A Hybrid Logic Formalization of Information Structure Sensitive Discourse Interpretation

Geert-Jan M. Kruijff & Ivana Kruijff-Korbayová

Center for Computational Linguistics, Charles University, Prague, Czech Republic
{gj,korbay}@ufal.mff.cuni.cz

Abstract. In Prague School linguistics, information structure is a crucial aspect of the linguistic meaning of a sentence, and its interpretation in discourse context. Building on this tradition, we present an information-structure sensitive account of discourse interpretation, formalized as a hybrid modal logic, which can be smoothly related to a dependency grammar. This formalization creates a bridge between the Praguian approach to information structure and contemporary accounts of dynamic discourse interpretation, and allows efficient implementation.

1 Introduction

Information structure (IS) is an inherent aspect of the linguistic meaning of a sentence that a speaker employs as a means to present some parts of the linguistic meaning as context-dependent, and others as context-affecting. The Prague School has long argued for the need to consider IS, and to provide an integrated description of both the effects IS has on discourse interpretation, and its realization through various structural means [13]. With that, the Prague School approach differs from those who either consider only a syntactic description of IS (following the Government & Binding tradition), or only its semantic description (after Karttunen, Rooth). Steedman's theory of IS [14] is similar in spirit to the Prague School, although its formal description differs.

Because of the context-dependent/affecting nature of IS, it is most natural to conceive of its interpretation in a dynamic discourse-oriented fashion, such as Discourse Representation Theory (DRT, [17]). Recently, there have been various proposals for formalizing this idea. Vallduví [15] proposes an instruction-based dynamic account using File-Change Semantics, which Dekker and Hendriks [3] reformulate in DRT. Steedman [14] proposes a semantics for IS using alternative sets, and also discusses their dynamic interpretation. Peregrin [12] offers an extensional dynamic interpretation of the Praguian notion of IS, which we [8, 7] have extended to an intensional DRT-based account.

These proposals suffer from various problems. Peregrin and Steedman do not specify any discourse model, while Vallduví relies on a discourse model that has been criticized by various authors (e.g., [3]). Furthermore, Peregrin's, Vallduví's, and Dekker and Hendriks' accounts lack a relation between IS and its realization (grammar). Steedman's grammar treatment concentrates on intonation as a means of realizing IS; the related treatment of word order proposed by Hoffman is problematic [6]. Our earlier accounts also do not have a fully worked out relation between IS and its realization (grammar), and the representation of IS in complex cases is flawed.

The present account attempts to overcome these problems. We offer a new formalization of the Praguian notions of IS relating a detailed account of IS realization [6] with a computable fragment of hybrid modal logic [2], in which we develop an IS-sensitive approach to dynamic discourse interpretation. By this we hope to make the Praguian notions relating IS more explicit and precise.

Characteristics of the approach. We assume that the linguistic meaning of a sentence is specified as a *dependency tree*, where dependency relations ("semantic roles") connect heads and dependents, and *informativity* is specified for each node. In the present paper, we only distinguish two types of informativity: *contextually dependent* (bound, CB) vs. *contextually affecting* (nonbound, NB).[1] Abstractly, it is possible to represent a dependency tree with a *head* and dependents $\delta_1, ..., \delta_n$ of kinds $\rho_1, ..., \rho_n$ with informativity $\iota_{head}, \iota_1, ..., \iota_2$ as a formula in a modal logic, as in (1).

(1) $[\iota_{head}]head \wedge [\iota_1]\langle\rho_1\rangle\delta_1 \wedge ... \wedge [\iota_n]\langle\rho_n\rangle\delta_n$

We employ *hybrid (modal) logic* [2] as the basis for our formalization. It allows to distinguish different sorts of propositions besides multiple unary modal operators. Particularly, one can distinguish *nominals.* A nominal is a term that enables one to refer, in the object language, to a state in the underlying model. The jump-operator @ makes it possible to jump to a state named by a nominal i and evaluate a formula ϕ there: $@_i\phi$. We adopt Kruijff's formalization of the basic DRT notions in hybrid logic [6]: Nominals are interpreted as discourse referents that are bound to propositions using the jump-operator. Consider example (2). (2a) shows its representation structure according to DRT. (2b) shows the corresponding hybrid logical formula (v models the speaker's vantage point.).[2]

(2) (What does Kathy study?) Kathy studies MATHEMATICS.

a.

e_1,x,y
study(e_1,x,y) *kathy(x)* *math(y)*

b. $@_v([\textsc{cb}](s \wedge \textbf{study}) \wedge [\textsc{cb}]\langle\textsc{Actor}\rangle(k \wedge \textbf{Kathy})$
$\wedge [\textsc{nb}]\langle\textsc{Patient}\rangle(m \wedge \textbf{math}))$

[1] In DGL [6], four types of informativity are distinguished: CB and NB, CB* and NB*, where CB* corresponds to the c marker in [4] or Steedman's Theme-focus [14]. NB* corresponds to the focus proper in [13] or Steedman's Rheme-focus [14].

[2] SMALL CAPITALS in example sentences indicate words carrying pitch accents. Each example sentence is presented as an answer to a question, which helps to indicate the intended IS.

A *discourse representation structure* (DRS) consists of a list of *discourse referents* and a list of *conditions*, each of which can itself be a DRS. Co-reference between an anaphoric expression and its antecedent is captured by binding of discourse referents. A DRS can be viewed as a predicate logic formula where the discourse referents are variables bound by the existential operator. However, merging DRSs is more involved than simply conjoining formulas, because it allows binding a discourse referent introduced in a DRS K_2 to a discourse referent introduced in a DRS K_1 as long as K_2 is at the same level or subordinate to K_1 (cf. the continuation of (2) with (3), and the merging of their DRSs in (4)).

(3) It FASCINATES her.

(4) $$\begin{array}{|l|}\hline e_1,x,y \\ \hline study(e_1,x,y) \\ kathy(x) \\ math(y) \\ \hline\end{array} \otimes \begin{array}{|l|}\hline e_2,u,v \\ \hline fascinate(e_2,u,v) \\ u=? \\ v=? \\ \hline\end{array} \to \begin{array}{|l|}\hline e_1,e_2,x,y \\ \hline study(e_1,x,y) \\ kathy(x) \\ math(y) \\ fascinate(y,x) \\ \hline\end{array}$$

Dependency Grammar Logic (DGL, [6]) provides a framework in which representations like (2b) are obtained in a compositional, monotonic way from an analysis of the sentence's surface form. Because IS is represented explicitly, the representation of the sentence in (2) is different from that for the sentence in (5) (unlike the DRS, which is the same).

(5) (Who studies mathematics?) KATHY studies mathematics.
   a. same as (2a)
   b. $@_v([\text{CB}](s \wedge \textbf{study}) \wedge [\text{NB}]\langle \text{ACTOR}\rangle(k \wedge \textbf{Kathy}) \wedge [\text{CB}]\langle \text{PATIENT}\rangle(m \wedge \textbf{math}))$

In this paper we do not deal with the realization of IS (cf. [6]). Rather, we focus on how to interpret linguistic meaning, represented as a hybrid logical formulas like (2b) or (5b). In §2 we show how we derive the IS-partitioning and we describe the IS-structures that our approach allows to be derived. In §3 we give a formalization of the dynamic interpretation of IS in our approach.

2 Topic/Focus Articulation

DGL follows the approach to IS advocated by the Prague School [13]. IS is hereby referred to as the *Topic/Focus Articulation* (TFA) of a sentence, and is derived recursively from the indication of informativity of the individual nodes in its linguistic meaning. A moderate form of recursivity of both the primitive notions (CB/NB) and TFA is employed.

To establish TFA, we use rules that rewrite a logical formula just indicating informativity to a logical formula with the TFA-bipartitioning, represented as $\mathcal{T} \bowtie \mathcal{F}$ [7]. The idea of using rewriting stems from Oehrle [10], but the rules implement the TFA recursion defined in [13], with the amendments of [4](p.164).

In the hybrid logic formalism, we represent TFA as $@_h(T \bowtie F)$. T and F are conjunctions of terms, whereby T may be empty (written as $\top$). By definition, F must not be empty;[3] if at any point an empty focus (written as $\bot$) is obtained, a deeper embedded NB element is sought to serve as focus. A rewrite rule is stated as $\mathcal{R}(\phi \mapsto \psi)$, rewriting ϕ into ψ. Containment $\Gamma[\cdot]$ is not recursive, but pertains only to the current level of conjunction.

(6) If a verbal head of the clause is CB, then it belongs to the topic.
$\mathcal{R}(@_h([\textsc{cb}](\mathcal{E} \wedge \phi) \wedge \Phi) \mapsto @_h([\textsc{cb}](\mathcal{E} \wedge \phi) \bowtie \Phi))$

(7) If a verbal head of the clause is NB, then it belongs to the focus.
$\mathcal{R}(@_h([\textsc{nb}](\mathcal{E} \wedge \phi) \wedge \Phi) \mapsto @_h(\top \bowtie [\textsc{nb}](\mathcal{E} \wedge \phi) \wedge \Phi))$

(8) If a dependent δ of a verbal head is CB, then δ belongs to the topic (including any nodes it governs).
$\mathcal{R}(@_h(\Phi \bowtie [\textsc{cb}]\delta \wedge \Psi) \mapsto @_h([\textsc{cb}]\delta \wedge \Phi \bowtie \Psi))$

(9) If a dependent δ of a verbal head is NB, then δ belongs to the focus (including any nodes it governs).
$\mathcal{R}(@_h(\Phi \bowtie [\textsc{nb}]\delta \wedge \Psi) \mapsto @_h(\Phi \bowtie \Psi \wedge [\textsc{nb}]\delta))$

(10) If a CB dependent of type δ is an embedded clause, then it should be placed first (topic proper).
$\mathcal{R}(@_h(\Phi[[\textsc{cb}]\langle\delta\rangle(\Gamma[(\mathcal{E} \wedge \pi)])] \bowtie \Psi) \mapsto @_h([\textsc{cb}]\langle\delta\rangle(\Gamma[(\mathcal{E} \wedge \pi)]) \wedge \Phi \bowtie \Psi)$

(11) If a NB dependent of type δ is an embedded clause, then it should be placed last (focus proper).
$\mathcal{R}(@_h(\Phi \bowtie \Psi[[\textsc{nb}]\langle\delta\rangle(\Gamma[(\mathcal{E} \wedge \pi)])]) \mapsto @_h(\Phi \bowtie \Psi \wedge [\textsc{nb}]\langle\delta\rangle(\Gamma[(\mathcal{E} \wedge \pi)]))$

(12) Embedded focus: If in $\Phi \bowtie \Psi$, Ψ contains no inner participants ($\delta \in$ {Actor, Patient, Addressee, Effect, Origin }) whereas Φ does, then a NB modification of a CB dependent is part of the focus:
$\mathcal{R}(@_h(\Phi[[\textsc{cb}]\langle\delta\rangle(\Gamma[[\textsc{nb}]\langle\delta'\rangle(d \wedge \Delta)])] \bowtie \Psi) \mapsto$
$\mapsto @_h(\Phi[[\textsc{cb}]\langle\delta\rangle(\Gamma[])] \bowtie [\textsc{cb}]\langle\delta\rangle[\textsc{nb}]\langle\delta'\rangle(d \wedge \Delta) \wedge \Psi))$

A valid TFA is a structure $\Phi \bowtie \Psi$ to which we can no longer apply any of the rewrite rules given in (6) through (12), and where $\Psi \neq \bot$.

TFA Structures. (13) exemplifies the application of the above rules. We obtain a relational TFA structure, where the relata may be distributed across the $\bowtie$ operator, while maintaining their mutual relations through nominal reference.

(13) (What did the cat eat?) The cat ate a SAUSAGE.
$@_h([\textsc{nb}](\mathcal{E} \wedge \mathbf{eat}) \wedge [\textsc{cb}]\langle\textsc{Actor}\rangle(c \wedge \mathbf{cat}) \wedge [\textsc{nb}]\langle\textsc{Patient}\rangle(s \wedge \mathbf{saus}))$
(7),$@_h(\top \bowtie [\textsc{nb}](\mathcal{E} \wedge \mathbf{eat}) \wedge [\textsc{cb}]\langle\textsc{Actor}\rangle(c \wedge \mathbf{cat}) \wedge [\textsc{nb}]\langle\textsc{Patient}\rangle(s \wedge \mathbf{saus}))$
(8),$@_h([\textsc{cb}]\langle\textsc{Actor}\rangle(c \wedge \mathbf{cat}) \bowtie [\textsc{nb}](\mathcal{E} \wedge \mathbf{eat}) \wedge [\textsc{nb}]\langle\textsc{Patient}\rangle(s \wedge \mathbf{saus}))$

[3] Steedman [14] discusses examples with IS-partitioning corresponding to "all-topic" which are not allowed for in [13] (and the current formalization in DGL).

We also obtain the desired TFA for examples like (14):

(14) (Which teacher did you meet?) I met the teacher of CHEMISTRY.

$@_h([\textsc{cb}](\mathcal{E} \wedge \textbf{meet}) \wedge [\textsc{cb}]\langle\textsc{Actor}\rangle(i \wedge \textbf{I})$
$\wedge [\textsc{cb}]\langle\textsc{Patient}\rangle(t \wedge \textbf{teacher} \wedge [\textsc{nb}]\langle\textsc{Appurtenance}\rangle(c \wedge \textbf{chem})))$

(6),(8),(8),(12), $@_h([\textsc{cb}](\mathcal{E} \wedge \textbf{meet}) \wedge [\textsc{cb}]\langle\textsc{Actor}\rangle(i \wedge \textbf{I})$
$[\textsc{cb}]\langle\textsc{Patient}\rangle(t \wedge \textbf{teacher}) \bowtie [\textsc{cb}]\langle\textsc{Patient}\rangle[\textsc{nb}]\langle\textsc{Appurtenance}\rangle(c \wedge \textbf{chem}))$

The rewriting in (14) relies crucially on rule (12) handling embedded foci. The formulation of rule (12) differs from Sgall et al.'s [13], in that it is a generalization similar to that proposed by Koktová [5]. (12) enables us to deal properly with examples like (15), which answers a so-called *double-focus question*.

(15) (Whom did you give what book?) I gave the book on SYNTAX to KATHY.

$@_h([\textsc{cb}](\mathcal{E} \wedge \textbf{give}) \wedge [\textsc{cb}]\langle\textsc{Actor}\rangle(i \wedge \textbf{I})$
$\wedge [\textsc{cb}]\langle\textsc{Patient}\rangle(b \wedge \textbf{book} \wedge [\textsc{nb}]\langle\textsc{Appurtenance}\rangle(s \wedge \textbf{syn}))$
$\wedge [\textsc{nb}]\langle\textsc{Addressee}\rangle(k \wedge \textbf{Kathy}))$

(6),(8),(8),(12), $@_h([\textsc{cb}](\mathcal{E} \wedge \textbf{give}) \wedge [\textsc{cb}]\langle\textsc{Actor}\rangle(i \wedge \textbf{I})$
$\wedge [\textsc{cb}]\langle\textsc{Patient}\rangle(b \wedge \textbf{book}) \bowtie [\textsc{cb}]\langle\textsc{Patient}\rangle[\textsc{nb}]\langle\textsc{Appurtenance}\rangle(s \wedge \textbf{syn})$
$\wedge [\textsc{nb}]\langle\textsc{Addressee}\rangle(k \wedge \textbf{Kathy}))$

Examples (14) and (15) can be combined to form (16), which can be analyzed straightforwardly in the present framework. In contrast, (16) seems impossible to analyze in Vallduví's account [15], and it is not entirely clear how it would be handled in Steedman's account [14].

(16) (Which teacher did you give what book?)
I gave the book on SYNTAX to the teacher of ENGLISH.

$@_h([\textsc{cb}](\mathcal{E} \wedge \textbf{give}) \wedge [\textsc{cb}]\langle\textsc{Actor}\rangle(i \wedge \textbf{I})$
$\wedge [\textsc{cb}]\langle\textsc{Patient}\rangle(b \wedge \textbf{book} \wedge [\textsc{nb}]\langle\textsc{Appurtenance}\rangle(s \wedge \textbf{syn}))$
$\wedge [\textsc{cb}]\langle\textsc{Addressee}\rangle(t \wedge \textbf{teacher} \wedge [\textsc{nb}]\langle\textsc{Appurtenance}\rangle(c \wedge \textbf{English})))$

(6),(8),(8),(8),(12),(12), $@_h([\textsc{cb}](\mathcal{E} \wedge \textbf{give}) \wedge [\textsc{cb}]\langle\textsc{Actor}\rangle(i \wedge \textbf{I}) \wedge [\textsc{cb}]\langle\textsc{Patient}\rangle(b \wedge \textbf{book})$
$[\textsc{cb}]\langle\textsc{Addressee}\rangle(t \wedge \textbf{teacher}) \bowtie [\textsc{cb}]\langle\textsc{Patient}\rangle[\textsc{nb}]\langle\textsc{Appurtenance}\rangle(s \wedge \textbf{syn})$
$\wedge [\textsc{cb}]\langle\textsc{Addressee}\rangle[\textsc{nb}]\langle\textsc{Appurtenance}\rangle(c \wedge \textbf{English}))$

Formally, nominals ensure that dependents and heads remain properly linked. This avoids the problems of a typed approach like Kruijff-Korbayová's [7] when complex TFA structures like (15) are concerned.

3 Dynamic TFA-sensitive Discourse Interpretation

Following dynamic approaches to interpretation of IS, e.g., [7, 12, 14], the $\bowtie$-operator which connects the topic and the focus controls how the sentence is interpreted with respect to a discourse model. Essentially, a hybrid logical formula of the form $T \bowtie F$ is interpreted by first evaluating T against the current (discourse) model, and only if T can be interpreted, evaluating F.

We define a discourse structure D as a structure $\langle \mathcal{D}, \{R_{\mathsf{D}}\}, \mathsf{HB}, \mathsf{P}\rangle$. HB is a hybrid logical back-and-forth structure with spatial extension, as defined by Kruijff [6]. P is a sorted structure on which we interpret objects and properties, which may overlap with HB's sorted spatial structure. $\mathcal{D}$ is a set of nominals understood as points in a discourse, and $\{R_{\mathsf{D}}\}$ is a set of relations modelling models in D. $\{R_{\mathsf{D}}\}$ includes at least $\lhd$, the relation that defines a total order over the nominals in D.

A discourse model $\mathfrak{M}_{\mathsf{D}}$ is a tuple (D, V) with D a discourse structure and V a hybrid valuation. A linguistic meaning represented as $@_h(\mathcal{T} \bowtie \mathcal{F})$ is interpreted by evaluating $\mathfrak{M}_{\mathsf{D}}, w \models @_h(\mathcal{T} \bowtie \mathcal{F})$ where w is the denotation of h. This evaluation proceeds as follows: from the point reached by the preceding discourse, various "discourse continuations" are possible (i.e., various states w are accessible under R). We first evaluate the topic, i.e., $\mathfrak{M}_{\mathsf{D}}, w \models @_h(\mathcal{T})$, which intuitively means selecting the state(s) w on which the topic can be positively evaluated. Then, we continue by evaluating the focus on w, given that $@_h(\mathcal{T})$ holds, i.e. $\mathfrak{M}_{\mathsf{D}}, w \models @_h(\mathcal{T} \wedge \mathcal{F})$. If the topic-evaluation phase fails, the linguistic meaning is infelicitous in the given context. If the topic-evaluation phase succeeds, but the focus-evaluation phase fails, the linguistic meaning is false in the given context.

This gives us a basic dynamic model of interpretation, modeling $\bowtie$ similarly to Kruijff-Korbayová [7](p.79ff) or Musken et al.'s dynamic conjunction [9]. The important step now is to define a notion of discourse accessibility, without which we could not, for example, resolve the pronominal anaphors in (3).

Discourse referent accessibility. For the discourse model to support a formula ϕ, i.e., $\mathfrak{M}_{\mathsf{D}}, w \models @_h(\phi)$ we need to specify the meaning of contextual boundness. We first of all have the following standard definitions:

$$\begin{array}{lll} \mathfrak{M}, w \models \phi \ \wedge \ \psi & \text{iff} & \mathfrak{M}, w \models \phi \textit{ and } \mathfrak{M}, w \models \psi \\ \mathfrak{M}, w \models \langle \pi \rangle \phi & \text{iff} & \exists w'(w R_\pi w' \ \&\ \mathfrak{M}, w' \models \phi) \\ \mathfrak{M}, w \models [\pi] \phi & \text{iff} & \forall w'(w R_\pi w' \Rightarrow \mathfrak{M}, w' \models \phi) \end{array}$$

For the modal relation CB we define the accessibility relations R_{cb} as follows: $w R_{cb} w'$ & $\mathfrak{M}, w' \models \phi$ means that there is a state p in $\mathcal{D}$, $p \lhd w$, such that at p either $\mathfrak{M}, p \models [\textsc{cb}]\phi$ or $\mathfrak{M}, p \models [\textsc{nb}]\phi$. The accessibility relation R_{nb} connects D with HB, P, over which it models universal accessibility.(Cf. [6] for details.)

Next, for a dependency relation δ the accessibility relation R_δ is defined from $\mathsf{HB} \cup \mathsf{P}$ to $\mathsf{HB} \cup \mathsf{P}$, interpreting $\langle \delta \rangle \phi$ on a state s that is of the right sort given ϕ.

If we consider the generic discourse (modal) relation $\mathfrak{R}$ to be modeled with $\lhd$ as its underlying accessibility relation, we can specify *discourse accessibility*:

(17) $@_p\langle XS\rangle a \rightarrow @_p\langle XS\rangle a \ \wedge\ @_i[\iota]\langle\delta\rangle p \ \wedge\ @_j\langle\mathfrak{R}\rangle i \ \wedge\ @_j[\iota']\langle\delta'\rangle a$,
for any $\delta, \delta' \in \Delta$, $\iota, \iota' \in \{cb, nb\}$.

Using accessibility, the representation of (3) is as follows:

(18) $@_{d'}([\textsc{cb}]\langle\textsc{Actor}\rangle(p \ \wedge\ @_p\langle\textsc{xs}\rangle(a \wedge \textit{object})) \ \wedge\ [\textsc{cb}]\langle\textsc{Patient}\rangle(p' \ \wedge\ @_{p'}\langle\textsc{xs}\rangle(a' \wedge$ $\textit{female})) \bowtie [\textsc{nb}](f \ \wedge\ \textbf{fascinate}))$

Salience. The salience of an item x at a current point in the discourse, h, is defined as follows. If x is NB under h, then the salience of x is 0: **Salience**(h[NB]x)=0. If x is CB under h, then the salience of x is defined as follows. Let $\lhd^*$ be the non-reflexive transitive closure of $\lhd$. Let $l^{nb}(h,x)$ be the length of the path from h to h', with $h' \lhd^* h$ and x NB under h'. Let $l^{cb}(h,x)$ be the length of the path from h to h'', with x last CB-refered to under h''. If there is no h", then $l^{cb}(h,x)$=0. The salience of a CB item x under h is calculated as in (19).

(19) $$\textbf{Salience}(\mathrm{h}[\textsc{cb}]\mathrm{x}) = \begin{cases} l^{nb}(h,x)\text{-}l^{cb}(h,x) & \text{if } x \text{ is realized as a pronoun} \\ 1 & \text{if } x \text{ is realized as a definite noun} \end{cases}$$

This model of calculating the salience of discourse referents is a rudimentary, simplifed version of that in [13]. Our point is to show that one can incorporate a salience metric into the present framework and use it in interpretation as a partial ordering over possible antecedents, at every point in the discourse. If for a CB item under h there are several possible antecedents to which it could be referring, then by definition the *most salient possible antecedent* is preferred.

Discourse Merging. Given a specification of linguistic meaning for an individual sentence, $@_h(\mathcal{T} \bowtie \mathcal{F})$, and a representation of the discourse so far, $\mathfrak{D}$, both formulated as hybrid logical formulas. By definition we have that $\mathfrak{M}_{\mathsf{D}} \models \mathfrak{D}$. The empty discourse is modeled as $\top$. The merge-operator $\otimes$ for merging $\mathfrak{D}$ and $@_h(\mathcal{T} \bowtie \mathcal{F})$, $\mathfrak{D} \otimes @_h(\mathcal{T} \bowtie \mathcal{F})$ is defined as follows.

i. If $\mathfrak{D} = \top$, then take a nominal $d \in \mathsf{D}$, designate d as $\mathbf{current}(d)$, and interpret $@_d(\mathcal{T} \bowtie \mathcal{F})$ (equating d and h, $@_d h$). Let $\mathfrak{D} = @_d(\mathcal{T} \bowtie \mathcal{F})$
ii. If $\mathfrak{D} \neq \top$, then take a nominal $d \in \mathsf{D}$ for which it holds that $d' \lhd d$, $\mathbf{current}(d')$. Evaluate $@_d(\mathcal{T} \bowtie \mathcal{F})$. Let $\mathfrak{D} = \mathfrak{D} \wedge @_{d'}\langle\mathfrak{R}\rangle d \ \wedge\ @_d(\mathcal{T} \bowtie \mathcal{F})$, and set $\mathbf{current}(d)$.

We illustrate the result of discourse merging for the discourse (2+3) below:

(20) $@_d([\textsc{cb}](s \wedge \mathbf{study}) \wedge [\textsc{cb}]\langle\textsc{Patient}\rangle(m \wedge \mathbf{math}) \bowtie [\textsc{nb}]\langle\textsc{Actor}\rangle(k \wedge \mathbf{Kathy})) \wedge @_d\langle\mathfrak{R}\rangle d' \wedge @_{d'}([\textsc{cb}]\langle\textsc{Actor}\rangle(m \wedge \mathbf{math}) \wedge [\textsc{cb}]\langle\textsc{Patient}\rangle(k \wedge \mathbf{Kathy}) \bowtie [\textsc{nb}](f \wedge \mathbf{fascinate}))$

4 Conclusions

We gave an intensional logical formalization of IS and its dynamic interpretation, and showed how the Praguian views on *representing* and *interpreting* IS can be employed in a fully formalized setting oriented towards dynamic discourse processing, with the perspective of providing an efficient implementation [1].

The formalization incorporates various aspects that are novel, or that overcome shortcomings of previous approaches. For example, we have explicitly incorporate a basic notion of salience in interpretation, and we are capable of dealing with the representation of complex IS phenomena like double foci and embedded foci (unlike e.g. [15]). Furthermore, the approach can be smoothly related to a dependency-based grammar formalism (DGL) for the *realization* of IS [6]. When taken altogether, this enables us to account for the realization, representation, and interpretation of IS in a compositional and monotonic fashion.

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