Dynamic Interpretations and Interpretation Structures

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1 Introduction

Dynamic semantics has its roots in the research of anaphoric reference. It is well known that in general anaphoric relations are highly context sensitive and defeasible. However, most standard frameworks of dynamic semantics, such as Discourse Representation Theory (DRT) and Dynamic Predicate Logic, do not deal with problems of interpretation revision [1] (cf. [6]). Furthermore, these frameworks are strictly incremental in the sense that any old information is more entrenched than any new information.

Recently, several proposals have been made to overcome these shortcomings of Dynamic Semantics. Asher tried in [1] to combine DRT with belief revision. However, Asher kept main features of DRT unchanged and only allowed limited revision of DRSs. At first, Asher reformulated DRSs as partial models and defined monotonic core logic of DRSs. Then, he completed this partial monotonic logic with a non-monotonic logic, where applications of the non-monotonic logic were strongly restricted. He called this method *local revision* and contrasted it to *global revision* in AGM model that is a standard framework for formal treatment of belief revision (cf. [3]).

In this paper, I propose a flexible framework of dynamic semantics. I will show how to construct interpretations that can be revised. A Theory of Interpretation Structures (TIS) as proposed in this paper can be located not only in the tradition of dynamic semantics but also in the tradition of belief revision whose classical position is stated in [3]. TIS is a theory of global revision; one of its essential features lies in keeping revised information in the interpretation structure (IS). This makes cancellation of revision easily performable. In TIS, revision is realized by restructuring IS. This paper demonstrates TIS as a powerful framework for dynamic interpretations.

2 Natural Representation Language

NRL (Natural Representation Language) is a framework of dynamic semantics; it was proposed in [8]. In this section, NRL is briefly described by giving its axioms. NRL is a framework of extensional mereology (cf. Definition 1) combined with individuation by sortal predicates and with use of Skolem symbols (cf. Definition 2 and 3). Formulas of NRL are called *Discourse formulas* or *D-formulas*. NRL uses '{' and '}' as parentheses and comma ',' as the conjunction.

[1] Theory of segmented DRSs (Discourse Representation Structures) proposed by Asher deals with structures of DRSs, but he uses the framework for describing discourse structures and not for analyzing interpretation revisions (cf. [2])

Definition 1. *Extensional Mereology* (EM) consists of the following axioms, axiom schemas and definitions. Let $\{\psi \equiv \chi\}$ be an abbreviation of $\{\{\psi \to \chi\}, \{\chi \to \psi\}\}$.
MA1. Axioms for lattice theory.
MA2. Additional axioms for Boolean algebra.
MD1. $x \subset y \equiv \{x \cap y = x\}$.
MD2. $x \subsetneq y \equiv \{x \subset y, x \neq y\}$.
MD3. $x \subset_p y \equiv \{x \subset y, x \neq \emptyset\}$.
MA3. $\exists u\, \psi(u) \to \exists x\{\psi(x), \forall u\{\psi(u) \to u \subset_p x\}\}$.
MD4. $\{x = max(u)[\psi(u)]\} \equiv \{\{\psi(x), \forall u\{\psi(u) \to u \subset_p x\}\} \vee \{\forall u \neg\psi(u), x = \emptyset\}\}$.
MA4. For all Skolem function symbol d_k : $d_k(x \cup y) = d_k(x) \cup d_k(y)$.

$\subset_p$ in Definition 1 is *part-of* relation, which is the essential notion of mereology.

Definition 2. *Extensional Mereology with Sortal Individuation*(EMSI) is an axiom system with EM and the following axioms and definitions. Predicate F that satisfies this axiom system is called "sortal predicate".
SA1. $\neg F(\emptyset)$.
SD1. $x \subset_F y \equiv \{F(x), F(y), x \subset y\}$.
SD2. $atom_F(x) \equiv \{F(x), \forall u\{u \subset_F x \to u = x\}\}$.
SD3. $x \varepsilon_F y \equiv \{atom_F(x), x \subset_F y\}$.
SA2. $F(x) \to \{\forall u\{u\varepsilon_F x \equiv u\varepsilon_F y\} \to x = y\}$.
SA3. $F(x) \to \exists u\{u\varepsilon_F x\}$.
SA4. $\{\forall u \forall v\{\{u\varepsilon_F x, v\varepsilon_F x\} \to u = v\}, \forall u\{u\varepsilon_F x \to u = x\}\} \to \forall u\{u \subset_F x \to u = x\}$.
SD4. $x \subsetneq_F y \equiv \{F(x), F(y), x \subsetneq y\}$.
SD5. $\{x = sum_F(u)[\psi(u)]\} \equiv \forall u\{u\varepsilon_F x \equiv \{\psi(u), atom_F(u)\}\}$.
SD6. $\{x = max_F(u)[\psi(u)]\}\} \equiv \{\{\exists y\{F(y), \psi(y), \forall u\{\{F(u), \psi(u)\} \to u \subset_F y\}\} \to$
$\forall u\{\{F(u), \psi(u)\} \equiv u \subset_F x\}\}, \{\neg\exists y\{F(y), \psi(y), \forall u\{\{F(u), \psi(u)\} \to u \subset_F y\}\} \to x = \emptyset\}\}$.
SD7. $collective(x, \psi(u)) \equiv \{\psi(x), \forall u\{u \subsetneq x, u \neq \emptyset\} \to \neg\psi(u)\}\}$.
SD8. $collective_F(x, \psi(u)) \equiv \{\psi(x), \forall u\{u \subsetneq_F x \to \neg\psi(u)\}\}$.
SD9. $distributive(x, \psi(u)) \equiv \forall u\{u \subset_p x \to \psi(u)\}$.
SD10. $distributive_F(x, \psi(u)) \equiv \forall u\{u \subset_F x \to \psi(u)\}$.
SD11. When G is a unary predicate symbol, $non_F[G](x) \equiv \forall u\{u\varepsilon_F x \to \neg G(u)\}$.
SD12. A function symbol α of type $\langle thing, thing\rangle$ that satisfies the following condition is called "adjective":
$\forall x\{\{F(x), F(\alpha(x))\} \to \{\alpha(x) \subset_F x\}\} \vee \{\exists x\{\alpha(x) \subset_p x\}, \forall x\{\alpha(x) \subset x\}\}$.

F in Definition 2 is intended as a sortal predicate that can be used for individuation of structured objects. For example, "human" and "animal" are sortal predicates. $\subset_F$ corresponds to IS-A relation with respect to F and ε_F expresses INSTANCE-OF relation with respect to F.

Definition 3. NRL is a theory of two-sorted logic with the following axioms and axiom schemas.
LA0. Axiom system EMSI.
LA1. Standard axioms for + .
LD1. $\{cd_F(x) = 1\} \equiv atom_F(x)$.
LA2. $\{x \cap y = \emptyset, cd_F(y) = 1\} \to \{cd_F(x) = n \equiv cd_F(x \cup y) = n + 1\}$.

cd_F means the *cardinality* of x with respect to F, i.e. the number of F-objects in x. In Definition 3, this notion is recursively defined.

The semantics of NRL is defined as follows:

Definition 4. Let $M = \langle\langle \mathbf{U}, \mathbf{N}\rangle, V\rangle$. Let $\mathbf{N}$ be the set of natural numbers and K be a D-formula.

1. M^* is a *Skolem expansion* of M with respect to K *iff*
   $[M^* = \langle\langle \mathbf{U}, \mathbf{N}\rangle, V^*\rangle]\&[V \subseteq V^*]\&$
   [For all Skolem constant symbols d_k, $V^*(d_k) \in \mathbf{U}$]&
   [For all n-ary Skolem function symbols d_k, $V^*(d_k)$ is a function from $\mathbf{U}^n$ into $\mathbf{U}$].
2. K is *true* with respect to M, β *iff*
   $\exists M^*([M^*$ is a Skolem expansion of M with respect to $K]\&$
   [K is true with respect to $M^*, \beta])$
3. K is *true* with respect to M *iff*
   K is true with respect to M, β for all assignments β .

NRL is a framework of dynamic semantics that can be easily applied to represent the meaning of sentences with mass terms and sentences with plural terms. By using NRL, plural anaphora can be represented as simple as singular anaphora. This is a major advantage of NRL compared to DRT in [5].

3 Theory of Interpretation Structures

In this paper, the *Theory of Interpretation Structures* (TIS) is constructed in a similar way as the construction of the *Theory of Belief Structures* (TBS) that is a framework for belief revision (cf. [10]).

Definition 5.

1. Let L be a language of NRL. Then, an *Interpretation Structure* ($IS = \langle \mathbf{S}, >, \sim\rangle$) is defined as follows:
   (a) $\mathbf{S}$ is a set of D-formulas in L.
   (b) $>$ is a partial ordering on $\mathbf{S}^2$.
   (c) $\sim$ is an equivalence relation on $\mathbf{S}^2$.
2. Given an interpretation structure IS. Then, the *intended content of* IS, denoted as $IC(IS)$, satisfies the following conditions:
   (a) $\forall X1, X2 \in \mathbf{S}(X1 > X2 \Rightarrow (X2 \in IC(IS) \Rightarrow X1 \in IC(IS)))$.
   (b) $\forall X1, X2 \in \mathbf{S}(X1 \sim X2 \Rightarrow (X2 \in IC(IS) \Leftrightarrow X1 \in IC(IS)))$.

IS and $IC(IS)$ can be seen as a partial description of interpreter's belief state. $K_1 > K_2$ means roughly that K_1 is *more firmly believed than* K_2. $K_1 \sim K_2$ means that K_1 is *as firmly believed as* K_2.

For change of IS and for interpretation of $IC(IS)$, we accept principles 1 - 3.

Interpretation Principles

1. For alteration of IS, there are the following three methods:
   (a) change of ordering,
   (b) addition of a new piece of information,
   (c) deletion of an old piece of information.
2. Principles for interpreters
   (a) An interpreter desires that his $IC(IS)$ is consistent. Therefore, he tries to avoid any contradiction when he finds one.
   (b) An interpreter desires that his $IC(IS)$ becomes richer in the long run.
   (c) Conservatism: The costs of interpretation revisions are high and therefore not desirable if not necessary.
3. Holistic principle for the intended content:
   NRL's interpretation is holistic, i.e. the total intended content is interpreted as a whole. This results from the interpretation method of Skolem symbols (cf. Definition 4).

By using the first group of principles, replacement of information can be defined by at first applying deletion (1c) to old information and then applying addition (1b) to new information. However, in TIS, replacement is rarely used. This is because the content replacement with respect to $IC(IS)$ can also be achieved by order change. Order change is preferable to replacement, because IS after order change still contains information that can be used in undoing this replacement in $IC(IS)$.

The idea behind TIS is similar to the approach of epistemic entrenchment proposed by Gardenfors (cf. [3] Cahp. 4). However, TIS is less formally characterized than AGM model, so that more flexible treatment of problems becomes possible, while TIS has less formal results than AGM model.

4 Dynamic Interpretations

4.1 Standard Interpretations

A standard interpretation of a discourse consists of the following two steps:

1. Constructing an interpretation structure (IS).
2. Identifying the intended content from $IS(IC(IS))$ by using interpretation principles in section 3.

In NRL, d_n and indexed pronouns, such as he_n, are used as Skolem symbols. In the following description, K_n describes the content of a given sentence and C_n describes a possible context for interpretation. In general, there are multiple possible context interpretations from which an appropriate one should be chosen.

Example 1. (Plural anaphora):
(1) Most farmers own a donkey. They are very cruel. They have a bad time.

K_1 : $\{d_1 =$ FARMER, $d_2 = sum_{human}(u)[u\varepsilon_{human}d_1, d_3(u)\varepsilon_{animal}$ DONKEY, u owns $d_3(u)], Most_{human}(d_2, d_1)\}$,
where $Most_F(x, y) \equiv 2 \times cd_F(x) > cd_F(y)$, i.e. *more than half* of x are y.

$K_2 : \{cd_{human}(they_1) > 1, they_1$ are very cruel$\}$.
$C_{2pn1} : \{they_1 = d_1\}$.
$C_{2pn2} : \{they_1 = d_2\}$.
$C_{2r1} : \{distributive_{human}(u)[they_1, u$ is very cruel$]\}$.
$C_{2r2} : \{collective_{human}(u)[they_1, u$ are very cruel$]\}$.
$K_3 : \{cd_{animal}(they_2) > 1, they_2$ have a bad time$\}$.
$C_{3pn1} : \{they_2 = d_1\}$.
$C_{3pn2} : \{they_2 = d_2\}$.
$C_{3pn3} : \{they_2 = d_3(d_2)\}$.
$C_{3r1} : \{distributive_{animal}(u)[they_2, u$ has a bad time$]\}$.
$C_{3r2} : \{collective_{animal}(u)[they_2, u$ have a bad time$]\}$.

$d_3(d_2)$ means *the donkeys that at least one of the farmers own*. Axiom MA4 justifies this use of $d_3(d_2)$. The following tables and diagram show how an interpretation structure grows during the process of interpretation. At first, IS is determined. Then, $IC(IS)$ is calculated according to interpretation principles in section 3:

IS :

IS_1 :	$(\{K_1\}, \emptyset)$
IS_2 :	$K_1 \sim K_2 \& K_2 > C_{2pn2} > C_{2pn1} \& K_2 > C_{2r1} > C_{2r2}$
IS_3 :	$IS_2 \& (K_2 \sim K_3$ $\& K_3 > C_{3pn3} > C_{3pn1} \& C_{3pn3} > C_{3pn2} \& K_3 > C_{3r1} > C_{3r2})$

IS_3:

K_1	
$\wr$ $> C_{2pn2}$	$> C_{2pn1}$
K_2	
$\wr$ $> C_{2r1}$	$> C_{2r2}$
$\wr$	$> C_{3pn1}$
$\wr$ $> C_{3pn3}$	$> C_{3pn2}$
K_3	
$> C_{3r1}$	$> C_{3r2}$

$IC(IS)$:

Stage 1	$IC(IS_1)$:	K_1
Stage 2	$IC(IS_2)$:	$IC(IS_1) \cup (K_2 \cup C_{2pn2} \cup C_{2r1})$
Stage 3	$IC(IS_3)$:	$IC(IS_2) \cup (K_3 \cup C_{3pn3} \cup C_{3r1})$

C_{2pn1} is incompatible with $K_1 \cup K_2 \cup C_{2pn2}$ and C_{2r2} is incompatible with $K_1 \cup K_2 \cup C_{2r1}$, so that they are omitted from $IC(IS_2)$. From the same reason, C_{3pn1}, C_{3pn2}, and C_{3r2} are excluded from $IC(IS_3)$. The resulting interpretation of the discourse of (1) is given by $IC(IS_3)$, i.e., $K_1 \cup K_2 \cup C_{2pn2} \cup C_{2r1} \cup K_3 \cup C_{3pn3} \cup C_{3r1}$:

$\{d_1 =$ FARMER, $d_2 = sum_{human}(u)[u \varepsilon_{human} d_1, d_3(u) \varepsilon_{animal}$ DONKEY,
u owns $d_3(u)], Most_{human}(d_2, d_1)\}$
$\cup \{cd_{human}(they_1) > 1, they_1$ are very cruel$\} \cup \{they_1 = d_2\}$
$\cup \{distributive_{human}(u)[they_1, u$ is very cruel$]\}$
$\cup \{cd_{animal}(they_2) > 1, they_2$ have a bad time$\} \cup \{they_2 = d_3(d_2)\}$
$\cup \{distributive_{animal}(u)[they_2, u$ has a bad time$]\}$.

This interpretation corresponds to the following anaphora resolution:

> Most farmers own a donkey. They, *the farmers who own a donkey*, are very cruel. They, *the donkeys that at least one of the farmers own*, have a bad time.

In TIS, not only the resulting interpretation but also interpretation structure is kept and used as a context for the ongoing interpretation process. This is a fundamental difference to systems proposed in [1], [11], and [12].

4.2 Revising Interpretation

Interpretation revision is carried out by restructuring IS. This can be achieved by changing the order of the old IS. After restructuring, the standard interpretation can be continued:

Step 1. Restructuring IS.
Step 2. Identifying the intended content from IS.

Example 2. (Revision):
(2) John has never read Russian novels. But Bill likes them.

$K_1 : \{d_1 = \mathit{Russian}(\text{NOVEL}),\ d_2 = \mathit{John},\ d_3 = \mathit{sum}_{\mathit{book}}(u)[u\varepsilon_{\mathit{book}} d_1, d_1 \text{ has read } u],\ \mathit{cd}_{\mathit{book}}(d_3) = 0\}.$
$K_2 : \{d_4 = \mathit{Bill}, \mathit{cd}_{\mathit{human}}(\mathit{them}_1) > 1, d_4 \text{ likes } \mathit{them}_1\}.$
$C_A : \{\mathit{them}_1 = d_3\}.$
$C_B : \{\mathit{them}_1 = d_1\}.$

IS_1: $\boxed{K_1}$

IS_2:

K_1	
≀	
K_2	$> C_A > C_B$

Judgement of IS_2: $K_1 \cup K_2 \cup C_A$ has no model. Thus, IS_2 has to be restructured. Otherwise, anaphora resolution is impossible.

IS_{2R}:

K_1	
≀	
$K_2 > C_B$	$> C_A$

The resulting interpretation of this discourse is given by $K_1 \cup K_2 \cup C_B$.

Kamp proposed a two-stage theory for the interpretation of presuppositions; these two stages consist of computation and judgment (cf. [4]). The process of revision described above is compatible with this two-stage theory. In order to compare TIS with DRT, we would like to consider examples (3a) and (3b).

Example 3a.
(3a) Walter has a rabbit. His rabbit is white.

DRT interprets this example as follows (cf. [4] p. 231):

$(\{s_0, w, y, t, s\},$
$\{n \subseteq s_0, t = n, t \subseteq s, Walter(w), rabbit(y), s_0 : have(w, y), s : white(y)\})$.

In this DRS, s_0 and s are used as discourse referents for states. In TIS, the same example is interpreted as follows, where t_s represents the *speech time*:

$K_1 : \{d_1 = \text{Walter}, d_2 \varepsilon_{animal}\ \text{RABBIT}, s_0 : have(d_1, d_2), t_s \subset_p s_0\}$.
$C_1 : \{d_1 \varepsilon_{human} male(\text{HUMAN})\}$.
$K_2 : \{d_3 \varepsilon_{animal}\ \text{RABBIT}, s_1 : have(his_1, d_3), s_2 : white(d_3), t_s \subset_p s_1, t_s \subset_p s_2\}$.
$C_2 : \{his_1 = d_1, d_3 = d_2\}$.

$$IS_1 : \begin{array}{|l|} \hline K_1 > C_1 \\ \wr \\ K_2 > C_2 \\ \hline \end{array}$$

$IC(IS_1) = K_1 \cup C_1 \cup K_2 \cup C_2$.

The content of $IC(IS_1)$ is essentially identical with the previous DRS. Their main difference lies in redundancy of TIS formulation. However, this redundancy is not necessarily disadvantageous. To show this, let us consider the case that (3a) is continued as follows:

Example 3b.
(3b) Walter has a rabbit. His rabbit is white. But Walter's is not white. It is brown.

In this example, it is likely "His" refers to a person who is not Walter. In such a case, it is quite difficult to accommodate the previous DRS to this change, because the change requires *ad hoc* addition of some discourse referents and corresponding changes in conditions of the DRS. In TIS, the change is accommodated by slightly restructuring IS and adding interpretation of new information, as follows:

$K_3 : \{d_4 = \text{Walter}, s_3 : have(d_4, d_5), s_4 : \neg white(d_5), t_s \subset_p s_3, t_s \subset_p s_4\}$.
$C_3 : \{d_4 = d_1, d_5 = d_2\}$.
$C_{2R} : \{his_1 \neq d_1\}$. (an alternative interpretation of anaphora)
$K_4 : \{s_5 : brown(it_1)\}$.
$C_4 : \{it_1 = d_5, s_5 = s_4\}$.

$$IS_2 : \begin{array}{|l|l} \hline K_1 > C_1 & \\ \wr & \\ K_2 > C_{2R} & > C_2 \\ \hline \wr & \\ K_3 > C_3 & \\ \wr & \\ K_4 > C_4 & \\ \hline \end{array}$$

$IC(IS_2) = K_1 \cup C_1 \cup K_2 \cup C_{2R} \cup K_3 \cup C_3 \cup K_4 \cup C_4$.

This shows that accommodation of IS to interpretation change of anaphora resolution is straightforward. C_{2R}, which states *"His" does not refer to Walter*, is added to IS_1 and is preferred to the previous anaphora resolution described by C_2. Then, $IC(IS_2)$ is calculated from IS_2 according to the interpretation principles proposed in section 3.

4.3 Interpretation of Metonymy

TIS can be applied to various problems, such as interpretation of metonymy [2] and disambiguation of interpretation of expressions.

Example 4. (Presupposition and Metonymy):
(4) Plato is on the top shelf. It is bound in leather. He is a famous Greek philosopher.

$MB_0 : \{\psi(d_1)\}$, where $\psi(d_1)$ describes the presupposition about *the shelf*.
$K_1 : \{d_2 = Plato, d_1 \varepsilon_{furniture}$ SHELF, d_2 is on the top of $d_1\}$.
$K_2 : \{it_1$ is bound in leather$\}$.
$C_{2A} : \{it_1 = d_1\}$.
$C_{2B} : \{d_2$ wrote $d_3, d_3 \varepsilon_{thing}$BOOK, $it_1 = d_3\}$.
$K_3 : \{he_1 \varepsilon_{human} famous(Greek($PHILOSOPHER$))\}$.
$C_3 : \{he_1 = d_2\}$.

$$IS_3 : \begin{array}{|l|l} \hline MB_0 > K_1 & \\ \hline \quad\quad \wr & \\ \quad\quad K_2 \;\; > C_{2B} & > C_{2A} \\ \hline \quad\quad \wr & \\ \quad\quad K_3 \;\; > C_3 & \\ \hline \end{array}$$

The resulting interpretation of this discourse is given by

$$MB_0 \cup K_1 \cup K_2 \cup C_{2B} \cup K_3 \cup C_3.$$

In the case of interpretation of metonymy, flexibility of context interpretation plays an essential role. The interpretation

$$IC(IS_2) := IC(IS_1) \cup (K_2 \cup C_{2A})$$

is rejected, because a shelf cannot be bound in leather and it has therefore no model. This example also shows how to integrate presuppositions and contents of mutual beliefs into IS.

4.4 Disambiguation

From our last discussions, it must be obvious how to disambiguate the meaning of an expression. Suppose predicate F has two meanings, namely F_A and F_B.

$K_1 : \{\psi(d_1), F(d_1)\}$, where $F := \lambda x(F_A(x) \vee F_B(x))$.
$C_A : \{F_A(d_1)\}, C_B : \{F_B(d_1)\}$.

In this case, disambiguation can be achieved by the following restructuring of IS:

$$\text{Stage 1: } \begin{array}{|l|l} \hline K_1 & > C_A \\ & > C_B \\ \hline \end{array}$$

[2] For interpretation of metonymy, see [9].

Stage 2: $K_1 \cup C_A$ is impossible. Thus, according to interpretation principle (2b), C_B should be preferred to C_A, in order to make $IC(IS)$ as rich as possible.

Stage 3: $\boxed{K_1 > C_B \,|\, > C_A}$

When the meaning of F_A is inappropriate, its order is diminished and F_B becomes preferred. As a result, F_B is integrated in $IC(IS)$ (cf. Stage 3).

Generally, anaphoric resolution can be seen as a process of disambiguation (cf. [11], [12]), if there are several interpretation possibilities of an anaphoric relation. Cancellation of a disambiguation can be easily realized within TIS, while this is difficult for Reyle's approach, because his system removes information for alternative interpretations after disambiguation.

In some cases, *context identification* is meant by *disambiguation*. For example, many problems of *temporal underspecifications* discussed in [12] can be interpreted as problems of *context identification* in the sense of this paper. Let us consider the following example (cf. [12] p. 264):

Example 5.
(5a) John made a short trip to London. He visited the British Museum.
(5b) John made a short trip to London. He visited the Louvre.

The interpretation of (5a) within TIS is straightforward, because the standard strategy for identification of temporal contexts yields a consistent result:

$K_{a1} : \{d_1 = \text{John}, d_2 = \text{London}, s_1\text{: } \textit{make-a-short-trip}(d_1, d_2), s_1 < t_s\}.$
$K_{a2} : \{d_3 = \text{British Museum}, e_1 : \textit{visit}(he_1, d_3), e_1 < t_s\}.$
$C_{a21} : \{he_1 = d_1\}.$
$C_{a22} : \{e_1 \subset_p s_1\}.$

$$IS_{a2}: \begin{array}{|l|} \hline K_{a1} \\ \hline \quad \wr \quad > C_{a21} \\ K_{a2} \\ \qquad > C_{a22} \\ \hline \end{array}$$

$IC(IS_{a2}) = K_{a1} \cup K_{a2} \cup C_{a21} \cup C_{a22}.$

The sentence (5b) seems unintelligible, if we interpret "He" as referring to John. In interpretation of (5a), we assumed that John's visit of the British Museum took place during his stay in London, but this kind of interpretation is impossible for (5b), because the Louvre is located totally outside of London. Thus, we need to revise this line of interpretation:

$K_{b2} : \{d_4 = \text{Louvre}, e_1 : \textit{visit}(he_2, d_4), e_2 < t_s\}.$
$C_{b21} : \{he_2 = d_1\}.$
$C_{b22} : \{e_2 \subset_p s_1\}.$
$C_{b21R} : \{he_2 \neq d_1\}.$
$C_{b22R} : \{e_2 \cap s_1 = \emptyset\}.$
$C_{b2B} : \{s_1 < e_2\}$. (Note that C_{b2B} implies C_{b22R}.)

IS_{b2A}:	K_{a1}	
	$\wr \;\; > C_{b21R}$	$> C_{b21}$
	K_{b2}	
		$> C_{b22}$
		$> C_{b22R}$

$IC(IS_{b2A}) = K_{a1} \cup K_{b2} \cup C_{b21R} = K_{a1} \cup K_{b2} \cup \{he_2 \neq d_1\}$.
(John made a short trip to London. *The other pesron* visited the Louvre.)

In (5b), we have no evidence for the temporal relation between John's trip to London and the visit of the Louvre by the other person. In TIS, this interpretation can be expressed by making temporal interpretation ambiguous. Thus, IS_{b2A} implies the information $K_{b2} > C_{b22} \& K_{b2} > C_{b22R}$ and $IC(IS_{b2A})$ does not contain any information on temporal relation between e_2 and s_1.

It is also possible to interpret the person referred by "He" as John. In this case, his visit of the Louvre must take place after his stay in London:

IS_{b2B}:	K_{a1}	
	$\wr \;\; > C_{b21}$	$> C_{b21R}$
	K_{b2}	
	$> C_{b2B}$	$> C_{b22}$

$IC(IS_{b2B}) = K_{a1} \cup K_{b2} \cup C_{b21} \cup C_{b2B} = K_{a1} \cup K_{b2} \cup \{he_2 = d_1\} \cup \{s_1 < e_2\}$.
(John made a short trip to London. *Then John* visited the Louvre.)

5 Conclusions

TIS is a theory that combines NRL, a framework of dynamic semantics, with interpretation revision. By using TIS, interpretation processes can be described in detail. In this paper, I have sketched how to apply TIS to choice and revision of anaphoric references, representation of presuppositions, and interpretation of metonymies. TIS can also be applied to the distinction between the attributive and referential use of definite descriptions (cf. [7]).

References

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