connected to (4a) by *Contrast*, whilst (4bii) is connected to (4a) by *Correction* (see also Asher and Lascarides (2003, 352) for a similar example). The distinction is obvious: the utterance of (4bi) contextually implies that Oriana accepts (4a) or at least she is not opposing to (4a), whilst the utterance of (4bii) carries a conversational implicature that Amadís didn't defeated Dardán (at least from Oriana's perspective). This implicature can hardly be canceled; instead, it can be made explicit by adding a rejection particle *no* before the utterance of (4bii). It is worthwhile noticing that it is exactly this conversational implicature, but not the mere assertion that Galaor defeated Dardán, that rejects (4a). If this conversational implicature (that Amadís didn't defeated Dardán) is made explicit, the assertion that Galaor defeated Dardán can be seen as contrasted with this implicature. The potential qud-trees for (4a-4bi) (=(7)) are presented in Figure 9.7 in Section 9.3 of Chapter 9.[6] The qud-tree for (4a-4bii) is offered in Figure 11.2. (4bii) can be seen as a combination of $\pi_{0.1.2}$ and $\pi_{0.2.1}$ in Figure 11.2: literally, (4bii) is equivalent to $\pi_{0.2.1}$ but the use of the cleft-structure and the prosodic focus on *Galaor* in (4bii) signals that $\pi_{0.1.2}$ is an implicature of (4bii). The analysis of *Correction* as a composite of *Rejection* and *Contrast* is not novel here. Similar ideas can also be found in Umbach (2004), Jasinskaja (2012, 2013) and Repp (2016). *Rejection* is not a standard rhetorical relation in Asher and Lascarides (2003) but it can be seen

with (3a), it is incompatible with (3a) under a commonsense view. In other words, (3b) normally or defeasibily implies the negation of (3a). In light of this, we shall maintain *Counter-Expectation* as a non-veridical rhetorical relation.

[6]In Section 9.3 of Chapter 9, we propose that the insertion of *but* gives rise to a different interpretation of (4bi), i.e., that the assertion of (4bi) rejects an expectation that Amadís defeated not only Dardán, but also Endriago.



- π_0:= Between Amadís and Galaor, who defeated Dardán?
- $\pi_{0.1}$:= Did Amadís defeat Dardán?
- $\pi_{0.1.1}$:= Yes (= Amadís defeated Dardán.)
- $\pi_{0.1.2}$:= No (= Amadís didn't defeat Dardán.)
- $\pi_{0.2}$:= Did Galaor defeat Dardán?
- $\pi_{0.2.1}$:= Yes (= Galaor defeated Dardán.)

Figure 11.2: Qud-tree for (4a-4bii): Correction

as a variant of *Correction*: if no further information (such as $\pi_{0.2.1}$ in Figure 11.2) is added, *Correction* degenerates into *Rejection*.[7]

The qud-tree for *Correction* differs from that for *Contrast* in that it contains a ternary structure, called *contradictory triangle* (i.e., $\pi_{0.1}$, $\pi_{0.1.1}$ and $\pi_{0.1.2}$ in Figure 11.2), wherein a polar question (i.e., $\pi_{0.1}$) is answered by both an affirmative answer (i.e., $\pi_{0.1.1}$) that the original speaker is (supposed to be) committed to, and a rejective answer (i.e., $\pi_{0.1.2}$) that the interlocutor is (supposed to be) committed to.

[7] In Asher and Lascarides (2003), there is not a specific rhetorical relation that corresponds to *Rejection* considered here. *Rejection* is implicitly considered part of *Correction* (see Asher and Lascarides (2003, 470) for related examples).

Definition 39 (Contradictory Triangle)**.** *In a qud-tree, a contradictory triangle is a ternary sub-qud-tree in which the root node is a polar question and the two terminal nodes are respectively an affirmative answer and a rejective answer.*

Consider the qud-tree for *Counter-Expectation* in Figure 9.10 in Chapter 9. It also contains a contradictory triangle. The observation that the qud-tree for a strong non-veridical rhetorical relation must contain a contradictory triangle can be directly explained in terms of the definition of strong non-veridicality: the presence of a contradictory triangle captures the fact that two speech acts connected by a strong non-veridical rhetorical relation are incompatible with each other.[8]

11.3.3 Weak non-veridicality

If $\mathfrak{R}$ is a non-veridical rhetorical relation, but the two speech acts that $\mathfrak{R}$ connects are not incompatible with each other, then $\mathfrak{R}$ is called a *weak non-veridical rhetorical relation*. The notion of *weak non-veridicality* is formally defined as follows:

Definition 40 (Weak Non-Veridicality)**.** *Let $\mathfrak{R}$ denote a rhetorical relation, α and β stand for two speech acts, and $K(x)$ denote the proposition expressed in x (x is an assertion). $\mathfrak{R}$ is weak non-veridical iff $\mathfrak{R}$ satisfies the following requirement:*

$$\neg(K(\mathfrak{R}(\alpha,\beta)) \mapsto (K(\alpha) \wedge K(\beta))) \wedge \neg(K(\beta) \mapsto \neg K(\alpha)).$$

[8]Observe that in a contradictory triangle, the two terminal nodes represent an affirmative answer and a rejective answer to the root node (i.e., a polar question). The two terminal nodes are therefore connected by *Rejection*. The qud-trees for *Counter-Expectation* (see Figure 9.10) and *Correction* (see Figure 11.2) show that both rhetorical relations can be reduced to a pair of more primitive rhetorical relations, among which, *Rejection* is necessary. The necessary presence of *Rejection* is the most intuitive reflection of the requirement that the two speech acts connected by a strongly non-veridical rhetorical relation must be incompatible.

This requirement is consisted of two parts, $\neg(K(\mathfrak{R}(\alpha,\beta)) \mapsto (K(\alpha) \wedge K(\beta)))$ and $\neg(K(\beta) \mapsto \neg K(\alpha))$, the former intuitively showing that $\mathfrak{R}$ is not veridical, and the latter showing that $\mathfrak{R}$ is not strongly non-veridical.[9] There are many weak non-veridical rhetorical relations, the most typical ones in Asher and Lascarides (2003) being *Alternation* and *Consequence*. Weak non-veridical rhetorical relations differ from strong non-veridical rhetorical relations in that they can connect two discourse units that are compatible. For this reason, it is unreasonable to require that a qud-tree for a weak non-veridical rhetorical relation contain a contradictory triangle. It is pertinent to wonder if a qud-tree for a weak non-veridical rhetorical relation such as *Alternation* and *Consequence* has any characteristic features that distinguish it from qud-trees for other rhetorical relations. The answer is positive: it contains a *hypothetical promotion branch* (to be defined later).

To a first approximation, consider the following example:

(5) a. **Lisuarte**: Galaor loves Maria.
  b. **Oriana**: i. (If so,) He would also love $[\text{Claudia}]_{\mathcal{F}}$.
    ii. Or $[\text{Claudia}]_{\mathcal{F}}$.
    iii. He also loves $[\text{Claudia}]_{\mathcal{F}}$.

There is no doubt that the three speech acts in (5b) are all relevant reactions to (5a). The difference between them is obvious: (5bi) and (5bii) are connected to (5a) by *Consequence* and *Alternation* respectively, two weak non-veridical rhetorical relations; in contrast, (5biii) is connected to (5a) by *Parallel*, a veridical rhetorical relation. On the basis of the focus marking and contextually available information, it is easy to infer that (5bi) and (5bii) are intended to answer (6a) and (6b) respectively whilst (5biii) is intended to answer (6c).

(6) a. If Galaor loves Maria, whom else would Galaor love?
  b. If Galaor does not love Maria, whom does he love?

[9] It is sufficient to notice that what are embedded under $\neg$ in the two parts of the requirement for weak non-veridicality are exactly requirements for veridicality and strong non-veridicality respectively.

c. Besides Maria, whom else does Galaor love?

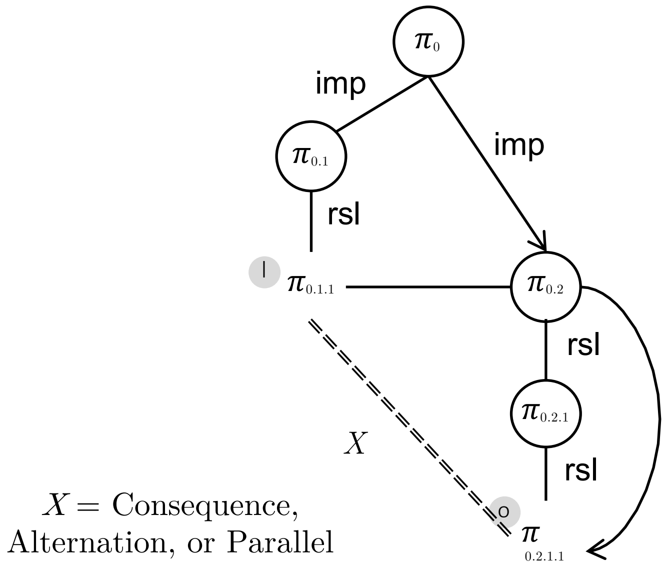
The qud-trees for (5a-5bi), (5a-5bii), and (5a-5biii) are all structurally identical, as shown in Figure 11.3. The notations for nodes differ with respect to whether it is a qud-tree for *Consequence*, *Alternation*, or *Parallel*. Please note that if we let Figure 11.3 represent a qud-tree for *Consequence* or *Alternation*, the (only) horizontal branch in this figure represents a hypothetical update: $\pi_{0.1.1}$ promotes the implication of $\pi_{0.2}$ from π_0 in a *hypothetical* way in the sense that $\pi_{0.2}$ contains an assumption that the proposition expressed in $\pi_{0.1.1}$ is either true (if X = *Consequence*) or false (if X = *Alternation*). In light of this, we call this branch a *hypothetical promotion branch*, defined as follows:

Definition 41 (Hypothetical Promotion Branch)**.** *In a qud-tree, a hypothetical promotion branch is a horizontal branch relating an assertion and a question such that* (*a*) *the former promotes the latter, and* (*b*) *the latter contains an assumption that the proposition expressed in the former is either true or false.*

In contrast, if we let Figure 11.3 represent a qud-tree for *Parallel*, then $\pi_{0.1.1}$ promotes the implication of $\pi_{0.2}$ from π_0 in a *factive* way in the sense that $\pi_{0.2}$ either presupposes or at least presumes the truth of the proposition expressed in $\pi_{0.1.1}$. It is not a surprise that a qud-tree for a weak non-veridical rhetorical relation contains a hypothetical promotion branch: it captures the idea that if a speech act is connected to a preceding speech act by a weak non-veridical rhetorical relation, the former neither affirms or rejects the latter. It remains unclear whether there is a relationship between hypothetical promotion branches and contradictory triangles. This remains for future scrutiny.

11.4 Recovering Temporality

This section considers the temporal consequence requirements imposed by some rhetorical relations in Asher and Lascarides (2003) and



- Notations for (5a-5bi) (X = *Consequence*):
  - π_0:= Whom does Galaor love?
  - $\pi_{0.1}$:= Did Galaor love Maria?
  - $\pi_{0.1.1}$:= Yes (= Galaor loves Maria.)
  - $\pi_{0.2}$:= If Galaor loves Maria, whom else would he love?
  - $\pi_{0.2.1}$:= If Galaor loves Maria, would he love Claudia?
  - $\pi_{0.2.1.1}$:= Yes (= If Galaor loves Maria, he would also love Claudia).
- Notations for (5a-5bii) (X = *Alternation*):
  - π_0:= Whom does Galaor love?
  - $\pi_{0.1}$:= Did Galaor love Maria?
  - $\pi_{0.1.1}$:= Yes (= Galaor loves Maria.)
  - $\pi_{0.2}$:= If Galaor does not love Maria, whom does he love?
  - $\pi_{0.2.1}$:= If Galaor does not love Maria, does he love Claudia?
  - $\pi_{0.2.1.1}$:= Yes (= If Galaor does not love Maria, he loves Claudia.)
- Notations for (5a-5biii) (X = *Parallel*):
  - π_0:= Whom does Galaor love, Maria or Claudia?
  - $\pi_{0.1}$:= Did Galaor love Maria?
  - $\pi_{0.1.1}$:= Yes (= Galaor loves Maria.)
  - $\pi_{0.2}$:= Besides Maria, whom else does Galaor love?
  - $\pi_{0.2.1}$:= Besides Maria, does Galaor love Claudia?
  - $\pi_{0.2.1.1}$:= Yes (= He also loves Claudia.)

Figure 11.3: Qud-trees for (5a-5bi), (5a-5bii), and (5a-5biii): Consequence, Alternation and Parallel

shows how they are recovered in the qud-reduction of these rhetorical relations by appealing to the introduction of explicit timelines (von Stutterheim & Klein, 1989; Riester, 2019).

11.4.1 Temporal consequences

The notion of temporal consequence is used by Asher and Lascarides (2003) to account for the difference between some related and sometimes very similar rhetorical relations. Roughly, a rhetorical relation $\mathfrak{R}$ imposes a temporal consequence requirement on the two speech acts α and β that $\mathfrak{R}$ connects iff the event described by α stands in some temporal relationship to the event described by β. Here are four typical axioms for temporal consequence requirements (see Asher and Lascarides (2003, 460-463) for more details):

Definition 42 (Temporal Consequence)**.** *Let $\mathfrak{R}$ denote a rhetorical relation, and α and β denote two speech acts, $e(\alpha)$ denote the event expressed in α. Here are four typical axioms for temporal consequence requirements:*

- *Temporal Consequence of Background:*
  $\mathsf{Background}(\alpha, \beta) \rightarrow \mathsf{overlap}(e(\alpha), e(\beta))$.
- *Temporal Consequence of Elaboration:*
  $\mathsf{Elaboration}(\alpha, \beta) \rightarrow \mathsf{part\text{-}of}(e(\alpha), e(\beta))$.
- *Temporal Consequence of Explanation:*
  $\mathsf{Explanation}(\alpha, \beta) \rightarrow \mathsf{precede}(e(\beta), e(\alpha))$.
- *Temporal Consequence of Result:*
  $\mathsf{Result}(\alpha, \beta) \rightarrow \mathsf{precede}(e(\alpha), e(\beta))$.

The temporal consequence of background specifies that if β provides background information for α, then the events expressed in α and β must overlap in time. The temporal consequence of elaboration specifies that if β is an elaboration for α, then the event expressed in β is part of the event expressed in α. The temporal consequence of explanation specifies that if β is an explanation for α, then the event expressed in α is preceded by the event expressed in β. The temporal consequence of result specifies that if β is a result for α, the event expressed in β is preceded by the event expressed in α.

11.4.2 Timelines in qud-trees

The requirements for temporal consequence imposed by *Background*, *Elaboration*, *Explanation* and *Result* are not taken into account in the qud-reduction of these rhetorical relations in Section 9.3 of Chapter 9. This section considers in detail how a qud-tree for any of the above four rhetorical relations can be enriched with its corresponding temporal consequence requirement.

To start with, consider the rhetorical relation *Result*. The temporal consequence requirement imposed by *Result* is as follows:

- Temporal Consequence of Result:
  $\mathsf{Result}(\alpha, \beta) \rightarrow \mathsf{precede}(e(\alpha), e(\beta))$.

This rule intuitively specifies that if β is a result of α, then the event expressed in β is preceded by the event expressed in α. Consider again the following example (repeated from (21) in Chapter 9):

(7) a. Speaker a: John pushed Bill.
  b. Speaker b: He $[\text{fell}]_{\mathcal{F}}$.

(7b) is taken as a result of (7a). There is a temporal order between the two events described by (7a) and (7b), which is correctly captured by the temporal consequence requirement of result: the event described by (7b) is preceded by the event described by (7a). This important temporal order is not taken into account in the qud-tree proposed for (7) (=(21)) in Figure 9.13 (in Chapter 9). In order to capture the linear temporal order between (7a) and (7b), following von Stutterheim and Klein (1989) and more recently, Riester (2019), we introduce an explicit linear timeline such that the events described by (7a) and (7b) are both distributed over this timeline.[10] The timeline for (7) consists of two concrete time points: t_1 for the event that John pushed Bill and t_2 for the event that Bill fell. By making explicit the timeline for (7), we obtain the following time-indexed counterpart (7) in which t_2 is preceded by t_1 in the timeline:

(8) a. Speaker a: John pushed Bill at t_1.
b. Speaker b: He [fell]$_{\mathcal{F}}$ at t_2.

The original qud-tree for (7) presented in Figure 9.13 can be now further amended by taking into account the explicit timeline, as shown in Figure 11.4 (where T stands for the time interval $[t_1, t_2]$).

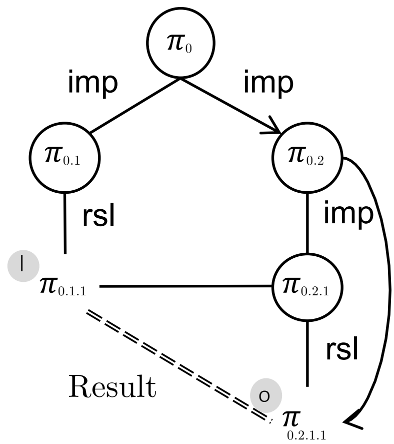
Let us now turn to the other three rhetorical relations *Background*, *Elaboration* and *Explanation*, each also imposing a temporal consequence requirement, as summarized below:

- Temporal Consequence of Background: $\mathsf{Background}(\alpha, \beta) \rightarrow \mathsf{overlap}(e(\alpha), e(\beta))$.
- Temporal Consequence of Elaboration: $\mathsf{Elaboration}(\alpha, \beta) \rightarrow \mathsf{part\text{-}of}(e(\alpha), e(\beta))$.
- Temporal Consequence of Explanation: $\mathsf{Explanation}(\alpha, \beta) \rightarrow \mathsf{precede}(e(\beta), e(\alpha))$.

Inspired by the treatment of *Result*, we propose to take into account the temporal consequence requirements imposed by *Background*, *Elaboration*, and *Explanation* by introducing an explicit timeline for the events described by the speech acts that each of the three rhetorical relations connects. Consider the following examples:

(9) a. Speaker a: Bill arrived at John's party at 20h last nigt.
b. Speaker b: [Mary]$_{\mathcal{F}}$ was there.

[10]The basic motivation for introducing an explicit timeline, according to von Stutterheim and Klein (1989, 43-44), is that temporal progression in a linguistic discourse can be represented by a series of questions distributed over a timeline.



- π_0:= What happened to Bill at T?
- $\pi_{0.1}$:= What happened to Bill at t_1? (where $t_1 : T$)
- $\pi_{0.1.1}$:= John pushed him (at t_1).
- $\pi_{0.2}$:= What happened to Bill at t_2? (where $t_2 : T$ and $T = [t_1, t_2]$)
- $\pi_{0.2.1}$:= How did Bill react to $\pi_{0.1}$ at t_2?
- $\pi_{0.2.1.1}$:= He (= Bill) fell (at t_2).

Figure 11.4: Time-indexed qud-tree for (8): Result

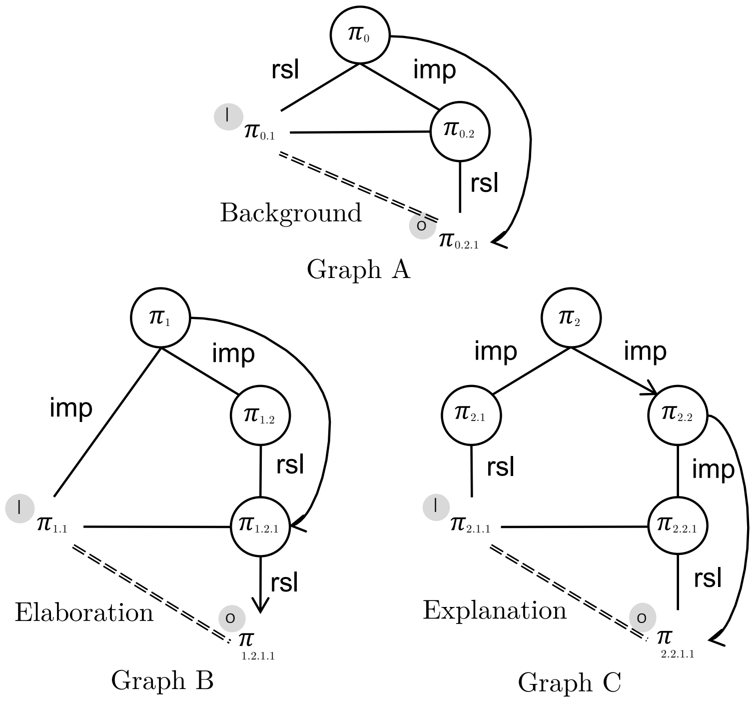
(10) a. Speaker a: Bill had a great meal.
b. Speaker b: He ate lots of $[\text{salmon}]_{\mathcal{F}}$.

(11) a. Speaker a: Bill fell.
b. Speaker b: John pushed him.

In (9), (9b) is connected to (9a) by *Background*: (9b) provides background information for (9a). The events described by (9a) and (9b) overlap in time: the event that Mary was there at John's party happened at the same time when Bill arrived at the John's party. Let t_1 denote *20h last night*, and t_2 denote the time that Mary was there at John's party, t_1 and t_2 overlaps. For this reason, in this case, there is no need to distinguish between t_1 and t_2. The qud-tree for (9) is presented in Graph A of Figure 11.5. Turning to (10), (10b) is connected to (10a) by *Elaboration*: (10b) provides further complementary information for (10a). The events described by (10a) and (10b) partially overlap in time: the event that Bill ate a lot of salmon is part of the bigger event that Bill had a great meal. Let T denote the time interval during which Bill had a great meal and t_1 denote the time that he ate lots of salmon, then t_1 is a time point or a smaller time internal in T. The qud-tree for (10) is presented in Graph B of Figure 11.5. Finally, let us consider (11). (11b) is connected to (11a) by a rhetorical relation called *Explanation*: (11b) provides an explanation for why (11a) is the case. There is a temporal order between the events described by (11a) and (11b): the event that Bill fell is preceded by the event that John pushed him. Let t_1 denote the time that Bill fell and t_2 denote the time that John pushed him, then t_2 necessarily precedes t_1. The qud-tree for (11) is presented in Graph C of Figure 11.5.

11.5 Co-/Subordination

Perhaps the most famous property of rhetorical relations is that they can be either coordinating or subordinating (Hobbs, 1979; Mann & Thompson, 1988; Txurruka, 2003; Asher & Lascarides, 2003; Asher &



- Notations for (9) (Graph A):
  - π_0:= How was John's party at 20h last night?
  - $\pi_{0.1}$:= Bill arrived at 20h last night.
  - $\pi_{0.2}$:= Who was there at that time?
  - $\pi_{0.2.1}$:= Mary was there (at that time).
- Notations for (10) (Graph B):
  - π_1:= What did Bill do at T?
  - $\pi_{1.1}$:= He had a great meal at T.
  - $\pi_{1.2}$:= What did Bill do at t_1? (where $t_1 : T$)
  - $\pi_{1.2.1}$:= What did Bill eat at t_1 during the meal?
  - $\pi_{1.2.1.1}$:= He ate lots of salmon (at t_1).
- Notations for (11) (Graph C):
  - π_2:= What happened to Bill at T?
  - $\pi_{2.1}$:= What happened to Bill at t_1? (where $t_1 : T$)
  - $\pi_{2.1.1}$:= He (= Bill) fell (at t_1).
  - $\pi_{2.2}$:= What happened to Bill at t_2? (where $t_2 : T$ and $T = [t_2, t_1]$)
  - $\pi_{2.2.1}$:= What happened to Bill at t_2 that caused $\pi_{2.1}$?
  - $\pi_{2.2.1.1}$:= John pushed him (at t_2).

Figure 11.5: Time-indexed qud-trees for (9)-(11): Background, Elaboration, and Explanation

Vieu, 2005; Onea, 2016, 2019). This section examines the possibility of recovering the coordinating/subordinating nature of a rhetorical relation in the qud-reduction of this rhetorical relation.

11.5.1 Co-/subordinating relations

To determine whether a rhetorical relation is coordinating or subordinating is a complicated issue. Though people generally have some intuitions about what amounts to a coordinating rhetorical relation and what amounts to a subordination one (see, in particular, Hobbs (1979)), it is unclear how such an important distinction can be pinned down. In the early stage of Asher and Lascarides' theory and even in their (2003) book, although much attention has been paid to the coordinating/subordinating distinction, there is not a fixed criterion to determine whether a rhetorical relation is coordinating or subordinating. Asher and Vieu (2005) is the first systematic attempt to define the coordinating/subordinating distinction, taking inspirations from earlier works such as Polanyi (1988). Asher and Vieu propose a series of four tests to distinguish between subordinating and coordinating rhetorical relations, among which, the first test is appealing to us (see Asher and Vieu (2005, 600-601) for more details):[11]

> **Asher and Vieu's First Test**
> Let $\mathfrak{R}(\alpha, \beta)$ denote a discourse unit, where $\mathfrak{R}$ is a rhetorical relation, α and β denote two speech acts. If γ, a new speech act, can be attached to α, $\mathfrak{R}$ is subordinating, and if γ can be attached only to β, $\mathfrak{R}$ is coordinating.

This test naturally follows from the *right frontier constraint* (Polanyi, 1988; Grosz & Sidner, 1986; Mann & Thompson, 1988; Asher & Lascarides, 2003) that a discourse unit (such as a speech act) can only be attached on the right frontier of the ongoing discourse (see Afantenos

[11] Nevertheless, Asher and Vieu point out that this test does not always function well. For more details, see Asher and Vieu (2005) and Prévot and Vieu (2008).

and Asher (2010) for more discussion). According to Asher and Lascarides, coordination blocks the right frontier. Therefore, along this line of reasoning, if $\mathfrak{R}$ blocks the possibility of attaching γ to α, then $\mathfrak{R}$ is predicted to be coordinating, and if $\mathfrak{R}$ does not have such blocking effects, then $\mathfrak{R}$ is subordinating. In Asher and Lascarides (2003), typical coordinating rhetorical relations include *Narration*, *Continuation*, *Contrast*, among others, and typical subordinating rhetorical relations include *Elaboration*, *Explanation*, *Question Resolution* (called *Question-Answer Pair* in Asher and Lascarides' terminology), among others.[12] Asher and Vieu observe that some rhetorical relations (for example, *Result*) which are traditionally considered coordinating, can exhibit subordinating properties in certain cases (see Prévot and Vieu (2008) and Onea (2019) for more related discussion).

11.5.2 Coordination-Qud Nexus

In Asher and Vieu's (2005) tests, to determine whether a rhetorical relation $\mathfrak{R}$ is coordinating or subordinating, one must refer to an extra discourse unit (or speech act) such as γ in their first test. If Asher and Vieu are on the right tract, then it seems too demanding to require that the coordinating/subordinating nature of rhetorical relations be captured in the qud-reduction. This is because the qud-reduction of rhetorical relations is RQB-based. It applies to only elementary one-turn dialogues and no extra speech acts (except inferred ones) can be resorted to (see Section 11.1 for related discussion). However, it will be shown below that the qud-reduction of rhetorical relation *is* able to capture the coordinating/subordinating distinction, and moreover, it is achieved in a more natural and intuitive way in contrast to the approach suggested by Asher and Vieu (2005).

Let us now scale down to the elementary one-turn dialogue setting $\phi \oplus \psi$, in which ϕ and ψ are both elementary speech acts and ψ is a reaction to ϕ. Let $\mathfrak{R}$ denote the rhetorical relation that connects

[12] The reader is referred to Appendix D of Asher and Lascarides (2003) to check whether a rhetorical relation is subordinating or coordinating.

ψ to ϕ. Observe that the coordinating/subordinating nature of $\mathfrak{R}$ determines how ψ is connected to ϕ. This reminds us of the *optimality constraint*, which is the (only) constraint, among the five constraints for the inference of a proper bridging qud, that imposes stringent requirements on the structural relationship between ϕ, ψ and a proper bridging qud ρ for them. The optimality constraint is repeated here:

> **Optimality Constraint** (opt):
> Let $\phi \oplus \psi$ denote an elementary one-turn dialogue and let ρ denote a bridging qud for $\mathring{\phi}$ and ψ. ρ is *optimal* relative to ϕ and ψ, written as $\mathsf{opt}(\rho, \mathring{\phi}, \psi)$ iff either (a), (b) or (c) is satisfied (where $q : \{I_c(F(I(\mathring{\phi}))), I_k(F(I(\mathring{\phi}))), I(\mathring{\phi})\}$):
>
> (a) If $\mathring{\phi}$ is a question, then $F(q)$ dominates ψ;
>
> $$\mathsf{opt}(\rho, \mathring{\phi}, \psi) := \mathsf{dom}(F(q), \psi).$$
>
> (b) If $\mathring{\phi}$ is an assertion, then either (i) $F(q)$ dominates ψ, or (ii) $\mathring{\phi}$ promotes the implication of ψ from ρ (if ψ is a question) or $\mathring{\phi}$ promotes the implication of the current qud for ψ from ρ.
>
> $$\begin{aligned}\mathsf{opt}(\rho, \mathring{\phi}, \psi) := \ & \mathsf{dom}(F(q), \psi) \vee \mathsf{pro}(\mathring{\phi}, \rho, \psi) \ \vee \\ & \exists x : \Psi_{\mathcal{E}}.\mathsf{cgr}(\psi, x) \wedge \mathsf{pro}(\mathring{\phi}, \rho, x).\end{aligned}$$
>
> (c) If $\mathring{\phi}$ is an assertion and (b) is not satisfied, then ρ is the current qud for ψ and ρ contains materials that are commonly shared by both $\mathring{\phi}$ and ψ.
>
> $$\mathsf{opt}(\rho, \mathring{\phi}, \psi) := \mathsf{cgr}(\psi, \rho) \wedge \mathsf{anaph}(\rho, \mathring{\phi}, \psi).$$

Let $\phi \oplus \psi$ satisfies clause (a) such that ψ is by definition an elaboration on $F(q)$. In this case, the rhetorical relation $\mathfrak{R}$ that connects ϕ and ψ is a subordinating one (see Figures 9.3, 9.8, 9.9, 9.10, and Graph B in 9.4 for illustrating examples). Let us now turn to clause (c). If $\phi \oplus \psi$

satisfies clause (c), then ψ is a relevant reaction to $\mathring{\phi}$ in virtue of the fact that $\mathring{\phi}$ and ψ both answer a contextually salient question ρ and moreover, since $\phi \oplus \psi$ does not satisfy clause (b), ϕ and ψ do not have further potential inferential connections. In this case, the rhetorical relation $\mathfrak{R}$ connecting ϕ and ψ is a coordinating one (see Graph A in Figure 9.7 and also Figure 9.11 for illustrating examples).

To a first approximation, let us consider the following two examples (repeated from examples (7) and (9) in Chapter 9):

(12) a. **Lisuarte**: Did Amadís visit London yesterday?
b. **Oriana**: Amadís visited [Paris]$_{\mathcal{F}}$.

(13) a. **Lisuarte**: Amadís defeated Dardán.
b. **Oriana**: He didn't defeat Endriago.

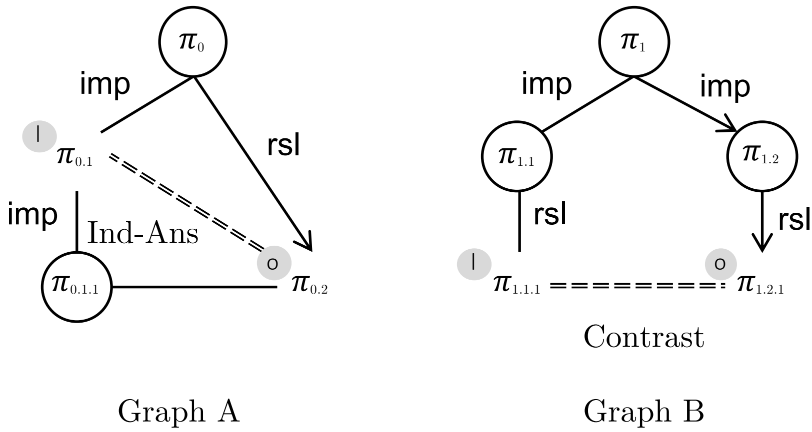
(12) satisfies clause (a): (12b) provides useful information facilitating the resolution of (12a). In contrast, (13) satisfies clause (c): (13a) and (13b) are both answers to (14) and have no further connections.

(14) Whom did Amadís defeat, Dardán or Endriago?

The rhetorical relation for (12a) and (12b), namely, *Indirect Answer*, is subordinating, whereas the rhetorical relation for (13a) and (13b), namely, *Contrast*, is coordinating. The qud-trees for (12a) and (12b) are respectively given in Graph A and Graph B in Figure 11.6 (repeated from Graph A of Figure 9.7 and Graph B in Figure 9.8).

Is there any fundamental difference between a qud-tree for a subordinating relation such as Graph A in Figure 11.6 and a qud-tree for a coordinating one such as Graph B in Figure 11.6? The answer is positive: if a qud-tree for a rhetorical relation $\mathfrak{R}$ is asymmetric such as Graph A in Figure 11.6, then $\mathfrak{R}$ is subordinating, and in contrast, if it is symmetric such as Graph B in Figure 11.6, $\mathfrak{R}$ is coordinating.[13] This generalizes to all of the examples considered so far (see examples

[13] For the definition of *symmetry*, see Section 7.5 of Chapter 7.



- Notations for (12) (Graph A):
  - π_0:= Where did Amadís visit?
  - $\pi_{0.1}$:= Did Amadís visit London yesterday?
  - $\pi_{0.1.1}$:= Since $\pi_{0.2}$, then $\pi_{0.1}$?
  - $\pi_{0.2}$:= Amadís visited $[\text{Paris}]_{\mathcal{F}}$.
- Notations for (13) (Graph B):
  - π_0:= Whom did Amadís defeat, Dardán or Endriago?
  - $\pi_{0.1}$:= Did Amadís deafeated Dardán?
  - $\pi_{0.1.1}$:= Yes (= Amadís defeated Dardán.)
  - $\pi_{0.2}$:= Did Amadís defeat Endriago?
  - $\pi_{0.2.1}$:= No (= Amadís didn't defeat Endriago.)

Figure 11.6: Qud-trees for (12) and (13): Indirect Answer and Contrast

in Chapter 9 for details). This connection is captured by the following principle called *coordination-qud nexus* (CQN):[14]

> **Coordination-Qud Nexus** (**CQN**, to be revised)
> $\mathfrak{R}$ is a coordinating rhetorical relation iff the qud-tree for $\mathfrak{R}$ is symmetric.

The rationale behind this principle is easy to capture. If $\mathfrak{R}$ is coordinating, the pair of speech acts that $\mathfrak{R}$ connects stands in a simple conjunctive relation, both answering a topical question (as required by Asher and Lascarides). In this case, it gives rise to a symmetric qud-tree which consists of two trunks that never intersect expect that they are connected by the root node (inhabited by the topical question for both speech acts connected by $\mathfrak{R}$). In contrast, if $\mathfrak{R}$ is subordinating, the two speech acts that $\mathfrak{R}$ connects stands in a more complex relation. In this case, it gives rise to an asymmetric qud-tree which consists of two or more trunks that might be connected to each other by some promoting relations between nodes.

11.5.3 Pseudo-asymmetric qud-trees

This final (sub)section considers a potential challenge to CQN. This challenge is mainly related to clause (b) of optimality constraint, or more specifically, the second part of clause (b) (see the previous section). The first part of clause (b), similar to clause (a), is a retention of EQR. Similar to clause (a), which licenses a subordinating rhetorical relation, this first part of clause (b) should also license a subordinating rhetorical relation. This is confirmed by our analysis for example (12) in Section 9.3 of Chapter 9. The second part of clause (b) specifies another alternative condition: for ψ to be a relevant reaction to an assertion ϕ, ϕ promotes either ψ (if ψ is a question) or the current qud of ψ. If $\phi \oplus \psi$ really satisfies this condition, then the qud-tree for

[14]For the time being, the coordination-qud nexus is only a hypothesis because it is only partially proved by examples considered thus far.

$\phi \oplus \psi$ must contain a promoting relation and is necessarily asymmetric. Under this circumstance, the rhetorical relation for $\phi \oplus \psi$ must be subordinating. Therefore, whenever a qud-tree for a rhetorical relation $\mathfrak{R}$ satisfies either the first or the second part of clause (*b*), it is asymmetric and under CQN, $\mathfrak{R}$ is predicted to be subordinating.

This predication is challenged by some tricky examples. To start with, consider again (15) (repeated from (7) in Chapter 9):

(15) a. **Lisuarte**: Amadís defeated Dardán.
b. **Oriana**: But he didn't defeat Endriago.

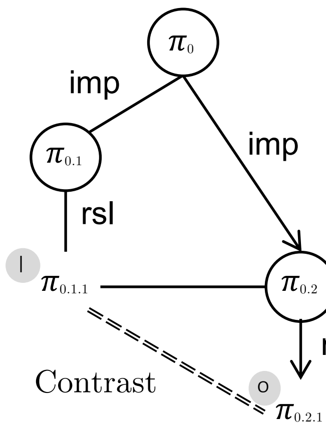
(15) satisfies the second part of clause (*b*) of optimality constraint: (15a) promotes the implication of the current qud for (15b):

(16) Did Amadís defeat Endriago as well?

(16) is inferred due to the presence of the particle *but* in (15b): (15b) rejects an expectation that Oriana infers from Lisuarte's assertion (15a) that Amadís defeated Endriago as well. This indicates that the performance of (15b) presupposes some discourse antecedent such as (15a) that contrasts with (15b). The promoting relation between (15a) and (16) is exactly intended to capture this indirect presupposition. The rhetorical relation that connects (15a) and (15b), following Asher and Lascarides' line of reasoning, should be *Contrast*. Therefore, under CQN, it is predicted that the qud-tree for (15) is symmetric. Nevertheless, due to the promoting relation between (15a) and the current qud of (15b), the qud-tree for (15) is indeed asymmetric, as shown in Figure 11.7 (cf. Graph B in Figure 11.6).

Let us now consider the following example (repeated from (5) in Section 11.3), which presents a very similar paradox:

(17) a. **Lisuarte**: Galaor loves Maria.
b. **Oriana**: i. (If so,) He would also love [Claudia]$_{\mathcal{F}}$.
ii. Or [Claudia]$_{\mathcal{F}}$.
iii. He also loves [Claudia]$_{\mathcal{F}}$.



- π_0:= Whom did Amadís defeat, Dardán or Endriago?
- $\pi_{0.1}$:= Did Amadís deafeated Dardán?
- $\pi_{0.1.1}$:= Yes (= Amadís defeated Dardán.)
- $\pi_{0.2}$:= Did Amadís defeat Endriago as well?
- $\pi_{0.2.1}$:= No (= But he didn't defeat Endriago.)

Figure 11.7: Qud-tree for (15): Contrast

The rhetorical relations for the above three pairs of speech acts are respectively: *Consequence* for (17a-17bi), *Alternation* for (17a-17bii), and *Parallel* for (17a-17biii). The three rhetorical relations, according to Asher and Lascarides (2003), are all coordinating. Under CQN, it is predicted that the qud-trees for all of the three rhetorical relations are symmetrical. Counter to our expectation, they are all indeed asymmetrical, as they all satisfy the second part of clause (*b*) of optimality constraint, thus containing a promotion branch! The qud-trees for (17a-17bi), (17a-17bii), and (17a-17biii) are structurally identical, as shown in Figure 11.8 (repeated from Figure 11.3). The notations for nodes differ with respect to whether Figure 11.8 presents a qud-tree for *Consequence*, *Alternation*, or *Parallel*. Let us pay particular attention to the (only) promoting relation connecting $\pi_{0.1.1}$ and $\pi_{0.2}$ in Figure 11.8. If Figure 11.8 represents a qud-tree for *Consequence* or *Alternation*, then the promoting relation in this qud-tree is hypothetical (see Section 11.3 for more related discussion). If we let Figure 11.8 represent a qud-tree for *Parallel*, the promoting relation in this qud-tree captures the fact that (17biii) presupposes (17a).

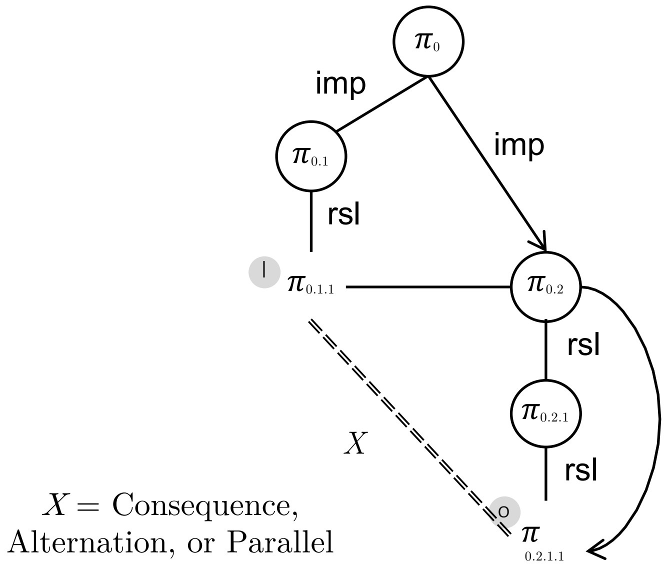
How does the promoting relation in a qud-tree for a coordinating relation differ from that contained in a qud-tree for a subordinating relation? Let us now consider the following examples (repeated from (9)-(11)), each containing a typical subordination relation.

(18) a. Speaker *a*: Bill arrived at John's party at 20h last nigt.
     b. Speaker *b*: $[\text{Mary}]_{\mathcal{F}}$ was there.

(19) a. Speaker *a*: Bill had a great meal.
     b. Speaker *b*: He ate lots of $[\text{salmon}]_{\mathcal{F}}$.

(20) a. Speaker *a*: Bill fell.
     b. Speaker *b*: John pushed him.

The three examples have already been discussed in Section 11.4: the inference of a proper bridging qud for any of the three pairs of speech acts satisfies the second part of clause (*b*) of optimality constraint. For



- Notations for (17a-17bi) (X = *Consequence*):
  - π_0:= Whom does Galaor love?
  - $\pi_{0.1}$:= Did Galaor love Maria?
  - $\pi_{0.1.1}$:= Yes (= Galaor loves Maria.)
  - $\pi_{0.2}$:= If Galaor loves Maria, whom else would he love?
  - $\pi_{0.2.1}$:= If Galaor loves Maria, would he love Claudia?
  - $\pi_{0.2.1.1}$:= Yes (= If Galaor loves Maria, he would also love Claudia).
- Notations for (17a-17bii) (X = *Alternation*):
  - π_0:= Whom does Galaor love?
  - $\pi_{0.1}$:= Did Galaor love Maria?
  - $\pi_{0.1.1}$:= Yes (= Galaor loves Maria.)
  - $\pi_{0.2}$:= If Galaor does not love Maria, whom does he love?
  - $\pi_{0.2.1}$:= If Galaor does not love Maria, does he love Claudia?
  - $\pi_{0.2.1.1}$:= Yes (= If Galaor does not love Maria, he loves Claudia.)
- Notations for (17a-17biii) (X = *Parallel*):
  - π_0:= Whom does Galaor love, Maria or Claudia?
  - $\pi_{0.1}$:= Did Galaor love Maria?
  - $\pi_{0.1.1}$:= Yes (= Galaor loves Maria.)
  - $\pi_{0.2}$:= Besides Maria, whom else does Galaor love?
  - $\pi_{0.2.1}$:= Besides Maria, does Galaor love Claudia?
  - $\pi_{0.2.1.1}$:= Yes (= He also loves Claudia.)

Figure 11.8: Qud-trees for (17a-17bi), (17a-17bii), and (17a-17biii): Consequence, Alternation and Parallel (repeated)

this reason, the qud-trees for (18)-(20), as shown in Figure 11.9 (repeated from Figure 11.5), all contain a promoting relation. To a first approximation, let us consider the promoting relation in the qud-tree for *Elaboration*, which relates $\pi_{1.1}$ and $\pi_{1.2.1}$. In this case, the promotion relation captures the fact that $\pi_{1.1}$ evokes $\pi_{1.2.1}$. To our surprise, this observation generalizes to the other two qud-trees: in the qud-tree for *Background*, $\pi_{0.1}$ evokes $\pi_{0.2}$ on the basis of the commonsense knowledge that everything happens with a background; in the qud-tree for *Explanation*, $\pi_{2.1.1}$ evokes $\pi_{2.2.1}$ on the basis of the commonsense knowledge that everything happens with an explanation.[15]

In light of the above comparisons, we shall conclude that in the case that a qud-tree for an elementary one-turn dialogue $\phi \oplus \psi$ satisfies the second part of clause (b) of optimality constraint, the rhetorical relation connecting ϕ and ψ is subordinating iff the (only) promoting relation in the qud-tree for $\phi \oplus \psi$ is tantamount to question evocation. In contrast, if the (only) promoting relation in the qud-tree for $\phi \oplus \psi$ (that satisfies the second part of clause (b)) is not tantamount to question evocation, the rhetorical relation for $\phi \oplus \psi$ must be coordinating. This straightforwardly applies to the characterization of the asymmetric qud-trees for (15) and (17). In this dissertation, the qud-trees for (15) and (17) are dubbed *pseudo-asymmetric qud-trees*. The property of *pseudo-asymmetry* is defined as follows:

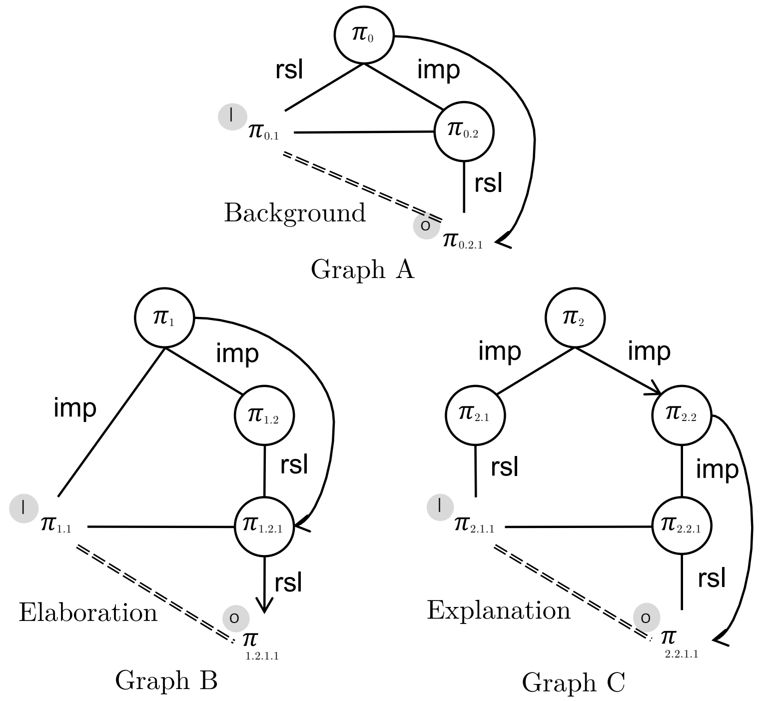
Definition 43 (Pseudo-Asymmetry)**.** *Let $\mathbb{Q}$ denote a qud-tree for an elementary one-turn dialogue. $\mathbb{Q}$ is pseudo-asymmetric iff $\mathbb{Q}$ satisfies the following requirements:*

(a) (*The question inhabiting the root node of*) $\mathbb{Q}$ *satisfies the second part of clause* (b) *of optimality constraint.*

(b) *The* (*only*) *promoting relation contained in* $\mathbb{Q}$ *is not tantamount to question evocation.*

The old principle of coordination-qud nexus can be now further ex-

[15] The notion of *question evocation* is defined in Section 5.5 of Chapter 5.



- Notations for (18) (Graph A):
  - π_0:= How was John's party at 20h last night?
  - $\pi_{0.1}$:= Bill arrived at 20h last night.
  - $\pi_{0.2}$:= Who was there at that time?
  - $\pi_{0.2.1}$:= Mary was there (at that time).
- Notations for (19) (Graph B):
  - π_1:= What did Bill do at T?
  - $\pi_{1.1}$:= He had a great meal at T.
  - $\pi_{1.2}$:= What did Bill do at t_1? (where $t_1 : T$)
  - $\pi_{1.2.1}$:= What did Bill eat at t_1 during the meal?
  - $\pi_{1.2.1.1}$:= He ate lots of salmon (at t_1).
- Notations for (20) (Graph C):
  - π_2:= What happened to Bill at T?
  - $\pi_{2.1}$:= What happened to Bill at t_1? (where $t_1 : T$)
  - $\pi_{2.1.1}$:= He (= Bill) fell (at t_1).
  - $\pi_{2.2}$:= What happened to Bill at t_2? (where $t_1 : T$ and $T = [t_2, t_1]$)
  - $\pi_{2.2.1}$:= What happened to Bill at t_2 that caused $\pi_{2.1}$?
  - $\pi_{2.2.1.1}$:= John pushed him (at t_2).

Figure 11.9: Qud-trees for (18)-(20): Background, Elaboration, and Explanation (repeated)

tended, by taking into account the above discussion:

> **Coordination-Qud Nexus, revised (RCQN)**
> $\mathfrak{R}$ is a coordinating rhetorical relation iff the qud-tree for $\mathfrak{R}$ is either symmetric or pseudo-asymmetric.

(15) and (17) are clearly not counterexamples for RCQN.

Before closing this (sub)section, let us consider an intriguing phenomenon extensively discussed in the literature. To a first approximation, consider the following example:[16]

(21) a. [Lea was admitted by Oxford]$_\alpha$, [so her mother bought her a big cake]$_\beta$. [She told this good news to their neighbors]$_\gamma$.

b. [Lea was tested positive]$_{\alpha'}$, [so her interview with Mary was canceled]$_{\beta'}$. [She had contact with a Covid case yesterday]$_{\gamma'}$.

In (21a), the most plausible interpretation of the pronoun *she* in γ is that *she* refers to *her mother* in β but not *Lea* in α. This amounts to saying that the attachment of β to α is likely to block the potential anaphoric relation between *she* and *Lea*. By the first test proposed by Asher and Vieu, the rhetorical relation *Result* for α and β is coordinating. In (21b), however, the pronoun *she* in γ' is more likely interpreted as referring to *Lea* in α' but not *Mary* in β'. This shows that the attachment of β' to α' does not block the possibility of attaching new materials to α'. Consequently, the rhetorical relation *Result* for α' and β' is subordinating.[17] The difference between the two *Result*'s is first observed by Asher and Vieu (2005): though *Result* seems to be coordinating by default, it can be used as a subordinating relation

[16]For more related examples, see Asher and Vieu (2005) and Onea (2019).

[17]Enric Vallduví and Laia Mayol (p.c.) pointed out to me that the interpretation of *she* in either γ or γ' in context-sensitive: in (21a), while it is more plausible to interpret *she* as referring to *her mother*, it is possible that in certain contexts, *she* refers to *Lea*; and likewise, in (21b), while it seems more plausible to interpret *she* as anaphoric to *Lea*, it is not completely impossible that in certain contexts, *she* refers to *Mary*. This indicates that the right frontier of a discourse unit is not fixed but is sensitive to the discourse context in which it is evaluated.

in some discourse contexts (pp.600-601). Asher and Vieu do not go much beyond observing this intriguing phenomenon.

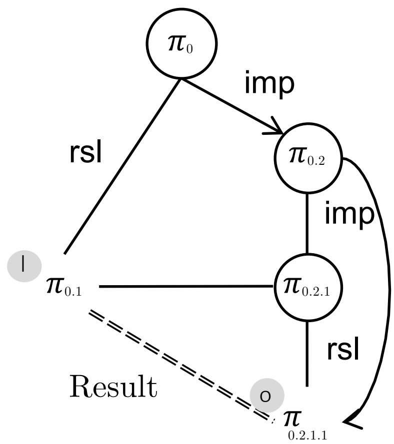
Under RCQN, the ambiguous interpretation of *Result* can be captured in a more intuitive way. To see how, let us first apply dialogical transformation to the first two utterances in (21a) and (21b), returning the following two elementary one-turn dialogues:

(22) a. Speaker a: Lea was admitted by Oxford.
b. Speaker b: So her mother bought her a big cake.

(23) a. Speaker a: Lea was tested positive.
b. Speaker b: So her interview with Mary was canceled.

The qud-trees for (22) and (23) are structurally identical, as shown in Figure 11.10. The notations for nodes differ with respect to whether Figure 11.10 represents a qud-tree for either (22) or (23). Let us now take a close look at the promoting relation in Figure 11.10. Let Figure 11.10 represent a qud-tree for (22), the promoting relation between $\pi_{0.1}$ and $\pi_{0.2.1}$ is not tantamount to question evocation because that Lea was admitted by Oxford does not guarantee that Lea's mother would do anything. Under this analysis, the qud-tree for (22) is predicted to be pseudo-asymmetric, and according to RCQN, the rhetorical relation *Result* for (22) should be coordinating. In contrast, if we let Figure 11.10 represent a qud-tree for (23), the promoting relation between $\pi_{0.1}$ and $\pi_{0.2.1}$ is equivalent to question evocation: given that Lea was tested positive, it is pertinent to wonder how her life was affected (in virtue of the regular practice that if one is tested positive, one is required to stay at home for one or two weeks).[18] Under this analysis, the qud-tree for (23) turns out to be truly asymmetric, and according to RCQN, the rhetorical relation *Result* for (23) should be subordinating. It is worthwhile mentioning that our account for the ambiguous interpretation of *Result* loosely agrees with Onea's (2019), according to which, *Result* is a subordinating relation when "the first

[18]That if one is tested positive, one is required to stay at home for one or two weeks is considered part of commonsense knowledge.



- Notations for (22):
  - $\pi_0 := F$(What did Lea's mother do (at t_2)?)
  - $\pi_{0.1} :=$ Lea was admitted by Oxford (at t_1). (where t_1 precedes t_2)
  - $\pi_{0.2} :=$ What did Lea's mother do (at t_2)?
  - $\pi_{0.2.1} :=$ What did Lea's mother do (at t_2) after $\pi_{0.1}$?
  - $\pi_{0.2.1.1} :=$ Her mother bought her a big cake (at t_2).
- Notations for (23):
  - $\pi_0 := F$(How about Lea's interview with Mary (at t_2)?)
  - $\pi_{0.1} :=$ Lea was tested positive (at t_1). (where t_1 precedes t_2)
  - $\pi_{0.2} :=$ How about Lea's interview with Mary (at t_2)?
  - $\pi_{0.2.1} :=$ How about Lea's interview with Mary (at t_2) as a result of $\pi_{0.1}$?
  - $\pi_{0.2.1.1} =$ It was canceled (at t_2).

Figure 11.10: Qud-trees for (22) and (23): Result

sentence [that *Result* connects] licenses a potential question [that is, an evoked question in our sense] about its result" (p.174), and whenever this does not happen, *Result* can only be coordinating.[19]

11.6 Summary

This chapter has examined the possibility of reducing rhetorical relations (defined *à la* Asher and Lascarides (2003)) to qud-relations. The results provide supportive evidence for the working hypothesis RQH that whenever qud-relations are conceived as the most primitive rhetorical relations, other intricate rhetorical relations can be reduced to a family of qud-relations. More importantly, it is shown that the qud-reduction of rhetorical relations provides a more intuitive and direct way to capture many important properties of rhetorical relations: (a) the qud-tree for a non-veridical rhetorical relation must contain either a contradictory triangle or a hypothetical promotion branch; (b) the qud-tree for a rhetorical relation that imposes a temporal consequence requirements must be backed by an explicit timeline; (c) the qud-tree for a coordinating rhetorical relation is either symmetric or pseudo-asymmetric. The analysis of the relationship between rhetorical relations and qud-trees presented in this chapter is far from being complete and more research is called for on this topic.

[19] There is an important distinction between our account for *Result* and Onea's (2019): in our account, regardless of whether *Result* is coordinating or subordinating, the qud-tree for *Result* is asymmetric, but in Onea's proposal, the qud-tree for *Result* is symmetric if *Result* is analyzed as a coordinating relation, or asymmetric if *Result* is analyzed as a subordinating relation. The reason for why such a distinction emerges remains for future scrutiny.

Chapter 12

Conclusion

Drawing upon two theoretic frameworks, i.e., the qud-based approach to discourse and type-theoretical semantics, this dissertation develops a qud-based discourse model dubbed RiD (acronym for *Reasoning in Dialogue*) after a thorough exploration of the inferential articulation of speech acts in linguistic discourse. The goal of this final chapter is two-fold: on the one hand, it pulls together the research questions that were opened at the beginning with the answers that were obtained in the course of analyses, thus providing a guide to read this dissertation from the end; and on the other, after a review of the results obtained thus far, it outlines some drawbacks and limitations of RiD, together with a series of future tracks for improving this new discourse model.

12.1 Results: A Summary

There is a general consensus that people reason in their communication, and to be more concrete, that people reason with speech acts in a cooperative way in an attempt to achieve some sort of agreement (see Trafford (2017)). There are two predominant approaches to the formal modeling of human communication or alternatively linguistic discourse: one, called the *relation-based approach*, conceives that speech acts are connected to each other via various kinds of *rhetorical relations* in linguistic discourse; the other, called the *qud-based approach*, argues for an underlying layer of linguistic discourse constituted by two primitive *qud-based relations* (or simply *qud-relations*), namely, *question resolution* and *question implication*. This dissertation represents a first step towards the ambitious enterprise of unifying the two different approaches under the assumption that qud-relations are the most fundamental rhetorical relations and other intricate rhetorical relations are reducible to qud-relations. To make this project feasible, we restricted our scope of investigation to two types of speech acts, *assertions* and *questions*, and considered their occurrence in only *elementary one-turn dialogues*, i.e., dialogues that consists of only two speech acts, each containing only one eventuality description.

To be specific, this dissertation answered three research questions (motivated in Chapter 2), the solutions being summarized as follows:

(Q1) What does one express by performing a speech act and how is the performance of a speech act warranted?

(Q1.1) What does a speech act express if it is not meant to be addressed to any audience and what entitles one to perform such a speech act?

Proposal: In linguistic discourse, a speech act is, first and foremost, normative: by performing a speech act, one acknowledges a commitment and assumes the responsibility of vindicating one's entitlement to endorse such a commitment. To vindicate one's entitlement to a speech act, one provides a reason that consists of a series of justificatory commitments, which can be further justified until the final reason is self-evident.

(Q1.2) What does a speech act express if it is addressed to specific audience and how it differs from a speech act that is not addressed to any audience?

Proposal: In linguistic discourse, a speech act is said to be impersonal iff it is not addressed to anyone. In a two-entry scorekeeping model of discourse, an impersonal speech act is one that the speaker addresses to him-/herself. In contrast, second-personal speech acts target specific audience. In addressing a question, one addresses a (practical) commitment requesting the interlocutor to answer the question under the assumption that the interlocutor will accept the address and is aware of a full answer to this question. In addressing an assertion, one addresses to the interlocutor a (doxastic) commitment to the asserted proposition and a (practical) commitment requesting the interlocutor to answer a polar question on whether the asserted proposition is true, under the assumption that the interlocutor will accept the address and is aware of a full answer to this polar question.

(Q2) How can the relevance of a reaction to a speech act in an elementary one-turn dialogue be properly characterized? Is it possible to define the relevance of a reaction to a speech act in an elementary one-turn dialogue in terms of the existence of a proper bridging qud for the two concerned speech acts?

Proposal: To characterize the relevance of ψ to ϕ in an elementary one-turn dialogue $\phi \oplus \psi$, we propose a hypothesis called *relevance via qud-bridging*, defining the relevance of ψ to ϕ in terms of the possibility of inferring a proper qud that dominates $\mathring{\phi}$ and ψ. The inference of a proper qud, if any, for $\mathring{\phi}$ and ψ should comply with a series of five constraints: accessibility constraint, minimality constraint, concordance constraint, optimality constraint, and informativity constraint. The notion of relevance defined as such is shown to be more comprehensive and more practical for implementation purposes than other similar definitions offered by qud- and relation-oriented theorists. In the course of developing such a new definition of relevance, we introduce a new method using qud-trees for representing discourse fragments.

(Q3) Under the view that rhetorical relations emerge from addressing and reacting to speech acts in elementary one-turn dialogues, is it possible to reduce rhetorical relations that occur in elementary one-turn dialogues to qud-relations?

Proposal: Under the hypothesis that rhetorical relations emerge as an epiphenomenon of addressing and reacting to speech acts, it is shown that a rhetorical relation can be reduced to a set of qud-relations: every rhetorical relation is abstracted from a complex discourse unit which can be intuitively represented by a qud-tree; and furthermore, some important properties of rhetorical relations can be directly retrieved from the qud-trees for these relations. The overall results provide support for the ambitious enterprise of unifying qud-based and relation-based approaches to discourse coherence, though there are still many subtle problems that need to be dealt with in future work.

The solutions to the three research questions all together contribute to the development of a new qud-based discourse model dubbed RiD (in contrast with Roberts' (1996/2012) and Ginzburg's (2012)). RiD consists of three interrelated parts: a normative account of speech acts, a type-theoretical framework for speech act representation, and a theory of reasoning with speech acts in linguistic discourse. The first two parts grow out of the examination of question (Q1) and the third part emerges from the examination of questions (Q2) and (Q3).

12.2 Drawbacks and Prospects

The new discourse model RiD developed in this dissertation represents the first step of an attempt to the unification of relation-based and qud-based approaches to discourse modeling, but it is undoubtedly far from being satisfactory. Here are some drawbacks and possible future tracks for improving and extending RiD:

(a) There are many different types of speech acts that are not considered in this dissertation and are not part of RiD. It is unclear how these speech acts interact with assertions and/or questions, and how RiD can be enriched with these speech acts.

> **Future track**: In order to obtain a more comprehensive view of discourse, RiD should be enriched with other types of speech acts. Sadock and Zwicky (1985) advocate that there are three primitive types of speech acts: *assertions*, *questions*, and *commands*.[1] The first two types of speech acts are already part of RiD. Future investigations should further enrich RiD with commands. There are many different proposals for the analysis of commands (see Portner (2004, 2007), Fox (2012, 2015), and Ginzburg (2012)). The simplest idea, largely inspired by Ginzburg (2012), is that a command can be conceived as a specific type of question requesting a time point at which this command is fulfilled. This idea should be carefully probed in the future. Apart from commands, RiD should be also further extended with non-canonical speech acts, which fall under two categories: (a) *composite speech acts* (largely motivated by Asher and Reese (2007)), which encode two or more speech acts: for example, a *biased question* encodes an information-seeking question, and an assertion that expresses the speaker's bias towards a particular answer to the question; (b) *insincere*

[1] The original claim of Sadock and Zwicky (1985) is the following: one might find it "a surprising fact that most languages are similar in presenting three basic sentence types with similar functions and often strikingly similar forms" and "these are the declarative, interrogative, and imperative" (p.160): a declarative is used to make an assertion, an interrogative is used to make a question, and an imperative is used to make a command (see Roberts (2018) for related discussion).

speech acts, which are uttered in an attempt to deceive or mislead the interlocutor: for example, a *lie* is an assertion that is uttered with the purpose to cheat the interlocutor.

(*b*) There is a close relationship between discourse structure and information structure (Büring, 2003; Bott, 2007; Vallduví, 2016). However, only one particular information-structural layer, i.e., focus-background articulation (see Section 3.5.3 of Chapter 3), is incorporated to RiD. It is pertinent to wonder if RiD can be extended with other layers of information structure.

Future track: In the literature of information structure, a sentence can be partitioned in very different ways. There are various models of information structure, for example, a three-dimensional model, best represented by Neeleman and Vermeulen (2012), which divides a sentence into three dimensions, *focus-background*, *topic-comment*, and *contrast*, and a two-dimensional hierarchical model, represented by Vallduví and Vilkuna (1998) and Steedman (2000, 2008), which first partitions a sentence into two parts, *theme* and *rheme*, and then partitions each part into *focus* and *background*. In RiD, only the focus-background layer is considered. In order to obtain a more comprehensive notion of information-structural congruence, other layers of information structure should be taken into account. Büring (2003) offers an inspiring attempt to decipher the connection of a contrastive topic contained in a sentence to the discourse in which the sentence is uttered. Future research shall further consider how Büring's analysis can be incorporated to RiD, and moreover, how previous information-structural analysis, mainly focusing on declarative sentences, can be extended to the analysis of non-declarative sentences (see Kamali and Krifka (2020) for a recent attempt).

(*c*) The novel RQB-based qud-model of discourse, central to RiD, provides a faithful characterization of the relevance of a reaction to a speech act (see Section 9.3 of Chapter 9). It is pertinent to wonder if this model can be applied to the annotation and analysis of large-scale discourse corpora.

> **Future track**: RiD is mainly designed for the analysis of dialogues (specifically, elementary one-turn dialogues). To apply RiD to the annotation of large-scale discourse corpora, the following two questions must be answered in advance: first, how to transform a non-dialogical discourse to a series of elementary one-turn dialogues (see van Deemter et al. (2008), Stoyanchev and Piwek (2011), Li et al. (2016), Bowden et al. (2016), Xu et al. (2018), and Petac et al. (2020) for recent inspiring attempts); second, how to constrain the inference/accommodation of implicit speech acts that are indispensable for the qud-reduction of elementary one-turn dialogues. Recent studies aiming at implementing qud-models of discourse to annotate large-scale discourse corpora, such as Riester (2019), Hesse et al. (2020) as well as Hesse et al. (2021), provide us with encouraging results. The similarity and dissimilarity between RiD and the qud-models (of discourse) implemented in the abovementioned recent studies remain for future scrutiny.

The potential tracks suggested above for further research will be considered in the future so as to obtain a more comprehensive and unified qud-based approach to discourse modeling.

Appendices

Appendix A

Type-Theoretical Framework

A Contexts

$$\frac{}{\langle - \rangle : \mathsf{ctx},}\ \text{EMP} \qquad \frac{\Gamma \vdash C : \mathsf{U} \qquad x \notin \mathsf{var}(\Gamma)}{\langle \Gamma, x : C \rangle : \mathsf{ctx}.}\ \text{EXT}$$

$$\frac{\Gamma \vdash A : \mathsf{U} \qquad \vdash f : \Gamma \to \Delta}{\Delta \vdash A(f) : \mathsf{U}}\ \text{SUBS}_1$$

$$\frac{\Gamma \vdash A : \mathsf{U} \qquad \vdash f : \Gamma \to \Delta}{\Delta \vdash a(f) : A(f)}\ \text{SUBS}_2$$

B Useful Type Formers

B.1 Function type ($\to$)

$$\frac{\Gamma \vdash A : \mathsf{U} \qquad \Gamma \vdash B : \mathsf{U}}{\Gamma \vdash A \to B : \mathsf{U},}\ \text{F}_{\to}$$

$$\frac{\Gamma, x : A \vdash b(x) : B}{\Gamma \vdash (\lambda x) b(x) : A \to B,}\ \text{I}_{\to}$$

$$\frac{\Gamma \vdash c : A \to B \qquad \Gamma \vdash a : A}{\Gamma \vdash \mathsf{app}(c, a) : B,}\ \text{E}_{\to}$$

$$\frac{\Gamma, x : A \vdash b(x) : B \qquad \Gamma \vdash a : A}{\Gamma \vdash \mathsf{app}((\lambda x)b(x), a) = b(a/x) : B.}\ \mathrm{C}_{\rightarrow}$$

B.2 Dependent function type (Π)

$$\frac{\Gamma \vdash A : \mathsf{U} \qquad \Gamma, x : A \vdash B(x) : \mathsf{U}}{\Gamma \vdash \Pi x : A.B(x) : \mathsf{U},}\ \mathrm{F}_{\Pi}$$

$$\frac{\Gamma, x : A \vdash b(x) : B(x)}{\Gamma \vdash (\lambda x)b(x) : \Pi x : A.B(x),}\ \mathrm{I}_{\Pi}$$

$$\frac{\Gamma \vdash c : \Pi x : A.B(x) \qquad \Gamma \vdash a : A}{\Gamma \vdash \mathsf{app}(c, a) : B(a/x),}\ \mathrm{E}_{\Pi}$$

$$\frac{\Gamma, x : A \vdash b(x) : B(x) \qquad \Gamma \vdash a : A}{\Gamma \vdash \mathsf{app}((\lambda x)b(x), a) = b(a/x) : B(a/x).}\ \mathrm{C}_{\Pi}$$

B.3 Product type (×)

$$\frac{\Gamma \vdash A : \mathsf{U} \qquad \Gamma \vdash B : \mathsf{U}}{\Gamma \vdash A \times B : \mathsf{U},}\ \mathrm{F}_{\times}$$

$$\frac{\Gamma \vdash a : A \qquad \Gamma \vdash b : B}{\Gamma \vdash (a, b) : A \times B,}\ \mathrm{I}_{\times}$$

$$\frac{\Gamma \vdash c : A \times B}{\Gamma \vdash \pi_l(c) : A,}\ \mathrm{E}_{l\times} \qquad \frac{\Gamma \vdash c : A \times B}{\Gamma \vdash \pi_r(c) : B,}\ \mathrm{E}_{r\times}$$

$$\frac{\Gamma \vdash a : A \qquad \Gamma \vdash b : B}{\Gamma \vdash \pi_l((a, b)) = a : A,}\ \mathrm{C}_{l\times} \qquad \frac{\Gamma \vdash a : A \qquad \Gamma \vdash b : B}{\Gamma \vdash \pi_r((a, b)) = b : B.}\ \mathrm{C}_{r\times}$$

B.4 Dependent product type (Σ)

$$\frac{\Gamma \vdash A : \mathsf{U} \qquad \Gamma, x : A \vdash B(x) : \mathsf{U}}{\Gamma \vdash \Sigma x : A.B(x) : \mathsf{U},}\ \mathrm{F}_{\Sigma}$$

$$\frac{\Gamma \vdash a : A \qquad \Gamma \vdash b : B(a)}{\Gamma \vdash (a, b) : \Sigma x : A.B(x),}\ \mathrm{I}_{\Sigma}$$

$$\frac{\Gamma \vdash c : \Sigma x : A.B(x)}{\Gamma \vdash \pi_l(c) : A,}\ \mathrm{E}_{l\Sigma} \qquad \frac{\Gamma \vdash c : \Sigma x : A.B(x)}{\Gamma \vdash \pi_r(c) : B(\pi_l(c)),}\ \mathrm{E}_{r\Sigma}$$

$$\frac{\Gamma \vdash a : A \qquad \Gamma \vdash b : B(a)}{\Gamma \vdash \pi_l((a,b)) = a : A,}\ \mathrm{C}_{l\Sigma} \qquad \frac{\Gamma \vdash a : A \qquad \Gamma \vdash b : B(a)}{\Gamma \vdash \pi_r((a,b)) = b : B(a).}\ \mathrm{C}_{r\Sigma}$$

B.5 Sum type (+)

$$\frac{\Gamma \vdash A : \mathsf{U} \qquad \Gamma \vdash B : \mathsf{U}}{\Gamma \vdash A + B : \mathsf{U},}\ \mathrm{F}_{+}$$

$$\frac{\Gamma \vdash a : A}{\Gamma \vdash \iota_l(a) : A + B,}\ \mathrm{I}_{l+} \qquad \frac{\Gamma \vdash b : B}{\Gamma \vdash \iota_r(b) : A + B,}\ \mathrm{I}_{r+}$$

$$\frac{\Gamma \vdash c : A + B \qquad \Gamma, x : A \vdash d(x) : C(\iota_l(x)) \qquad \Gamma, x : A \vdash e(y) : C(\iota_r(y))}{\Gamma \vdash \mathsf{D}(c, (x)d(x), (y)e(y)) : C(c),}\ \mathrm{E}_{+}$$

$$\frac{\Gamma \vdash a : A \qquad \Gamma, x : A \vdash d(x) : C(\iota_l(x)) \qquad \Gamma, y : B \vdash e(y) : C(\iota_r(y))}{\Gamma \vdash \mathsf{D}(\iota_l(a), (x)d(x), (y)e(y)) = d(a) : C(\iota_l(a)),}\ \mathrm{C}_{l+}$$

$$\frac{\Gamma \vdash b : B \qquad \Gamma, x : A \vdash d(x) : C(\iota_l(x)) \qquad \Gamma, y : B \vdash e(y) : C(\iota_r(y))}{\Gamma \vdash \mathsf{D}(\iota_r(b), (x)d(x), (y)e(y)) = e(b) : C(\iota_r(b)).}\ \mathrm{C}_{r+}$$

B.6 Identity type (=)

$$\frac{\Gamma \vdash A : \mathsf{U} \qquad \Gamma \vdash a, b : A}{\Gamma \vdash a =_A b : \mathsf{U},}\ \mathrm{F}_{=} \qquad \frac{\Gamma \vdash a = b : A}{\Gamma \vdash \mathsf{id}(a) : a =_A b,}\ \mathrm{I}_{=}$$

$$\frac{\begin{array}{cc}\Gamma \vdash a, b : A & \Gamma, x, y : A, z : x =_A y \vdash C(x, y, z) : \mathsf{U} \\ \Gamma \vdash p : a =_A b & \Gamma, x, y : A, z : x =_A y \vdash d(x) : C(x, y, z)\end{array}}{\Gamma \vdash \kappa(d(x), p) : C(a, b, p),}\ \mathrm{E}_{=}$$

$$\frac{\begin{array}{cc}\Gamma \vdash a, b : A & \Gamma, x, y : A, z : x =_A y \vdash C(x, y, z) : \mathsf{U} \\ \Gamma \vdash a =_A b & \Gamma, x, y : A, z : x =_A y \vdash d(x) : C(x, y, z)\end{array}}{\Gamma \vdash \kappa(d(x), \mathsf{id}(a)) = d(a) : C(a, b, \mathsf{id}(a)).}\ \mathrm{C}_{\in}$$

Putting $C = (x, y, z)(P(x) \to P(y))$ (where $P(x) : \mathsf{U}$, $x, y : A$, and $z :$

$x =_A y$) in $\mathrm{E}_=$, we get $\kappa(d(x), p) : P(a) \to P(b)$. Let $q : P(a)$, we obtain the following RP-rule (where $\mathsf{subs}(p, q) = \mathsf{app}(\kappa(d(x), p), q)$) for the replacement/substitution of equal terms.

$$\frac{\Gamma \vdash p : a =_A b \qquad \Gamma \vdash q : P(a)}{\Gamma \vdash \mathsf{subs}(p, q) : P(b).}\ \mathrm{RP}$$

B.7 Truncated types (||-||)

$$\frac{\Gamma \vdash A : \mathsf{U}}{\Gamma \vdash ||A|| : \mathsf{U},}\ \mathrm{F}_{||\text{-}||} \qquad \frac{\Gamma \vdash a : A}{\Gamma \vdash |a| : ||A||,}\ \mathrm{I}_{||\text{-}||}$$

$$\frac{\Gamma \vdash a : ||A|| \qquad \Gamma \vdash f : A \to B \qquad \Gamma \vdash \mathcal{I}(B)\ \mathsf{true}}{\Gamma \vdash \zeta(f, a) : B,}\ \mathrm{E}_{||\text{-}||}$$

$$\frac{\Gamma \vdash a : A \qquad \Gamma \vdash f : A \to B \qquad \Gamma \vdash \mathcal{I}(B)\ \mathsf{true}}{\Gamma \vdash \zeta(f, |a|) = f(a) : B.}\ \mathrm{C}_{||\text{-}||}$$

C Miscellaneous

$$\frac{\langle \overrightarrow{x_i} : \overrightarrow{A_i} \rangle : \mathsf{C}}{\langle \overrightarrow{x_i} : \overrightarrow{A_i} \rangle \vdash x_i : A_i,}\ \mathrm{VAR} \qquad \frac{\Gamma : \mathsf{C} \qquad \Delta \vdash b : B}{\Delta, \Gamma \vdash b : B,}\ \mathrm{WK}$$

$$\frac{\Gamma \vdash a : A}{\Gamma \vdash (a :: A) : A,}\ \mathrm{ANN} \qquad \frac{\Gamma \vdash A : \mathsf{U} \qquad \Gamma \vdash A\ \mathsf{true}}{\Gamma \vdash @_i : A.}\ @$$

$$\frac{\Gamma \vdash A : \mathsf{U} \qquad \Gamma \vdash a : A}{\Gamma \vdash A\ \mathsf{true},}\ \mathrm{TRUE}$$

$$\frac{\Gamma \vdash A : \mathsf{U} \qquad \Gamma \vdash A \rightsquigarrow B\ \mathsf{true}}{\Gamma \vdash B\ \mathsf{true}}\ \mathrm{PS}$$

D Coercive Subtyping

$$\frac{\Gamma \vdash f : B \to C \qquad \Gamma \vdash a : A \qquad \Gamma \vdash A \prec_c B : \mathsf{U}}{\Gamma \vdash f(a) = f(c(a)) : C}$$

E Useful Rules

(I1) $(A \to (B \to C)) \leftrightarrow (A \wedge B \to C)$
where $A, B, C : \mathsf{Prop}$. This rule is called curry-rule.

(I2) $(A \to (B \to C)) \leftrightarrow ((A \to B) \to (A \to C))$
where $A, B, C : \mathsf{Prop}$. This rule is called frege-rule.

(I3) $\neg\neg(A \to B) \leftrightarrow (\neg\neg A \to \neg\neg B)$
where $A, B : \mathsf{Prop}$. This rule shows that $\neg\neg$ distributes over $\to$.

(I4) $\forall x : D.(A(x) \to B(x)) \to (\forall x : D.A(x) \to \forall x : D.B(x))$
where $D : \mathsf{U}$ and $A, B : D \to \mathsf{Prop}$. This rule is called the distribution axiom of $\forall$. The converse is does not hold constructively.

(I5) $\neg\neg\forall x : D.A(x) \to \forall x : D.\neg\neg A(x)$
where $D : \mathsf{U}$ and $A : D \to \mathsf{Prop}$. The converse of this rule need not hold. For D finite, the converse of (I5) holds constructively.

(I6) $\forall x{:}D.||A(x)|| \leftrightarrow ||\forall x{:}D.||A(x)||||$
where $D : \mathsf{U}$ and $A : D \to \mathsf{U}$.

(I7) $||\forall x : D.A(x)|| \to \forall x : D.||A(x)||$
where $D : \mathsf{U}$ and $A : D \to \mathsf{U}$. The converse of this rule need not hold. For D finite, the converse of (I7) holds constructively.

(I8) $(A \to ||B||) \leftrightarrow (||A|| \to ||B||)$, where $A, B : \mathsf{U}$.

(I9) $||A \to B|| \to (A \to ||B||)$, where $A, B : \mathsf{U}$.

Appendix B

$\mathcal{A}$-Reasoning and $\mathcal{E}$-Reasoning

A Belief and Knowledge

A.1 Belief operator (B)

$$\frac{Y_x \vdash A : \mathsf{Prop} \qquad Y_x \vdash a : \mathsf{ind}}{Y_x \vdash \mathsf{B}_a(A) : \mathsf{Prop},}\ \mathrm{F}_{\mathsf{B}} \qquad \frac{[\Gamma_a]_x \vdash p : A}{Y_x \vdash \mathsf{bl}(p) : \mathsf{B}_a(A),}\ \mathrm{I}_{\mathsf{B}}$$

$$\frac{Y_x \vdash p : \mathsf{B}_a(A) \qquad Y_x \vdash f : \mathsf{B}_a(A \to B)}{Y_x \vdash \omega(f, p) : \mathsf{B}_a(B),}\ \mathrm{E}_{\mathsf{B}}$$

$$\frac{[\Gamma_a]_x \vdash p : A \qquad [\Gamma_a]_x \vdash f : A \to B}{Y_x \vdash \omega(f, \mathsf{bl}(p)) = \mathsf{bl}(f(p)) : \mathsf{B}_a(B).}\ \mathrm{E}_{\mathsf{B}}$$

Let $Y_x = \Gamma_a : \mathsf{ctx}$, the belief operator B defined above is reminiscent of intuitionistic belief studied in Artemov and Protopopescu (2016).

A.2 *Knowing-that* (K)

$$\frac{\Gamma_a \vdash A : \mathsf{Prop} \qquad \Gamma_a \vdash p : \mathsf{R}(A) \qquad \Gamma_a \vdash a : \mathsf{ind}}{\Gamma_a \vdash \mathsf{K}_a(A, p) : \mathsf{Prop},}\ \mathrm{I}_{\mathsf{K}}$$

$$\frac{\Gamma_a \vdash p : \mathsf{R}(A)}{\Gamma_a \vdash \mathsf{pk}(p) : \mathsf{K}_a(A, p),}\ \mathrm{I}_{\mathsf{K}}$$

$$\frac{\Gamma_a \vdash q : \mathsf{K}_a(A, p) \qquad \Gamma_a \vdash f : \mathsf{R}(A) \to \mathsf{R}(B)}{\Gamma_a \vdash \upsilon(f, q) : \mathsf{K}_a(B, f(p)),}\ \mathrm{E}_{\mathsf{K}}$$

$$\frac{\Gamma_a \vdash p : \mathsf{R}(A) \qquad \Gamma_a \vdash f : \mathsf{R}(A) \to \mathsf{R}(B)}{\Gamma_a \vdash \upsilon(f, \mathsf{pk}(p)) = \mathsf{pk}(f(p)) : \mathsf{K}_a(B, f(p)),}\ \mathrm{C}_{\mathsf{K}}$$

A.3 *Knowing-wh* (**Kh**)

$$\frac{\Gamma_a \vdash f : \mathcal{E} \qquad \Gamma_a \vdash p : \mathsf{R}(\hat{\varsigma}(f)) \qquad \Gamma_a \vdash a : \mathsf{ind}}{\Gamma_a \vdash \mathsf{Kh}_a(f, p) : \mathsf{Prop},}\ \mathrm{F}_{\mathsf{Kh}}$$

$$\frac{\Gamma_a \vdash p : \mathsf{R}(\hat{\varsigma}(f)) \qquad \Gamma_a \vdash r : f\text{-}\mathsf{fans}(\pi_l(p))}{\Gamma_a \vdash \mathsf{ik}(p, r) : \mathsf{Kh}_a(f, p),}\ \mathrm{I}_{\mathsf{Kh}}$$

$$\frac{\begin{array}{l}\Gamma_a \vdash q : \mathsf{Kh}_a(f, p) \\ \Gamma_a \vdash h : \mathsf{R}(\hat{\varsigma}(f)) \to \mathsf{R}(\hat{\varsigma}(g)) \qquad \Gamma_a \vdash s : g\text{-}\mathsf{fans}(\pi_l(h(p)))\end{array}}{\Gamma_a \vdash \upsilon_h(h, q, s) : \mathsf{Kh}_a(g, h(p)),}\ \mathrm{E}_{\mathsf{Kh}}$$

$$\frac{\begin{array}{ll}\Gamma_a \vdash p : \mathsf{R}(\hat{\varsigma}(f)) & \Gamma_a \vdash r : f\text{-}\mathsf{fans}(\pi_l(p)) \\ \Gamma_a \vdash h : \mathsf{R}(\hat{\varsigma}(f)) \to \mathsf{R}(\hat{\varsigma}(g)) & \Gamma_a \vdash s : g\text{-}\mathsf{fans}(\pi_l(h(p)))\end{array}}{\Gamma_a \vdash \upsilon_h(h, \mathsf{ik}(p, r), s) = \mathsf{ik}(h(p), s) : \mathsf{Kh}_a(g, h(p)).}\ \mathrm{C}_{\mathsf{Kh}}$$

B Useful Rules

$$\mathsf{R}(A) \to A. \tag{RT}$$

$$(A \to B) \to (\mathsf{R}(A) \to \mathsf{R}(B)). \tag{RD}$$

$$\mathsf{B}_a\mathsf{B}_a(A) \to \mathsf{B}_a(A). \tag{BB}$$

$$\mathsf{B}_a(A \to B) \to \mathsf{B}_a(A) \to \mathsf{B}_a(B). \tag{DB}$$

$$f\text{-}\mathsf{fans}(A) \leftrightarrow (A \to \varsigma(f)). \tag{FA}$$

$$\forall p, q : \mathsf{R}(A).\mathsf{K}_a(A, p) \leftrightarrow \mathsf{K}_a(A, q). \tag{PK}$$

$$\forall p, q : \mathsf{R}(\hat{\varsigma}(f)).\mathsf{Kh}_a(f, p) \leftrightarrow \mathsf{Kh}_a(f, q). \tag{QK}$$

$$\forall f : \mathsf{R}(A) \to \mathsf{R}(B).(\mathsf{K}_a(A, p) \to \mathsf{K}_a(B, f(p))). \tag{DK$_1$}$$

$$\forall f : \mathsf{R}(\hat{\varsigma}(f)) \to \mathsf{R}(\hat{\varsigma}(g)).(\mathsf{Kh}_a(f,p) \to \mathsf{Kh}_a(g, f(p))). \tag{DK$_2$}$$

$$\forall x : \mathsf{R}(A).(\mathsf{K}_a(B, \mathsf{r}_0(x)) \to \mathsf{B}_a(B = \pi_l(x) \in \mathsf{Prop})). \tag{EQ}$$

$$\forall A, B : \mathsf{Prop}.(f\text{-}\mathsf{fans}(A) \to g\text{-}\mathsf{fans}(B) \to A \to B) \to \hat{\varsigma}(f) \to \hat{\varsigma}(g). \tag{FR$_1$}$$

$$\forall A, B : \mathsf{Prop}.(f\text{-}\mathsf{fans}(A) \to g\text{-}\mathsf{fans}(B) \to f\text{-}\mathsf{pans}(B)) \to \mathsf{G}_a(f) \to \mathsf{G}_a(g). \tag{FR$_2$}$$

$$\mathsf{Kh}_a(f,p) \to \exists x : \mathsf{R}(\hat{\varsigma}(f)).f\text{-}\mathsf{fans}(\pi_l(x)) \wedge \mathsf{K}_a(\pi_l(x), \mathsf{r}_0(x)). \tag{QA}$$

$$\forall x : \mathsf{R}(\hat{\varsigma}(f)).(f\text{-}\mathsf{fans}(\pi_l(x)) \to \mathsf{K}_a(\pi_l(x), \mathsf{r}_0(x)) \to \mathsf{Kh}_a(f, x)). \tag{AQ}$$

$$\forall x : \mathsf{R}(\hat{\varsigma}(f)).(\mathsf{Kh}_a(f,x) \to \mathsf{B}_a(f\text{-}\mathsf{fans}(\pi_l(x))) \to \Sigma y : \varsigma(f).\mathsf{K}_a(\vartheta(f,y), \mathsf{r}_0(x))). \tag{CA}$$

C Assertional Reasoning

C.1 Conjunction (∧)

$$\frac{\Gamma \vdash A \text{ true} \qquad \Gamma \vdash B \text{ true}}{\Gamma \vdash A \wedge B \text{ true},}\ \mathrm{I}_{\wedge}$$

$$\frac{\Gamma \vdash A \wedge B \text{ true}}{\Gamma \vdash A \text{ true},}\ \mathrm{E}_{l\wedge} \qquad \frac{\Gamma \vdash A \wedge B \text{ true}}{\Gamma \vdash B \text{ true}.}\ \mathrm{E}_{r\wedge}$$

C.2 Implication (→)

$$\frac{\Gamma, A \text{ true} \vdash B \text{ true}}{\Gamma \vdash A \to B \text{ true},}\ \mathrm{I}_{\to}$$

$$\frac{\Gamma \vdash A \to B \text{ true} \qquad \Gamma \vdash A \text{ true}}{\Gamma \vdash B \text{ true}.}\ \mathrm{E}_{\to}$$

C.3 Disjunction (∨)

$$\frac{\Gamma \vdash A \text{ true}}{\Gamma \vdash A \vee B \text{ true},}\ \mathrm{I}_{l\vee} \qquad \frac{\Gamma \vdash B\text{true}}{\Gamma \vdash A \vee B \text{ true},}\ \mathrm{I}_{r\vee}$$

$$\frac{\Gamma \vdash A \to C \ \textsf{true} \qquad \Gamma \vdash B \to C \ \textsf{true} \qquad \Gamma \vdash A \vee B \ \textsf{true}}{\Gamma \vdash C \ \textsf{true}.} \ \mathrm{E}_{\vee}$$

C.4 Universal quantification ($\forall$)

$$\frac{\Gamma, x : A \vdash B(x) \ \textsf{true}}{\Gamma \vdash \forall x : A.B(x) \ \textsf{true},} \ \mathrm{I}_{\forall}$$

$$\frac{\Gamma \vdash \forall x : A.B(x) \ \textsf{true} \qquad \Gamma \vdash a : A}{\Gamma \vdash B(a) \ \textsf{true}.} \ \mathrm{E}_{\forall}$$

C.5 Existential quantification ($\exists$)

$$\frac{\Gamma \vdash a : A \qquad \Gamma \vdash B(a) \ \textsf{true}}{\Gamma \vdash \exists x : A.B(x) \ \textsf{true},} \ \mathrm{I}_{\exists}$$

$$\frac{\Gamma \vdash \exists x : A.B(x) \ \textsf{true} \qquad \Gamma, x : A, B(x) \ \textsf{true} \vdash C \ \textsf{true}}{\Gamma \vdash C \ \textsf{true}.} \ \mathrm{E}_{\exists}$$

D Erotetic Reasoning

D.1 Question resolution

- **Notation**:

  - $\Gamma_a \vdash a : A \cdots J$ denotes that $\Gamma_a \vdash a : A$ is labeled by J.
  - $\alpha := \Delta_b \vdash \mathsf{K}_b(p, r)$ true.
  - $\beta := \begin{bmatrix} [\Delta_b]_a & \vdash \forall x : \mathsf{R}(\hat{\varsigma}(f)).\forall y : (\mathsf{Kh}_b(f, x) \wedge \mathsf{B}_b(f\text{-}\mathsf{fans}(\pi_l(x)))). \\ & \mathsf{K}_b(\vartheta(f, \pi_l(@_i(x, y))), \mathsf{r}_0(x)) \ \textsf{true} \\ \Gamma_a & \vdash \mathsf{K}_a(\hat{\varsigma}(f), p) \wedge \mathsf{K}_a(\mathsf{G}_a(f), q) \ \textsf{true} \end{bmatrix}.$

The derivation for question resolution is divided into three phases:

- **Phase 1**.

$$
\dfrac{\dfrac{\dfrac{\alpha}{[\Delta_b]_a \vdash \mathsf{K}_b(p,r)\ \mathsf{true}}\ \text{SUBS}_2}{[\Delta_b]_a \vdash r : \mathsf{R}(p)}\ \text{PS}
\qquad
\dfrac{\dfrac{\dfrac{\dfrac{\Delta_b \vdash f\text{-}\mathsf{fans}(p)\ \mathsf{true}}{[\Delta_b]_a \vdash f\text{-}\mathsf{fans}(p)\ \mathsf{true} \cdots J_1}\ \text{SUBS}_2}{[\Delta_b]_a \vdash p \to \varsigma(f)\ \mathsf{true}}\ \text{FA,E}_{\to}}{[\Delta_b]_a \vdash p \to \hat{\varsigma}(f)\ \mathsf{true}}\ \text{I3,I8,E}_{\to}}{[\Delta_b]_a \vdash @_j : p \to \hat{\varsigma}(f)}\ @}
{\dfrac{[\Delta_b]_a \vdash (p,(@_j,r)) : \mathsf{R}(\hat{\varsigma}(f)) \cdots J_2 \qquad J_1}{[\Delta_b]_a \vdash \mathsf{Kh}_a(f,(p,(@_j,r)))\ \mathsf{true} \cdots J_3}\ \text{I}_{\mathsf{Kh}}}\ \text{RD,E}_{\to}
$$

- **Phase 2**.

$$
\dfrac{\dfrac{\dfrac{\dfrac{J_1}{[\Delta_b]_a \vdash \mathsf{B}_b(f\text{-}\mathsf{fans}(p))\ \mathsf{true}}\ \text{I}_{\mathsf{B}} \qquad J_3}{[\Delta_b]_a \vdash \mathsf{Kh}_a(f,(p,(@_j,r))) \wedge \mathsf{B}_b(f\text{-}\mathsf{fans}(p))\ \mathsf{true}}\ \text{I}_{\wedge}}{[\Delta_b]_a \vdash @_k : \mathsf{Kh}_a(f,(p,(@_j,r))) \wedge \mathsf{B}_b(f\text{-}\mathsf{fans}(p))}\ @
\qquad \dfrac{\beta}{\mu_1(\beta)}\ \mu_1 \qquad J_2}
{[\Delta_b]_a \vdash \mathsf{B}_a\mathsf{K}_a(\vartheta(f,\pi_l(@_i((p,(@_i,r)),@_k))),\mathsf{r}_0((p,(@_j,r))))\ \mathsf{true} \cdots J_4}\ \text{E}_{\forall}
$$

- **Phase 3**.

$$
\dfrac{\dfrac{\dfrac{J_2 \qquad J_4}{[\Delta_b]_a \vdash \mathsf{B}_a(\vartheta(f,\pi_l(@_i((p,(@_i,r)),@_k))) = p \in \mathsf{Prop})\ \mathsf{true}}\ \text{EQ,E}_{\to} \qquad J_4}{[\Delta_b]_a \vdash \mathsf{K}_b(p,r)\ \mathsf{true}}\ \text{RP}}{\Gamma_a \vdash \mathsf{B}_b\mathsf{K}_b(p,r)\ \mathsf{true}}\ \text{I}_{\mathsf{B}}
$$

D.2 Question implication

- **Notation**:
  - $\Gamma_a \vdash a : A \cdots J$ denotes that $\Gamma_a \vdash a : A$ is labeled by J.
  - $\alpha := \Gamma_a \vdash \mathsf{K}_a(u,w)\ \mathsf{true}$.
  - $\rho := \begin{bmatrix} [\Delta_b]_a & \vdash \forall x : \mathsf{R}(\hat{\varsigma}(f)).\forall y : (\mathsf{Kh}_b(f,x) \wedge \mathsf{B}_b(f\text{-}\mathsf{fans}(\pi_l(x)))). \\ & \quad \mathsf{K}_b(\vartheta(f,\pi_l(@_i(x,y))),\mathsf{r}_0(x))\ \mathsf{true} \\ \Gamma_a & \vdash \mathsf{K}_a(\hat{\varsigma}(f),p) \wedge \mathsf{K}_a(\mathsf{G}_a(f),q)\ \mathsf{true} \end{bmatrix}.$

– $\beta := \begin{bmatrix} [\Delta_b]_a & \vdash \forall x : \mathsf{R}(\hat{\varsigma}(g)).\forall y : (\mathsf{Kh}_b(g,x) \wedge \mathsf{B}_b(g\text{-}\mathsf{fans}(\pi_l(x)))). \\ & \quad \mathsf{K}_b(\vartheta(g, \pi_l(@_i(x,y))), \mathsf{r}_0(x))\ \mathsf{true} \\ \Gamma_a & \vdash \mathsf{K}_a(\hat{\varsigma}(g), r) \wedge \mathsf{K}_a(\mathsf{G}_a(g), s)\ \mathsf{true} \end{bmatrix}$.

– $P := \forall A, B : \mathsf{Prop}.(p\text{-}\mathsf{fans}(A) \to f\text{-}\mathsf{fans}(B) \to ((A \to B) \wedge p\text{-}\mathsf{pans}(B)).$

– $Q := \forall A, B : \mathsf{Prop}.(p\text{-}\mathsf{fans}(A) \to f\text{-}\mathsf{fans}(B) \to (A \to B).$

– $R := \forall A, B : \mathsf{Prop}.(p\text{-}\mathsf{fans}(A) \to f\text{-}\mathsf{fans}(B) \to p\text{-}\mathsf{pans}(B).$

– $S := \forall x : \mathsf{R}(\hat{\varsigma}(g)).\forall y : (\mathsf{B}_b\mathsf{Kh}_b(g,x) \wedge \mathsf{B}_b(g\text{-}\mathsf{fans}(\pi_l(x)))). \mathsf{K}_b(\vartheta(g, \pi_l(@_i(x,y))), \mathsf{r}_0(x)).$

The derivation for question implication is divided into three phases:

- **Phase 1**.

$$\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\alpha}{\Gamma_a \vdash w : \mathsf{R}(u)}\,\text{PS}}{\Gamma_a \vdash u\ \mathsf{true}}\,\text{RT,E}_\to \qquad \Gamma_a \vdash u \to P\ \mathsf{true}}{\Gamma_a \vdash P\ \mathsf{true} \cdots J_1}\,\text{E}_\to}{\Gamma_a \vdash Q\ \mathsf{true}}\,\text{I2, E}_\wedge}{\Gamma_a \vdash \hat{\varsigma}(f) \to \hat{\varsigma}(g)\ \mathsf{true}}\,\text{FR}_1\text{,E}_\to}{\Gamma_a \vdash \mathsf{R}(\hat{\varsigma}(f)) \to \mathsf{R}(\hat{\varsigma}(g))\ \mathsf{true}}\,\text{RD,E}_\to}{\Gamma_a \vdash @_j : \mathsf{R}(\hat{\varsigma}(f)) \to \mathsf{R}(\hat{\varsigma}(g))}\,@ \qquad \dfrac{\dfrac{\rho}{\mu_2(\rho)}\,\mu_2}{\Gamma_a \vdash \mathsf{K}_a(\hat{\varsigma}(f), p)\ \mathsf{true}}\,\text{E}_{l\wedge}}{\Gamma_a \vdash \mathsf{K}_a(\hat{\varsigma}(g), @_j(p))\ \mathsf{true} \cdots J_2}\,\text{E}_{\mathsf{K}}$$

- **Phase 2**.

$$\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{J_1}{\Gamma_a \vdash R\ \mathsf{true}}\,\text{I2,E}_\wedge}{\Gamma_a \vdash \mathsf{G}_a(f) \to \mathsf{G}_a(g)\ \mathsf{true}}\,\text{FR}_2\text{,E}_\to}{\Gamma_a \vdash \mathsf{R}(\mathsf{G}_a(f)) \to \mathsf{R}(\mathsf{G}_a(g))\ \mathsf{true}}\,\text{RD,E}_\to}{\Gamma_a \vdash @_k : \mathsf{R}(\mathsf{G}_a(f)) \to \mathsf{R}(\mathsf{G}_a(g))}\,@ \qquad \dfrac{\dfrac{\rho}{\mu_2(\rho)}\,\mu_2}{\Gamma_a \vdash \mathsf{K}_a(\mathsf{G}_a(f), q)\ \mathsf{true}}\,\text{E}_{r\wedge}}{\Gamma_a \vdash \mathsf{K}_a(\mathsf{G}_a(g), @_k(q))\ \mathsf{true}}\,\text{E}_{\mathsf{K}} \qquad J_2}{\Gamma_a \vdash \mathsf{K}_a(\hat{\varsigma}(g), @_j(p)) \wedge \mathsf{K}_a(\mathsf{G}_a(g), @_k(q))\ \mathsf{true} \cdots J_3}\,\text{I}_\wedge$$

- **Phase 3**.

$$\dfrac{\dfrac{J_3 \quad \begin{array}{c}\Gamma_a \vdash @_j(p) = r : \mathsf{R}(\hat{\varsigma}(g)) \\ \Gamma_a \vdash @_k(q) = s : \mathsf{R}(\mathsf{G}_a(g))\end{array}}{\Gamma_a \vdash \mathsf{K}_a(\hat{\varsigma}(g), r) \wedge \mathsf{K}_a(\mathsf{G}_a(g), s) \ \mathsf{true}}\ \text{RP} \qquad \dfrac{[\Delta_b]_a \vdash g : \mathcal{E}}{[\Delta_b]_a \vdash S \ \mathsf{true}}\ \text{CA},@}{\beta}\ [\,]$$

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