

# Combined discourse representations: Coherence relations and questions under discussion

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## Abstract

We analyze a text according to three different discourse theories; CCR, RST and QUD trees. We discuss differences with respect to segmentation and show how coherence relations can be mapped onto a discourse representation based on questions under discussion.

## 1 Introduction

The term *discourse structure* comprises issues relating to the organization and coherence of written or spoken, monologic or multi-speaker discourse. The central, recurring problems related to discourse-structure analysis involve (i) *discourse segmentation*, i.e. the rules that determine which spans of a text form elementary, independent discourse units, (ii) *attachment*, i.e. the question which units are (recursively) grouped together, thereby forming paragraphs and sections, and (iii) the *choice of discourse relations*: how many should be assumed, are they reducible to a set of abstract features?

In this paper, we will address the first and also, partly, the second problem, drawing on three different analyses of the same piece of discourse, within the Cognitive approach to Coherence Relations (CCR), Rhetorical Structure Theory (RST) and Question under Discussion (QUD) trees, briefly introduced in Section 2.<sup>1</sup> Specifically, we will be concerned with the following issues:

1. In Section 3 we discuss whether there are different levels of detail with regard to discourse segmentation. According to what rules are discourse units determined in different frameworks?
2. In Section 4 we compare analyses based on coherence relations (CCR, RST) with an ap-

<sup>1</sup>Other important frameworks, not addressed in this short paper, include SDRT (Asher and Lascarides, 2003) and PDTB (Prasad et al., 2008).

proach that uses questions under discussion. Is the question-answer relation simply a type of coherence relation? Can all relations be represented by means of questions? Can the different tree structures be mapped onto each other?

## 2 Some frameworks for discourse structure

### 2.1 RST

Rhetorical Structure Theory (RST: Mann and Thompson, 1988; Taboada and Mann, 2006) is a framework which postulates that discourse can be analyzed in the form of tree structures whose terminal elements are so called *elementary discourse units*. These units are recursively connected by coherence relations. Stede et al. (2017) list 31 RST relations. Most of these relations will subordinate one discourse unit (the satellite) to a second one (the nucleus), indicating that the nucleus is more important. Other relations are multinuclear and therefore coordinating.

### 2.2 CCR

The Cognitive approach to Coherence Relations (CCR: Sanders et al., 1992, see Hoek et al., 2019 for an up-to-date version) is a taxonomy of discourse relations that uses cognitively relevant primitives to describe the type of relation that holds between discourse segments. It defines discourse relations as the meaning ‘surplus’ compared to the meaning of the discourse segments in isolation. While CCR is most commonly used to depict relations between individual discourse segments, the approach is compatible with depicting the hierarchical structure of an entire text (e.g., Sanders and Spooren, 2009). Since CCR, unlike RST, does not include a nuclearity principle, an entire relation is related to the rest of the text in the hierarchical

discourse structure and attachment points are symmetrically located between two segments (similar to multinuclear relations in RST).

### 2.3 QUD trees

The QUD tree approach (Reyle and Riester, 2016; Riester et al., 2018; Riester, 2019) allows for a simultaneous analysis of the information structure and discourse structure of a text. The framework is based on the assumption that every assertion of a discourse (more precisely, its focus) is the answer to a typically implicit *question under discussion* (QUD: van Kuppevelt, 1995; Roberts, 2012). Inter-annotator agreement has been studied in De Kuthy et al. (2018). QUDs are hierarchically ordered, mirroring the topical organization of a discourse. As a result, QUDs are the non-terminal nodes of a tree structure, while all non-interrogative discourse segments are interpreted as complete or partial answers to their respective parent QUD node. The reconstruction of QUDs follows common principles of information structure theory (Rooth, 1992; Schwarzschild, 1999; Büring, 2016).

## 3 Discourse segmentation

### 3.1 Labeling conventions

In this section we discuss discourse segmentation in the different frameworks.<sup>2</sup> Examples are taken from a section of Barack Obama’s famous keynote address at the Democratic National Convention, Boston, July 27, 2004.<sup>3</sup> In order to allow for cross-referencing despite different segmentations, we adopt the following conventions: since both the CCR and RST analyses identified the same 31 segments, we took those as a basis. Whenever the segmentation turned out more granular in the QUD analysis (47 segments in total), sub-labels (1a, 1b, ...) were assigned, thereby indicating the segmentation differences between the approaches. Discourse relations translated into questions inherit all its immediate children indexes (Q25-29). QUDs as usual only inherit the indexes of their assertion children nodes (Q25a,27). The latter raises an exception in parallel structures where the super-question inherit the indexes of its sub-question children nodes (e.g. Q14,15,16). Since all questions

<sup>2</sup>For the complete RST, CCR and QUD annotations, check [http://bit.ly/osf\\_RST\\_QUD\\_CCR](http://bit.ly/osf_RST_QUD_CCR). For an interactive QUD analysis enhanced with discourse relations, see [http://bit.ly/ObamaQUD\\_RST\\_0-6](http://bit.ly/ObamaQUD_RST_0-6).

<sup>3</sup>[http://bit.ly/Obama\\_Keynote](http://bit.ly/Obama_Keynote)

of our sample discourse are implicit (i.e. reconstructed), no labeling conflicts arise.

### 3.2 Discourse segmentation in RST / CCR

Both RST and CCR take clauses as the basis for identifying discourse segments (see e.g., Stede et al., 2017 for RST and Hoek et al., 2017 for CCR). Exceptions to the clause-as-segment guideline apply, for instance, when a clause connects not to another clause, but to a noun phrase (e.g., some relative clauses), or when a clause does not relate to a complete other clause (e.g., clausal subjects). A discourse relation holds between a segment and another segment (e.g., 2 and 3 in Figure 1) or a group of segments (a complex tree node); for instance, segment 4 with segments 2 and 3. The hierarchical structure of an entire text includes all discourse segments.

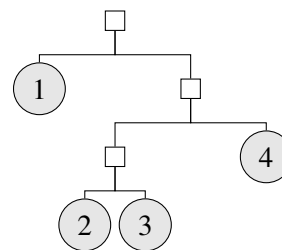


Figure 1: Sample CCR discourse tree

### 3.3 Discourse segmentation based on QUDs

Discourse segmentation in the QUD tree approach generally follows similar rules as in the aforementioned frameworks; in particular, it shares RST’s and CCR’s assumption that discourse segments are clauses or sentences, and that adjunct/complement but not argument clauses may form independent segments. However, the problem of segmentation is rephrased in terms of which chunks (not only main and adjunct clauses but also simpler adjuncts) can function as answers to an independent QUD. For instance, the complex sentence in (1) receives the QUD-structural representation in (2),<sup>4</sup> which is homomorphic to the tree in Figure 2.

- (1) [They would give me an African name, Barack, or “blessed”.]<sub>25</sub>

<sup>4</sup>Information structure labels: CT: contrastive topic, F: focus, NAI: non-at-issue material, T: (non-contrastive) topic

- (2) Q<sub>25a</sub>: {What would Obama’s parents do with him?}
- > A<sub>25a</sub>: [They]<sub>T</sub> would [give]<sub>F</sub> [me]<sub>T</sub> [an African name]<sub>F</sub>,
- > Q<sub>25b</sub>: {What name would they give to him?}
- >> A<sub>25b</sub>: [Barack,]<sub>F</sub>
- >> Q<sub>25c</sub>: {What does *Barack* mean?}
- >>> A<sub>25c</sub>: or [“blessed”]<sub>F</sub>.

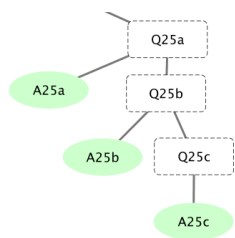


Figure 2: QUD tree for (2), with fine-grained segments

Example (2) shows that sentence [25] is divided into a main (or at-issue) discourse unit A<sub>25a</sub>, whose denotation provides an answer to Q<sub>25a</sub>, and two short (appositive, or non-at-issue) units, which do not answer Q<sub>25a</sub> but instead the subquestions Q<sub>25b</sub> and Q<sub>25c</sub>. Another area in which the QUD-tree framework systematically requires a sub-clausal segmentation are NP- or VP-level coordinations, compare (3), analyzed as in (4).<sup>5</sup>

- (3) [His father, my grandfather, was a cook, a domestic servant to the British]<sub>7</sub>
- (4) Q<sub>7,8</sub>: {What about Obama’s paternal grandfather?}
- > A<sub>7a</sub>: [His father,]<sub>T</sub> [my grandfather,]<sub>NAI</sub> was [a cook,]<sub>F</sub>
- > A<sub>7b</sub>: [a domestic servant to the British]<sub>F</sub>.

In the cases discussed, segmentation is motivated by information structure: every phrase containing a (contrastive) focus counts as a separate information unit, hence a discourse segment. Though these segments are smaller than discourse relation approaches generally allow, the link between these sub-clausal units can be captured by coherence relation labels such as ELABORATION (A<sub>25a</sub>-A<sub>25b</sub>), followed by a RESTATEMENT (A<sub>25b</sub>-A<sub>25c</sub>) in (2), and a LIST (A<sub>7a</sub>-A<sub>7b</sub>) in (4).

Informational backgrounding can occasionally

<sup>5</sup>So far we ignore the likewise independent status of the clause-internal apposition *my grandfather* in A<sub>7a</sub>, but see related comments in Riester, 2019, 180 ff.

also lead to the situation where adjunct clauses that are separate units according to CCR and RST – and are part of a, respectively, POSITIVE TEMPORAL SYNCHRONOUS and a CIRCUMSTANCE relation in Example (5) – are not separated from their matrix clause in the corresponding QUD analysis in (6). Since in (5), the information that the father studied *here* (i.e. in the US) is given information – thus, a non-informative statement – it is a non-autonomous part of the question background of Q<sub>10,11</sub>.

- (5) [While studying here,]<sub>10</sub> [my father met my mother.]<sub>11</sub>
- (6) Q<sub>10,11</sub>: {What happened to Obama’s father while he was studying in America?}
- > A<sub>10,11</sub>: While studying [here,]<sub>T</sub> [my father]<sub>T</sub> [met my mother]<sub>F</sub>.

## 4 Mapping coherence relations onto QUD tree representations

In this section, we discuss cases that show how discourse relations can be integrated into QUD representations. Because of space limitations, only a few examples are shown. We discuss subordinating and coordinating relations separately. CCR does not make this distinction, so both solutions in Sections 4.1 and 4.2 could be applied to CCR trees.

### 4.1 Subordinating (hypotactic) relations

Subordinating discourse relations typically correspond to likewise subordinated (and typically anaphoric) QUDs; see the example of a REASON relation in Figure 3, which directly translates into the *why*-question in (7).

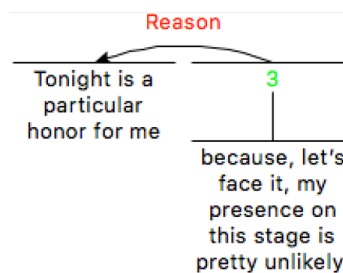


Figure 3: RST representation of subordinating relation

- (7) A<sub>2</sub>: Tonight is a particular honor for me  
 Q<sub>3</sub>: {Why is it a particular honor for Obama to speak on this stage?}  
 > A<sub>3</sub>: because, [let's face it,]<sub>NAI</sub> [my presence on this stage]<sub>T</sub> [is pretty unlikely]<sub>F</sub>.

Since the QUD tree approach is mainly concerned with the identification of information structural patterns, like topical continuity or contrastive parallelism, it can miss certain relations, like the concessive relation between sentences A<sub>7a,b</sub> and A<sub>8</sub> in Example (8). To capture the relation and represent its subordinating (RST) nature, we introduce an additional subquestion node Q<sub>8</sub>: *What did the grandfather want for his son, despite being a servant?*, corresponding to the missing CONCESSION, see A versus B in Figure 4. We represent the relation as a link between the two question nodes.

- (8) Q<sub>7,8</sub>: {What about Obama's paternal grandfather?}  
 > A<sub>7a</sub>: [His father,]<sub>T</sub> [my grandfather,]<sub>NAI</sub> was [a cook,]<sub>F</sub>  
 > A<sub>7b</sub>: [a domestic servant to the British]<sub>F</sub>.  
 > A<sub>8</sub>: But [my grandfather]<sub>T</sub> [had larger dreams]<sub>F</sub> for [his son]<sub>T</sub>.

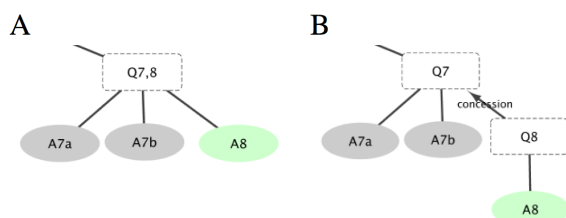


Figure 4: Inserting a subordinating discourse relation into a QUD tree

## 4.2 Coordinating (paratactic) relations

Coordinating RST relations, such as LIST, JOINT, DISJUNCTION or CONJUNCTION, are also easily translated into QUD structures: a QUD node dominates all coordinated segments, which are, in turn, interpreted as denoting partial answers to the QUD. In order to account for the slightly more complex meaning expressed by (adversative) CONTRAST or (temporal) SEQUENCE, we make use of subquestions and contrastive topics, as proposed by Büring (2003), Riester et al. (2018, 422ff.). For example,

the RST SEQUENCE in Figure 5 corresponds to the original QUD analysis in (9) below.

- (9) Q<sub>14,15,16</sub>: {What did the grandfather do after the Pearl Harbor attack?}  
 > Q<sub>14</sub>: {What did the grandfather do on the (exact) day after Pearl Harbor?}  
 >> A<sub>14</sub>: [The day after Pearl Harbor]<sub>CT</sub> [my grandfather]<sub>T</sub> [signed up for duty,]<sub>F</sub>  
 > A<sub>15</sub>: [joined Patton's army,]<sub>F</sub>  
 > A<sub>16</sub>: [marched across Europe]<sub>F</sub>

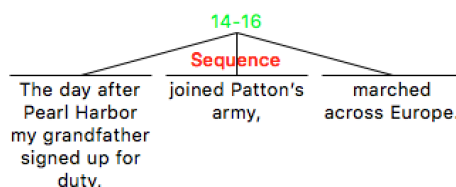


Figure 5: Example of a RST paratactic relation

For economic considerations, the analysis in (9) only contains a subquestion Q<sub>14</sub> for the segment which contains an explicit temporal contrastive topic (*the day after Pearl Harbor*). This results in a representation which is not yet entirely parallel. It is, however, permitted to add more subquestions that make the temporal background of each segment explicit. Each event takes place at its own topic time (cf. von Stutterheim and Klein, 1989; Klein, 1992), even if this is not always overtly expressed by an adverbial. The only caveat in this context is that the additional subquestions, in this case questions like Q<sub>15</sub>: *What did the grandfather do then (at t<sub>15</sub>)?*, should not introduce any more specific information than their respective answers. The augmented representation corresponding to Figure 5 is shown in Figure 6.

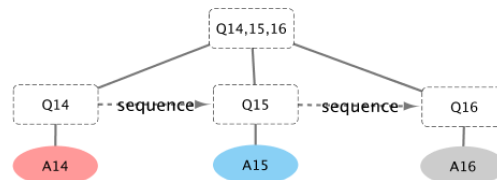


Figure 6: SEQUENCE relation expressed as a QUD tree

## 5 Conclusions

Analysing a discourse from different theoretical angles can bring many benefits. In our case, CCR

and RST analyses, which capture discourse relations, are augmented with QUDs and information structure. The QUD approach also offers a more fine-grained but nevertheless pragmatically motivated discourse segmentation, which we intend to examine more closely in future work. On the other hand, by integrating discourse relations into QUD tree analyses, we can expect to improve and solidify the resulting discourse structures. The QUD tree framework generally allows for the introduction of additional, and potentially more specific, QUDs, which, of course, has an impact on (the representation of) discourse structure itself. By considering coherence relations, we may expect the introduction of these additional questions, as well as their wording, to become more principled.

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