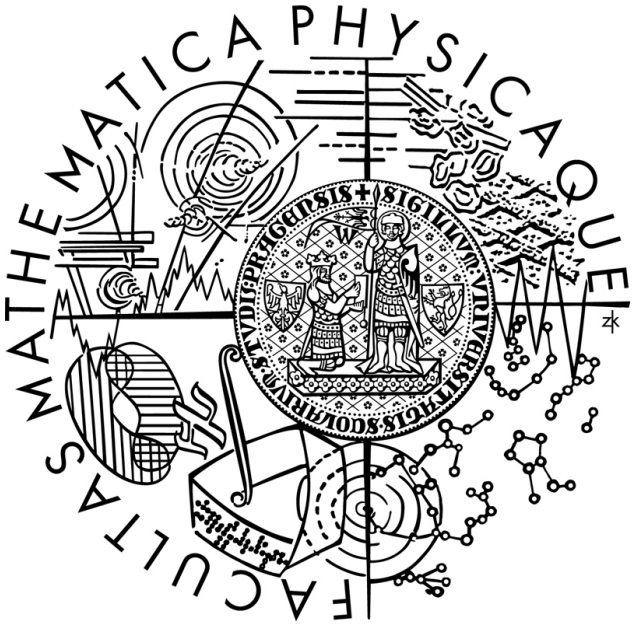
Univerzita Karlova v Praze

Matematicko-fyzikální fakulta

DIPLOMOVÁ PRÁCE



Václav Novák

Logical Representation of Language Structures

Ústav formální a aplikované lingvistiky

Vedoucí diplomové práce: Doc. RNDr. Jan Hajič, Dr.

Studijní program: Informatika, formální a počítačová lingvistika

I thank the following people for their contribution to this effort:

- Jan Hajič for offering the theme for this thesis, for his ideas about what the representation should fulfill and for the substantial support.
- Geert-Jan Kruijff for explaining some aspects of the hybrid logic and providing his own representation of several comparative sentences from chapter 8.
- Jaroslav Peregrin for providing me with some materials about modal logic and semantics of TFA and for consultations about the modal logic.

Prohlašuji, že jsem svou diplomovou práci napsal samostatně a výhradně s použitím citovaných pramenů. Souhlasím se zapůjčováním práce.

V Praze 16. dubna 2004 Václav Novák

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Abstrakt:

Tato diplomová práce má být základem pro manuál sémantické anotace, která bude zachycovat logickou strukturu psaných i mluvených textů v přirozeném jazyce. Logická reprezentace, jakož i pravidla pro její vytváření, jsou jazykově nezávislé. Práce vychází z temporální logiky Marka Steedmana a formálním jazykem je hybridní multimodální logika podle Patricka Blackburna. Inspiruje se Dependency Grammar Logic Geert-Jana Kruijffa, ovšem místo roviny jazykového významu zachycuje rovinu významu logického – obsahu. Základními problémy řešenými v této práci jsou segmentace vstupního textu do logických jednotek, zachycení referentů v diskurzu, reprezentace časoprostoru, vliv aktuálního členění na logický obsah a sémantické kategorie potřebné pro anotaci. Závěr tvoří příklad anotovaného diskurzu a anotace 37 testovacích vět Jana Hajiče.
Klíčová slova: hybridní logika DRT TFA obsah

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Abstract:

This thesis is meant as a basis for a semantic annotation manual. The annotation will translate the logical structure of written and spoken speech by a language-independent manner. The basis for this thesis can be found in temporal logic of Mark Steedman and the formalism introduced here elaborates on Patrick Blackburn's hybrid multimodal logic and Dependency Grammar Logic of Geert-Jan Kruijff, although it represents not the level of linguistic meaning but rather the level of logical meaning (content). The main issues discussed in this thesis are input text segmentation into logical units, discourse referents representation, time-spatial representation, the impact of topic-focus articulation on the logical content and the semantic categories needed for the annotation. In the last two chapters a complete discourse example and the annotation of 37 test cases of Jan Hajič are presented.
Keywords: hybrid logic DRT TFA content

Preface

This thesis is intended to serve as a basis for a manual for logical annotation of the content of utterances and texts in natural language. This difficult and complex task requires from the annotator to understand the text he or she annotates. The representation may seem similar to the tectogrammatical representation as described in Sgall, Hajičová and Panevová [20] and many modalities used in this formalism (described in chapter 6) come from node attributes and functors as specified in Panevová, Hajičová and Sgall [13]. Nevertheless, this approach has several substantial differences from the Prague Dependency Treebank described in Hajič et al. [6]. The annotation described in this work is an annotation of another level. It tries to depart from linguistic meaning and to annotate the import to the ontological reality behind the words and propositions. Since this task seems impossible in a direct manner (for instance, what should be the ontological representation of the verb *to shave*?), we must remain in the domain of words but on the other hand to take advantage of the understanding peculiar to the annotator and connect the content of an utterance with the knowledge of the world represented by the preceding discourse. On the other hand the logical representation should be language-independent. That's why we must distinguish different meanings of words – we always assign a 'meaning index' when using a word.

We will try to build a kind of 'semantic network' that will reflect the relationships between objects, events and propositions introduced in the text. Such a network should be an instantiation of Saussure's [19] idea that the content of a word is being delimited only by contents of other words and there can be no content of a language unit as such. This very property of language seems to deny any ontological annotation but still we will try to capture at least some spatial and temporal properties and various references, either direct or indirect.

In all cases the annotator should follow the content of the sentence. The syntax should help to draw a structure but it should never become the main measure of what is the right annotation, because as Karcevskij [8] notes, "the forms and the functions substantially slide over the slope of the reality.

Each of them exceeds the frame determined by its partner." In this thesis I don't describe the relationship between the semantic annotation and the syntax. Further inquiry can possibly find some interesting relations, but first we will need the annotation to be able to build a system that could learn the transformation "text → logical representation". The final ambition of the annotation should be that two texts expressing the same content will receive the same annotation.

The annotator should at first become familiar with the syntax and semantics of hybrid logic introduced in chapter 1. Then he or she can look at the examples in chapters 7 and 8 and find there the problems described in this thesis solved (or, at least, demonstrated). There is an hypertext version of this document available on the Internet[1], where the reader can easily switch between the examples and the theoretical chapters.

Note the conventions in this text:

Nominals are written as j, j_1^2, *volitive*.

Propositional symbols are written sans serif as John_1, be_1, tall.

Modal labels look like: ACTOR, PATIENT, WHERE, EVENTMOD.

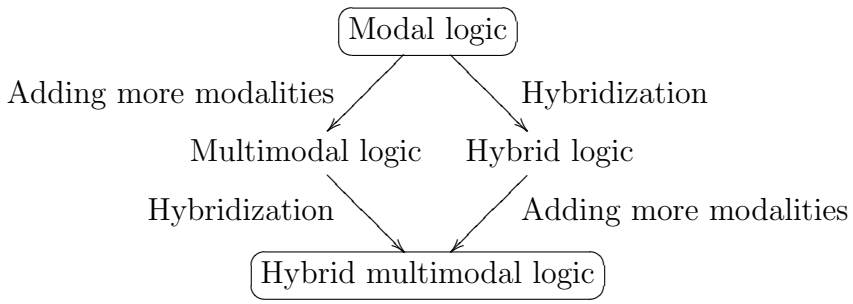
[1] http://www.matfyz.cz/vaklav/dipl/diplvn.pdf.gz

Chapter 1

Introduction to hybrid logic

The multimodal hybrid logic is the base for the approach presented in this thesis. Therefore I will briefly present modal logic as the kernel of hybrid logic, then I will discuss the multimodal logic, which is a natural extension of modal logic. In the third section we will hybridize the modal logic and in the last section I will show how to extend the hybrid logic to the multimodal hybrid logic in the same fashion as the modal logic was multimodalized. Readers familiar with multimodal and hybrid logics can skip to the section 1.4.

The evolution of logic was simultaneous in two directions. Here at first I add some more modal labels and then hybridize, but the other way works as well:



1.1 Modal logic

Definitions in this section are adapted from Blackburn [5].

1.1.1 Syntax

Let's first define the syntax of basic (propositional) modal logic.

Definition 1 (Formula of modal logic) *Given a set of* propositional symbols $PROP = \{\mathsf{p}, \mathsf{q}, \mathsf{p}', \mathsf{q}', \ldots\}$*, the set of well-formed formulas of the* basic propositional modal language *(over $PROP$) is defined to be:*

$$WFF := \mathsf{p} \mid \neg\phi \mid \phi \wedge \psi \mid \phi \vee \psi \mid \phi \rightarrow \psi \mid \Diamond\phi \mid \Box\phi, \tag{1.1}$$

for all $\mathsf{p} \in PROP$ and $\phi, \psi \in WFF$.

1.1.2 Semantics

The basic modal language is **interpreted** on *models*. A model $\mathfrak{M}$ (for a fixed choice of $PROP$) is a triple (W, R, V). Here W is a non-empty set of **states** and R is a *binary* relation on W. The pair (W, R) is called the **frame** underlying $\mathfrak{M}$, and $\mathfrak{M}$ is said to be a model based on this frame. V (the **valuation**) is a function with domain $PROP$ and range $Pow(W)$; it tells us at which states each propositional symbol is true. Interpretation is carried out as follows:

Definition 2 (Semantics of modal logic) *Let $\mathfrak{M} = (W, R, V)$ and $w \in W$. Then:*

$$\begin{array}{lll}
\mathfrak{M}, w \models \mathsf{p} & \text{iff} & w \in V(\mathsf{p}), \textit{where } \mathsf{p} \in PROP \\
\mathfrak{M}, w \models \neg\phi & \text{iff} & \mathfrak{M}, w \not\models \phi \\
\mathfrak{M}, w \models \phi \wedge \psi & \text{iff} & \mathfrak{M}, w \models \phi \textit{ and } \mathfrak{M}, w \models \psi \\
\mathfrak{M}, w \models \phi \vee \psi & \text{iff} & \mathfrak{M}, w \models \phi \textit{ or } \mathfrak{M}, w \models \psi \\
\mathfrak{M}, w \models \phi \rightarrow \psi & \text{iff} & \mathfrak{M}, w \not\models \phi \textit{ or } \mathfrak{M}, w \models \psi \\
\mathfrak{M}, w \models \Diamond\phi & \text{iff} & \exists w' \in W : (wRw' \;\&\; \mathfrak{M}, w' \models \phi) \\
\mathfrak{M}, w \models \Box\phi & \text{iff} & \forall w' \in W : (wRw' \Rightarrow \mathfrak{M}, w' \models \phi).
\end{array} \tag{1.2}$$

If $\mathfrak{M}, w \models \phi$ we say that ϕ is **satisfied** *in $\mathfrak{M}$ at w. If ϕ is satisfied at all states in all models based on a frame $\mathfrak{F}$, we say that ϕ is* **valid** *on $\mathfrak{F}$ and write $\mathfrak{F} \models \phi$. If ϕ is valid on all frames, then we say that it is* **valid** *and write $\models \phi$.*

This system is nowadays familiar to most logicians, but it is important to keep in mind that the models are not only "worlds" linked by an "accessibility relation" modelling necessity, possibility, and belief. Modal logic is broader than this. Models may be viewed as trees representing the content of utterances. The *nodes* are represented by states from W and edges are represented by the relation R. The *meaning* (or semantic import) of an utterance is the change of the graph (i.e. the change of the model).

But to represent real-world sentences we will need more than one relation and a tool for referring to states in the model. Let's add some more relations to our system.

1.2 Multimodal logic

Multimodal logic is the modal logic extended by changing relation R into a set of relations $\{R_\pi\}$.

1.2.1 Syntax

Definition 3 (Formula of multimodal logic) *Given a set of* propositional symbols $PROP = \{\mathsf{p}, \mathsf{q}, \mathsf{p}', \mathsf{q}', \ldots\}$ *and the set of modality labels* $MOD = \{\pi, \pi', \pi'', \ldots\}$*, the set of well-formed formulas of the* basic propositional multimodal language *(over* $PROP$ *and* MOD*) is defined to be:*

$$WFF := \mathsf{p} \mid \neg\phi \mid \phi \wedge \psi \mid \phi \vee \psi \mid \phi \rightarrow \psi \mid \langle\pi\rangle\phi \mid [\pi]\phi, \tag{1.3}$$

for all $\mathsf{p} \in PROP$*,* $\pi \in MOD$ *and* $\phi, \psi \in WFF$*.*

1.2.2 Semantics

Definition 4 (Semantics of multimodal logic) *A model* $\mathfrak{M}$ *(for a fixed choice of* $PROP$ *and* MOD*) is a triple* $(W, \{R_\pi, \pi \in MOD\}, V)$*. Here* W *is a non-empty set of* **states** *and* R_π *are* binary *relations on* W*. The pair* $(W, \{R_\pi\})$ *is called the* **frame** *underlying* $\mathfrak{M}$*, and* $\mathfrak{M}$ *is said to be a model based on this frame.* V *(the* **valuation***) is a function with domain* $PROP$ *and range* $Pow(W)$*; it tells us at which states each propositional symbol is true. Interpretation is carried out as follows: Let* $\mathfrak{M} = (W, \{R_\pi, \pi \in MOD\}, V)$ *and* $w \in W$*. Then:*

$$\begin{array}{lll}
\mathfrak{M}, w \models \mathsf{p} & \text{iff} & w \in V(\mathsf{p}), \textit{where } \mathsf{p} \in PROP \\
\mathfrak{M}, w \models \neg\phi & \text{iff} & \mathfrak{M}, w \not\models \phi \\
\mathfrak{M}, w \models \phi \wedge \psi & \text{iff} & \mathfrak{M}, w \models \phi \textit{ and } \mathfrak{M}, w \models \psi \\
\mathfrak{M}, w \models \phi \vee \psi & \text{iff} & \mathfrak{M}, w \models \phi \textit{ or } \mathfrak{M}, w \models \psi \\
\mathfrak{M}, w \models \phi \rightarrow \psi & \text{iff} & \mathfrak{M}, w \not\models \phi \textit{ or } \mathfrak{M}, w \models \psi \\
\mathfrak{M}, w \models \langle\pi\rangle\phi & \text{iff} & \exists w' \in W : (wR_\pi w' \;\&\; \mathfrak{M}, w' \models \phi) \\
\mathfrak{M}, w \models [\pi]\phi & \text{iff} & \forall w' \in W : (wR_\pi w' \Rightarrow \mathfrak{M}, w' \models \phi).
\end{array} \tag{1.4}$$

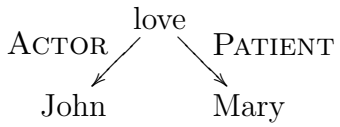
This definition is very similar to the modal version, but this little difference enables us to start representing the discourse.

John loves Mary. (1.5)

We can try to interpret sentence 1.5 as a model that is specified in 1.6:

$$\begin{aligned} PROP &= \emptyset \\ MOD &= \{\textsc{Actor}, \textsc{Patient}\} \\ W &= \{\text{John}, \text{Mary}, \text{love}\} \\ R &= \Big((\text{love}, \text{John}), (\text{love}, \text{Mary})\Big) \end{aligned} \tag{1.6}$$

You can imagine the model 1.6 as 1.7:



(1.7)

This is a very basic example of the structure we will try to assign to utterances. Now it is so simplified that it recalls a simplified TR know from Sgall [20]. But we need something more to be able to refer in a simple manner to states in our system. Why the multimodal logic isn't sufficient for knowledge representing:

1. Even in this simple example 1.5 we are not able to represent the meaning of the sentence as a formula. We would like to say that the meaning of 1.5 is something like

$$\begin{aligned} \mathfrak{M}, \text{love} \models (\ &\langle \textsc{Actor} \rangle \text{ John} \\ &\& \ \langle \textsc{Patient} \rangle \text{ Mary}) \end{aligned} \tag{1.8}$$

   The problem is that this is not a formula.

2. Another problem is definability of classes of frames[1]. As Blackburn in [4] pointed out, we cannot define *irreflexivity* of a modality π using orthodox multimodal logic—we can not express the fact that for every state $w \in W$: $\mathfrak{M}, w \models \neg \langle \text{F} \rangle\ w$. The respective hybrid formula will be shown in example 1.13 on page 7.

Let's proceed to the Hybrid logic described in the next section.

1.3 Hybrid logic

In this section I will introduce the definition of *basic hybrid language* $\mathcal{H}(@)$ as presented in Areces and Blackburn [1], which is a sublanguage of the $\mathcal{H}(\downarrow, @)$. The mutual relationship and properties of $\mathcal{H}(\downarrow, @)$ and $\mathcal{H}(@)$ are discussed in Areces, Blackburn and Marx [2].

[1] A formula ϕ *defines* a class of frames $\mathbf{F}$ iff ϕ is valid on all the frames in $\mathbf{F}$ and falsifiable on any frame not in $\mathbf{F}$.

1.3.1 Syntax

Definition 5 (Formula of hybrid logic) *Let $PROP$ be a set of* propositional symbols $PROP = \{\mathsf{p}, \mathsf{q}, \mathsf{p}', \mathsf{q}', \ldots\}$ *and NOM a set of* **nominals** *distinct from $PROP$, $NOM = \{i, j, k, \ldots\}$. The set of well-formed formulas of the* basic hybrid language *(over $PROP$ and NOM) is defined to be:*

$$WFF := i \mid \mathsf{p} \mid \neg\phi \mid \phi \wedge \psi \mid \Diamond\phi \mid @_i\phi \tag{1.9}$$

for all $\mathsf{p} \in PROP$, $i \in NOM$ and $\phi, \psi \in WFF$.

Nominals are the principal hybrid mechanism for referring to points, thus they play the role played by terms in classical logic. But note: *nominals are formulas, not terms*. Further, nominals can occur as subscripts to the @ symbol. Such a combination—for example, $@_k$—is called a **satisfaction operator**.

1.3.2 Semantics

The basic hybrid language is **interpreted** on *models*. A model $\mathfrak{M}$ (for a fixed choice of $PROP$) is a triple (W, R, V). Here W is a non-empty set of **states** and R is a *binary* relation on W. The pair (W, R) is called the **frame** underlying $\mathfrak{M}$, and $\mathfrak{M}$ is said to be a model based on this frame. V (the **hybrid valuation**) is a function with domain $PROP \cup NOM$ and range $Pow(W)$; it tells us at which states each propositional symbol is true and for all nominals $V(i)$ is a *singleton* set. That is, nominals are true at precisely one point in any model. They 'name' this point by being true there and nowhere else. We call the unique point in $V(i)$ the **denotation** of i. Interpretation is carried out as follows:

Definition 6 (Semantics of hybrid logic) *Let $\mathfrak{M} = (W, R, V)$, $i \in NOM$ and $w \in W$. Then:*

$$\begin{array}{lll}
\mathfrak{M}, w \models \mathsf{p} & \text{iff} & w \in V(\mathsf{p}), \textit{where } \mathsf{p} \in PROP \\
\mathfrak{M}, w \models \neg\phi & \text{iff} & \mathfrak{M}, w \not\models \phi \\
\mathfrak{M}, w \models \phi \wedge \psi & \text{iff} & \mathfrak{M}, w \models \phi \textit{ and } \mathfrak{M}, w \models \psi \\
\mathfrak{M}, w \models \Diamond\phi & \text{iff} & \exists w' \in W : (wRw' \;\&\; \mathfrak{M}, w' \models \phi) \\
\mathfrak{M}, w \models i & \text{iff} & w \text{ is the denotation of } i. \\
\mathfrak{M}, w \models @_i\phi & \text{iff} & \mathfrak{M}, u \models \phi, \text{ where } u \text{ is the denotation of } i \ (u \in V(i)).
\end{array} \tag{1.10}$$

If $\mathfrak{M}, w \models \phi$ we say that ϕ is **satisfied** *in $\mathfrak{M}$ at w. If ϕ is satisfied at all states in all models based on a frame $\mathfrak{F}$, we say that ϕ is* **valid** *on $\mathfrak{F}$ and write $\mathfrak{F} \models \phi$. If ϕ is valid on all frames, then we say that it is* **valid** *and write $\models \phi$.*

Notes:

1. The satisfaction operator $@_i$ shifts the point of evaluation to the denotation of i. So $@_i\phi$ says: "ϕ is satisfied at the point named by i."

2. The formula prefixed by a satisfaction operator can itself be a nominal. For example $@_i j$ is a well formed formula and it has a useful meaning: it asserts that the nominal j is true at the point named by i, i.e. i and j name the same point.

Now we are ready for the last step to Multimodal hybrid logic.

1.4 Multimodal hybrid logic

Multimodal hybrid logic is the hybrid logic extended by changing relation R into a set of relations $\{R_\pi\}$.

1.4.1 Syntax

Definition 7 (Basic hybrid multimodal language $\mathcal{H}(@)$) *Given a set of* propositional symbols $PROP = \{\mathsf{p}, \mathsf{q}, \mathsf{p}', \mathsf{q}', \ldots\}$ *and a set of modality labels* $MOD = \{\pi, \pi', \pi'', \ldots\}$. *Let* NOM *be a nonempty set of* **nominals**, *disjoint from* $PROP$ *and* MOD. *Typically, elements of* NOM *are written as* i, j, k. *We define the basic hybrid multimodal language* $\mathcal{H}(@)$ *(over* $PROP$, MOD *and* NOM*) to be the set of well-formed formulas such that:*

$$WFF := i \mid \mathsf{p} \mid \neg\phi \mid \phi \wedge \psi \mid \phi \vee \psi \mid \phi \rightarrow \psi \mid \langle\pi\rangle\phi \mid [\pi]\phi \mid @_i\phi. \qquad (1.11)$$

for all $i \in NOM$, $\mathsf{p} \in PROP$, $\pi \in MOD$ *and* $\phi, \psi \in WFF$. *For any nominal* i, *we call the symbol sequence* $@_i$ *a satisfaction operator.*

1.4.2 Semantics

Definition 8 (Semantics of hybrid multimodal logic) *A model* $\mathfrak{M}$ *(for a fixed choice of* $PROP$, MOD *and* NOM*) is a triple* $(W, \{R_\pi, \pi \in MOD\}, V)$. *Here* W *is a non-empty set of* **states** *and* R_π *are* binary *relations on* W. *The pair* $(W, \{R_\pi\})$ *is called the* **frame** *underlying* $\mathfrak{M}$, *and* $\mathfrak{M}$ *is said to be a model based on this frame.* V *(the* **hybrid valuation***) is a function with domain* $PROP \cup NOM$ *and range* $Pow(W)$ *such that for all nominals* i, $V(i)$ *is a singleton subset of* W. *We call the unique state in* $V(i)$ *the* **denotation** *of* i.

Interpretation is carried out as follows: Let $\mathfrak{M} = (W, \{R_\pi, \pi \in MOD\}, V)$, $w' \in W$ *and* $w \in W$. *Then:*

$$\begin{array}{lll}
\mathfrak{M}, w \models \mathsf{p} & \text{iff} & w \in V(\mathsf{p}), \textit{where } \mathsf{p} \in PROP \\
\mathfrak{M}, w \models \neg\phi & \text{iff} & \mathfrak{M}, w \not\models \phi \\
\mathfrak{M}, w \models \phi \wedge \psi & \text{iff} & \mathfrak{M}, w \models \phi \textit{ and } \mathfrak{M}, w \models \psi \\
\mathfrak{M}, w \models \phi \vee \psi & \text{iff} & \mathfrak{M}, w \models \phi \textit{ or } \mathfrak{M}, w \models \psi \\
\mathfrak{M}, w \models \phi \rightarrow \psi & \text{iff} & \mathfrak{M}, w \not\models \phi \textit{ or } \mathfrak{M}, w \models \psi \\
\mathfrak{M}, w \models \langle\pi\rangle\phi & \text{iff} & \exists w' \in W : (wR_\pi w' \;\&\; \mathfrak{M}, w' \models \phi) \\
\mathfrak{M}, w \models [\pi]\phi & \text{iff} & \forall w' \in W : (wR_\pi w' \Rightarrow \mathfrak{M}, w' \models \phi). \\
\mathfrak{M}, w \models i & \text{iff} & w \in V(i), \text{where } i \in NOM. \\
\mathfrak{M}, w \models @_i\phi & \text{iff} & \mathfrak{M}, w' \models \phi, \text{where } w' \text{ is the denotation of } i.
\end{array} \tag{1.12}$$

If ϕ *is satisfied at all states in all hybrid models based on a frame* $\mathfrak{F}$, *then we say that* ϕ *is valid on* $\mathfrak{F}$, *which we can write as* $\mathfrak{F} \models \phi$. *If* ϕ *is valid on all frames, then we say that it is valid and write* $\models \phi$.

With this modification of modal logic we can define the irreflexivity of a relation F. It can be expressed by following schema of axioms from Blackburn [4]:

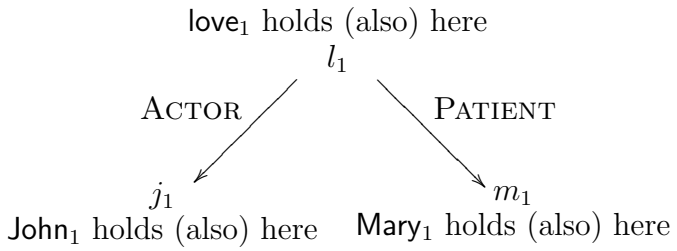
$$@_i \neg \langle \mathrm{F} \rangle\, i \tag{1.13}$$

Now, recall example 1.5 from page 3. Using hybrid logic the model will change a little:

$$\begin{aligned}
PROP &= \{\mathsf{John}_1, \mathsf{Mary}_1\} \\
MOD &= \{\textsc{Actor}, \textsc{Patient}\} \\
NOM &= \{l_1, j_1, m_1\}
\end{aligned}$$

$$\begin{aligned}
W &= \{w_1, w_2, w_3\} \\
R &= \big((w_1, w_2), (w_1, w_3)\big) \\
V &= \big((l_1, \{w_1\}), (j_1, \{w_2\}), (m_1, \{w_3\}), \\
&\qquad (\mathsf{love}_1, \{w_1\}), (\mathsf{John}_1, \{w_2\}), (\mathsf{Mary}_1, \{w_3\})\big)
\end{aligned} \tag{1.14}$$

Note that the meaning of 'John$_1$' and 'Mary$_1$' is now different. While in 1.6 John was a state, now it is the set of all Johns. The image corresponding to 1.14 could be 1.15:



(1.15)

What is important about this approach is that now we can represent the semantic import by the formula 1.16 in hybrid multimodal language $\mathcal{H}(@)$:

$$\begin{aligned} @_{l_1}(&\mathsf{love}_1 \\ &\wedge \langle \textsc{Actor} \rangle \, (j_1 \wedge \mathsf{John}_1) \\ &\wedge \langle \textsc{Patient} \rangle \, (m_1 \wedge \mathsf{Mary}_1) \\ &) \end{aligned} \tag{1.16}$$

What does formula 1.16 say?

1. The propositional symbol love_1 holds in the state labelled by l_1.
2. $(l_1, j_1) \in R_{\textsc{Actor}}$ and John_1 holds at j_1.
3. $(l_1, m_1) \in R_{\textsc{Patient}}$ and Mary_1 holds at m_1.

Now it's clear that this is what figure 1.15 shows. This formalism enables us to represent the same objects of discourse with the same nominals and also provides us with the possibility to link occurrences of objects, events, states or whatever else together. The complete annotation of 1.5 can be found on the page 86.

The approach here is to capture the objects of discourse as nominals – they can be easily referred to and we can use them even for entities we don't know much about. If, for example, two actions happen at the same place, we can call the place p_1 and capture the connection of those actions even if we have no idea where p_1 can be. The nominals itself don't tell us anything about the nature of the entities they represent – they are useful for referencing. On the other hand the propositional symbols like John_1 or table_1 don't identify any entities, they are used for characterising the entities. We could say they ascribe a property.

We use this division for distinguishig what we can annotate well from what we can annotate worse. From the text we can quite precisely understand and annotate the relations between the entities of the world introduced by the text, but in the characterisation of the entities we can not get much further beyond the words (if the speaker calls an action '*running*', what do we really know about it?).

The relations between entities and the entities itself can be viewed and treated as language-independent, but what about the "words"? All we can do is distinguish clearly different senses of the words by different indices – this is what we will do. But we can not count upon an "ontological" or "interlingual" dictionary because there is no such as explained in the Preface, we will use the words from the original language of the text. Nevertheless we call the approach language-independent – we hope that annotations of the same text

in different languages will lead to the same structure that will differ only in the "labels" of entities. In that case we could then use machines to learn the mapping of these "labels" from one language to another depending on their position in the structure and on the "labels" of neighbouring entities.

Now let me introduce another two simplified examples, the first is about the direct linking and the second shows how to set up an indirect link between occurrences of the same entity of the discourse.

$$\begin{array}{l}\text{John loves Mary.}\\ \text{She hates him.}\end{array} \tag{1.17}$$

In this case the annotator knows who are the people referenced by 'she' and 'him'. The connection can be formalized by 1.18:

$$\begin{array}{l}@_{l_1}\,(\mathsf{love_1}\\ \quad \wedge \langle \textsc{Actor}\rangle\,(j_1 \wedge \mathsf{John_1})\\ \quad \wedge \langle \textsc{Patient}\rangle\,(m_1 \wedge \mathsf{Mary_1})\\ \quad)\\ \\ @_{h_1}(\mathsf{hate_1}\\ \quad \wedge \langle \textsc{Actor}\rangle\,(m_1 \wedge \mathsf{she_1})\\ \quad \wedge \langle \textsc{Patient}\rangle\,(j_1 \wedge \mathsf{he_1})\\ \quad)\end{array} \tag{1.18}$$

In the next example the reference is revealed too late to represent it in such a direct manner:

$$\begin{array}{l}\text{John talked about Mary while somebody knocked on the door.}\\ \text{It was her.}\end{array} \tag{1.19}$$

In this case the annotator can't reduce the first sentence to 'John talked to Mary while she knocked on the door.' The reference is thus represented indirectly. Note that the temporal aspects are ignored for the sake of simplicity.

$$
\begin{aligned}
&@_{t_1}(\mathsf{talk_1} \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (j_1 \wedge \mathsf{John_1}) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (m_1 \wedge \mathsf{Mary_1}) \\
&\quad) \\
&@_{k_1}(\mathsf{knock_1} \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (s_1 \wedge \mathsf{somebody_1}) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (d_1 \wedge \mathsf{door_1}) \\
&\quad) \\
&@_{b_1}(\mathsf{be_4} \\
&\quad \wedge \langle \textsc{Actor} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (m_1 \wedge \mathsf{she_1}) \\
&\quad)
\end{aligned}
\tag{1.20}
$$

The annotator could simply replace the third formula by $@_{s_1}(m_1 \wedge \mathsf{she_1})$ but this would reduce the sentence and furthermore if the discourse had continued like 'No, it was not her!', such sentence would be impossible to represent because the nominals s_1 and m_1 would be irreversibly unified.

Chapter 2

Segmentation

2.1 Segmentational potential of sentential boundaries

When an annotator works with a discourse, he or she surely has to divide the text into relatively small units and annotate them sequentially. Consider following examples:

Mary travels a lot. John loves her. (2.1)

Mary travels a lot and John loves her. (2.2)

These two texts differ in style but the ontological content of both texts is the same. We would like to have the same logical representation for both texts but this can be hardly done in case we have each text segmented in different manner, although in the section 2.2 I will show that sometimes the hybrid logic itself can help us to segment the text properly. At first glance we can find out two ways of unifying the approach to discourse segmentation. We can either make the segments as long as possible, or we can divide the text into units as small as possible. It's obvious that we can not follow the first way, since we would get the whole discourse as one unit and that would be too complicated to annotate at once.

Therefore I propose to divide the discourse into segments as short as possible. Now the question is 'What is the minimal size of discourse to be a single unit?' In the next section I will try to use the notion of 'proposition' to divide the text into formulas, but even now it's obvious that the sentence boundary is a point where we will draw the boundary between the formulas. In fact the proposition will correspond mostly to clausal boundaries.

2.2 Proposition as the logical measure

To annotate a piece of discourse into a formal representation, the annotator has to divide the text into propositions. Every proposition should correspond to a fact proposed by the speaker. Consider the sentence

The book you are standing on is my favourite Havlíček's novel. (2.3)

It can be segmented in two rather extreme ways. In the first case, the whole sentence is represented by a single formula as in 2.4:

$$
\begin{aligned}
&@_{i_1}(\mathsf{be}_1\\
&\quad \wedge \langle \textsc{Actor} \rangle\ (b_1 \wedge \mathsf{book}_1\\
&\qquad\qquad \wedge @_{s_1}(\mathsf{stand}_1\\
&\qquad\qquad\qquad \wedge \langle \textsc{Actor} \rangle\ y_1\\
&\qquad\qquad\qquad \wedge \langle \textsc{Where} \rangle\ (o_1\\
&\qquad\qquad\qquad\qquad\qquad \wedge \mathsf{on}_1\\
&\qquad\qquad\qquad\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ b_1\\
&\qquad\qquad\qquad\qquad\qquad)\\
&\qquad\qquad\qquad \wedge \langle \mathrm{NB} \rangle\ b_1 \wedge\ \langle \mathrm{NB} \rangle\ s_1\\
&\qquad\qquad\qquad \wedge \langle \textsc{Stime} \rangle\ t_1\\
&\qquad\qquad\qquad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ t_1)\\
&\qquad\qquad\qquad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{P} \rangle\ t_1)\\
&\qquad\qquad\qquad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\qquad\qquad\qquad)\\
&\qquad\qquad)\\
&\quad \wedge \langle \textsc{Patient} \rangle\ (n_1 \wedge \mathsf{novel}_1\\
&\qquad\qquad \wedge \langle \textsc{Actor} \rangle\ (h_1 \wedge \mathsf{Havlíček}_1)\\
&\qquad\qquad \wedge \langle \textsc{App} \rangle\ x_1\\
&\qquad\qquad \wedge \langle \textsc{Rstr} \rangle\ (f_1 \wedge \mathsf{favourite}_1)\\
&\qquad\qquad)\\
&\quad \wedge \langle \mathrm{NB} \rangle\ n_1 \wedge\ \langle \mathrm{NB} \rangle\ h_1\ \langle \mathrm{NB} \rangle\ f_1\\
&\quad \wedge \langle \textsc{Stime} \rangle\ t_1\\
&\quad \wedge \langle \textsc{Etime1} \rangle\ e_3\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e_4\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)
\end{aligned}
\tag{2.4}
$$

In the second case, the sentence is as fragmented as possible:

$$
\begin{aligned}
&@_{s_1}(\mathsf{stand}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1 \\
&\quad \wedge \langle \textsc{Where} \rangle\ o_1 \\
&\quad \wedge \langle \mathrm{NB} \rangle\ b_1 \wedge \langle \mathrm{NB} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ t_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge \langle \mathrm{F} \rangle\ t_1) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge \langle \mathrm{P} \rangle\ t_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad) \\
&@_{o_1}(\mathsf{on}_1 \\
&\quad \wedge \langle \textsc{Appurtenance} \rangle\ b_1 \\
&\quad) \\
&@_{b_1}(\mathsf{book}_1) \\
&@_{i_1}(\mathsf{be}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ b_1 \\
&\quad \wedge \langle \textsc{Patient} \rangle\ n_1 \\
&\quad \wedge \langle \mathrm{NB} \rangle\ n_1 \wedge \langle \mathrm{NB} \rangle\ h_1\ \langle \mathrm{NB} \rangle\ f_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ t_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ t_1 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad) \\
&@_{n_1}(\wedge\ \mathsf{novel}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ h_1 \\
&\quad \wedge \langle \textsc{App} \rangle\ x_1 \\
&\quad \wedge \langle \textsc{Rstr} \rangle\ f_1 \\
&\quad) \\
&@_{h_1}(\mathsf{Havlíček}_1) \\
&@_{f_1}(\mathsf{favourite}_1)
\end{aligned}
\tag{2.5}
$$

The formulae in 2.5 could be rephrased as 2.6:

> You are standing ... on something.
> It's a book,
> it's ... a novel, (2.6)
> by Havlíček,
> and my favourite.

Now the key observation here is that 2.4 is logically equivalent to 2.5! This is exactly what we want—the content delivered by the utterance should be independent of how the speaker divides it into clauses and sentences. Note that the order of formulas is not important. All permutations of formulae

are equivalent. The order of the discourse is maintained solely by the order of STIMEs.

The formalism itself provides us with a natural segmentation of the facts proposed by the speaker. Still, there is a problem: We want to keep track of who said which proposition, who was the hearer, where and when the utterance took place. This could be easily represented by modals SPEAKER, HEARER and STIME. The question is however, where to place these modals. To every formula? Whenever anything changes? We will follow the rule 'Place such pragmatic information to every event'. And at the same time I propose to segment the text into formulae on the basis of clausal[1] boundaries. In this way the pragmatic information will be always at the same place as temporal information as described in chapter 3.

On one hand the segmentation doesn't matter but on the other hand it is convenient to have segments together with pragmatic information. Therefore the representation of 2.3 would be 2.7:

[1] I will place a segment boundary also between 'potential clauses' as in sentence represented by 7.14 and 7.15 on page 72.

$$
\begin{aligned}
&@_{s_1}(\mathsf{stand}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ y_1 \\
&\quad \wedge \langle \textsc{Where} \rangle\ (o_1 \\
&\qquad\qquad \wedge \mathsf{on}_1 \\
&\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ b_1 \\
&\qquad\qquad) \\
&\quad \wedge \langle \mathrm{NB} \rangle\ b_1 \wedge \langle \mathrm{NB} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ t_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge \langle \mathrm{F} \rangle\ t_1) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge \langle \mathrm{P} \rangle\ t_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge \langle \textsc{Hearer} \rangle\ y_1 \\
&) \\
&@_{i_1}(\mathsf{be}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (b_1 \wedge \mathsf{book}_1) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (n_1 \wedge \mathsf{novel}_1 \\
&\qquad\qquad \wedge \langle \textsc{Actor} \rangle\ (h_1 \wedge \mathsf{Havlíček}_1) \\
&\qquad\qquad \wedge \langle \textsc{App} \rangle\ x_1 \\
&\qquad\qquad \wedge \langle \textsc{Rstr} \rangle\ (f_1 \wedge \mathsf{favourite}_1) \\
&\qquad\qquad) \\
&\quad \wedge \langle \mathrm{NB} \rangle\ n_1 \wedge \langle \mathrm{NB} \rangle\ h_1\ \langle \mathrm{NB} \rangle\ f_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ t_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ e_3 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e_4 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge \langle \textsc{Hearer} \rangle\ y_1 \\
&)
\end{aligned}
\tag{2.7}
$$

Note that not all segments necessarily have identifiable stage (speaker, hearer and time). But even if we don't know such information, we should introduce a new nominal for later reference.

The Stime relation identifies the time of the utterance, but more events can share the same Stime. We should assign the same Stime to those events that can be permutated without a negative impact on the smoothness of the discourse. See chapter 7 for examples of using Stime.

Chapter 3

Temporality

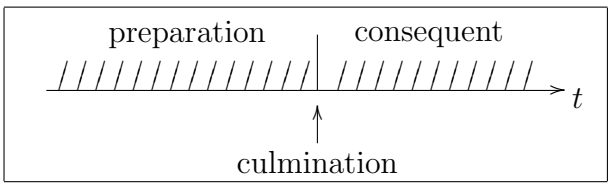
In this chapter I will discuss the temporal aspect of utterances and how it can be represented in a way compatible with the formalism introduced in chapter 1

3.1 Event nucleus

According to Moens and Steedman [11] (page 18), temporal ontology of verbs can be modelled by a structure called event nucleus.

Definition 9 (The event nucleus) *An event nucleus is defined as a structure comprising a culmination, an associated preparatory process, and a consequent state. Any or all of these elements may be compounds of another events.*

The event nucleus is distributed over time span as in picture 3.1.



(3.1)

The event nucleus

3.1.1 Aspectual types

Every verb occurrence can be classified into an aspectual type. Steedman distinguishes[1] four types:

[1]Categories like activity and accomplishment are ways of viewing a happening, rather than intrinsic properties of verbs and the associated propositions, or of objective reality

1. **Activity** is what Moens and Steedman in [11] call 'process' and Steedman in [21] calls 'activity'. Activity is extended in time, but it doesn't result in a very distinct change in the world. An example could be

   Mary is swimming. (3.2)

   Porota přichází. (3.3)

   "The jury is coming."

2. **Achievement** is described in [21] as being instantaneous and by resulting in a distinct change in the state of the world. An example:

   Keats has finnished the sonnet. (3.4)

   Water has reached the top. (3.5)

3. **Accomplishment** is a composite of activity and achievement which is brought about by the activity:

   Samedi au soir, il a couri au bal. (3.6)

   "Saturday evening, he ran to the ball."

   In ca. 3 Stunden werden wir den Gipfel erreichen. (3.7)

   "In approx. 3 hours we will reach the summit."

4. **State** describes an indefinitely extending states of affairs. Typically, the states are expressed by verbs like understand, love, know, ...

The aspectual type of a proposition depends strongly on the situation in which the verb is used. The same verb can be classified to several types depending on its tense, its modifiers, and the context.

For example 'reach' is a verb, which expresses achievement, but in 3.8 the proposition conveyed by the verb is an accomplishment:

It took him three hours to reach the summit. (3.8)

The sentence does not say that the act of reaching the summit took three hours. It rather expresses the duration of the preparation associated with this event.

In my view the aspectual category of a verb occurrence can not be clearly distinguished as the annotator doesn't know what can be understood as instantaneous and what is a "distinct" change in the world. Kruijff [9] mentions an example 3.9 (example 53 in [9]):

---

and the external world.

$$\begin{cases} \textbf{Activity}\text{: Kathy walked.} \\ \textbf{Accomplishment}\text{: Kathy walked till dawn.} \end{cases} \tag{3.9}$$

Since the first sentence is an activity, it should not bring any distinct changes to the world. On the other hand, the accomplishment is a composite of an activity and an achievement and an achievement should describe a distinct change in the state of the world. In my opinion there is no reason to say that the latter sentence results in a more distinct change than the former.

Nevertheless the annotator should keep in mind that verbs sometimes express events that have two important time anchors (the beginning of the preparation and the culmination point) and sometimes events that have only one time anchor (the time in which the event simply took place). We will not classify events to Steedmans' aspectual types, instead, we will use two temporal relations ETIME1 and ETIME2.

- ETIME1 anchors the beginning of the accomplishment, activity or state.
- ETIME2 anchors the time of culmination, time of achievement or the end of an activity or the end of a state.

In case the annotator needs only one anchor, he or she should use ETIME2 (the point of achievement). Examples on temporal problems are described in sections 3.1.2 and 3.3.

Now, here is the example 3.8 annotated as 3.10:

$$\begin{aligned} &@_{r_1}(\mathsf{reach}_1 \\ &\quad \wedge \langle \textsc{Actor} \rangle\ (h_1 \wedge \mathsf{he}_1) \\ &\quad \wedge \langle \textsc{Patient} \rangle\ (s_1 \wedge \mathsf{summit}_1) \\ &\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\ &\quad \wedge \langle \textsc{Etime1} \rangle\ e_1 \\ &\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{F} \rangle\ s_1) \\ &\quad \wedge \langle \textsc{HowLong} \rangle\ (h_2 \\ &\qquad\qquad\qquad \wedge \mathsf{hour}_1 \\ &\qquad\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ 3 \\ &\qquad\qquad\quad) \\ &\quad \wedge \langle \mathrm{NB} \rangle\ h_2 \\ &\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\ &) \end{aligned} \tag{3.10}$$

Note that the HOWLONG modality (if used as a modifier of an event) determines the time between ETIME1 and ETIME2. In examples 3.24, 3.25 and 3.27 you can see different usages of HOWLONG.

The relation F is the *future* relation, it originates in Prior [17]. $@_x \langle \mathrm{F} \rangle y$ means:"From x you can go to future to y" (in other words: x precedes y). The inverse relation is P.

3.1.2 Referring to event nucleus

In this section I present several examples that illustrate different kinds of temporal reference. These examples are from section 3.3.3 of Kruijff [9] but partially originate in Steedman [21].

In all these examples the relative clause establishes a reference point for the main clause to refer to anaphorically.

When Elijah took Kathy's pawn, she took his queen. (3.11)

In this case the relative clause precedes the main clause. This can be represented as 3.12.

$$
\begin{array}{l}
@_{t_1}(\mathsf{take}_1 \\
\quad \wedge \langle \textsc{Actor} \rangle\ (e_0 \wedge \mathsf{Eliah}_1) \\
\quad \wedge \langle \textsc{Patient} \rangle\ (p_1 \\
\qquad\qquad \wedge \mathsf{pawn}_1 \\
\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ (k_1 \wedge \mathsf{Kathy}_1) \\
\qquad\qquad) \\
\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge \langle \mathrm{F} \rangle\ s_1) \\
\quad \wedge \langle \mathrm{NB} \rangle\ e_0 \wedge \langle \mathrm{NB} \rangle\ t_1 \wedge \langle \mathrm{NB} \rangle\ p_1 \\
\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge \langle \textsc{Hearer} \rangle\ y_1 \\
) \\
@_{t_2}(\mathsf{take}_1 \\
\quad \wedge \langle \textsc{Actor} \rangle\ (k_1 \wedge \mathsf{she}_1) \\
\quad \wedge \langle \textsc{Patient} \rangle\ (q_1 \\
\qquad\qquad \wedge \mathsf{queen}_1 \\
\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ (e_0 \wedge \mathsf{he}_1) \\
\qquad\qquad) \\
\quad \wedge \langle \textsc{Stime} \rangle\ (s_2 \wedge \langle \mathrm{P} \rangle\ s_1) \\
\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge \langle \mathrm{F} \rangle\ s_2 \wedge \langle \mathrm{P} \rangle\ e_1) \\
\quad \wedge \langle \mathrm{NB} \rangle\ t_2 \wedge \langle \mathrm{NB} \rangle\ q_1 \\
\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge \langle \textsc{Hearer} \rangle\ y_1 \\
)
\end{array}
\tag{3.12}
$$

The act of taking the pawn take place in e_1 ($\langle \mathrm{F} \rangle\ s_1$ means that from e_1 we can go to future and we will find s_1—the speech time). The act of taking

queen took place in the time e_2, which is sooner than the utterance but later than e_1.

When Eliah took Kathy's pawn,
he did not know it was protected by one of Kathy's knights. (3.13)

In this example, the event in the main clause happens in the same time as the event in the relative clause. The representation follows:

$$
\begin{aligned}
&@_{t_1}(\mathsf{take}_1\\
&\quad \wedge \langle \textsc{Actor} \rangle\ (e_0 \wedge \mathsf{Eliah}_1)\\
&\quad \wedge \langle \textsc{Patient} \rangle\ (p_1\\
&\qquad\qquad \wedge \mathsf{pawn}_1\\
&\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ (k_1 \wedge \mathsf{Kathy}_1)\\
&\qquad\qquad)\\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ s_1)\\
&\quad \wedge \langle \mathrm{NB} \rangle\ e_0 \wedge\ \langle \mathrm{NB} \rangle\ t_1 \wedge\ \langle \mathrm{NB} \rangle\ p_1\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)\\
&@_{k_2}(\mathsf{know}_1\\
&\quad \wedge \mathsf{negative}\\
&\quad \wedge \langle \textsc{Actor} \rangle\ (e_0 \wedge \mathsf{he}_1)\\
&\quad \wedge \langle \textsc{Patient} \rangle\ p_2\\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_2 \wedge\ \langle \mathrm{P} \rangle\ s_1)\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ s_2)\\
&\quad \wedge \langle \mathrm{NB} \rangle\ p_2\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)\\
&@_{p_2}(\mathsf{protect}_1\\
&\quad \wedge \langle \textsc{Actor} \rangle\ (k_2 \wedge\ \langle \textsc{ElementOf} \rangle\ (k_3\\
&\qquad\qquad \wedge \mathsf{knight}_1\\
&\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ \mathit{plural}\\
&\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ (k_1 \wedge \mathsf{Kathy}_1)\\
&\qquad\qquad))\\
&\quad \wedge \langle \textsc{Patient} \rangle\ (p_1 \wedge \mathsf{it})\\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_3 \wedge\ \langle \mathrm{P} \rangle\ s_2)\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ s_3)\\
&\quad \wedge \langle \mathrm{NB} \rangle\ p_2 \wedge\ \langle \mathrm{NB} \rangle\ k_2\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)
\end{aligned}
\tag{3.14}
$$

The nominal e_1 is used in both events to represent the temporal relationship.

When Elijah took Kathy's pawn, he used a rook. (3.15)

This example shows that the main clause can refer not only temporarily but rather to the whole event in the relative clause. Consider 3.16 as a

representation of 3.15:

$$
\begin{array}{l}
@_{t_1}(\mathsf{take}_1 \\
\quad \wedge \langle \textsc{Actor} \rangle\ (e_0 \wedge \mathsf{Eliah}_1) \\
\quad \wedge \langle \textsc{Patient} \rangle\ (p_1 \\
\qquad\qquad \wedge \mathsf{pawn}_1 \\
\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ (k_1 \wedge \mathsf{Kathy}_1) \\
\qquad\qquad) \\
\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge \langle \mathrm{F} \rangle\ s_1) \\
\quad \wedge \langle \mathrm{NB} \rangle\ e_0 \wedge \langle \mathrm{NB} \rangle\ t_1 \wedge \langle \mathrm{NB} \rangle\ p_1 \\
\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge \langle \textsc{Hearer} \rangle\ y_1 \\
)\\
@_{u_1}(\mathsf{use}_1 \\
\quad \wedge \langle \textsc{Actor} \rangle\ (e_0 \wedge \mathsf{he}_1) \\
\quad \wedge \langle \textsc{Patient} \rangle\ (r_1 \wedge \mathsf{rook}_1) \\
\quad \wedge \langle \textsc{Stime} \rangle\ (s_2 \wedge \langle \mathrm{P} \rangle\ s_1) \\
\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge \langle \mathrm{F} \rangle\ s_2) \\
\quad \wedge \langle \mathrm{NB} \rangle\ r_1 \wedge \langle \mathrm{NB} \rangle\ u_1 \\
\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge \langle \textsc{Hearer} \rangle\ y_1 \\
)\\
@_{t_1}\ \langle \textsc{Means} \rangle\ r_1
\end{array}
\tag{3.16}
$$

These two events are not linked only by common time e_1 but also by the formula in the last row.

> When Eliah won his only game against Kathy,
> he used the John Wayne opening. (3.17)

In example 3.17, the reference point established by the relative clause doesn't precede the main clause's. The second sentence refers to the preparation of the event in the first sentence. It is reflected in the annotation:

$$
\begin{aligned}
&@_{w_1}(\mathsf{win}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (e_0 \wedge \mathsf{Eliah}_1) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (g_1 \\
&\qquad\qquad \wedge \mathsf{game}_1 \\
&\qquad\qquad) \\
&\quad \wedge \langle \textsc{HowOften} \rangle\ (o_0 \wedge \mathsf{once}_1) \\
&\quad \wedge \langle \textsc{Addressee} \rangle\ (k_1 \wedge \mathsf{Kathy}_1) \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ e_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{F} \rangle\ s_1) \\
&\quad \wedge \langle \mathrm{NB} \rangle\ e_0 \wedge\ \langle \mathrm{NB} \rangle\ w_1 \wedge\ \langle \mathrm{NB} \rangle\ g_1 \wedge\ \langle \mathrm{NB} \rangle\ o_0 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad) \\
&@_{u_1}(\mathsf{use}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (e_0 \wedge \mathsf{he}_1) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (o_1 \\
&\qquad\qquad \wedge \mathsf{opening}_1 \\
&\qquad\qquad \wedge \langle \textsc{Patient} \rangle\ g_1 \\
&\qquad\qquad \wedge \langle \textsc{Actor} \rangle\ (j_1 \wedge \mathsf{John}_1 \wedge \mathsf{Wayne}_1) \\
&\qquad\qquad) \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_2 \wedge\ \langle \mathrm{P} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ s_2) \\
&\quad \wedge \langle \mathrm{NB} \rangle\ u_1 \wedge\ \langle \mathrm{NB} \rangle\ o_1 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
\tag{3.18}
$$

The time of the act of using the opening turns up in the beginning of the winning described in the first clause. Note also that the structure of the representation of the first clause differs from the syntactic structure. First, there is the word 'against' which can be a dependent of either 'won', or 'game'. In my interpretation this difference is not important and I place as a rule such ambiguous modifiers towards the event.

The other expression is 'only'. Semantically the HowOften dependency relation fits more to the event itself than to the word 'game'.

3.2 Temporal formalization

To recapitulate section 3.1.2, we will use relations Etime1 and Etime2 to anchor the beginning resp. the end of the event. When the event is

instantaneous, we will use only the relation ETIME2 – the achievement point. The ETIME1 anchor can be added later, see also example 3.63 on the page 38.

When we annotate the beginning and the end of an event, it does not mean that the event is permanently in progress between the two points. If we know about a point in which the event is in progress, we will use the WHEN relation (see also example 3.68 on the page 39).

To simplify the annotation we will suppose these schemata of axioms:

$$\begin{array}{l} @_a \langle \mathrm{F} \rangle\ b \rightarrow @_b \langle \mathrm{P} \rangle\ a \\ @_b \langle \mathrm{P} \rangle\ a \rightarrow @_a \langle \mathrm{F} \rangle\ b \end{array} \tag{3.19}$$

This is the mutual inversion of P and F. The choice between them will depend on the point we are in. If we are in a point x from which it is possible to go to the future to a point y, we will write $\langle \mathrm{F} \rangle\ y$ instead of the more complicated $@_y \langle \mathrm{P} \rangle\ x$.

$$(\ \langle \textsc{Etime1} \rangle\ e_1 \wedge\ \langle \textsc{Etime2} \rangle\ e2) \rightarrow @_{e_1} \langle \mathrm{F} \rangle\ e_2 \tag{3.20}$$

We will not annotate that the start of an event precedes the end. It is provided by the rule 3.20.

$$\langle \textsc{When} \rangle\ r \rightarrow (\ \langle \textsc{Etime1} \rangle\ \langle \mathrm{F} \rangle\ r \wedge\ \langle \textsc{Etime2} \rangle\ \langle \mathrm{P} \rangle\ r) \tag{3.21}$$

This rule ensures that if we know that an event is in progress in a time r, then it must have started before r and will end after r.

3.3 Reference time

Reichenbach advanced in his [18] the view that, linguistically speaking, tense does not quantify over *two* times, like "now" and "then", but over *three* times: the speech time(S), the event time (E), and the reference time (R).

The time S is obviously the time in which the sentence is uttered[2]. The event time E is the time (or *temporal extension*) of the expressed proposition. Finally, the reference time R is the time (or context) that we are talking *about*, or from which point the event E is viewed.

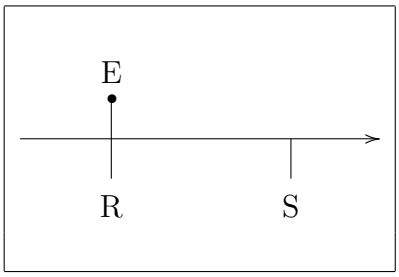
In this section I will show that the reference time (R) is not necessary for the representation of content. The reference time in a language has only one function: to temporarily relate two events. From my point of view the reference time is rather a syntactical means of relating timepoints. We can relate two time points by the priorian relations P and F[3]. Each subsection

[2]We use the relation STIME to annotate the time S.

[3]See Prior [17] for more about Past and Future operators.

contains several examples of an English tense and their annotation with no use of reference time.

3.3.1 Simple past



(3.22)

Simple past

In case of simple past tense there are only two interesting times, the reference time is the same as the event time. The Reichenbach's diagram is a bit simplifying as the example 3.23 shows:

I lived in Rome for six years. (3.23)

The event lasted for six years and it should be reflected in the annotation. I present two representations of 3.23: In 3.24 the structure i_1 is an interval representing the time between e_1 and e_2. Annotation 3.25 is a "shortcut" for 3.24, because the HowLong relation always relates Etime1 and Etime2. If we needed relate other times than Etime1 and Etime2, we would use a structure similar to i_1. See such an example 3.27 on page 26.

$$
\begin{aligned}
&@_{l_1}(\mathsf{live}_2 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1 \\
&\quad \wedge \langle \textsc{Where} \rangle\ (r_1 \wedge \mathsf{Rome}_1) \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ e_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge \langle \mathrm{F} \rangle\ s_1) \\
&\quad \wedge @_{i_1}(\ \langle \textsc{Etime1} \rangle\ e_1 \wedge \langle \textsc{Etime2} \rangle\ e_2) \\
&\quad \wedge @_{i_1}(\ \langle \textsc{HowLong} \rangle\ (t_1 \\
&\qquad\qquad\qquad\qquad \wedge \mathsf{year} \\
&\qquad\qquad\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ 6 \\
&\qquad\qquad\qquad\qquad)) \\
&\quad \wedge \langle \mathrm{NB} \rangle\ t_1 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
\tag{3.24}
$$

$$
\begin{aligned}
&@_{l_1}(\mathsf{live}_2\\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1\\
&\quad \wedge \langle \textsc{Where} \rangle\ (r_1 \wedge \mathsf{Rome}_1)\\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1\\
&\quad \wedge \langle \textsc{Etime1} \rangle\ e_1\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{F} \rangle\ s_1)\\
&\quad \wedge \langle \textsc{HowLong} \rangle\ (t_1\\
&\qquad\qquad \wedge \mathsf{year}\\
&\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ 6\\
&\qquad\qquad)\\
&\quad \wedge \langle \mathrm{NB} \rangle\ t_1\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)
\end{aligned}
\tag{3.25}
$$

I saw Jack two days ago. (3.26)

In this example the 'two days ago' dependent describes the duration between the event time and the speech time. It is represented in a way similar to example 3.23. The difference is that we can not leave the structure i_1 out, since the HowLong relation would specify the duration of the event of 'seeing'.

$$
\begin{aligned}
&@_{s_1}(\mathsf{see}_1\\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1\\
&\quad \wedge \langle \textsc{Patient} \rangle\ (j_1 \wedge \mathsf{Jack})\\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ s_1)\\
&\quad \wedge @_{i_1}(\ \langle \textsc{Etime1} \rangle\ e_1 \wedge\ \langle \textsc{Etime2} \rangle\ s_1)\\
&\quad \wedge @_{i_1}(\ \langle \textsc{HowLong} \rangle\ (t_1\\
&\qquad\qquad \wedge \mathsf{day}\\
&\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ 2\\
&\qquad\qquad))\\
&\quad \wedge \langle \mathrm{NB} \rangle\ t_1\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)
\end{aligned}
\tag{3.27}
$$

They met during the war. (3.28)

Example 3.28 introduces a new relation: When. It restricts the time of the event by the time of the state it leads to. In other words

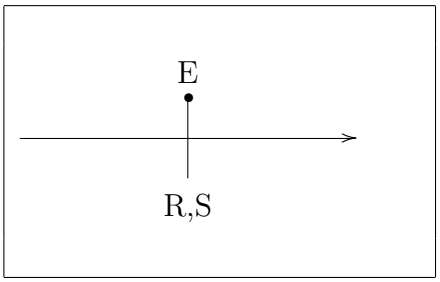
1. Since the WHEN relation leads from m_1, it refers to the state denoted by e_1. If there was another time ETIME1, it would restrict the whole interval as in e.g. 3.35.

2. Since the WHEN relation leads to w_1, the time of w_1 is "extracted" from the state w_1 and e_1 is intersected with the time of w_1.

3. The absence of ETIME1 relation from m_1 indicates that the annotator considers the event m_1 to be instantaneous.

$$
\begin{aligned}
&@_{m_1}(\mathsf{meet}_2 \\
&\quad \wedge \langle \text{ACTOR} \rangle\ a_1 \\
&\quad \wedge \langle \text{PATIENT} \rangle\ b_1 \\
&\quad \wedge \langle \text{STIME} \rangle\ s_1 \\
&\quad \wedge \langle \text{ETIME2} \rangle\ (e_1\ \langle \text{F} \rangle\ s_1) \\
&\quad \wedge \langle \text{WHEN} \rangle\ (w_1 \wedge \mathsf{war}_1) \\
&\quad \wedge \langle \text{NB} \rangle\ m_1 \wedge\ \langle \text{NB} \rangle\ w_1 \\
&\quad \wedge \langle \text{SPEAKER} \rangle\ x_1 \wedge\ \langle \text{HEARER} \rangle\ y_1 \\
&\quad)
\end{aligned}
\tag{3.29}
$$

3.3.2 Simple present



(3.30)

Simple present

Present simple tense is once again a case of a tense that is not as simple as the diagram shows. Although it suits to utterances like 3.32, I dare to say that for most utterances in present simple tense the situation is much more complex. The tense is used for describing regular activities as in 3.33 or rather atemporal facts as in 8.6 on page 89.

I want a cup of tea. (3.31)

In this example the event time is absolutely unspecified. We don't know since when the speaker has wanted the cup or till when he or she will still want

it. The annotation reflects this intuition. We only know that the proposition holds at the time of utterance. However, the annotator may decide, in a particular context, that the event lies completely after the utterance time ($@h_1$ ⟨ETIME1⟩ s_1) . Note the similarity to a simple future example 3.42.

$$
\begin{aligned}
&@_{h_1}(\mathsf{have_1}\\
&\quad\wedge \langle\textsc{Actor}\rangle\ x_1\\
&\quad\wedge \langle\textsc{Patient}\rangle\ (c_1\\
&\qquad\qquad\wedge \mathsf{cup_1}\\
&\qquad\qquad\wedge \langle\textsc{Material}\rangle\ (t_1 \wedge \mathsf{tea_1})\\
&\qquad\qquad)\\
&\quad\wedge \langle\textsc{DeontMod}\rangle\ \textit{volitive}\\
&\quad\wedge \langle\textsc{Stime}\rangle\ s_1\\
&\quad\wedge \langle\textsc{Etime1}\rangle\ (e_1 \wedge\ \langle\mathrm{F}\rangle\ s_1)\\
&\quad\wedge \langle\textsc{Etime2}\rangle\ (e_2 \wedge\ \langle\mathrm{P}\rangle\ s_1)\\
&\quad\wedge \langle\mathrm{NB}\rangle\ c_1\\
&\quad\wedge \langle\textsc{Speaker}\rangle\ x_1 \wedge\ \langle\textsc{Hearer}\rangle\ y_1\\
&)
\end{aligned}
\tag{3.32}
$$

The sun rises in the east. (3.33)

In this example the event time is even less specified than in 3.31, the event of rising happens at some unspecified moments. From the sentence I can entail that such event began at least once at a time in the past (e_2) and that it has not ended (the end (e_3) of the event or events lies in the future).

$$
\begin{aligned}
&@_{r_1}(\mathsf{rise_1}\\
&\quad\wedge \langle\textsc{Actor}\rangle\ (s_1 \wedge \mathsf{sun_1})\\
&\quad\wedge \langle\textsc{Where}\rangle\ (e_1 \wedge \mathsf{east_1})\\
&\quad\wedge \langle\textsc{Stime}\rangle\ s_1\\
&\quad\wedge \langle\textsc{Etime2}\rangle\ (e_2 \wedge\ \langle\mathrm{F}\rangle\ s_1)\\
&\quad\wedge \langle\textsc{Etime2}\rangle\ (e_3 \wedge\ \langle\mathrm{P}\rangle\ s_1)\\
&\quad\wedge \langle\mathrm{NB}\rangle\ e_1\\
&\quad\wedge \langle\textsc{Speaker}\rangle\ x_1 \wedge\ \langle\textsc{Hearer}\rangle\ y_1\\
&)
\end{aligned}
\tag{3.34}
$$

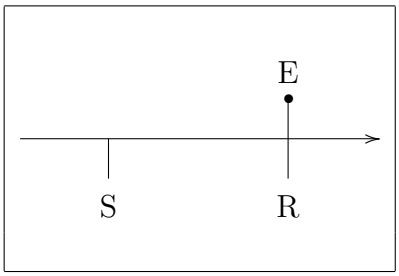
I play tennis on Sunday mornings. (3.35)

This is an example of iteration. The e_1 is the beginning of the iterative event and e_2 is the end. Between these two moments the action may be

interrupted. It is the WHEN relation that restricts the activity to Sunday mornings.

$$
\begin{aligned}
&@_{p_1}(\mathsf{play_1} \\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1 \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (t_1 \wedge \mathsf{tennis_1}) \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{P} \rangle\ s_2) \\
&\quad \wedge \langle \textsc{When} \rangle\ (m_1 \\
&\qquad\qquad \wedge \mathsf{morning_1} \\
&\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ \mathit{plural} \\
&\qquad\qquad \wedge \langle \textsc{Rstr} \rangle\ (s_1 \wedge \mathsf{Sunday_1}) \\
&\qquad\qquad) \\
&\quad \wedge \langle \mathrm{NB} \rangle\ p_1 \wedge\ \langle \mathrm{NB} \rangle\ m_1 \wedge\ \langle \mathrm{NB} \rangle\ t_1 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
\tag{3.36}
$$

3.3.3 Simple future



(3.37)

Simple future

The simple future tense is similar to the simple past tense. Only the relation to the utterance time is inverse.

I will never help you. (3.38)

In this example the

$$
\begin{aligned}
&@_{h_1}(\mathsf{help}_1 \\
&\quad \wedge \mathsf{negative} \\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1 \\
&\quad \wedge \langle \textsc{Addressee} \rangle\ y_1 \\
&\quad \wedge \langle \textsc{TillWhen} \rangle\ (f_1 \wedge \mathsf{forever}_1) \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \mathrm{P} \rangle\ s_1) \\
&\quad \wedge \langle \mathrm{NB} \rangle\ h_1 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
\tag{3.39}
$$

Liverpool are going to win the match. (3.40)

In this example it would be useful to represent that the e_1 timepoint is in the near future to the s_1. The problem is that this near future can vary from a few seconds to several months. This aspect of the utterance is thus not annotated.

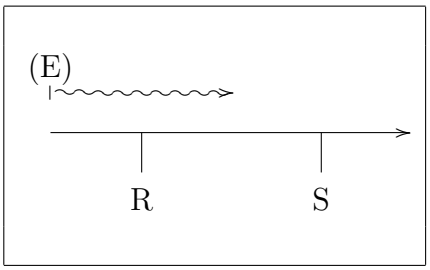
$$
\begin{aligned}
&@_{w_1}(\mathsf{win}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (l_1 \wedge \mathsf{Liverpool}_2) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (m_1 \wedge \mathsf{match}_1) \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \mathrm{P} \rangle\ s_1) \\
&\quad \wedge \langle \mathrm{NB} \rangle\ w_1 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
\tag{3.41}
$$

I'll have the steak, please. (3.42)

Note the similarity to the example 3.31. However, there are some differences. This sentence does not speak about the present, the event completely lies in the future. Note the *volitive* deontic modality in spite of the fact that the verb is syntactically *declarative*.

$$
\begin{aligned}
&@_{h_1}(\mathsf{have}_2 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1 \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (s_1 \wedge \mathsf{steak}_1) \\
&\quad \wedge \langle \textsc{DeontMod} \rangle\ \mathit{volitive} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_2 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \mathrm{P} \rangle\ s_2) \\
&\quad \wedge \langle \mathrm{NB} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
\tag{3.43}
$$

3.3.4 Past perfect



(3.44)

Past perfect

Past perfect is the first tense that is said to have three distinct times. But what is the reference time? A speaker can not utter a clause in the past perfect tense when there is no reference point established in the discourse. The reference timepoints are the event times of utterances that have occurred before the use of the past perfect[4]. Example 3.45 illustrate this:

When I got to the party, Peter had gone home. (3.45)

The first clause introduces the timepoint e_1 and the event time in the second clause is restricted in the way that it precedes e_1. No explicit annotation of the reference time in g_2 could enhance the representation of its content.

[4]It is not always *before*, consider an alternative of ex. 3.45: "Peter had gone home, when I got to the party". However, such exceptions can be annotated without any need of reference time, too, while this sentence would receive the same representation as 3.45.

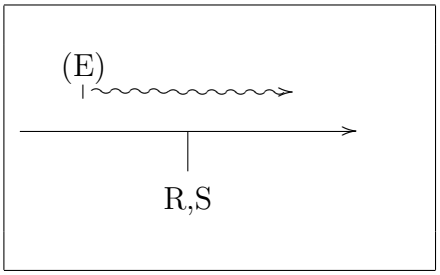
$$
\begin{aligned}
&@_{g_1}(\mathsf{get}_1\\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1\\
&\quad \wedge \langle \textsc{WhereTo} \rangle\ (p_1 \wedge \mathsf{party}_1)\\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ s_1)\\
&\quad \wedge \langle \mathrm{NB} \rangle\ g_1 \wedge\ \langle \mathrm{NB} \rangle\ p_1\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)\\
&@_{g_2}(\mathsf{go}_1\\
&\quad \wedge \langle \textsc{Actor} \rangle\ (p_2 \wedge \mathsf{Peter}_1)\\
&\quad \wedge \langle \textsc{WhereTo} \rangle\ (h_1\\
&\qquad\qquad \wedge \mathsf{home}_1\\
&\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ p_2\\
&\qquad\qquad)\\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{F} \rangle\ e_1)\\
&\quad \wedge \langle \mathrm{NB} \rangle\ g_2 \wedge\ \langle \mathrm{NB} \rangle\ h_1 \wedge\ \langle \mathrm{NB} \rangle\ p_2\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)
\end{aligned}
\tag{3.46}
$$

I didn't want to go to the cinema with the others because I'd seen the film before. (3.47)

The temporal aspects of this example are similar to the previous one. This example is interesting because of the relationship between 'going to cinema' in the former clause and 'seeing the film' in the latter. This sentence entails that the cinema played the film (that the speaker had seen) at the time at which he or she didn't go there (or at the time he or she went there if he or she changed his or her mind). The state denoted by p_1 represent this entailment.

$$
\begin{aligned}
&@_{g_1}(\mathsf{go}_1\\
&\quad \wedge \mathsf{negative}\\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1\\
&\quad \wedge \langle \textsc{WhereTo} \rangle\ (c_1 \wedge \mathsf{cinema}_1)\\
&\quad \wedge \langle \textsc{DeontMod} \rangle\ \mathit{volitive}\\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ s_1)\\
&\quad \wedge \langle \textsc{Accompaniment} \rangle\ (o_1\\
&\qquad\qquad\qquad \wedge \mathsf{other}_1\\
&\qquad\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ \mathit{plural}\\
&\qquad\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ x_1\\
&\qquad\qquad\qquad)\\
&\quad \wedge \langle \textsc{Cause} \rangle\ s_2\\
&\quad \wedge \langle \mathrm{NB} \rangle\ c_1\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)\\
&@_{s_2}(\mathsf{see}_1\\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1\\
&\quad \wedge \langle \textsc{Patient} \rangle\ (f_1 \wedge \mathsf{film}_1)\\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_2 \wedge\ \langle \mathrm{P} \rangle\ s_1)\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{F} \rangle\ e_1)\\
&\quad \wedge \langle \mathrm{NB} \rangle\ s_2\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)\\
&@_{p_1}(\mathsf{play}_1\\
&\quad \wedge \langle \textsc{Actor} \rangle\ c_1\\
&\quad \wedge \langle \textsc{Patient} \rangle\ f_1\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e_1\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)
\end{aligned}
\tag{3.48}
$$

3.3.5 Present perfect



(3.49)

Present perfect

How long have we known Peter? (3.50)

In this question the speaker asks what is the time between e_1 – the time in which they began to know Peter – and s_1 – the time of the utterance (exactly as in the diagram 3.49 the time between '(E)' and 'S'). The time e_2 is the end of knowing Peter, the use of the perfect tense suggests that this timepoint is after the utterance time.

Note that in my interpretation the speaker includes the hearer to the group identified by 'we' and that in case of question the NB relation has a key role in distinguishing what is the core of the question.

$$
\begin{aligned}
&@_{k_1}(\mathsf{know}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (w_1 \\
&\qquad\qquad \wedge\ \mathsf{we} \\
&\qquad\qquad \wedge @_{x_1}\ \langle \textsc{MemberOf} \rangle\ w_1 \\
&\qquad\qquad \wedge @_{y_1}\ \langle \textsc{MemberOf} \rangle\ w_1 \\
&\qquad\qquad) \\
&\quad \wedge\ @_{i_1}(\ \langle \textsc{HowLong} \rangle\ l_1 \\
&\qquad\quad \langle \textsc{Etime1} \rangle\ e_1 \\
&\qquad\quad \langle \textsc{Etime2} \rangle\ s_1 \\
&\qquad) \\
&\quad \wedge\ \langle \textsc{Patient} \rangle\ (p_1 \wedge \mathsf{Peter}_1) \\
&\quad \wedge\ \langle \textsc{EventMod} \rangle\ \mathit{interrogative} \\
&\quad \wedge\ \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge\ \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ s_1) \\
&\quad \wedge\ \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{P} \rangle\ s_1) \\
&\quad \wedge\ \langle \mathrm{NB} \rangle\ l_1 \\
&\quad \wedge\ \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
\tag{3.51}
$$

How many times has he been married? (3.52)

In this example I suggest to use the HowOften relation to represent a 'how many times' expression, because they are semantically near. Sometimes they are difficult to distinguish[5] and the hearer can answer this question with a 'how often' expression appropriately.

$$
\begin{aligned}
@_{m_1}(&\mathsf{marry_1}\\
&\wedge \langle \textsc{Actor} \rangle\ (h_1 \wedge \mathsf{he_1})\\
&\wedge \langle \textsc{Patient} \rangle\ p_1\\
&\wedge \langle \textsc{HowOften} \rangle\ o_1\\
&\wedge \langle \textsc{EventMod} \rangle\ \mathit{interrogative}\\
&\wedge \langle \textsc{Stime} \rangle\ s_1\\
&\wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ s_1)\\
&\wedge \langle \textsc{Etime2} \rangle\ s_1\\
&\wedge \langle \mathrm{NB} \rangle\ o_1\\
&\wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
)&
\end{aligned}
\tag{3.53}
$$

I've lost my wallet. (3.54)

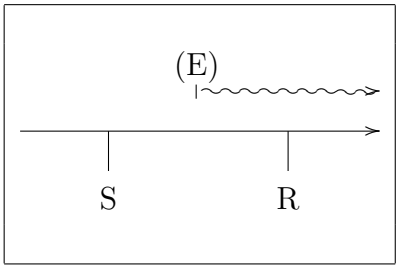
In this case the use of the perfect tense suggests that the consequences of the event last. I believe it is a matter of interpretation in the context whether this sentence entails that the speaker doesn't have the wallet at the time of the utterance. If the annotator interprets this sentence as having such entailment, he or she should add 3.56 to 3.55.

$$
\begin{aligned}
@_{l_1}(&\mathsf{loose_1}\\
&\wedge \langle \textsc{Actor} \rangle\ x_1\\
&\wedge \langle \textsc{Patient} \rangle\ (w_1\\
&\qquad \wedge \mathsf{wallet_1}\\
&\qquad \wedge \langle \textsc{Appurtenance} \rangle\ x_1\\
&\qquad)\\
&\wedge \langle \textsc{Stime} \rangle\ s_1\\
&\wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ s_1)\\
&\wedge \langle \mathrm{NB} \rangle\ l_1 \wedge\ \langle \mathrm{NB} \rangle\ w_1\\
&\wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
)&
\end{aligned}
\tag{3.55}
$$

[5] See example 3.17 on page 22.

$$
\begin{aligned}
@_{h_1}(&\mathsf{have}_1 \\
&\wedge \langle \textsc{Actor} \rangle\ x_1 \\
&\wedge \langle \textsc{Patient} \rangle\ w_1 \\
&\wedge \mathsf{negative} \\
&\wedge \langle \mathrm{NB} \rangle\ h_1 \\
&\wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\wedge \langle \textsc{Etime1} \rangle\ e_1 \\
&\wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{P} \rangle\ s_1) \\
&\wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
)&
\end{aligned}
\tag{3.56}
$$

3.3.6 Future perfect



(3.57)

Future perfect

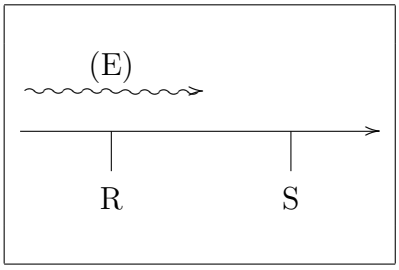
I'll have it done by tomorrow. (3.58)

Here the annotator must realize that this 'do' represents an accomplishment, it is not only an activity. The perfective aspect (culmination) of the event is reflected in the Extent relation.

Note also the indexical expression 'tomorrow'. It must be specified to which timepoint the expression should be associated.

$$
\begin{aligned}
&@_{d_1}(\mathsf{do}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1 \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (i_1 \wedge \mathsf{it}_1) \\
&\quad \wedge \langle \textsc{Extent} \rangle\ (c_1 \wedge \mathsf{completely}_1) \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ e_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \\
&\qquad\qquad \wedge \langle \mathrm{P} \rangle\ s_1 \\
&\qquad\qquad \wedge \langle \mathrm{F} \rangle\ (t_1 \\
&\qquad\qquad\qquad \wedge \mathsf{tomorrow}_1 \\
&\qquad\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ s_1 \\
&\qquad\qquad\qquad) \\
&\qquad\qquad) \\
&\quad \wedge \langle \mathrm{NB} \rangle\ t_1 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
\tag{3.59}
$$

3.3.7 Past progressive



(3.60)

Past progressive

I was reading a book during the flight. (3.61)

Here we want to associate the event of reading to the flight. The flight is not an event itself, but it doesn't prevent it from having a temporal extension described by relations Etime1 and Etime2.

The interpretation 3.62 annotates the 'during' expression as two constraints:

1. The event of reading a book started after the start of the flight ($@_{e_1}\ \langle \mathrm{P} \rangle\ f_1$).
2. The event of reading a book finished before the end of the flight ($@_{e_2}\ \langle \mathrm{F} \rangle\ f_2$).

In a real discourse annotation the flight f_0 would be already in the stock of shared knowledge before this utterance.

$$
\begin{aligned}
&@_{r_1}(\mathsf{read}_1\\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1\\
&\quad \wedge \langle \textsc{Patient} \rangle\ (b_1 \wedge \mathsf{book}_2)\\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1\\
&\quad \wedge @_{f_0}(\mathsf{flight}_1 \wedge\ \langle \textsc{Etime1} \rangle\ f_1 \wedge\ \langle \textsc{Etime2} \rangle\ f_2)\\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \mathrm{P} \rangle\ f_1)\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{F} \rangle\ f_2 \wedge\ \langle \mathrm{F} \rangle\ s_1)\\
&\quad \wedge \langle \mathrm{NB} \rangle\ r_1 \wedge\ \langle \mathrm{NB} \rangle\ b_1\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)
\end{aligned}
\tag{3.62}
$$

When the phone rang, I was having a bath. (3.63)

If we mark the point of ringing as e_1 and the event of having bath as being from e_2 to e_3, the following representation reflects the intuition that we can imagine the relationship of these timepoints as $e_2 \longrightarrow e_1 \longrightarrow e_3$. Note that I annotated the event of ringing as instantaneous. It's because the speaker presented the ringing in such a way. The annotator can also introduce a Etime1 point for event r_1 but if the annotator finds out the need for such a time anchor later, he or she can just add such a new point e_0 by formula $@_{r_1}\ \langle \textsc{Etime1} \rangle\ e_0$.

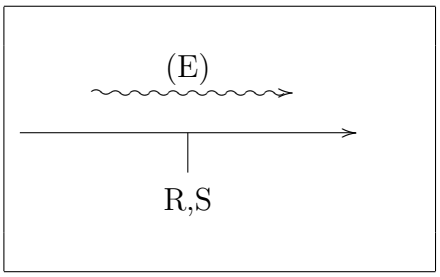
$$
\begin{aligned}
&@_{r_1}(\mathsf{ring}_1\\
&\quad \wedge \langle \textsc{Actor} \rangle\ (p_1 \wedge \mathsf{phone}_1)\\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ s_1)\\
&\quad \wedge \langle \mathrm{NB} \rangle\ r_1\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)\\
&@_{h_1}(\mathsf{have}_2\\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1\\
&\quad \wedge \langle \textsc{Patient} \rangle\ (b_1 \wedge \mathsf{bath}_1)\\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1\\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_2 \wedge\ \langle \mathrm{F} \rangle\ e_1)\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_3 \wedge\ \langle \mathrm{P} \rangle\ e_1)\\
&\quad \wedge \langle \mathrm{NB} \rangle\ b_1\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)
\end{aligned}
\tag{3.64}
$$

I was going out with Jack when I first met Harry. (3.65)

This sentence has a temporal scheme very similar to the previous one.

$$
\begin{aligned}
&@_{g_1}\ (\mathsf{go\_out}_1\\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1\\
&\quad \wedge \langle \textsc{Patient} \rangle\ (j_1 \wedge \mathsf{Jack}_1)\\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1\\
&\quad \wedge \langle \textsc{Etime1} \rangle\ e_1\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{F} \rangle\ s_1)\\
&\quad \wedge \langle \mathrm{NB} \rangle\ g_1 \wedge\ \langle \mathrm{NB} \rangle\ j_1\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)\\
&@_{m_1}(\mathsf{meet}_1\\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1\\
&\quad \wedge \langle \textsc{Patient} \rangle\ (h_1 \wedge \mathsf{Harry}_1)\\
&\quad \wedge \langle \textsc{Manner} \rangle\ (t_1 \wedge \mathsf{time}_2 \wedge\ \langle \textsc{Rstr} \rangle\ (f_1 \wedge \mathsf{first}_1))\\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_2 \wedge\ \langle \mathrm{P} \rangle\ s_1)\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_3 \wedge\ \langle \mathrm{P} \rangle\ e_1 \wedge\ \langle \mathrm{F} \rangle\ e_2 \wedge\ \langle \mathrm{F} \rangle\ s_2)\\
&\quad \wedge \langle \mathrm{NB} \rangle\ m_1 \wedge\ \langle \mathrm{NB} \rangle\ h_1 \wedge\ \langle \mathrm{NB} \rangle\ f_1\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)
\end{aligned}
\tag{3.66}
$$

3.3.8 Present progressive



(3.67)

Present progressive

Don't turn the TV off. I'm watching it. (3.68)

In the case of the present progressive tense we have one more information in comparison with the simple present tense. We know not only that the event started in the past and will finish in the future, but also that it is under run at the time of the utterance. This is important in case of repetitive actions. One can say 'I watch the TV every day' and this sentence does

not entail that it is happening at the utterance time. The entailment is represented as '$@_{w_1}$ $\langle$When$\rangle$ s_2' – meaning 'The event w_1 is in progress at the timepoint denoted by s_2. When we know that the event was in progress at the time s_2, it is not necessary to write $@_{e_2}$ $\langle$F$\rangle$ s_2 and $@_{e_3}$ $\langle$P$\rangle$ s_2, while this can be inferred automatically. The rule would be $\langle$When$\rangle$ $r \rightarrow$ ($\langle$Etime1$\rangle$ $\langle$F$\rangle$ $r \wedge$ $\langle$Etime2$\rangle$ $\langle$P$\rangle$ r) . See also example 3.73 on the page 41.

$$
\begin{aligned}
&@_{t_1}\,(\mathsf{turn\_off_1}\\
&\quad \wedge \langle \textsc{Actor} \rangle\ y_1\\
&\quad \wedge \langle \textsc{Patient} \rangle\ (t_2 \wedge \mathsf{TV_1})\\
&\quad \wedge \langle \textsc{Cause} \rangle\ w_1\\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{imperative}\\
&\quad \wedge \mathsf{negative}\\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge \langle \mathrm{P} \rangle\ s_1)\\
&\quad \wedge \langle \mathrm{NB} \rangle\ t_1\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)\\
&@_{w_1}(\mathsf{watch_1}\\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1\\
&\quad \wedge \langle \textsc{Patient} \rangle\ (t_2 \wedge \mathsf{it_1})\\
&\quad \wedge \langle \textsc{When} \rangle\ s_2\\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_2 \wedge \langle \mathrm{P} \rangle\ s_1)\\
&\quad \wedge \langle \textsc{Etime1} \rangle\ e_2\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e_3\\
&\quad \wedge \langle \mathrm{NB} \rangle\ w_1\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)
\end{aligned}
\tag{3.69}
$$

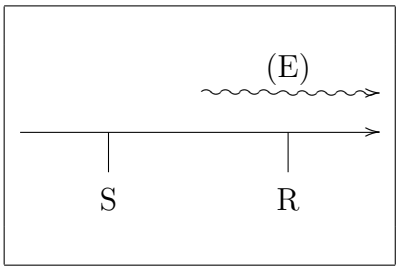
I'm doing a French evening course this year. (3.70)

In this example the only information about the start time e_1 is that it is restricted to the year of the utterance as well as the end time e_2. The course could have started or not at the time of the utterance. On the other hand the end of the course lies in the future.

Note that the annotator must decide whether the speaker talks about the calendar year (let's say $\mathsf{year_1}$) or an academic year (e.g. $\mathsf{year_2}$). If the annotator doesn't know what kind of year it should be, he or she should create a new propositional symbol $\mathsf{year_{n+1}}$, where n is the biggest index used for indexing year.

$$
\begin{aligned}
&@_{d_1}(\mathsf{do}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1 \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (c_1 \\
&\qquad\qquad \wedge\ \mathsf{course}_1 \\
&\qquad\qquad \wedge \langle \textsc{Patient} \rangle\ (f_1 \wedge \mathsf{French}_1) \\
&\qquad\qquad \wedge \langle \textsc{Rstr} \rangle\ (e_0 \wedge \mathsf{evening}_1) \\
&\qquad\qquad) \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \textsc{Rstr} \rangle\ (y_1 \\
&\qquad\qquad\qquad\qquad \wedge\ \mathsf{year}_2 \\
&\qquad\qquad\qquad\qquad \wedge \langle \textsc{App} \rangle\ s_1 \\
&\qquad\qquad\qquad\qquad) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \textsc{Rstr} \rangle\ y_1 \wedge\ \langle \textsc{P} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{NB} \rangle\ c_1 \wedge\ \langle \textsc{NB} \rangle\ f_1 \wedge\ \langle \textsc{NB} \rangle\ e_0 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_2 \\
&)
\end{aligned}
\tag{3.71}
$$

3.3.9 Future progressive



(3.72)

Future progressive

Here the reference time should be created by the discourse in a manner similar as in case of past progressive.

Come, I'll be waiting. (3.73)

In this example the time of 'waiting' from e_2 to e_3 is restricted to begin before e_1 and end after e_1. Moreover the event is in progress in the time e_1. The former facts can be inferred automatically from the latter, as in example 3.68 on the page 39. That's why the points e_2 and e_3 in this example are not explicitly connected to the point e_1.

$$
\begin{aligned}
&@_{c_1}\,(\mathsf{come_1}\\
&\quad \wedge \langle \textsc{Actor} \rangle\ y_1\\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{imperative}\\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \mathrm{P} \rangle\ s_1)\\
&\quad \wedge \langle \mathrm{NB} \rangle\ c_1\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)\\
&@_{w_1}(\mathsf{wait_1}\\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1\\
&\quad \wedge \langle \textsc{Patient} \rangle\ c_1\\
&\quad \wedge \langle \textsc{When} \rangle\ e_1\\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_2 \wedge\ \langle \mathrm{P} \rangle\ s_1)\\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_2 \wedge\ \langle \mathrm{P} \rangle\ s_2)\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e_3\\
&\quad \wedge \langle \mathrm{NB} \rangle\ w_1\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)
\end{aligned}
\tag{3.74}
$$

Chapter 4

Anaphora and reference

Anaphora solving and reference representation must be an inherent part of any logical discourse representation. In this chapter I will show how to refer to individuals, individual roles and events by means of hybrid logic. In section 4.5 I will also show the referring to subsets, supersets and other associated objects. Basics ideas in this chapter come from DRT as described in Van Eijck and Kamp [3].

4.1 Referring to a class or group

A group can be referenced in the same way as an individual. In the first occurrence[1] of the group we will assign a new nominal. The group can be distinguished by having an EXTENT relation. For example in 7.1 on the page 65 the expression 'two sons' establishes a new group with the extent of 2. If we don't know the extent so precisely, we can use the reserved *plural* nominal, as in 3.36 on the page 29. The extent may be expressed not only by a number, but also by a quantifier as in 8.7 on the page 89, where the group s_2 is the group of *all* squirrels, or by a fuzzy numeral as in 8.17 on the page 94, where the nominal c_1 represents the group of *many* countries.

Sometimes the group is not characterized and it's only a group of individuals that eventually had something in common. In this case we use the relation MEMBEROF to specify the group. See example 8.5 on the page 88, where in both interpretations the group s_1 is the group consisting of 'Peter' and 'Paul'. These two means of group specification can be combined.

To annotate a reference to a group, we must distinguish between the reference to the whole group from the reference to its members. This is

[1] It doesn't necessarily have to be the first occurrence in the text, it is the first time we come across the group in the annotational process.

exactly the difference shown in the example 8.5 on the page 88. In the first case the ACTOR is the group while in the second interpretation the members act.

The reference can be quite complex as in example 8.22 on the page 98. There we need three nominals:

- t_1 for the group referenced by 'them'. This nominal would be introduced earlier in the discourse under normal circumstances.
- f_1 for 'the five'. The use of the definite article should mean that they are mentioned before and the nominal should be associated as well as t_1.
- ev_1 denotes the actor. It references the members of the group, we could say it is an iteration over the group.

4.2 Reference by indexical tokens

In this section I will address not only expressions as 'I', 'you', 'now' or 'here'. I consider indexical also expressions not directly connected to the situation of the utterance, but those which don't have a reasonable sense without anchoring in a context, such as 'north', 'last' or 'this year'.

In the first case we can simply use the nominals introduced by the discourse. 'I' will get the same nominal as the one in SPEAKER relation, 'you' is the same case for the HEARER relation, 'now' can be identified with the time of speech related by STIME, see chapter 3 for a closer look on annotation of temporal aspects. 'here' can be represented by the speaker.

In the second case we will use the relation APPURTENANCE to "anchor" the expression. For example using of 'this year' as the specification of the endpoint of the event n_1 can be annotated as:

$$
\begin{array}{l}
@_{n_1}(\\
\quad \vdots \\
\quad \wedge \langle \text{ETIME2} \rangle \, (e_1 \wedge \langle \text{RSTR} \rangle \, (y_1 \wedge \mathsf{year}_1 \\
\qquad\qquad\qquad\qquad\qquad\qquad \wedge \langle \text{APPURTENANCE} \rangle \, s_1 \\
\qquad\qquad\qquad\qquad\qquad\quad) \\
\qquad\qquad\quad) \\
\quad \wedge \langle \text{STIME} \rangle \, s_1 \\
)
\end{array}
\tag{4.1}
$$

A complete example with 'this year' can be found on the page 40.

See also example 8.14 on the page 93 for 'north' and 5.11 on the page 55 for 'last'.

There are some other expressions that are not exactly indexical but need to be assigned to an object in order to make sense. We should always recognize such expression and add the information not explicitly mentioned in the sentence. Examples of such expressions could be 'home' from example 3.45 on the page 31 and 'others' from example 3.47 on the page 32.

4.3 Referring to objects and concepts

The key to the ability to refer back to an entity lies in assigning every object of the discourse a nominal.

Jaroslav loves Apples.
He could sing all their songs. (4.2)

In this example, the second sentence refers to 'Jaroslav' as an individual from the first sentence, and also to 'Apples', as a concept. The possibility to refer to these objects is enabled by introducing nominals in the first sentence:

$$
\begin{aligned}
&@_{l_1}(\mathsf{love_2}\\
&\quad \wedge \langle \textsc{Actor} \rangle\ (j_1 \wedge \mathsf{Jaroslav_1})\\
&\quad \wedge \langle \textsc{Patient} \rangle\ (a_1 \wedge \mathsf{Apples_1})\\
&\quad \wedge \langle \mathrm{NB} \rangle\ j_1 \wedge\ \langle \mathrm{NB} \rangle\ a_1 \wedge\ \langle \mathrm{NB} \rangle\ l_1\\
&\quad \wedge \langle \textsc{Stime} \rangle\ t_1\\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ t_1)\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{P} \rangle\ t_1)\\
&\quad)\\
&@_{s_1}(\mathsf{sing_1}\\
&\quad \wedge \langle \textsc{Actor} \rangle\ (j_1 \wedge \mathsf{he_1})\\
&\quad \wedge \langle \textsc{Patient} \rangle\ (s_2\\
&\qquad\qquad \wedge \mathsf{song_1}\\
&\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ \mathit{every}\\
&\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ (a_1 \wedge \mathsf{they_1})\\
&\qquad\qquad)\\
&\quad \wedge \langle \mathrm{NB} \rangle\ s_2 \wedge\ \langle \mathrm{NB} \rangle\ s_1\\
&\quad \wedge \langle \textsc{DeontMod} \rangle\ \mathit{facultative}\\
&\quad \wedge \langle \textsc{Stime} \rangle\ (t_2 \wedge\ \langle \mathrm{P} \rangle\ t_1)\\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_3 \wedge\ \langle \mathrm{F} \rangle\ t_2)\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_4 \wedge\ \langle \mathrm{P} \rangle\ t_2)\\
&\quad)
\end{aligned}
\tag{4.3}
$$

Notice two things in this example:

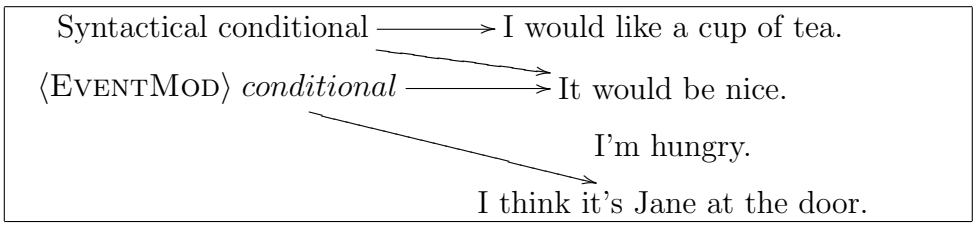
1. The propositional symbol love_2 differs from the symbol love_1 used in 'John loves Mary' (1.16 and later). It was because my interpretation of the sentence. As the annotator I decided that this *love* has a different meaning from the first *love* and therefore I assigned a new propositional symbol. If I thought the meaning of *love* is the same as before, I would use the same love_1.

2. The reference to the individual 'Jaroslav' is handled in the same way as the reference to 'Apples', because in this case the expression 'their' refers to the same entity, but the annotator must be aware of the difference between an individual and a concept. See example 2.5 on page 13 and note the difference between the physical 'book' and the notion of 'novel'.

4.4 Referring to events and propositions

In the approach introduced in this thesis the events are equated to the propositions that describe them. This may seem disadvantageous because we can not refer to a sentence as such, but on the other hand we can still refer to the content of the proposition. Instead of 'The preceding sentence is a lie.', we can annotate only 'The content of the preceding sentence is a lie.' (see example 8.32 on the page 104.) It is in question whether this can cause any trouble.

While each proposition is represented by a nominal, it is easy to refer to. However, it's important to distinguish **real** events from **hypothetical** events. The latter will receive the EventMod *conditional*. This modality should NOT be automatically connected with 'would' or any other means of *syntactical* modality. The *conditional* EventMod should be used in case of *hypothetical* speech. All combination of semantic and syntactic "conditional" modalities are possible:



The first and the last sentences are interesting because the syntactical 'conditional' doesn't correspond to our *conditional*. The first sentence should

be annotated exactly as example 3.31 on the page 27, it should get the EventMod *declarative* and DeontMod *volitive*.

In the last sentence the utterance consists of two events: the event of thinking and the event of being at the door. The former needs to refer to the latter. But the latter is not real, because this sentence doesn't state that it's Jane at the door.

On the other hand consider following sentence:

I'll go because it's Jane at the door. (4.4)

In this case again the first event refers to the second (as a Cause) but this time the second event is real—by this sentence the speaker states that Jane is at the door.

To sum up, here is the representation of 'I think it's Jane at the door':

$$
\begin{aligned}
&@_{th_1}(\mathsf{think}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1 \\
&\quad \wedge \langle \textsc{Patient} \rangle\ b_2 \\
&\quad \wedge \langle \textsc{NB} \rangle\ th_1 \wedge\ \langle \textsc{NB} \rangle\ b_2 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ t_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1^1 \wedge\ \langle \textsc{F} \rangle\ t_1) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1^2 \wedge\ \langle \textsc{P} \rangle\ t_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad) \\
&@_{b_2}\ (\mathsf{be}_2 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (j_2 \wedge \mathsf{Jane}_1) \\
&\quad \wedge \langle \textsc{Where} \rangle\ (d_2 \wedge \mathsf{door}_1) \\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \textit{conditional} \\
&\quad \wedge \langle \textsc{NB} \rangle\ j_2 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (t_2 \wedge\ \langle \textsc{P} \rangle\ t_1) \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_2^1 \wedge\ \langle \textsc{F} \rangle\ t_2) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2^2 \wedge\ \langle \textsc{P} \rangle\ t_2) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
\tag{4.5}
$$

And here the representation of 4.4:

$$
\begin{aligned}
&@_{g_1}(\mathsf{go}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1 \\
&\quad \wedge \langle \textsc{Where} \rangle\ w_1 \\
&\quad \wedge \langle \textsc{Cause} \rangle\ b_2 \\
&\quad \wedge \langle \mathrm{NB} \rangle\ g_1 \wedge\ \langle \mathrm{NB} \rangle\ b_2 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ t_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1^1 \wedge\ \langle \mathrm{P} \rangle\ t_1) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e_1^2 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad) \\
&@_{b_2}(\mathsf{be}_2 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (j_2 \wedge \mathsf{Jane}_1) \\
&\quad \wedge \langle \textsc{Where} \rangle\ (d_2 \wedge \mathsf{door}_1) \\
&\quad \wedge \langle \mathrm{NB} \rangle\ j_2 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (t_2 \wedge\ \langle \mathrm{P} \rangle\ t_1) \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_2^1 \wedge\ \langle \mathrm{F} \rangle\ t_2) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2^2 \wedge\ \langle \mathrm{P} \rangle\ t_2) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
\tag{4.6}
$$

For more examples of handling 'would' and *conditional*, see examples 8.35 on the page 106 , 7.17 on the page 74 and 7.27 on the page 79.

4.5 Reference by association

Reference by association is the worst kind of reference for any computational approach because it relies on the hearer's (or computer's) knowledge of the world. It is not a reference directly to an object or event in the stock of shared knowledge (SSK). It's rather the reference to something that is closely semantically connected to a highly activated item in SSK. The analysis of items' activation in SSK can be found in Sgall, Hajičová and Panevová [20].

We will represent such a connection according to its kind. The most often used relation will probably be Appurtenance. Examples of associative reference can be:

The flat is nice but the walls need repainting.
When I finally got to the shop, the doughnuts were sold out.
I love Paris. I wish I could be in one of the lovely gardens.

All these examples have one thing in common: the second clause refers to something in the first clause, but this reference is not explicit. It's the

annotator's knowledge of the world that enables him or her to entail that the walls are the walls of the flat just mentioned, that the doughnuts were sold in the particular shop and that "the gardens" are the gardens of Paris. However for the sake of logical representation it is necessary to represent such associations because they have essential influence for the content of the sentence.

To look at some annotated examples of association, see example 3.47 on the page 32 and 5.11 on the page 55.

Chapter 5

Topic-focus articulation

In this chapter I address the importance of representing topic-focus articulation (TFA) and its representation.

5.1 Need for TFA

The representation of TFA should be an inherent part of any semantic representation for several important reasons:

1. To quote Peregrin [16]: "Different TFA's lead not only to different felicity conditions, but to quite different propositions."

2. To quote Peregrin [14]: "In case of sentences with a generic noun phrase the subject-predicate structuring that is yielded by the TFA determines the scope and thus can mean differences not only regarding felicity conditions, but also regarding truth conditions proper, like in case of *Every man loves a woman.*"

3. The TFA has major influence on the stock of shared knowledge.

4. To quote Peregrin [15]: "The TFA pattern triggers an existential presupposition connected with the topic, and it gives the focus a certain claim of exhaustiveness of the significant."

The importance of the TFA for the meaning of a sentence is described in detail also in Hajičová, Panevová and Sgall [20].

In the following example 5.1 the person C must have placed the intonation centre on the word 'Lisa', otherwise the discourse would be infelicitous. If this discourse was a piece of scene played by some actors and if the actor

playing C would place the intonation centre on the word 'killed', it would reveal his or her incomprehension of the situation.

The utterance of C is an example of the ACTOR being in the focus of the sentence. In case of English the difference can seem minor while it's in the intonation and we usually work with a written text. But there are at least two reasons for considering such a difference as an important one:

1. Intonation is not the only one form to express the function of focus. C could say for instance 'It was Lisa who killed him' or 'He was killed by Lisa'. And as Kruijff [9] (in chapters 6-8) notes, in some languages the intonation is not the primary form for expressing the TFA.

2. The meaning of 'LISA killed him' really differs from the meaning of 'Lisa KILLED him'. In spite of the fact that in this case the truth conditions seem to be the same, it is often not the case as example 5.11 shows.

Here is the example. For the sake of completeness there is also the corresponding annotation.

A : Remember the film we saw last week? How Mary killed John?
B : No, it's not true!
C : That's right, Lisa killed him.

(5.1)

$$
\begin{aligned}
&@_{r_1}(\mathsf{remember}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (e_1 \wedge\ \langle \textsc{Extent} \rangle\ \mathit{every} \\
&\qquad\qquad \wedge \langle \textsc{Rstr} \rangle\ (g_1 \\
&\qquad\qquad\qquad\qquad \wedge @_{b_1}\ \langle \textsc{MemberOf} \rangle\ g_1 \\
&\qquad\qquad\qquad\qquad \wedge @_{c_1}\ \langle \textsc{MemberOf} \rangle\ g_1 \\
&\qquad\qquad\qquad\qquad) \\
&\qquad\qquad) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (f_1 \wedge \mathsf{film}_1) \\
&\quad \wedge \langle \mathrm{NB} \rangle\ f_1 \wedge\ \langle \mathrm{NB} \rangle\ r_1 \\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{interrogative} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ a_1 \wedge\ \langle \textsc{Hearer} \rangle\ g_1 \\
&\quad)
\end{aligned}
\tag{5.2}
$$

$$
\begin{aligned}
&@_{s_2}(\mathsf{see}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (w_1 \wedge \mathsf{we}_1 \\
&\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ \mathit{every} \\
&\qquad\qquad \wedge \langle \textsc{Rstr} \rangle\ (g_2 \\
&\qquad\qquad\qquad\qquad \wedge @_{a_1}\ \langle \textsc{MemberOf} \rangle\ g_2 \\
&\qquad\qquad\qquad\qquad \wedge @_{b_1}\ \langle \textsc{MemberOf} \rangle\ g_2 \\
&\qquad\qquad\qquad\qquad \wedge @_{c_1}\ \langle \textsc{MemberOf} \rangle\ g_2 \\
&\qquad\qquad\qquad\qquad) \\
&\qquad\qquad) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ f_1 \\
&\quad \wedge \langle \mathrm{NB} \rangle\ s_2 \wedge\ \langle \mathrm{NB} \rangle\ e_3 \wedge\ \langle \mathrm{NB} \rangle\ l_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_3 \wedge\ \langle \mathrm{P} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_3 \\
&\qquad\qquad \wedge \mathsf{week}_1 \\
&\qquad\qquad \wedge \langle \textsc{Rstr} \rangle\ (l_1 \wedge \mathsf{last}_1) \\
&\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ s_3 \\
&\qquad\qquad) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ a_1 \wedge\ \langle \textsc{Hearer} \rangle\ g_1 \\
&)
\end{aligned}
\tag{5.3}
$$

$$
\begin{aligned}
&@_{r_2}(\mathsf{remember}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ e_1 \\
&\quad \wedge \langle \textsc{Patient} \rangle\ k_1 \\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{interrogative} \\
&\quad \wedge \langle \mathrm{NB} \rangle\ k_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_3 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ a_1 \wedge\ \langle \textsc{Hearer} \rangle\ g_1 \\
&\quad)
\end{aligned}
\tag{5.4}
$$

$$
\begin{aligned}
&@_{k_1}(\mathsf{kill}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (m_1 \wedge \mathsf{Mary}_1) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (j_1 \wedge \mathsf{John}_1) \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_3 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e_3 \\
&\quad \wedge \langle \mathrm{NB} \rangle\ m_1 \wedge\ \langle \mathrm{NB} \rangle\ k_1 \wedge\ \langle \mathrm{NB} \rangle\ j_1 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ a_1 \wedge\ \langle \textsc{Hearer} \rangle\ g_1 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ f_1 \\
&\quad)
\end{aligned}
\tag{5.5}
$$

$$
\begin{aligned}
&@_{b_2}(\mathsf{be}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (k_1 \wedge \mathsf{it}_1) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (t_1 \wedge \mathsf{true}_1) \\
&\quad \wedge \langle \mathrm{NB} \rangle\ t_1 \\
&\quad \wedge \mathsf{negative} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_5 \wedge\ \langle \mathrm{P} \rangle\ s_3) \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_4 \wedge\ \langle \mathrm{F} \rangle\ s_5) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_5 \wedge\ \langle \mathrm{P} \rangle\ s_5) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ b_1 \wedge\ \langle \textsc{Hearer} \rangle\ a_1 \\
&)
\end{aligned}
\tag{5.6}
$$

$$
\begin{aligned}
&@_{b_3}(\mathsf{be}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ b_2 \\
&\quad \wedge \langle \textsc{Patient} \rangle\ t_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_6 \wedge\ \langle \mathrm{P} \rangle\ s_5) \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_6 \wedge\ \langle \mathrm{F} \rangle\ s_6) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_7 \wedge\ \langle \mathrm{P} \rangle\ s_6) \\
&\quad \wedge \langle \mathrm{NB} \rangle\ b_3 \wedge\ \langle \mathrm{NB} \rangle\ t_1 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ c_1 \wedge\ \langle \textsc{Hearer} \rangle\ a_1 \\
&)
\end{aligned}
\tag{5.7}
$$

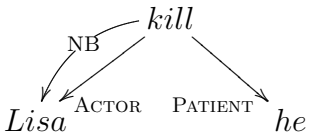
$$
\begin{aligned}
&@_{k_2}(\mathsf{kill}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (l_2 \wedge \mathsf{Lisa}_1) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (j_1 \wedge \mathsf{he}_1) \\
&\quad \wedge \langle \mathrm{NB} \rangle\ l_2 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_7 \wedge\ \langle \mathrm{P} \rangle\ s_6) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e_3 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ c_1 \wedge\ \langle \textsc{Hearer} \rangle\ a_1 \\
&)
\end{aligned}
\tag{5.8}
$$

5.2 TFA representation

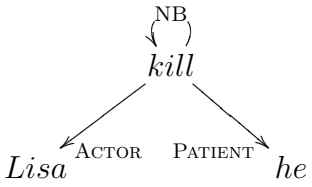
The topic-focus articulation of each event is annotated by the relation NB. This relation relates the event with everything in the focus. It may happen that the relation will connect the event itself.

In the case of example 5.1 the possible variants of TFA could be:

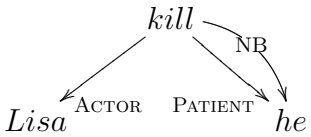
- LISA killed him.



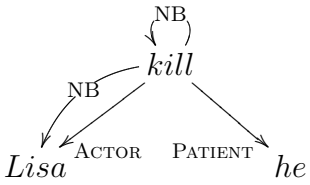
- Lisa KILLED him.



- Lisa killed HIM.



- LISA KILLED him.



Now what is the criterion for a nominal to be annotated as NB in an event:

1. In case of a **question** everything that the speaker asks about will be NB:

When did he give you what? (5.9)

$$
\begin{aligned}
&@_{g_1}(\mathsf{give}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (h_1 \wedge \mathsf{he}_1) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ p_1 \\
&\quad \wedge \langle \textsc{Addressee} \rangle\ y_1 \\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{interrogative} \\
&\quad \wedge \langle \mathrm{NB} \rangle\ e_1 \wedge\ \langle \mathrm{NB} \rangle\ p_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1\ \langle \mathrm{F} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&)
\end{aligned}
$$

Do you love him? (5.10)

$$
\begin{aligned}
&@_{l_1}(\mathsf{love}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ y_1 \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (h_1 \wedge \mathsf{he}_1) \\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{interrogative} \\
&\quad \wedge \langle \mathrm{NB} \rangle\ l_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&)
\end{aligned}
$$

Some more examples on questions are 3.50, 3.52, 7.19, 8.3, 8.25, 8.26 and 8.33.

2. In case of a **negative** sentence everything under the scope of the negation will be NB[1]. The examples are 5.11, 3.47, 3.68, 7.11, 7.18, 7.28, 7.32, 8.10 and 8.22.

3. In other cases the information that the speaker present as "new" should be annotated as NB. Note that this has nothing in common with the presence of the item in the stock of the shared knowledge—in 'Lisa killed HIM' the PATIENT is presented as already introduced, but he is NB. The decision on whether a particular information should be marked as NB depends strongly on the interpretation. For example in 3.33 on the page 28: 'The sun rises in the east.' In my interpretation the speaker didn't want to state that the sun rises. The statement was rather about the direction from which the sun rises. That's why I didn't encounter the 'rise' into the focus and let it as a presupposition (see Hajičová [7] for more about presuppositions and allegations).

At the end of this chapter here is an example of two sentences where the TFA plays the key role in representing and understanding the underlying semantics. It is a paraphrase of one of Hajičová's examples. In spite of the fact that in the first sentence of 5.11 we can read that 'We did not win', it is not true as the second sentence reveals. Without annotating the TFA we could not be able to distinguish whether 'we' won or not and it is definitely a difference in truth conditions.

We did not win because of Harry.
It was Peter who scored in the last minute! (5.11)

[1] In case of a negative question, it will be annotated as if it was positive.

$$
\begin{array}{l}
@_{w_1}(\mathsf{win}_1 \\
\quad \wedge \langle \textsc{Actor} \rangle\ (w_2 \wedge \mathsf{we}_1 \\
\qquad\qquad \wedge @_{x_1}\ \langle \textsc{MemberOf} \rangle\ w_2 \\
\qquad\quad) \\
\quad \wedge \langle \textsc{Patient} \rangle\ m_1 \\
\quad \wedge \langle \textsc{Cause} \rangle\ (h_1 \wedge \mathsf{Harry}_1) \\
\quad \wedge \mathsf{negative} \\
\quad \wedge \langle \mathrm{NB} \rangle\ h_1 \\
\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ s_1) \\
\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
)\\
@_{sc_2}(\mathsf{score}_1 \\
\quad \wedge \langle \textsc{Actor} \rangle\ (p_2 \wedge \mathsf{Peter}_1) \\
\quad \wedge \langle \textsc{Consequence} \rangle\ w_1 \\
\quad \wedge \langle \mathrm{NB} \rangle\ p_2 \wedge\ \langle \mathrm{NB} \rangle\ l_2 \\
\quad \wedge \langle \textsc{Stime} \rangle\ (s_2 \wedge\ \langle \mathrm{P} \rangle\ s_1) \\
\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{F} \rangle\ s_2 \\
\qquad\quad \wedge \langle \mathrm{Rstr} \rangle\ (m_2 \wedge \mathsf{minute}_1 \\
\qquad\qquad\qquad \wedge \langle \mathrm{Rstr} \rangle\ (l_2 \wedge \mathsf{last}_1) \\
\qquad\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ m_1 \\
\qquad\qquad\quad) \\
\qquad\quad) \\
\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
)
\end{array}
$$

Chapter 6

Propositional symbols and modalities

In this chapter I will introduce the principle of indexing the propositional symbols and some of the modalities that should serve to the annotation. Many of them will have if not the same, then at least similar meaning as their counterparts in Panevová, Hajičová and Sgall [13].

As Tesnière [22] noticed, a sentence is like a solar system. This holds not only for the syntax but also for the semantics. We will start in the centre, classifying verbs, objects and their properties, then some spatio-temporal modalities are introduced, and in the last section there are some modalities useful for annotation of associative reference.

6.1 Propositional symbols

The objects and events are represented by nominals, but also described by propositional symbols. Propositional symbols should be indexed except for reserved propositional symbols and citation contexts such as in the ForeignPhrase relation. We should assign 1 to the first occurrence of an expression and then when we meet the same expression, we must decide whether its meaning is the same as one of the meanings used before or whether it is a new one. In the former case we will use the same number, in the latter we would create a new index by adding 1 to the biggest index used. In this thesis I use 1 for the "primary" meaning of an expression and higher numbers in case the expression appears to have another meaning. I chose this strategy because in this thesis the examples are too small. For instance I use these indices for some meanings of 'be':

be_1	ACTOR is an instance of PATIENT
be_2	ACTOR is WHERE (spatially)
be_3	ACTOR has a property PATIENT
be_4	ACTOR = PATIENT
be_5	ACTOR is in PATIENT (non-spatially)[a]

[a] in a book, in a film, ...

6.2 Sentence structure modalities

6.2.1 Event properties

Event properties are of two kinds: verbal modality and deontic modality (see also Panevová, Benešová and Sgall [12]). I added one more modality – text element modality

Modality	**Reserved nominal**	*note*/**example**
EVENTMOD	*interrogative*	
	indicative	*the default*
	imperative	
	conditional	*Not syntactical*[a]!
DEONTMOD	*debitive*	must
	hortative	have to *(as obligation)*
	volitive	want
	possibilitive	may
	permissive	be allowed to
	facultative	be able to
	declarative	*the default*
TEXTELEMENT	*text*	*the default*
	heading	
	note	
	writing	The text is the speaker[b]

[a] See section 4.4 for understanding the difference between syntactical conditional and the *conditional* EVENTMOD

[b] See example 8.28 on the page 102.

6.2.2 Event and object modifiers

In this section the inner participants and free modifications are listed. Their use is the same as on the level of TR. Some of the modifications are left out because they seem synonymous with relations concerning information linking.

Inner participants
Actor
Addressee
Effect
Origin
Patient

Free modifications	*note*/**example**
Accompaniment	with, without
Attitude	gladly, seemly, rightly
Benefactive	for who, against who
Criterion	in one's respect
Extent	very, a bit, all, two
ForeignPhrase	"Veritas in vino."
Manner	quickly
Means	by foot
Norm	according to rules
Regard	in consideration of, regardless of
Substitution	instead

6.2.3 Object modifiers

Modifications	*note*/**example**
Appurtenance	whose
Descriptive	*non-restrictive*
Identity	*or name*
Material	cup of tea
Restriction	except
Rstr	japanese border
Vocative	

6.2.4 Information linking

Modifications	*note*/**example**
Adversative	but, however
Cause	because
Consequence	for
Disjunction	either, or
Gradation	even
Intent	for, in order to

6.3 Temporal modalities

Modifications	*note*/**example**
When HowLong HowOften	
P F	*past* *future*

6.4 Spatial modalities

Modifications	*note*/**example**
WhereFrom WhereThrough WhereTo Where	 8.25 on the page 100 and 2.7 on the page 15

6.5 Ontological modalities

Modifications	*note*/**example**
MemberOf InstanceOf More Less	

6.6 Unused TR functors

Panevová, Hajičová and Sgall in [13] distinguish more modalities but for some reasons they are superfluous for the semantic annotation:

aim (AIM) is equal to Intent.

apposition (APPS) is a syntactical category. It must be annotated according to its semantic function.

comparison (CPR) can be substituted by More and Less relations in combination with Extent. See example 8.21 on the page 97.

complement (COMPL) is only a syntactical category. The expression will get usually a Rstr relation.

concession (CNCS) is synonymous with ADVERSATIVE.

condition (COND) can be modeled using CAUSE.

confrontation (CONFR) can be substituted by ADVERSATIVE.

conjunction (CONJ) is the default information link.

counterfactual (CTERF) can be modeled using *conditional* EVENTMOD in combination with CAUSE, see section 4.4 on using *conditional*.

dependent part of phraseme (DPHR) is used for annotating idioms. In this thesis the example 7.12 on the page 71 could be considered as a sketch of future handling of such structures.

difference (DIFF) is the same case as 'comparison'.

ethical dative (ETHD) is a matter of the style, not of the content. The stylistic representation of a speech is beyond the scope of this thesis.

heritage (HER) can be modeled using ORIGIN.

intensification (INTF) is also a matter of style. The semantical aspects of intensification should show up in the TFA representation.

parenthesis (PAR) is replaced by NOTE.

reason (REAS) is replaced by CAUSE.

reference to preceding text (PREC) is annotated according to its semantic function with one of 'information linking' relations.

restriction (RESTR) is the negation of MEMBEROF.

result (RESL) can be substituted by MANNER and EXTENT.

rhematizer (RHEM) must be reflected in the TFA representation and its meaning annotated by some other means.

temp. from when (TFRWH) will become an ETIME1 of the entity it refers to.

temp. parallel (TPAR) can be expressed by use of F and P operators on ETIME1 and ETIME2

temp. to when (TOWH) can be expressed using other temporal relations.

vocative (VOCAT) is semantically superfluous.

Chapter 7

Discourse example

A Story about Two Sons

> Jesus said: I will tell you a story about a man who had two sons. Then you can tell me what you think. The father went to the older son and said, "Go work in the vineyard today!" His son told him that he would not do it, but later he changed his mind and went. The man then told his younger son to go work in the vineyard. The boy said he would, but he didn't go. Which one of the sons obeyed his father? "The older one," the chief priests and leaders answered.
>
> Then Jesus told them: You can be sure that tax collectors and prostitutes will get into the kingdom of God before you ever will! When John the Baptist showed you how to do right, you would not believe him. But these evil people did believe. And even when you saw what they did, you still would not change your minds and believe.

Matthew 21.28-32

This piece of discourse is adapted as it was on the Internet[1]. The language of the example should be 'contemporary English'. In this chapter I will try to present an annotation according to the rules presented in this thesis. Each segment will receive a number and respective representation. I use the convention to use the segment number for indexing the nominals so that for every nominal it would be clear where it appeared for the first time. This convention does not involve the propositional symbols. See section 6.1 for indexing of propositional symbols.

[1] http://www.biblegateway.com/cgi-bin/bible?passage=MATT%2B21&language=english&version=CEV

Segments overview		
No.	**Page**	**Segment**
7.1	65	A story about Two Sons
7.2	65	Jesus said:
7.3	66	I will tell you a story about a man
7.4	66	who had two sons.
7.5	67	Then you can tell me
7.6	67	what you think.
7.7	68	The father went to the older son
7.8	68	and said,
7.9	69	"Go work in the vineyard today!"
7.10	70	His son told him
7.11	70	that he would not do it,
7.12	71	but later he changed his mind
7.13	71	and went.
7.14	72	The man then told his younger son
7.15	73	to go work in the vineyard.
7.16	74	The boy said
7.17	74	he would,
7.18	75	but he didn't go.
7.19	75	Which one of the sons obeyed his father?
7.20	76	"The older one,"
7.21	76	the chief priests and leaders answered.
7.22	77	Then Jesus told them:
7.23	77	You can be sure
7.24	78	that tax collectors and prostitutes will get into the kingdom of God
7.25	78	before you ever will!
7.26	79	When John the Baptist showed you
7.27	79	how to do right,
7.28	80	you would not believe him.
7.29	80	But these evil people did believe.
7.30	81	And even when you saw
7.31	81	what they did,
7.32	82	you still would not change your minds
7.33	82	and believe.
7.34	83	Matthew
7.35	83	21.28-32

A story about Two Sons (7.1)

$$
\begin{aligned}
@_{t_1}(&\mathsf{tell}_1 \\
&\wedge \langle \textsc{Actor} \rangle\ a_1 \\
&\wedge \langle \textsc{Effect} \rangle\ (st_1 \wedge \mathsf{story}_1 \\
&\qquad \wedge \langle \textsc{Patient} \rangle\ (so_1 \\
&\qquad\qquad \wedge \mathsf{son}_1 \\
&\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ (tw_1 \wedge 2) \\
&\qquad\qquad) \\
&\qquad) \\
&\wedge \langle \textsc{TextElement} \rangle\ \mathit{heading} \\
&\wedge \langle \mathrm{NB} \rangle\ st_1 \wedge\ \langle \mathrm{NB} \rangle\ so_1 \\
&\wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\wedge \langle \textsc{Etime1} \rangle\ (e_1^1 \wedge\ \langle \mathrm{P} \rangle\ s_1) \\
&\wedge \langle \textsc{Etime2} \rangle\ e_1^2 \\
&\wedge \langle \textsc{Speaker} \rangle\ a_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
)&
\end{aligned}
$$

Jesus said: (7.2)

$$
\begin{aligned}
@_{sa_2}(&\mathsf{say}_1 \\
&\wedge \langle \textsc{Actor} \rangle\ (je_2 \wedge \mathsf{Jesus}_1) \\
&\wedge \langle \textsc{Effect} \rangle\ ef_2 \\
&\wedge \langle \mathrm{NB} \rangle\ je_2 \wedge\ \langle \mathrm{NB} \rangle\ sa_2 \\
&\wedge \langle \textsc{Stime} \rangle\ (s_2 \wedge\ \langle \mathrm{P} \rangle\ s_1) \\
&\wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{F} \rangle\ s_2) \\
&\wedge \langle \textsc{Speaker} \rangle\ a_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
)&
\end{aligned}
$$

I will tell you a story about a man (7.3)

$$
\begin{array}{l}
@_{t_3}(\mathsf{tell}_1 \\
\quad \wedge \langle \textsc{Actor} \rangle\ je_2 \\
\quad \wedge \langle \textsc{Effect} \rangle\ (st_3 \wedge \mathsf{story}_1 \\
\qquad\qquad \wedge \langle \textsc{Patient} \rangle\ (m_3 \wedge \mathsf{man}_1) \\
\qquad\quad) \\
\quad \wedge \langle \textsc{Addressee} \rangle\ y_3 \\
\quad \wedge \langle \textsc{NB} \rangle\ st_1 \wedge \langle \textsc{NB} \rangle\ m_3 \\
\quad \wedge \langle \textsc{Stime} \rangle\ e_2 \\
\quad \wedge \langle \textsc{Etime2} \rangle\ (e_3 \wedge \langle \textsc{P} \rangle\ s_3) \\
\quad \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge \langle \textsc{Hearer} \rangle\ y_3 \\
\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_2 \\
)
\end{array}
$$

---

who had two sons. (7.4)

$$
\begin{array}{l}
@_{h_4}(\mathsf{have}_1 \\
\quad \wedge \langle \textsc{Actor} \rangle\ m_3 \\
\quad \wedge \langle \textsc{Patient} \rangle\ (so_1 \wedge \mathsf{son}_1 \\
\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ (tw_1 \wedge 2) \\
\qquad\quad) \\
\quad \wedge \langle \textsc{NB} \rangle\ h_4 \wedge \langle \textsc{NB} \rangle\ so_1 \wedge \langle \textsc{NB} \rangle\ tw_1 \\
\quad \wedge \langle \textsc{Stime} \rangle\ e_2 \\
\quad \wedge \langle \textsc{Etime2} \rangle\ (e_4 \wedge \langle \textsc{F} \rangle\ e_2) \\
\quad \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge \langle \textsc{Hearer} \rangle\ y_3 \\
\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_2 \\
)
\end{array}
$$

Then you can tell me (7.5)

$$
\begin{aligned}
&@_{t_5}(\mathsf{tell}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ y_3 \\
&\quad \wedge \langle \textsc{Effect} \rangle\ ef_5 \\
&\quad \wedge \langle \textsc{Addressee} \rangle\ je_2 \\
&\quad \wedge \langle \textsc{DeontMod} \rangle\ \mathit{permissive} \\
&\quad \wedge \langle \textsc{NB} \rangle\ t_5 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_5 \wedge\ \langle \textsc{P} \rangle\ e_2) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_5 \wedge\ \langle \textsc{P} \rangle\ e_3) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge\ \langle \textsc{Hearer} \rangle\ y_3 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_2 \\
&\quad)
\end{aligned}
$$

what you think. (7.6)

$$
\begin{aligned}
&@_{t_6}(\mathsf{think}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ y_3 \\
&\quad \wedge \langle \textsc{Patient} \rangle\ ef_5 \\
&\quad \wedge \langle \textsc{NB} \rangle\ ef_5 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_5 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_6^1 \wedge\ \langle \textsc{P} \rangle\ e_3) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e_6^2 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge\ \langle \textsc{Hearer} \rangle\ y_3 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_2 \\
&\quad)
\end{aligned}
$$

The father went to the older son (7.7)

$$
\begin{aligned}
&@_{g_7}(\mathsf{go}_2 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (m_3 \\
&\qquad \wedge \langle \textsc{Descriptive} \rangle\ (f_7 \wedge \mathsf{father}_1 \\
&\qquad\quad \wedge \langle \textsc{Appurtenance} \rangle\ so_1 \\
&\qquad)\\
&\quad)\\
&\quad \wedge \langle \textsc{Patient} \rangle\ (so_7 \wedge \mathsf{son}_1 \\
&\qquad \wedge \langle \textsc{Rstr} \rangle\ (o_7 \wedge \mathsf{old} \wedge\ \langle \textsc{Extent} \rangle\ (m_7 \wedge \mathsf{more}_1)) \\
&\qquad \wedge \langle \textsc{MemberOf} \rangle\ so_1 \\
&\quad)\\
&\quad \wedge \langle \textsc{NB} \rangle\ g_7 \wedge\ \langle \textsc{NB} \rangle\ so_7 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_7 \wedge\ \langle \textsc{P} \rangle\ s_5) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_7 \wedge\ \langle \textsc{F} \rangle\ s_7) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge\ \langle \textsc{Hearer} \rangle\ y_3 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_2 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_3 \\
&\quad)
\end{aligned}
$$

Note the use of Appurtenance. We should add this modifier in all such cases because it is semantically obligatory (see Panevová's criteria in Kruijff [9]).

---

and said, (7.8)

$$
\begin{aligned}
&@_{sa_8}(\mathsf{say}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ m_3 \\
&\quad \wedge \langle \textsc{Effect} \rangle\ ef_8 \\
&\quad \wedge \langle \textsc{Addressee} \rangle\ so_7 \\
&\quad \wedge \langle \textsc{NB} \rangle\ sa_8 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_7 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_8 \wedge\ \langle \textsc{P} \rangle\ e_7 \wedge\ \langle \textsc{F} \rangle\ s_7) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge\ \langle \textsc{Hearer} \rangle\ y_3 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_2 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_3 \\
&\quad)
\end{aligned}
$$

"Go work in the vineyard today!" (7.9)

$$
\begin{aligned}
&@_{g_9}\,(\mathsf{go}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ so_7 \\
&\quad \wedge \langle \textsc{Intent} \rangle\ i_9 \\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{imperative} \\
&\quad \wedge \langle \mathrm{NB} \rangle\ g_9 \wedge\ \langle \mathrm{NB} \rangle\ i_9 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ e_8 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_9 \wedge\ \langle \mathrm{P} \rangle\ e_8) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ m_3 \wedge\ \langle \textsc{Hearer} \rangle\ so_7 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_2 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_8 \\
&\quad)\\
&@_{w_9}(i_9 \wedge \mathsf{work}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ so_7 \\
&\quad \wedge \langle \textsc{Where} \rangle\ (v_9 \wedge \mathsf{vineyard}_1) \\
&\quad \wedge \langle \textsc{When} \rangle\ (t_9 \wedge \mathsf{today}_1 \wedge\ \langle \textsc{Appurtenance} \rangle\ e_8) \\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{imperative} \\
&\quad \wedge \langle \mathrm{NB} \rangle\ v_9 \wedge\ \langle \mathrm{NB} \rangle\ w_9 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ e_8 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_9^1 \wedge\ \langle \mathrm{P} \rangle\ e_9) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e_9^2 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ m_3 \wedge\ \langle \textsc{Hearer} \rangle\ so_7 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_2 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_8 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_3 \\
&\quad)
\end{aligned}
$$

His son told him (7.10)

$$
\begin{aligned}
&@_{t_{10}}(\mathsf{tell}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (so_7 \\
&\qquad \wedge \langle \textsc{Descriptive} \rangle\ (so_{10} \wedge \mathsf{son}_1 \\
&\qquad\quad \wedge \langle \textsc{Appurtenance} \rangle\ m_3 \\
&\qquad) \\
&\quad) \\
&\quad \wedge \langle \textsc{Effect} \rangle\ ef_{10} \\
&\quad \wedge \langle \textsc{Addressee} \rangle\ m_3 \\
&\quad \wedge \langle \textsc{NB} \rangle\ t_{10} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_{10} \wedge \langle \textsc{P} \rangle\ s_7) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_{10} \wedge \langle \textsc{P} \rangle\ e_8 \wedge \langle \textsc{F} \rangle\ s_{10}) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge \langle \textsc{Hearer} \rangle\ y_3 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_2 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_3 \\
&\ )
\end{aligned}
$$

that he would not do it, (7.11)

$$
\begin{aligned}
&@_{d_{11}}(\mathsf{do}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ so_7 \\
&\quad \wedge \langle \textsc{Patient} \rangle\ ef_8 \\
&\quad \wedge \mathsf{negative} \\
&\quad \wedge \langle \textsc{NB} \rangle\ d_{11} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ e_{10} \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_{11} \wedge \langle \textsc{P} \rangle\ e_{10}) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ so_7 \wedge \langle \textsc{Hearer} \rangle\ m_3 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_2 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_{10} \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_3 \\
&\ )
\end{aligned}
$$

but later he changed his mind (7.12)

$$
\begin{aligned}
&@_{c_{12}}(\mathsf{change\_mind}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ so_7 \\
&\quad \wedge \langle \textsc{Adversative} \rangle\ t_{10} \\
&\quad \wedge \langle \textsc{NB} \rangle\ c_{12} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_{12} \wedge\ \langle \textsc{P} \rangle\ s_{10}) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_{12} \wedge\ \langle \textsc{P} \rangle\ e_{10}) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge\ \langle \textsc{Hearer} \rangle\ y_3 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_2 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_3 \\
&\quad)
\end{aligned}
$$

and went. (7.13)

$$
\begin{aligned}
&@_{g_{13}}(\mathsf{go}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ so_7 \\
&\quad \wedge \langle \textsc{Intent} \rangle\ i_9 \\
&\quad \wedge \langle \textsc{NB} \rangle\ g_{13} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_{13} \wedge\ \langle \textsc{P} \rangle\ s_{12}) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_{13} \wedge\ \langle \textsc{P} \rangle\ e_{12} \wedge\ \langle \textsc{F} \rangle\ s_{13}) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge\ \langle \textsc{Hearer} \rangle\ y_3 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_2 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_3 \\
&\quad)
\end{aligned}
$$

The man then told his younger son (7.14)

In this case it is unclear whether 'then' refers to e_{10} or e_{13}. I have chosen the latter.

$$
\begin{aligned}
&@_{t_{14}}(\mathsf{tell}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (m_3 \wedge \mathsf{man}_1) \\
&\quad \wedge \langle \textsc{Addressee} \rangle\ (so_{14} \wedge \mathsf{son}_1 \\
&\qquad\qquad \wedge \langle \textsc{Rstr} \rangle\ (y_{14} \wedge \mathsf{young}_1 \wedge \langle \textsc{Extent} \rangle\ (m_{14} \wedge \mathsf{more}_1)) \\
&\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ m_3 \\
&\qquad\qquad) \\
&\quad \wedge \langle \textsc{Effect} \rangle\ ef_{14} \\
&\quad \wedge \langle \textsc{NB} \rangle\ so_{14} \wedge \langle \textsc{NB} \rangle\ t_{14} \wedge \langle \textsc{NB} \rangle\ y_{14} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_{14} \wedge \langle \textsc{P} \rangle\ s_{13}) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_{14} \wedge \langle \textsc{P} \rangle\ e_{13} \wedge \langle \textsc{F} \rangle\ s_{14}) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge \langle \textsc{Hearer} \rangle\ y_3 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_2 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_3 \\
&\quad)
\end{aligned}
$$

to go work in the vineyard. (7.15)

$$
\begin{aligned}
&@_{g_{15}}\,(\mathsf{go}_2\\
&\quad \wedge \langle \textsc{Actor} \rangle\ so_{14}\\
&\quad \wedge \langle \textsc{Intent} \rangle\ i_{15}\\
&\quad \wedge \langle \textsc{EventMod} \rangle\ imperative\\
&\quad \wedge \langle \mathrm{NB} \rangle\ g_{15} \wedge\ \langle \mathrm{NB} \rangle\ i_{15}\\
&\quad \wedge \langle \textsc{Stime} \rangle\ e_{14}\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_{15} \wedge\ \langle \mathrm{P} \rangle\ e_{14})\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ m_3 \wedge\ \langle \textsc{Hearer} \rangle\ so_{14}\\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_2\\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1\\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_{14}\\
&\quad)\\
&@_{w_{15}}(i_{15} \wedge \mathsf{work}_1\\
&\quad \wedge \langle \textsc{Actor} \rangle\ so_{14}\\
&\quad \wedge \langle \textsc{Where} \rangle\ (v_9 \wedge \mathsf{vineyard}_1)\\
&\quad \wedge \langle \textsc{EventMod} \rangle\ imperative\\
&\quad \wedge \langle \mathrm{NB} \rangle\ w_{15} \wedge\ \langle \mathrm{NB} \rangle\ v_9\\
&\quad \wedge \langle \textsc{Stime} \rangle\ e_{14}\\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e^1_{15} \wedge\ \langle \mathrm{P} \rangle\ e_{15})\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e^2_{15}\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ m_3 \wedge\ \langle \textsc{Hearer} \rangle\ so_{14}\\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_2\\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1\\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_{14}\\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_3\\
&\quad)
\end{aligned}
$$

The boy said (7.16)

$$
\begin{aligned}
&@_{sa_{16}}(\mathsf{say_1} \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (so_{14} \wedge \mathsf{boy_1}) \\
&\quad \wedge \langle \textsc{Addressee} \rangle\ m_3 \\
&\quad \wedge \langle \textsc{Effect} \rangle\ ef_{16} \\
&\quad \wedge \langle \mathrm{NB} \rangle\ sa_{16} \wedge\ \langle \mathrm{NB} \rangle\ ef_{16} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_{16} \wedge\ \langle \mathrm{P} \rangle\ s_{14}) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_{16} \wedge\ \langle \mathrm{P} \rangle\ e_{14} \wedge\ \langle \mathrm{F} \rangle\ s_{16}) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge\ \langle \textsc{Hearer} \rangle\ y_3 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_2 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_3 \\
&\quad)
\end{aligned}
$$

he would, (7.17)

$$
\begin{aligned}
&@_{d_{17}}(\mathsf{do_1} \\
&\quad \wedge \langle \textsc{Actor} \rangle\ so_{14} \\
&\quad \wedge \langle \textsc{Patient} \rangle\ ef_{14} \\
&\quad \wedge \langle \mathrm{NB} \rangle\ d_{17} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ e_{16} \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_{17} \wedge\ \langle \mathrm{P} \rangle\ e_{16}) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ so_{14} \wedge\ \langle \textsc{Hearer} \rangle\ m_3 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_2 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_{16} \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_3 \\
&\quad)
\end{aligned}
$$

but he didn't go. (7.18)

$$
\begin{aligned}
&@_{d_{18}}(\mathsf{do}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ so_{14} \\
&\quad \wedge \langle \textsc{Patient} \rangle\ g_{15} \\
&\quad \wedge \mathsf{negative} \\
&\quad \wedge \langle \textsc{Adversative} \rangle\ sa_{16} \\
&\quad \wedge \langle \textsc{NB} \rangle\ d_{18} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_{18} \wedge\ \langle \textsc{P} \rangle\ s_{16}) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_{18} \wedge\ \langle \textsc{F} \rangle\ s_{18} \wedge\ \langle \textsc{P} \rangle\ e_{16}) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge\ \langle \textsc{Hearer} \rangle\ y_3 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_2 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_3 \\
&\quad)
\end{aligned}
$$

Which one of the sons obeyed his father? (7.19)

$$
\begin{aligned}
&@_{o_{19}}(\mathsf{obey}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (so_{19} \wedge \mathsf{son}_1 \\
&\qquad\qquad \wedge \langle \textsc{MemberOf} \rangle\ so_1 \\
&\qquad\quad) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (m_3 \\
&\qquad\qquad \wedge \langle \textsc{Rstr} \rangle\ (f_{19} \wedge \mathsf{father}_1 \\
&\qquad\qquad\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ so_{19} \\
&\qquad\qquad\qquad\quad) \\
&\qquad\quad) \\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{interrogative} \\
&\quad \wedge \langle \textsc{NB} \rangle\ so_{19} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_{19} \wedge\ \langle \textsc{P} \rangle\ s_{18}) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_{19} \wedge\ \langle \textsc{F} \rangle\ s_{19}) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge\ \langle \textsc{Hearer} \rangle\ y_3 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_2 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad)
\end{aligned}
$$

"The older one," (7.20)

$$
\begin{aligned}
&@_{d_{20}}(\mathsf{do}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ so_7 \\
&\quad \wedge \langle \textsc{Patient} \rangle\ o_{19} \\
&\quad \wedge \langle \textsc{NB} \rangle\ so_7 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_{20} \wedge\ \langle \textsc{P} \rangle\ s_{19}) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_{20} \wedge\ \langle \textsc{F} \rangle\ s_{20}) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ g_{20} \wedge\ \langle \textsc{Hearer} \rangle\ je_2 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad)
\end{aligned}
$$

the chief priests and leaders answered. (7.21)

$$
\begin{aligned}
&@_{a_{21}}(\mathsf{answer}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (g_{20} \\
&\qquad \wedge \langle \textsc{MemberOf} \rangle\ (p_{21} \wedge \mathsf{priest}_1 \\
&\qquad\quad \wedge \langle \textsc{Rstr} \rangle\ (c_{21} \wedge \mathsf{chief}_1) \\
&\qquad\quad \wedge \langle \textsc{Extent} \rangle\ plural \\
&\qquad\quad) \\
&\qquad \wedge \langle \textsc{MemberOf} \rangle\ (l_{21} \wedge \mathsf{leader}_1 \\
&\qquad\quad \wedge \langle \textsc{Extent} \rangle\ plural \\
&\qquad\quad) \\
&\qquad \wedge \langle \textsc{Extent} \rangle\ plural \\
&\qquad) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ o_{19} \\
&\quad \wedge \langle \textsc{Effect} \rangle\ d_{20} \\
&\quad \wedge \langle \textsc{NB} \rangle\ d_{20} \wedge\ \langle \textsc{NB} \rangle\ c_{21} \wedge\ \langle \textsc{NB} \rangle\ l_{21} \wedge\ \langle \textsc{NB} \rangle\ p_{21} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_{21} \wedge\ \langle \textsc{P} \rangle\ s_{19}) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (s_{20} \wedge\ \langle \textsc{F} \rangle\ s_{21}) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ a_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad)
\end{aligned}
$$

Then Jesus told them: (7.22)

$$
\begin{aligned}
&@_{t_{22}}(\mathsf{tell}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ je_2 \\
&\quad \wedge \langle \textsc{Effect} \rangle\ ef_{22} \\
&\quad \wedge \langle \textsc{Addressee} \rangle\ g_{20} \\
&\quad \wedge \langle \textsc{NB} \rangle\ t_{22} \wedge\ \langle \textsc{NB} \rangle\ ef_{22} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_{22} \wedge\ \langle \textsc{P} \rangle\ s_{21}) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_{22} \wedge\ \langle \textsc{P} \rangle\ e_{21} \wedge\ \langle \textsc{F} \rangle\ s_{22}) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ a_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad)
\end{aligned}
$$

You can be sure (7.23)

$$
\begin{aligned}
&@_{b_{23}}(\mathsf{be}_3 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ g_{20} \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (su_{23} \wedge \mathsf{sure}_1 \\
&\qquad\qquad \wedge \langle \textsc{Patient} \rangle\ p_{23} \\
&\qquad\quad) \\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{imperative} \\
&\quad \wedge \langle \textsc{NB} \rangle\ su_{23} \wedge\ \langle \textsc{NB} \rangle\ p_{23} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ e_{22} \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_{23} \wedge\ \langle \textsc{P} \rangle\ e_{22}) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge\ \langle \textsc{Hearer} \rangle\ g_{20} \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_{22} \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad)
\end{aligned}
$$

that tax collectors and prostitutes will get into the kingdom of God (7.24)

$$
\begin{aligned}
&@_{g_{24}}(\mathsf{get}_2 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (cp_{24} \\
&\qquad \wedge \langle \textsc{MemberOf} \rangle\ (c_{24} \wedge \mathsf{collector}_1 \\
&\qquad\qquad \wedge \langle \textsc{Rstr} \rangle\ (t_{24} \wedge \mathsf{tax}_1) \\
&\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ plural \\
&\qquad\qquad) \\
&\qquad \wedge \langle \textsc{MemberOf} \rangle\ (p_{24} \wedge \mathsf{prostitute}_1 \\
&\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ plural \\
&\qquad\qquad) \\
&\qquad \wedge \langle \textsc{Extent} \rangle\ plural \\
&\qquad) \\
&\quad \wedge \langle \textsc{WhereTo} \rangle\ (k_{24} \wedge \mathsf{kingdom}_1 \\
&\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ (go_{24} \wedge \mathsf{God}_1) \\
&\qquad\qquad) \\
&\quad \wedge \langle \mathrm{NB} \rangle\ cp_{24} \wedge\ \langle \mathrm{NB} \rangle\ k_{24} \wedge\ \langle \mathrm{NB} \rangle\ g_{24} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ e_{22} \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_{24} \wedge\ \langle \mathrm{P} \rangle\ e_{22}) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge\ \langle \textsc{Hearer} \rangle\ g_{20} \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ p_{23} \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_{22} \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad)
\end{aligned}
$$

---

before you ever will! (7.25)

$$
\begin{aligned}
&@_{g_{25}}(\mathsf{get}_2 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ g_{20} \\
&\quad \wedge \langle \textsc{WhereTo} \rangle\ k_{24} \\
&\quad \wedge \langle \mathrm{NB} \rangle\ e_{22} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_{24} \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_{25} \wedge\ \langle \mathrm{P} \rangle\ e_{24}) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge\ \langle \textsc{Hearer} \rangle\ g_{20} \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ p_{23} \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_{22} \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad)
\end{aligned}
$$

When John the Baptist showed you (7.26)

$$
\begin{aligned}
&@_{sh_{26}}(\mathsf{show}_2 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (j_{26} \wedge \mathsf{John}_1 \wedge \mathsf{Baptist}_1) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ p_{26} \\
&\quad \wedge \langle \textsc{Addressee} \rangle\ g_{20} \\
&\quad \wedge \langle \mathrm{NB} \rangle\ sh_{26} \wedge\ \langle \mathrm{NB} \rangle\ p_{26} \wedge\ \langle \mathrm{NB} \rangle\ j_{26} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_{26} \wedge\ \langle \mathrm{P} \rangle\ e_{22}) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_{26} \wedge\ \langle \mathrm{F} \rangle\ s_{26}) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge\ \langle \textsc{Hearer} \rangle\ g_{20} \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_{22} \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad)
\end{aligned}
$$

how to do right, (7.27)

$$
\begin{aligned}
&@_{d_{27}}(\mathsf{do}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ g_{20} \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (r_{27} \wedge \mathsf{right}_2) \\
&\quad \wedge \langle \textsc{Manner} \rangle\ p_{26} \\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{conditional} \\
&\quad \wedge \langle \mathrm{NB} \rangle\ p_{26} \wedge\ \langle \mathrm{NB} \rangle\ r_{27} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_{26} \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ e^1_{27} \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e^2_{27} \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge\ \langle \textsc{Hearer} \rangle\ g_{20} \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_{22} \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad)
\end{aligned}
$$

you would not believe him. (7.28)

$$
\begin{aligned}
&@_{b_{28}}(\mathsf{believe}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ g_{20} \\
&\quad \wedge \langle \textsc{Patient} \rangle\ p_{26} \\
&\quad \wedge \langle \textsc{Addressee} \rangle\ j_{26} \\
&\quad \wedge \mathsf{negative} \\
&\quad \wedge \langle \textsc{NB} \rangle\ b_{28} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_{26} \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e^1_{28} \wedge\ \langle \textsc{P} \rangle\ e_{26}) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e^2_{28} \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge\ \langle \textsc{Hearer} \rangle\ g_{20} \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_{22} \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad)
\end{aligned}
$$

But these evil people did believe. (7.29)

$$
\begin{aligned}
&@_{b_{29}}(\mathsf{believe}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (cp_{24} \wedge \mathsf{people}_1 \\
&\qquad\qquad \wedge \langle \textsc{Descriptive} \rangle\ (ev_{29} \wedge \mathsf{evil}_1) \\
&\qquad\qquad) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ p_{26} \\
&\quad \wedge \langle \textsc{Addressee} \rangle\ j_{26} \\
&\quad \wedge \langle \textsc{Adversative} \rangle\ b_{28} \\
&\quad \wedge \langle \textsc{NB} \rangle\ b_{29} \wedge\ \langle \textsc{NB} \rangle\ ev_{29} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_{29} \wedge\ \langle \textsc{P} \rangle\ s_{26}) \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e^1_{29} \wedge\ \langle \textsc{F} \rangle\ s_{29}) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e^2_{29} \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge\ \langle \textsc{Hearer} \rangle\ g_{20} \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ ef_{22} \\
&\quad \wedge \langle \textsc{MemberOf} \rangle\ st_1 \\
&\quad)
\end{aligned}
$$

And even when you saw (7.30)

$$@_{se_{30}}(\mathsf{see}_1 \wedge \langle \textsc{Actor} \rangle\ g_{20} \wedge \langle \textsc{Patient} \rangle\ p_{30} \wedge \langle \textsc{Gradation} \rangle\ b_{29} \wedge \langle \textsc{NB} \rangle\ se_{30} \wedge \langle \textsc{NB} \rangle\ p_{30} \wedge \langle \textsc{Stime} \rangle\ (s_{30} \wedge \langle \textsc{P} \rangle\ s_{29}) \wedge \langle \textsc{Etime2} \rangle\ (e_{30} \wedge \langle \textsc{F} \rangle\ s_{30}) \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge \langle \textsc{Hearer} \rangle\ g_{20} \wedge \langle \textsc{MemberOf} \rangle\ ef_{22} \wedge \langle \textsc{MemberOf} \rangle\ st_1)$$

what they did, (7.31)

$$@_{d_{31}}(\mathsf{do}_1 \wedge \langle \textsc{Actor} \rangle\ cp_{24} \wedge \langle \textsc{Patient} \rangle\ p_{30} \wedge \langle \textsc{NB} \rangle\ p_{30} \wedge \langle \textsc{Stime} \rangle\ s_{30} \wedge \langle \textsc{Etime1} \rangle\ (e^1_{29} \wedge \langle \textsc{F} \rangle\ s_{30}) \wedge \langle \textsc{Etime2} \rangle\ (e_{31} \wedge \langle \textsc{F} \rangle\ s_{30}) \wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge \langle \textsc{Hearer} \rangle\ g_{20} \wedge \langle \textsc{MemberOf} \rangle\ ef_{22} \wedge \langle \textsc{MemberOf} \rangle\ st_1)$$

you still would not change your minds (7.32)

$@_{c_{32}}(\mathsf{change\_mind}_1$
$\wedge \langle \textsc{Actor} \rangle\ g_{20}$
$\wedge\ \mathsf{negative}$
$\wedge \langle \textsc{Adversative} \rangle\ se_{30}$
$\wedge \langle \textsc{NB} \rangle\ c_{32}$
$\wedge s_{30}$
$\wedge \langle \textsc{Etime1} \rangle\ e_{30}$
$\wedge \langle \textsc{Etime2} \rangle\ e_{32}$
$\wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge \langle \textsc{Hearer} \rangle\ g_{20}$
$\wedge \langle \textsc{MemberOf} \rangle\ ef_{22}$
$\wedge \langle \textsc{MemberOf} \rangle\ st_1$
)

---

and believe. (7.33)

$@_{b_{33}}(\mathsf{believe}_1$
$\wedge \langle \textsc{Actor} \rangle\ g_{20}$
$\wedge \langle \textsc{Patient} \rangle\ p_{26}$
$\wedge \langle \textsc{Addressee} \rangle\ j_{26}$
$\wedge\ \mathsf{negative}$
$\wedge \langle \textsc{NB} \rangle\ b_{33}$
$\wedge \langle \textsc{Stime} \rangle\ s_{30}$
$\wedge \langle \textsc{Etime1} \rangle\ e_{30}$
$\wedge \langle \textsc{Etime2} \rangle\ e_{32}$
$\wedge \langle \textsc{Speaker} \rangle\ je_2 \wedge \langle \textsc{Hearer} \rangle\ g_{20}$
$\wedge \langle \textsc{MemberOf} \rangle\ ef_{22}$
$\wedge \langle \textsc{MemberOf} \rangle\ st_1$
)

Matthew (7.34)

$$
\begin{aligned}
&@_{b_{34}}(\mathsf{be_4}\\
&\quad \wedge \langle \textsc{Actor} \rangle\ a_1\\
&\quad \wedge \langle \textsc{Patient} \rangle\ (m_{34} \wedge \mathsf{Matthew_1})\\
&\quad \wedge \langle \textsc{NB} \rangle\ m_{34}\\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_{34} \wedge\ \langle \textsc{P} \rangle\ s_2)\\
&\quad \wedge \langle \textsc{Etime1} \rangle\ e^1_{34}\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e^2_{34}\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ a_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)
\end{aligned}
$$

21.28-32 (7.35)

$$
\begin{aligned}
&@_{b_{35}}(\mathsf{be_5}\\
&\quad \wedge \langle \textsc{Actor} \rangle\ st_1\\
&\quad \wedge \langle \textsc{Patient} \rangle\ (ci_{35} \wedge\ \langle \textsc{Rstr} \rangle\ (bi_{35} \wedge \mathsf{bible_1})\\
&\qquad\qquad \wedge \langle \textsc{Rstr} \rangle\ (ch_{35} \wedge \mathsf{chapter_1}\\
&\qquad\qquad\qquad \wedge \langle \textsc{Identity} \rangle\ (i^1_{35} \wedge 21)\\
&\qquad\qquad)\\
&\qquad\qquad \wedge \langle \textsc{Rstr} \rangle\ (ve_{35} \wedge \mathsf{verse_2}\\
&\qquad\qquad\qquad \wedge \langle \textsc{Identity} \rangle\ (i^2_{35}\\
&\qquad\qquad\qquad\qquad \wedge \langle \textsc{Less} \rangle\ (m^1_{35} \wedge 28)\\
&\qquad\qquad\qquad\qquad \wedge \langle \textsc{More} \rangle\ (m^2_{35} \wedge 32)\\
&\qquad\qquad\qquad\qquad)\\
&\qquad\qquad\qquad)\\
&\qquad\qquad)\\
&\quad \wedge \langle \textsc{NB} \rangle\ i^1_{35} \wedge\ \langle \textsc{NB} \rangle\ m^1_{35} \wedge\ \langle \textsc{NB} \rangle\ m^2_{35}\\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_{34}\\
&\quad \wedge \langle \textsc{Etime1} \rangle\ e^1_{35}\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e^2_{35}\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ a_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)
\end{aligned}
$$

Chapter 8

Comparative sentences

Following sentences are provided by Jan Hajič as a "test suite" of a semantic annotation. I present annotations of each sentence here in this chapter. Since these sentences are not bound in a context, I always think out the—in my view—most plausible one. Sometimes I add an explanation of my understanding of the context. Another representation of these sentences is offered by Geert-Jan Kruijff in [10].

The nominals in this chapter are in every example independent from those in other examples because this is not a discourse. The use of the same nominal in more examples is entirely coincidental and doesn't mean any semantic connection unlike in the chapter 7.

This car is red. (8.1)

The $\mathsf{be_3}$ should have the sense of ascribing a property in PATIENT to the ACTOR[1]. If I wrote $@_{c_1}\mathsf{red_1}$, I would loose the information that it is the opinion of x_1, not an absolute truth, furthermore there may arise a need to reference the proposition b_1 later.

$$
\begin{aligned}
&@_{b_1}(\mathsf{be_3}\\
&\quad \wedge \langle \text{ACTOR} \rangle\ (c_1\\
&\qquad\qquad \wedge \mathsf{car_1}\\
&\qquad\qquad \wedge \langle \text{WHERE} \rangle\ x_1\\
&\qquad\qquad)\\
&\quad \wedge \langle \text{PATIENT} \rangle\ (r_1 \wedge \mathsf{red_1})\\
&\quad \wedge \langle \text{NB} \rangle\ r_1 \wedge\ \langle \text{NB} \rangle\ c_1\\
&\quad \wedge \langle \text{STIME} \rangle\ s_1\\
&\quad \wedge \langle \text{ETIME1} \rangle\ (e_1 \wedge\ \langle \text{F} \rangle\ s_1)\\
&\quad \wedge \langle \text{ETIME2} \rangle\ (e_2 \wedge\ \langle \text{P} \rangle\ s_1)\\
&\quad \wedge \langle \text{SPEAKER} \rangle\ x_1 \wedge\ \langle \text{HEARER} \rangle\ y_1\\
&\quad)
\end{aligned}
$$

John loves Mary. (8.2)

$$
\begin{aligned}
&@_{l_1}(\mathsf{love_1}\\
&\quad \wedge \langle \text{ACTOR} \rangle\ (j_1 \wedge \mathsf{John_1})\\
&\quad \wedge \langle \text{PATIENT} \rangle\ (m_1 \wedge \mathsf{Mary_1})\\
&\quad \wedge \langle \text{STIME} \rangle\ s_1\\
&\quad \wedge \langle \text{NB} \rangle\ l_1 \wedge\ \langle \text{NB} \rangle\ j_1 \wedge\ \langle \text{NB} \rangle\ m_1\\
&\quad \wedge \langle \text{ETIME1} \rangle\ (e_1 \wedge\ \langle \text{F} \rangle\ s_1)\\
&\quad \wedge \langle \text{ETIME2} \rangle\ (e_2 \wedge\ \langle \text{P} \rangle\ s_1)\\
&\quad \wedge \langle \text{SPEAKER} \rangle\ x_1 \wedge\ \langle \text{HEARER} \rangle\ y_1\\
&\quad)
\end{aligned}
$$

[1]The different meanings of 'be' are listed in the section 6.1

Who works for IBM? (8.3)

$$
\begin{aligned}
&@_{w_1}(\mathsf{work}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ u_1 \\
&\quad \wedge \langle \textsc{Benefactive} \rangle\ (i_1 \wedge \mathsf{IBM}) \\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{interrogative} \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \mathrm{NB} \rangle\ u_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{P} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
$$

Bring the paper! (8.4)

$$
\begin{aligned}
&@_{b_1}(\mathsf{bring}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ y_1 \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (p_1 \wedge \mathsf{paper}_1) \\
&\quad \wedge \langle \textsc{WhereTo} \rangle\ x_1 \\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{imperative} \\
&\quad \wedge \langle \mathrm{NB} \rangle\ b_1 \wedge\ \langle \mathrm{NB} \rangle\ p_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \mathrm{P} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
$$

Peter and Paul go to movies. (8.5)

This sentence can be understood in two quite distinct ways:

1. They go together:

$$
\begin{array}{l}
@_{g_1}(\mathsf{go}_1 \\
\quad \wedge \langle \textsc{Actor} \rangle\ (u_1 \\
\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ \mathit{all} \\
\qquad\qquad \wedge \langle \textsc{Rstr} \rangle\ s_1 \\
\qquad\qquad) \\
\quad \wedge @_{p_1}(\mathsf{Peter}_1 \wedge\ \langle \textsc{MemberOf} \rangle\ s_1) \\
\quad \wedge @_{p_2}(\mathsf{Paul}_1 \wedge\ \langle \textsc{MemberOf} \rangle\ s_1) \\
\quad \wedge \langle \textsc{Where} \rangle\ w_1 \\
\quad \wedge \langle \textsc{Cause} \rangle\ (m_1 \\
\qquad\qquad \wedge \mathsf{movie}_1 \\
\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ \mathit{plural} \\
\qquad\qquad) \\
\quad \wedge \langle \mathrm{NB} \rangle\ p_1 \wedge\ \langle \mathrm{NB} \rangle\ p_2 \wedge\ \langle \mathrm{NB} \rangle\ g_1 \wedge\ \langle \mathrm{NB} \rangle\ m_1 \\
\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ s_1) \\
\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{P} \rangle\ s_1) \\
\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
)
\end{array}
$$

2. They go not necessarily together:

$$
\begin{array}{l}
@_{g_1}(\mathsf{go}_1 \\
\quad \wedge \langle \textsc{Actor} \rangle\ (u_1 \\
\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ \mathit{every} \\
\qquad\qquad \wedge \langle \textsc{Rstr} \rangle\ s_1 \\
\qquad\qquad) \\
\quad \wedge @_{p_1}(\mathsf{Peter}_1 \wedge\ \langle \textsc{MemberOf} \rangle\ s_1) \\
\quad \wedge @_{p_2}(\mathsf{Paul}_1 \wedge\ \langle \textsc{MemberOf} \rangle\ s_1) \\
\quad \wedge \langle \textsc{Where} \rangle\ w_1 \\
\quad \wedge \langle \textsc{Cause} \rangle\ (m_1 \\
\qquad\qquad \wedge \mathsf{movie}_1 \\
\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ \mathit{plural} \\
\qquad\qquad) \\
\quad \wedge \langle \mathrm{NB} \rangle\ p_1 \wedge\ \langle \mathrm{NB} \rangle\ p_2 \wedge\ \langle \mathrm{NB} \rangle\ g_1 \wedge\ \langle \mathrm{NB} \rangle\ m_1 \\
\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ s_1) \\
\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{P} \rangle\ s_1) \\
\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
)
\end{array}
$$

Things fall down. (8.6)

$$
\begin{aligned}
&@_{f_1}(\mathsf{fall}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (t_1 \\
&\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ \mathit{every} \\
&\qquad\qquad \wedge \langle \textsc{Rstr} \rangle\ (t_2 \wedge \mathsf{thing}_1 \wedge\ \langle \textsc{Extent} \rangle\ \mathit{plural}) \\
&\qquad\quad) \\
&\quad \wedge \langle \textsc{WhereTo} \rangle\ (d_1 \wedge \mathsf{down}_1 \\
&\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ t_1 \\
&\qquad\quad) \\
&\quad \wedge \langle \textsc{NB} \rangle\ d_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \textsc{F} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \textsc{P} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
$$

Every squirrel is grey or brown. (8.7)

$$
\begin{aligned}
&@_{b_1}(\mathsf{be}_3 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (s_1 \\
&\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ \mathit{every} \\
&\qquad\qquad \wedge \langle \textsc{Rstr} \rangle\ (s_2 \wedge \mathsf{squirrel}_1 \wedge\ \langle \textsc{Extent} \rangle\ \mathit{all}) \\
&\qquad\quad) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (c_1 \wedge\ \langle \textsc{MemberOf} \rangle\ c_2) \\
&\quad \wedge @_{g_1}(\mathsf{grey}_1 \wedge\ \langle \textsc{MemberOf} \rangle\ c_2) \\
&\quad \wedge @_{b_2}(\mathsf{brown}_1 \wedge\ \langle \textsc{MemberOf} \rangle\ c_2) \\
&\quad \wedge \langle \textsc{NB} \rangle\ c_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \textsc{F} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \textsc{P} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
$$

He can do it. (8.8)

Temporal aspects of such sentence depend strongly on the situation, I left the interpretation open.

The deontic modality depends on the context, too. It could be also *permissive*. This should be clear from the context.

$$
\begin{aligned}
&@_{d_1}(\mathsf{do}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (h_1 \wedge \mathsf{he}_1) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (i_1 \wedge \mathsf{it}_1) \\
&\quad \wedge \langle \textsc{DeontMod} \rangle\ \mathit{facultative} \\
&\quad \wedge \langle \textsc{NB} \rangle\ d_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ e_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e_2 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
$$

We saw three cars. (8.9)

$$
\begin{aligned}
&@_{s_1}(\mathsf{see}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (w_1 \\
&\qquad\qquad \wedge \mathsf{we}_1 \\
&\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ \mathit{plural} \\
&\qquad\qquad \wedge @_{x_1}\ \langle \textsc{MemberOf} \rangle\ w_1 \\
&\qquad\qquad) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (c_1 \wedge \mathsf{car}_1 \wedge\ \langle \textsc{Extent} \rangle\ (t_1 \wedge 3)) \\
&\quad \wedge \langle \textsc{NB} \rangle\ t_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
$$

The students did not eat that food. (8.10)

The word 'that' is reflected in annotation of contextual boundness: In case of 'the food' f_1 would not be marked as NB.

$$
\begin{aligned}
&@_{e_1}(\mathsf{eat}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (s_1 \\
&\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ \mathit{every} \\
&\qquad\qquad \wedge \langle \textsc{Rstr} \rangle\ (s_2 \wedge \mathsf{student}_1 \wedge\ \langle \textsc{Extent} \rangle\ \mathit{plural}) \\
&\qquad\qquad) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (f_1 \wedge \mathsf{food}_1) \\
&\quad \wedge \mathsf{negative} \\
&\quad \wedge \langle \mathrm{NB} \rangle\ e_1 \wedge\ \langle \mathrm{NB} \rangle\ f_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_3 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ e_2 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_3 \wedge\ \langle \mathrm{F} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&)
\end{aligned}
$$

Someone named Smith will come tomorrow. (8.11)

If we knew from the context that Mr. Smith shall come to a place other than of x_1, we would annotate the place differently.

$$
\begin{aligned}
&@_{c_1}(\mathsf{come}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (s_1 \wedge\ \langle \textsc{Identity} \rangle\ (s_2 \wedge \mathsf{Smith}_1)) \\
&\quad \wedge \langle \textsc{WhereTo} \rangle\ x_1 \\
&\quad \wedge \langle \textsc{When} \rangle\ (t_1 \wedge \mathsf{tomorrow}_1 \wedge\ \langle \textsc{Appurtenance} \rangle\ s_1) \\
&\quad \wedge \langle \mathrm{NB} \rangle\ s_1 \wedge\ \langle \mathrm{NB} \rangle\ c_1 \wedge\ \langle \mathrm{NB} \rangle\ t_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_3 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \mathrm{P} \rangle\ s_3) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&)
\end{aligned}
$$

The party that gets the most votes wins. (8.12)

$$
\begin{array}{l}
@_{g_1}\,(\mathsf{get}_1 \\
\quad \wedge \langle \textsc{Actor} \rangle\ (p_1 \wedge \mathsf{party}) \\
\quad \wedge \langle \textsc{Patient} \rangle\ (v_1 \\
\qquad\qquad \wedge\ \mathsf{vote}_1 \\
\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ (m_1 \wedge \mathsf{most}) \\
\qquad\quad) \\
\quad \wedge \langle \mathrm{NB} \rangle\ m_1 \wedge\ \langle \mathrm{NB} \rangle\ g_1 \\
\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
\quad \wedge \langle \textsc{Etime1} \rangle\ e_1 \\
\quad \wedge \langle \textsc{Etime2} \rangle\ e_2 \\
\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
\quad) \\
@_{w_1}(\mathsf{win}_1 \\
\quad \wedge \langle \textsc{Actor} \rangle\ p_1 \\
\quad \wedge \langle \mathrm{NB} \rangle\ w_1 \\
\quad \wedge \langle \textsc{Stime} \rangle\ (s_2 \wedge\ \langle \mathrm{P} \rangle\ s_1) \\
\quad \wedge \langle \textsc{Etime2} \rangle\ e_2 \\
\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
\quad)
\end{array}
$$

Nouns correspond usually to entities. (8.13)

$$
\begin{array}{l}
@_{c_1}(\mathsf{correspond}_1 \\
\quad \wedge \langle \textsc{Actor} \rangle\ (n_1 \wedge \mathsf{noun}_1 \wedge\ \langle \textsc{Extent} \rangle\ \mathit{every}) \\
\quad \wedge \langle \textsc{Patient} \rangle\ (e_1 \wedge \mathsf{entity}_1 \\
\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ n_1 \\
\qquad\quad) \\
\quad \wedge \langle \textsc{When} \rangle\ (u_1 \wedge \mathsf{usually}_1) \\
\quad \wedge \langle \mathrm{NB} \rangle\ n_1 \wedge\ \langle \mathrm{NB} \rangle\ c_1 \wedge\ \langle \mathrm{NB} \rangle\ e_1 \\
\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
\quad \wedge \langle \textsc{Etime1} \rangle\ (e_2 \wedge\ \langle \mathrm{F} \rangle\ s_1) \\
\quad \wedge \langle \textsc{Etime2} \rangle\ (e_3 \wedge\ \langle \mathrm{P} \rangle\ s_1) \\
\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
\quad)
\end{array}
$$

She was seen north of the capital, Cairo. (8.14)

$$
\begin{aligned}
&@_{s_1}(\mathsf{see}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ a_1 \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (s_1 \wedge \mathsf{she}_1) \\
&\quad \wedge \langle \textsc{Where} \rangle\ (p_1 \wedge \mathsf{north}_1 \wedge\ \langle \textsc{Appurtenance} \rangle\ c_1) \\
&\quad \wedge @_{c_1}(\mathsf{capital}_1 \wedge\ \langle \textsc{Identity} \rangle\ (c_2 \wedge \mathsf{Cairo}_1)) \\
&\quad \wedge \langle \textsc{NB} \rangle\ p_1 \wedge\ \langle \textsc{NB} \rangle\ c_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_2 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \textsc{F} \rangle\ s_2) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
$$

If I go there, it will be a surprise. (8.15)

$$
\begin{aligned}
&@_{g_1}(\mathsf{go}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ x_1 \\
&\quad \wedge \langle \textsc{Where} \rangle\ p_1 \\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{conditional} \\
&\quad \wedge \langle \textsc{NB} \rangle\ g_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \textsc{P} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e_2 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad) \\
&@_{b_1}(\mathsf{be}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ g_1 \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (s_2 \wedge \mathsf{surprise}_1) \\
&\quad \wedge \langle \textsc{NB} \rangle\ s_2 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ \ \langle \textsc{P} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_3 \wedge\ \langle \textsc{P} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
$$

The car was damaged because of the impact. (8.16)

In my interpretation the use of 'because of' is only a way how to indicate that 'impact' should be in the focus and therefore it is synonymous to 'The IMPACT damaged the car.'

$$
\begin{aligned}
&@_{d_1}(\mathsf{damage_1} \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (i_1 \wedge \mathsf{impact_1}) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (c_1 \wedge \mathsf{car_1}) \\
&\quad \wedge \langle \mathrm{NB} \rangle\ i_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge \langle \mathrm{F} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
$$

English is spoken in many countries. (8.17)

$$
\begin{aligned}
&@_{s_1}(\mathsf{speak_2} \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (a_1\ \langle \textsc{Extent} \rangle\ \mathit{plural}) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (en_1 \wedge \mathsf{English_1}) \\
&\quad \wedge \langle \textsc{Where} \rangle\ (c_1 \wedge \mathsf{country_1} \wedge \langle \textsc{Extent} \rangle\ (m_1 \wedge \mathsf{many_1})) \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \mathrm{NB} \rangle\ m_1 \wedge \langle \mathrm{NB} \rangle\ en_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge \langle \mathrm{F} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge \langle \mathrm{P} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
$$

Those people want only independence. (8.18)

$@_{h_1}(\mathsf{have}_1$
$\wedge \langle \textsc{Actor} \rangle\ (p_1 \wedge \mathsf{people}_1 \wedge \langle \textsc{Extent} \rangle\ \mathit{plural})$
$\wedge \langle \textsc{Patient} \rangle\ (a_1 \wedge \langle \textsc{Restrictive} \rangle\ (i_1 \wedge \mathsf{independence}_1))$
$\wedge \langle \textsc{DeontMod} \rangle\ \mathit{volitive}$
$\wedge \mathsf{negative}$
$\wedge \langle \textsc{NB} \rangle\ i_1$
$\wedge \langle \textsc{Stime} \rangle\ s_1$
$\wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge \langle \textsc{F} \rangle\ s_1)$
$\wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge \langle \textsc{P} \rangle\ s_1)$
$\wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge \langle \textsc{Hearer} \rangle\ y_1$
$)$

Bill's house is expensive to take care of. (8.19)

$@_{c_1}(\mathsf{care}_1$
$\wedge \langle \textsc{Actor} \rangle\ a_1$
$\wedge \langle \textsc{Patient} \rangle\ (h_1$
$\wedge \mathsf{house}_1$
$\wedge \langle \textsc{Appurtenance} \rangle\ (b_1 \wedge \mathsf{Bill}_1)$
$)$
$\wedge \langle \textsc{DeontMod} \rangle\ \mathit{conditional}$
$\wedge \langle \textsc{NB} \rangle\ c_1 \wedge \langle \textsc{NB} \rangle\ h_1 \wedge \langle \textsc{NB} \rangle\ b_1$
$\wedge \langle \textsc{Stime} \rangle\ s_1$
$\wedge \langle \textsc{Etime1} \rangle\ e_1$
$\wedge \langle \textsc{Etime2} \rangle\ e_2$
$\wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge \langle \textsc{Hearer} \rangle\ y_1$
$)$
$@_{b_2}(\mathsf{be}_3$
$\wedge \langle \textsc{Actor} \rangle\ c_1$
$\wedge \langle \textsc{Patient} \rangle\ (e_1 \wedge \mathsf{expensive}_1)$
$\wedge \langle \textsc{NB} \rangle\ e_1$
$\wedge \langle \textsc{Stime} \rangle\ s_1$
$\wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge \langle \textsc{F} \rangle\ s_1)$
$\wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge \langle \textsc{P} \rangle\ s_1)$
$\wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge \langle \textsc{Hearer} \rangle\ y_1$
$)$

Jane came earlier than Jim returned from the mall. (8.20)

See also section 3.3.4 for examples on the past perfect tense.

I use p_1 to unify those two places in the clauses. It's my interpretation and in a context there may be two different nominals.

$$
\begin{aligned}
&@_{c_1}(\mathsf{come_1} \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (j_1 \wedge \mathsf{Jane_1}) \\
&\quad \wedge \langle \textsc{WhereTo} \rangle\ p_1 \\
&\quad \wedge \langle \textsc{NB} \rangle\ e_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \textsc{F} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad) \\
&@_{r_1}(\mathsf{return_1} \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (j_2 \wedge \mathsf{Jim_1}) \\
&\quad \wedge \langle \textsc{WhereTo} \rangle\ p_1 \\
&\quad \wedge \langle \textsc{WhereFrom} \rangle\ (m_1 \wedge \mathsf{mall_1}) \\
&\quad \wedge \langle \textsc{NB} \rangle\ e_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \textsc{F} \rangle\ s_1 \wedge\ \langle \textsc{P} \rangle\ e_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
$$

Fred is taller than Christopher. (8.21)

$$
\begin{aligned}
&@_{b_1}(\mathsf{be}_3 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (f_1 \wedge \mathsf{Fred}_1) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (t_1 \wedge \mathsf{tall}_1 \wedge\ \langle \textsc{Extent} \rangle\ h_1) \\
&\quad \wedge \langle \mathrm{NB} \rangle\ h_1 \wedge\ \langle \mathrm{NB} \rangle\ f_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{P} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad) \\
&@_{b_2}(\mathsf{be}_3 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (c_1 \wedge \mathsf{Christopher}_1) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (t_2 \\
&\qquad\qquad \wedge \mathsf{tall}_1 \\
&\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ (h_2 \\
&\qquad\qquad\qquad\qquad \wedge \langle \textsc{Less} \rangle\ h_1 \\
&\qquad\qquad\qquad\qquad) \\
&\qquad\qquad) \\
&\quad \wedge \langle \mathrm{NB} \rangle\ h_1 \wedge\ \langle \mathrm{NB} \rangle\ c_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{P} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
$$

The five of them do not know about the hearing. (8.22)

$$
\begin{array}{l}
@_{k_1}(\mathsf{know_1} \\
\quad \wedge \langle \textsc{Actor} \rangle\ (ev_1 \wedge\ \langle \textsc{Extent} \rangle\ every \\
\qquad\qquad \wedge \langle \textsc{Rstr} \rangle\ (f_1 \wedge\ \langle \textsc{Rstr} \rangle\ (t_1 \wedge \mathsf{them_1} \\
\qquad\qquad\qquad\qquad\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ plural \\
\qquad\qquad\qquad\qquad\qquad\qquad) \\
\qquad\qquad\qquad\qquad\quad \wedge \langle \textsc{Extent} \rangle\ (f_2 \wedge \mathsf{5}) \\
\qquad\qquad\qquad\qquad) \\
\qquad\qquad) \\
\quad \wedge \langle \textsc{Patient} \rangle\ (h_1 \wedge \mathsf{hearing_1}) \\
\quad \wedge \mathsf{negative} \\
\quad \wedge \langle \mathrm{NB} \rangle\ k_1 \wedge\ \langle \mathrm{NB} \rangle\ h_1 \\
\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \mathrm{F} \rangle\ s_1) \\
\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{P} \rangle\ s_1) \\
\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
)
\end{array}
$$

After adding 1 pint of milk, put the mix onto a saucepan. (8.23)

$$
\begin{aligned}
&@_{a_1}(\mathsf{add}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ y_1 \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (p_1 \\
&\qquad\qquad \wedge\ \mathsf{pint}_1 \\
&\qquad\qquad \wedge \langle \textsc{Material} \rangle\ (m_1 \wedge \mathsf{milk}_1) \\
&\qquad\qquad \wedge \langle \textsc{Extent} \rangle\ (o_1 \wedge 1) \\
&\qquad\qquad) \\
&\quad \wedge \langle \textsc{WhereTo} \rangle\ m_2 \\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{imperative} \\
&\quad \wedge \langle \mathrm{NB} \rangle\ a_1 \wedge\ \langle \mathrm{NB} \rangle\ p_1 \wedge\ \langle \mathrm{NB} \rangle\ m_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \mathrm{P} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad) \\
&@_{p_2}(\mathsf{put}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ y_1 \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (m_2 \wedge \mathsf{mix}_1) \\
&\quad \wedge \langle \textsc{WhereTo} \rangle\ (p_3 \wedge \mathsf{saucepan}_1) \\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{imperative} \\
&\quad \wedge \langle \mathrm{NB} \rangle\ p_2 \wedge\ \langle \mathrm{NB} \rangle\ p_3 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_2 \wedge\ \langle \mathrm{P} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \mathrm{P} \rangle\ e_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
$$

He went to his dentist first and then he visited the city centre. (8.24)

$$
\begin{aligned}
&@_{g_1}(\mathsf{go}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (h_1 \wedge \mathsf{he}_1) \\
&\quad \wedge \langle \textsc{WhereTo} \rangle\ (d_1 \wedge \mathsf{dentist}_1 \wedge\ \langle \textsc{Appurtenance} \rangle\ h_1) \\
&\quad \wedge \langle \textsc{NB} \rangle\ g_1 \wedge\ \langle \textsc{NB} \rangle\ d_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \textsc{F} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad) \\
&@_{v_1}(\mathsf{visit}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (h_1 \wedge \mathsf{he}_1) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (c_1 \wedge \mathsf{center}_1 \wedge\ \langle \textsc{Appurtenance} \rangle\ (c_2 \wedge \mathsf{city}_1)) \\
&\quad \wedge \langle \textsc{NB} \rangle\ v_1 \wedge\ \langle \textsc{NB} \rangle\ c_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \textsc{F} \rangle\ s_1 \wedge\ \langle \textsc{P} \rangle\ e_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
$$

Is Alaska to the west of Mexico? (8.25)

$$
\begin{aligned}
&@_{b_1}(\mathsf{be}_2 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (a_1 \wedge \mathsf{Alaska}_1) \\
&\quad \wedge \langle \textsc{Where} \rangle\ (w_1 \\
&\qquad\qquad \wedge \mathsf{west}_1 \\
&\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ (m_1 \wedge \mathsf{Mexico}_1) \\
&\qquad\qquad) \\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{interrogative} \\
&\quad \wedge \langle \textsc{NB} \rangle\ w_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ e_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e_2 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
$$

How can the network be set up? (8.26)

$$
\begin{aligned}
&@_{s_1}(\mathsf{set\_up_1} \\
&\quad \wedge \langle \textsc{Actor} \rangle\ p_1 \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (n_1 \wedge \mathsf{network_1}) \\
&\quad \wedge \langle \textsc{Manner} \rangle\ m_1 \\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{interrogative} \\
&\quad \wedge \langle \textsc{DeontMod} \rangle\ \mathit{facultative} \\
&\quad \wedge \langle \textsc{NB} \rangle\ m_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \textsc{P} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
$$

Penguins - Avalanches 3 : 1 (8.27)

An annotator could maybe infer which team was visiting which (and add Where spec.), but I can't.

$$
\begin{aligned}
&@_{g_1}(\mathsf{get_1} \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (p_1 \wedge \mathsf{Penguins_1}) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (r_1 \wedge\ \langle \textsc{Extent} \rangle\ (t_1 \wedge \mathsf{3})) \\
&\quad \wedge \langle \textsc{NB} \rangle\ t_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \textsc{F} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad) \\
&@_{g_2}(\mathsf{get_1} \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (a_1 \wedge \mathsf{Avalanches_1}) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (r_2 \wedge\ \langle \textsc{Extent} \rangle\ (o_1 \wedge \mathsf{1})) \\
&\quad \wedge \langle \textsc{NB} \rangle\ o_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ (s_2 \wedge\ \langle \textsc{P} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \textsc{F} \rangle\ s_2) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
$$

TO THE TOP (8.28)

This can be for instance a command of a person in a lift or a writing on a box. I decided to annotate the latter meaning, assuming that the writing is the speaker.

$$
\begin{aligned}
&@_{k_1}(\mathsf{keep}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ y_1 \\
&\quad \wedge \langle \textsc{Patient} \rangle\ x_1 \\
&\quad \wedge \langle \textsc{Where} \rangle\ (t_1 \\
&\qquad\qquad \wedge \mathsf{top}_1 \\
&\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ (b_1 \wedge\ \langle \textsc{Appurtenance} \rangle\ x_1) \\
&\qquad\qquad) \\
&\quad \wedge \langle \textsc{When} \rangle\ (a_2 \wedge \mathsf{always}_1) \\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{imperative} \\
&\quad \wedge \langle \textsc{TextElement} \rangle\ \mathit{writing} \\
&\quad \wedge \langle \textsc{NB} \rangle\ t_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \textsc{F} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \textsc{P} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
$$

Republicans: No majority anymore (8.29)

$$
\begin{aligned}
&@_{h_1}(\mathsf{have}_1 \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (r_1 \wedge \mathsf{republican}_1 \wedge\ \langle \textsc{Extent} \rangle\ \mathit{plural}) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (m_1 \wedge \mathsf{majority}_1) \\
&\quad \wedge \langle \textsc{TextElement} \rangle\ \mathit{heading} \\
&\quad \wedge \langle \textsc{NB} \rangle\ e_2 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \textsc{F} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \textsc{F} \rangle\ s_1) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
$$

'Every man is a man' is a tautology. (8.30)

The speaker does not state that every man is a man, therefore I added the conditional verbal modality. If I didn't do so, it would mean that the speaker wanted to say that every man was a man.

$$
\begin{aligned}
&@_{b_1}(\mathsf{be_3}\\
&\quad \wedge \langle \textsc{Actor} \rangle\ (m_1 \wedge \mathsf{man_1} \wedge\ \langle \textsc{Extent} \rangle\ \mathit{every})\\
&\quad \wedge \langle \textsc{Patient} \rangle\ (m_2 \wedge \mathsf{man_1})\\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{conditional}\\
&\quad \wedge \langle \textsc{NB} \rangle\ m_2\\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1\\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \textsc{F} \rangle\ s_1)\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_2 \wedge\ \langle \textsc{P} \rangle\ s_1)\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)\\
&@_{b_2}(\mathsf{be_3}\\
&\quad \wedge \langle \textsc{Actor} \rangle\ b_1\\
&\quad \wedge \langle \textsc{Patient} \rangle\ (t_1 \wedge \mathsf{tautology_1})\\
&\quad \wedge \langle \textsc{NB} \rangle\ t_1\\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_1\\
&\quad \wedge \langle \textsc{Etime1} \rangle\ e_3\\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e_4\\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&\quad)
\end{aligned}
$$

Patricia brought it in already yesterday. (8.31)

$$
\begin{array}{l}
@_{b_1}(\mathsf{bring_1} \\
\quad \wedge \langle \textsc{Actor} \rangle\ (p_1 \wedge \mathsf{Patricia_1}) \\
\quad \wedge \langle \textsc{Patient} \rangle\ (i_1 \wedge \mathsf{it_1}) \\
\quad \wedge \langle \textsc{WhereTo} \rangle\ i_2 \\
\quad \wedge \langle \textsc{NB} \rangle\ b_1 \wedge\ \langle \textsc{NB} \rangle\ y_1 \\
\quad \wedge \langle \textsc{Stime} \rangle\ s_1 \\
\quad \wedge \langle \textsc{Etime2} \rangle\ (e_1 \\
\qquad\qquad \wedge \langle \textsc{F} \rangle\ s_1 \\
\qquad\qquad \wedge \langle \textsc{When} \rangle\ (y_1 \\
\qquad\qquad\qquad\qquad \wedge \mathsf{yesterday_1} \\
\qquad\qquad\qquad\qquad \wedge \langle \textsc{Appurtenance} \rangle\ s_1 \\
\qquad\qquad\qquad\qquad) \\
\qquad\qquad) \\
\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
\quad)
\end{array}
$$

The preceding sentence (8.31) is a lie. (8.32)

In this case I must do an exception. While in the other examples I always assume that I start annotating a new discourse and I don't care about conflicting nominals, in this example I assume that the annotation is a continuation of the preceding representation.

$$
\begin{array}{l}
@_{b_2}(\mathsf{be_3} \\
\quad \wedge \langle \textsc{Actor} \rangle\ b_1 \\
\quad \wedge \langle \textsc{Patient} \rangle\ (l_1 \wedge \mathsf{lie_1}) \\
\quad \wedge \langle \textsc{NB} \rangle\ l_1 \\
\quad \wedge \langle \textsc{Stime} \rangle\ (s_2 \wedge\ \langle \textsc{P} \rangle\ s_1) \\
\quad \wedge \langle \textsc{Etime1} \rangle\ e_1 \\
\quad \wedge \langle \textsc{Etime2} \rangle\ e_2 \\
\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
\quad)
\end{array}
$$

What time is it? (8.33)

$$
\begin{aligned}
@_{b_1}(&\mathsf{be_3}\\
&\wedge \langle \textsc{Actor} \rangle\ (s_1 \wedge \mathsf{time_2})\\
&\wedge \langle \textsc{Patient} \rangle\ w_1\\
&\wedge \langle \textsc{NB} \rangle\ w_1\\
&\wedge \langle \textsc{EventMod} \rangle\ \mathit{interrogative}\\
&\wedge \langle \textsc{Stime} \rangle\ s_1\\
&\wedge \langle \textsc{Etime2} \rangle\ s_1\\
&\wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
&)
\end{aligned}
$$

She thinks that Dick left for Europe in March. (8.34)

See also example 4.5 on the page 47 on how to annotate hypothetical events.

$$
\begin{aligned}
@_{l_1}(&\mathsf{leave_2}\\
&\wedge \langle \textsc{Actor} \rangle\ (d_1 \wedge \mathsf{Dick_1})\\
&\wedge \langle \textsc{WhereFrom} \rangle\ h_1\\
&\wedge \langle \textsc{Whereto} \rangle\ (eu_1 \wedge \mathsf{Europe_1})\\
&\wedge \langle \textsc{EventMod} \rangle\ \mathit{conditional}\\
&\wedge \langle \textsc{Stime} \rangle\ s_1\\
&\wedge \langle \textsc{NB} \rangle\ m_1 \wedge\ \langle \textsc{NB} \rangle\ l_1 \wedge\ \langle \textsc{NB} \rangle\ d_1 \wedge\ \langle \textsc{NB} \rangle\ eu_1\\
&\wedge \langle \textsc{Etime2} \rangle\ (e_1\\
&\qquad \wedge \langle \textsc{F} \rangle\ s_1\\
&\qquad \wedge \langle \textsc{When} \rangle\ (m_1 \wedge \mathsf{March_1} \wedge\ \langle \textsc{Appurtenance} \rangle\ s_1)\\
&\quad)\\
&\wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
)&\\
@_{t_1}(&\mathsf{think_1}\\
&\wedge \langle \textsc{Actor} \rangle\ (s_2 \wedge \mathsf{she_1})\\
&\wedge \langle \textsc{Effect} \rangle\ l_1\\
&\wedge \langle \textsc{NB} \rangle\ l_1 \wedge\ \langle \textsc{NB} \rangle\ t_1\\
&\wedge \langle \textsc{Stime} \rangle\ s_1\\
&\wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \textsc{F} \rangle\ s_1)\\
&\wedge \langle \textsc{Etime2} \rangle\ (e_1 \wedge\ \langle \textsc{P} \rangle\ s_1)\\
&\wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1\\
)&
\end{aligned}
$$

Don believes that David thinks that Rebecca will be successful. (8.35)

$$
\begin{aligned}
&@_{b_1}(\mathsf{be_3} \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (r_1 \wedge \mathsf{Rebecca_1}) \\
&\quad \wedge \langle \textsc{Patient} \rangle\ (s_1 \wedge \mathsf{succesful_1}) \\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{conditional} \\
&\quad \wedge \langle \textsc{NB} \rangle\ s_1 \wedge\ \langle \textsc{NB} \rangle\ b_1 \wedge\ \langle \textsc{NB} \rangle\ r_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_2 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_1 \wedge\ \langle \textsc{P} \rangle\ s_2) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ e_2 \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad) \\
&@_{t_1}(\mathsf{think_1} \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (d_1 \wedge \mathsf{David_1}) \\
&\quad \wedge \langle \textsc{Effect} \rangle\ b_1 \\
&\quad \wedge \langle \textsc{EventMod} \rangle\ \mathit{conditional} \\
&\quad \wedge \langle \textsc{NB} \rangle\ t_1 \wedge\ \langle \textsc{NB} \rangle\ d_1 \wedge\ \langle \textsc{NB} \rangle\ b_1 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_2 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_3 \wedge\ \langle \textsc{F} \rangle\ s_2) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_4 \wedge\ \langle \textsc{P} \rangle\ s_2) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad) \\
&@_{b_2}(\mathsf{believe_1} \\
&\quad \wedge \langle \textsc{Actor} \rangle\ (d_2 \wedge \mathsf{Don_1}) \\
&\quad \wedge \langle \textsc{Effect} \rangle\ t_1 \\
&\quad \wedge \langle \textsc{NB} \rangle\ b_2 \wedge\ \langle \textsc{NB} \rangle\ t_1 \wedge\ \langle \textsc{NB} \rangle\ d_2 \\
&\quad \wedge \langle \textsc{Stime} \rangle\ s_2 \\
&\quad \wedge \langle \textsc{Etime1} \rangle\ (e_5 \wedge\ \langle \textsc{F} \rangle\ s_2) \\
&\quad \wedge \langle \textsc{Etime2} \rangle\ (e_6 \wedge\ \langle \textsc{P} \rangle\ s_2) \\
&\quad \wedge \langle \textsc{Speaker} \rangle\ x_1 \wedge\ \langle \textsc{Hearer} \rangle\ y_1 \\
&\quad)
\end{aligned}
$$

'Seek' is a transitive verb. (8.36)

$@_{b_1}(\mathsf{be_3}$
$\wedge\ \langle\textsc{Actor}\rangle\ (s_1 \wedge\ \langle\textsc{Identity}\rangle\ (s_2 \wedge \mathsf{seek}))$
$\wedge\ \langle\textsc{Patient}\rangle\ (v_1 \wedge \mathsf{verb_1} \wedge\ \langle\textsc{Rstr}\rangle\ (t_1 \wedge \mathsf{transitive_1}))$
$\wedge\ \langle\textsc{NB}\rangle\ t_1 \wedge\ \langle\textsc{NB}\rangle\ v_1 \wedge\ \langle\textsc{NB}\rangle\ s_1$
$\wedge\ \langle\textsc{Stime}\rangle\ s_3$
$\wedge\ \langle\textsc{Etime1}\rangle\ (e_1 \wedge\ \langle\textsc{F}\rangle\ s_3)$
$\wedge\ \langle\textsc{Etime2}\rangle\ (e_2 \wedge\ \langle\textsc{P}\rangle\ s_3)$
$\wedge\ \langle\textsc{Speaker}\rangle\ x_1 \wedge\ \langle\textsc{Hearer}\rangle\ y_1$
$)$

Seeing is believing. (8.37)

$@_{s_1}(\mathsf{see_1}$
$\wedge\ \langle\textsc{Actor}\rangle\ a_1$
$\wedge\ \langle\textsc{Patient}\rangle\ b_1$
$\wedge\ \langle\textsc{Consequence}\rangle\ b_2$
$\wedge\ \langle\textsc{EventMod}\rangle\ \mathit{conditional}$
$\wedge\ \langle\textsc{NB}\rangle\ s_1$
$\wedge\ \langle\textsc{Stime}\rangle\ s_2$
$\wedge\ \langle\textsc{Etime2}\rangle\ e_1$
$\wedge\ \langle\textsc{Speaker}\rangle\ x_1 \wedge\ \langle\textsc{Hearer}\rangle\ y_1$
$)$
$@_{b_2}(\mathsf{believe_1}$
$\wedge\ \langle\textsc{Actor}\rangle\ a_1$
$\wedge\ \langle\textsc{Patient}\rangle\ b_1$
$\wedge\ \langle\textsc{When}\rangle\ (a_2 \wedge \mathsf{always_1})$
$\wedge\ \langle\textsc{NB}\rangle\ b_2$
$\wedge\ \langle\textsc{Stime}\rangle\ s_2$
$\wedge\ \langle\textsc{Etime1}\rangle\ (e_1 \wedge\ \langle\textsc{P}\rangle\ s_2)$
$\wedge\ \langle\textsc{Etime2}\rangle\ e_2$
$\wedge\ \langle\textsc{Speaker}\rangle\ x_1 \wedge\ \langle\textsc{Hearer}\rangle\ y_1$
$)$

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