ГОДИШНИК НА СОФИЙСКИЯ УНИВЕРСИТЕТ „СВ. КЛИМЕНТ ОХРИДСКИ"

ФАКУЛТЕТ ПО МАТЕМАТИКА И ИНФОРМАТИКА
Книга 1 — Математика
Том 87, 1993

ANNUAIRE DE L'UNIVERSITE DE SOFIA „ST. KLIMENT OHRIDSKI"

FACULTE DE MATHEMATIQUES ET INFORMATIQUE
Livre 1 — Mathématiques
Tome 87, 1993

SOME SITUATION THEORETICAL NOTIONS*

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Русанка Луканова, Робин Купр. НЕКОТОРЫЕ ПОНЯТИЯ СИТУАЦИОННОЙ ТЕОРИИ

Ситуационная теория ставит себе целью предложить адекватные математические средства для семантики естественных языков. За последние десять лет она пережила ряд перемен и продолжает развиваться. Со своей стороны ситуационная теория побуждает появление формализмов, подходящих для строения моделей некоторых ее объектов, которые не всегда фундированные [1, 2].

В этой статье мы напоминаем о некоторых понятиях ситуационной теории, введеных в [5, 11, 12], и предлагаем другие как например сильная/слабая информативность ситуации s' по отношению к другой ситуации s'', следование и эквивалентность суждений и типов. Они и их свойства необходимы для „исчисления" интерпретаций выражений (фраз), порожденных грамматикой GR2, исследована в [14]. Лучше было бы рассматривать эту статью как ставящую задачу о построении модели введеных понятий с помощью аппарата из [2], чем как вклад в теории моделей о ситуациях.

Roussanka Loukanova, Robin Cooper. SOME SITUATION THEORETICAL NOTIONS

Situation Theory is meant to provide an adequate mathematical tool for Semantics of Natural Languages. In the last ten years it has passed through a lot of changes and is still developing. On its part Situation Theory has motivated the appearance of formalisms appropriate for modelling situation theoretical objects that are not necessarily well founded ([1, 2]).

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* After having been used in [14], the notions introduced in this paper have undergone quite a lot of revisions in result of discussions between the authors during the stay of one of them, R. Loukanova, at the Center for Cognitive Science, Edinburgh University, Feb.–Mar., 1994. The stay was supported by a TEMPUS grant.

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In this article we remind some situation theoretical notions, introduced in [5, 11, 12], and suggest some others such as *strong/weak informativeness of a situation s' with respect to another situation s''*, *envolving* and *equivalence* for propositions and types. All of them and their properties are needed for the "calculations" of the interpretations of phrases generated by the grammar GR2 elaborated in [14]. One of the possibilities for representing the information transferred by uttering of natural language phrases is to accept that the models of the real situations including the situations described by the utterances are *informative with respect to* the situations used in them for describing some objects. Something more, in the situation semantics, proposed by the GR2, we assume that the described situations are *strongly informative with respect to* the speaker's resource situations. That gives a way to conclude whether what the speaker claims by an utterance is true. An important means for representing an equivalent but differently structured information in Situation Theory is the operation *absorption* of parameters (abstraction) over infons and propositions. By this operation complex relations and types are received in addition to the primitive relations and types. In this article we propose to use complex types as special kind relations — "situated" relations that could be prescribed to objects.

The article should be considered as setting a task for modelling the introduced notions with the apparatus developed in [2] rather than a contribution to the Model Theory of Situations.

1. INTRODUCTION

Let introduce informally some notions from Naive Situation Theory used in Situation Semantics. Short introductions into the terminology are also [5] and [11]. Building a formal model of Situation Theory presupposes some familiarity with the books [1] and [2]. For building models of Situation Theory see [9] and [10].

Situation theoretical objects are objects built up from the next primitives:

A — the collection of primitive individuals;

R — the collection of primitive relations; each relation comes with a set of argument roles associated with conditions for appropriate filling;

$\mathbb{T}$ — the collection of primitive types; each type comes with a set of argument roles associated with conditions for appropriate filling;

$\mathbb{P}$ — the collection of primitive parameters.

Let γ be a relation or a type (primitive or complex) with a set of argument roles $\mathrm{Arg}(\gamma)$. An *assignment (filling) for γ* is any partial function θ with $\mathrm{Dom}(\theta) \subseteq \mathrm{Arg}(\gamma)$, the values of which are situation theoretical objects satisfying the conditions for appropriateness for γ.

Basic *infons* (the term *infon* is an abbreviation for *information*) are objects of the kind

$$\ll \gamma, \theta; i \gg,$$

where γ is a relation or a type (primitive or complex), θ is an *assignment for* γ, and $i \in \{0, 1\}$. No order over the argument roles is assumed, but the following notations for infons $\ll \gamma, \theta; i \gg$ are used often in the literature on Situation Semantics:

$\ll \gamma, \mathrm{arg}_1 : \theta(\mathrm{arg}_1), \ldots, \mathrm{arg}_n : \theta(\mathrm{arg}_n); i \gg$,

$\ll \gamma, \theta(\mathrm{arg}_1), \ldots, \theta(\mathrm{arg}_n); i \gg$ (in this notation argument roles are implied and their revelation is left to the reader),

where γ is a relation, $\{\mathrm{arg}_1, \ldots, \mathrm{arg}_n\}$ is the set of argument roles of γ, θ is an assignment for γ, and $i \in \{0, 1\}$. Usually, it is said that $\theta(\mathrm{arg}_j)$ fills the argument role arg_j.

For example, if we have the primitive relations *chair* and *sit* and $a, b \in A$, then

$$\ll \text{chair}, \text{arg} : b; 1 \gg$$

and

$$\ll \text{sit}, \text{subj} - \text{arg} : a, \text{obj} - \text{arg} : b; 1 \gg$$

are infons. In the alternative notation these infons are written

$$\ll \text{chair}, b; 1 \gg \quad , \qquad \ll \text{sit}, a, b; 1 \gg .$$

When θ is not defined for some argument role arg_k, $k \in \{1, \ldots, n\}$, the following notation is used:

$$\ll \gamma, \text{arg}_1 : \theta(\text{arg}_1), \ldots, \text{arg}_k : \_ , \ldots, \text{arg}_n : \theta(\text{arg}_n); i \gg .$$

For example,

$$\ll \text{sit}, \text{subj} - \text{arg} : a, \text{obj} - \text{arg} : \_ ; 1 \gg$$

is an infon that does not specify the object a is sitting on. Such infons are called unsaturated and they are interpreted existentially, i.e. there is an object μ such that

$$\ll \text{sit}, \text{subj} - \text{arg} : a, \text{obj} - \text{arg} : \mu; 1 \gg .$$

Complex infons are obtained out of infons by the traditional operations like $\vee$, $\wedge$ and by quantification.

There is an operation over infons building complex relations — *absorption* of some of the parameters occurred in an infon (basic or complex).

Because of simplicity of the representation we assume that different occurrences of the constituent relations in an infon σ have different argument roles. We write $\sigma[\theta]$ when $\theta = \{\theta_1, \ldots, \theta_n\}$ is a list of the assignments occurred in σ. Let $\theta' = \{\theta'_1, \ldots, \theta'_n\}$ be another list of assignments for the argument roles in σ. We also write $\sigma[\theta']$ for the result of replacement in σ of the occurrences of the assignments $\theta_1, \ldots, \theta_n$ correspondingly with $\theta'_1, \ldots, \theta'_n$.

Let $\sigma(\xi_1, \ldots, \xi_n)$ be a parametric infon (basic or complex), where $\xi_1, \ldots, \xi_n$ is a list of some of the parameters in σ. The result of application of the operation *absorption of the parameters* $\xi_1, \ldots, \xi_n$ over the infon $\sigma(\xi_1, \ldots, \xi_n)$ is a *complex relation*, written

$$[\xi_1, \ldots, \xi_n / \sigma(\xi_1, \ldots, \xi_n)].$$

The argument roles of this relation are noted as $[\xi_1], \ldots, [\xi_n]$.

For example, the objects

$$[\xi / \ll \text{chair}, \xi; 1 \gg] \quad \text{and} \quad [\xi / \ll \text{chair}, \xi; 1 \gg \wedge \ll \text{sit}, a, \xi; 1 \gg]$$

are complex relations representing correspondingly the property to be a chair and the property to be a chair the individual a is sitting on.

The *propositions* are objects of the form $(\theta : T)$, where T is a type (primitive or complex) and θ is an assignment for argument roles of T.

A proposition $(\theta : T)$ is true just in the case when the objects that are values of the assignment θ are of type T.

In this article we are concerned mainly with a special kind of propositions, modelling the claims that in a situation s some objects are in or are not in some relations. For this purpose there is a primitive type $\models$ with two argument roles — the *situation* argument role and the *infon* role.

The proposition $(\theta : \models)$, where

$$\theta(\text{situation}) = s \text{ for some situation } s$$

and

$$\theta(\text{infon}) = \sigma \text{ for some infon } \sigma,$$

is written usually as

$$(s \models \sigma).$$

We write $s \models \sigma$ when the proposition $(s \models \sigma)$ is true, and $s \not\models \sigma$ when the proposition $(s \models \sigma)$ is false.

The situations are sets of infons and it is required that:

$$s \models \sigma \text{ iff } \sigma \in s \quad \text{for every basic infon } \sigma;$$

and for any infons σ_1 and σ_2

$$s \models \sigma_1 \wedge \sigma_2 \text{ iff } s \models \sigma_1 \text{ and } s \models \sigma_2,$$
$$\text{if } s \models \sigma_1 \vee \sigma_2, \text{ then } s \models \sigma_1 \text{ or } s \models \sigma_2.$$

Complex types are formed from propositions by the operation absorption. Let $p(\xi_1, \ldots, \xi_n)$ be a parametric proposition, where $\xi_1, \ldots, \xi_n$ is a list of some of the parameters occurred in p. The result of application of the operation *absorption of parameters* $\xi_1, \ldots, \xi_n$ over the proposition $p(\xi_1, \ldots, \xi_n)$ is a *complex type*, written

$$[\xi_1, \ldots, \xi_n / p(\xi_1, \ldots, \xi_n)].$$

The argument roles of this *type* are noted by $[\xi_1], \ldots, [\xi_n]$.

For example, we could form the type

$$[\xi, \zeta / (s \models \ll \text{chair}, \xi; 1 \gg \wedge \ll \text{sit}, \zeta, \xi; 1 \gg)].$$

The proposition

$$(\theta : [\xi, \zeta / (s \models \ll \text{chair}, \xi; 1 \gg \wedge \ll \text{sit}, \zeta, \xi; 1 \gg)]),$$

where $\theta([\xi]) = a$ and $\theta([\zeta]) = b$, represents the claim that the objects a and b are of type

$$[\xi, \zeta / (s \models \ll \text{chair}, \xi; 1 \gg \wedge \ll \text{sit}, \zeta, \xi; 1 \gg)].$$

This proposition is true just in the case when

$$s \models \ll \text{chair}, b; 1 \gg \wedge \ll \text{sit}, a, b; 1 \gg .$$

The absorption is a binding operator that binds the absorbed parameters, i.e. the parameters $\xi_1, \ldots, \xi_n$ are not already among the parameters of the object $[\xi_1, \ldots, \xi_n / \mu(\xi_1, \ldots, \xi_n)]$. The set of the parameters of a situation theoretical object μ, $\mathrm{Par}(\mu)$, is the set of the "free" parameters that occur in it. More precisely, we could define the set $\mathrm{Par}(\mu)$ inductively:

1. If $\mu \in A \cup R \cup \mathbb{T}$, then $\mathrm{Par}(\mu) = \varnothing$;
2. If $\mu \in \mathbb{P}$, then $\mathrm{Par}(\mu) = \{\mu\}$;

3. If $\mu = \ll \gamma, \theta; i \gg$, where γ is a relation or type, θ is an assignment for γ and $i \in \{0, 1\} \cup \mathbb{P}$, then

$$\mathrm{Par}(\mu) = \mathrm{Par}(\gamma) \cup \mathrm{Par}(i) \cup \bigcup_{\mathrm{arg} \in \mathrm{Arg}(\gamma)} \mathrm{Par}(\theta(\mathrm{arg}));$$

4. If $\mu = \mu_1 \vee \mu_2$, where μ_1 and μ_2 are infons (or types), then

$$\mathrm{Par}(\mu) = \mathrm{Par}(\mu_1) \cup \mathrm{Par}(\mu_2);$$

5. If $\mu = \mu_1 \wedge \mu_2$, where μ_1 and μ_2 are infons (or types), then

$$\mathrm{Par}(\mu) = \mathrm{Par}(\mu_1) \cup \mathrm{Par}(\mu_2);$$

6. If $\mu = [\xi / \nu(\xi)]$, where ξ is a set of parameters and ν is an infon or a proposition, then

$$\mathrm{Par}(\mu) = \mathrm{Par}(\nu) - \xi.$$

Let μ be a parametric situation theoretical object. Let c be a function such that $\mathrm{Dom}(c) \subseteq \mathbb{P}$, $\mathrm{Par}(\mu) \subseteq \mathrm{Dom}(c)$, and its values are situation theoretical objects that are not parametric. Let $\mu(c)$ be the object obtained by replacing each "free" occurrence of any parameter $\zeta \in \mathrm{Dom}(c) \cap \mathrm{Par}(\mu)$ with $c(\zeta)$. The function c is called *anchor* for μ when $\mu(c)$ is a situation theoretical object (i.e. all conditions for appropriateness are satisfied).

2. INFORMATIVENESS IN SITUATION SEMANTICS

Let go through some of the notions and their properties used for Situation Semantics provided by the grammar GR2 in [14]. Everywhere to the end of these notes we deal only with assignments which are total in sense that an assignment for a relation or a type is defined for all of its argument roles.

We accept that it is possible for a parametric proposition $p(\zeta_1, \ldots, \zeta_n)$ to be true. Truth parametric propositions have the existential interpretation:

Definition 1. A parametric proposition $p(\zeta)$ is true with respect to an anchor c for p if $p(c)$ is true.

Definition 2. A parametric proposition $p(\zeta)$ is *true* if there exists an anchor c for the parameters of $p(\zeta)$ such that $p(c)$ is true.

Definition 3. Let $p_1(\zeta)$ and $p_2(\xi)$ be parametric propositions, where ζ and ξ are correspondingly the lists of the parameters of the propositions p_1 and p_2. The proposition $p_1(\zeta)$ *involves* the proposition $p_2(\xi)$, written $p_1(\zeta) \Rightarrow p_2(\xi)$, if for any anchor c_1 for $p_1(\zeta)$, such that $p_1(c_1)$ is true, there exists an anchor c_2 for $p_2(\xi)$ that is an extension of c_1 and such that $p_2(c_2)$ is true too.

Definition 4. The propositions $p_1(\zeta)$ and $p_2(\xi)$ are *equivalent*, written $p_1(\zeta) \Leftrightarrow p_2(\xi)$, iff $p_1(\zeta) \Rightarrow p_2(\xi)$ and $p_2(\xi) \Rightarrow p_1(\zeta)$.

Let $\sigma(\xi)$ be a parametric infon (basic or complex), where $\xi = \xi_1, \ldots, \xi_n$ is a list of some of the parameters in σ. Let Arg_j be the set of the argument roles in σ, filled by the parameter ξ_j, $j \in \{1, \ldots, n\}$ (a parameter could fill more than one argument role in σ). We assume that for each $i, j \in \{1, \ldots, n\}$, if $i \neq j$, then $\text{Arg}_i \cap \text{Arg}_j = \varnothing$.

Every assignment θ of the argument roles of the relation $[\xi/\sigma(\xi)]$ in the infon $\ll [\xi/\sigma(\xi)], \theta; 1 \gg$ (or of the type $[\xi/(s \models \sigma(\xi))]$ in the proposition $(\theta : [\xi/(s \models \sigma(\xi))]))$ could be used to define an assignment θ', filling the argument roles in σ. The assignment θ' is the same as the existing already assignment in σ, possibly except for the argument roles in $\text{Arg}_1, \ldots, \text{Arg}_n$, and

(1) $$\theta'(\text{arg}) = \theta([\xi_j]) \quad \text{for each } \text{arg} \in \text{Arg}_j,\ j \in \{1, \ldots, n\}.$$

Property 1 ([12, p. 233]). For every situation s

$$(s \models \ll [\xi/\sigma(\xi)], \theta; 1 \gg) \Leftrightarrow (s \models \sigma[\theta']).$$

Property 2. For every type $[\xi/(s \models \sigma(\xi))]$ and its assignment θ

$$(\theta : [\xi/(s \models \sigma(\xi))]) \Leftrightarrow (s \models \sigma[\theta']).$$

Definition 5a. A situation s is *(weakly) propositionally informative*[3] if for any proposition p

$$(s \models \ll \text{true}, p; 1 \gg) \Rightarrow p.$$

Definition 5b. A situation s is *strongly propositionally informative* if for any proposition p

$$(s \models \ll \text{true}, p; 1 \gg) \Leftrightarrow p.$$

Corollary 1. Let s_1 be a propositionally informative situation. Then for any situation s, any parametric infon $\sigma(\xi)$ and any assignment θ of the argument roles of the type $[\xi/(s \models \sigma(\xi))]$

$$(s_1 \models \ll \text{true}, (\theta : [\xi/(s \models \sigma(\xi))]); 1 \gg) \Rightarrow (s \models \sigma[\theta']),$$

where θ' is defined as in (1).

Property 3. If s is a model of a real situation (i.e. s is in a set of situations modelling parts of the real world), then it is (weakly) propositionally informative.

We would like to model limited, partial parts of the world, that is why we do not accept that the real situations are strongly propositionally informative. A special case of the notion of strong propositional informativeness looks more appropriate for representing the cases when some situations are "truth–tellers" with respect to some situations.

Definition 5c. A situation s_1 is *strongly propositionally informative with respect to a situation* s if for any parametric infon $\sigma(\xi)$ and for any assignment θ of the argument roles of the type $[\xi/(s \models \sigma(\xi))]$

$$(s_1 \models \ll \text{true}, (\theta : [\xi/(s \models \sigma(\xi))]); 1 \gg) \Leftrightarrow (\theta : [\xi/(s \models \sigma(\xi))]).$$

If we accept a version of Situation Theory in which types are relations, a special kind of *situated relations*, then we could use them to build infons $\ll T, \theta; 1 \gg$, where T is a type and θ is an assignment for T. In such a way we could build two different propositions: $(\theta : T)$ and $(s \models \ll T, \theta; 1 \gg)$. If somebody insists on keeping a strong

[3] See the T-schema in [10].

distinction between the two kinds of objects — relations and types, a special two place primitive relation *be-of-type* could be used. Then the object $\ll T, \theta; i \gg$ could be introduced as a shorten record for the infon

$$\ll \text{be-of-type}, \theta, T; i \gg,$$

where T is a type, θ is an assignment for T, and $i \in \{0, 1\}$.

The intuition behind accepting the types to be used as relations and for building infons is that the proposition $(s \models \ll T, \theta; 1 \gg)$ carries different information than $(\theta : T)$. The proposition $(\theta : T)$ just says that the objects in θ are of type T, while the proposition $(s \models \ll T, \theta; 1 \gg)$ claims something else — situation s supports the information that the objects in θ are of type T. In particular, we could build the following propositions:

$$(\theta : [\xi/(s \models \sigma(\xi))]) \tag{2}$$

— the proposition that the objects in the assignment θ are of type $[\xi/(s \models \sigma(\xi))]$;

$$(s_1 \models \ll \text{true}, (\theta : [\xi/(s \models \sigma(\xi))]); 1 \gg) \tag{3}$$

— the proposition that the situation s_1 contains the information that the proposition $(\theta : [\xi/(s \models \sigma(\xi))])$ is true;

$$(s_1 \models \ll [\xi/(s \models \sigma(\xi))], \theta; 1 \gg) \tag{4}$$

— the proposition that the situation s_1 contains the information that the objects in the assignment θ are of type $[\xi/(s \models \sigma(\xi))]$.

Definition 6. A situation s_1 is (*weakly*) *informative with respect to a situation* s if for any parametric infon $\sigma(\xi)$ and for any assignment θ of the argument roles of the type $[\xi/(s \models \sigma(\xi))]$

$$(s_1 \models \ll [\xi/(s \models \sigma(\xi))], \theta; 1 \gg) \Rightarrow (s \models \sigma[\theta']),$$

where the assignment θ' is defined as in (1).

The difference between these notions of informativeness is that in the propositional variant (Definition 5a), when the proposition (3) is true, we could involve the information that the objects in θ have the property σ in the situation s: $s \models \sigma[\theta']$ (Corollary 1). In the other variant, given by Definition 6, the proposition (4) says that the situation s_1 contains the information that the objects θ have some "situated" properties. We could involve the information $s \models \sigma[\theta']$ directly by the fact $\ll [\xi/(s \models \sigma(\xi))], \theta; 1 \gg$ that is supported by the situation s_1. The proposition (3) says "too much", while the information given by the proposition (2) is not "enough" — it does not say where the information that the objects θ are of type $[\xi/(s \models \sigma(\xi))]$ comes from, i.e. where the information that $s \models \sigma[\theta']$ comes from.

The most suitable formalism for modelling situation theoretical notions is given by Aczel's universes of structured objects, [1], and by Lunnun's generalized λ-universes which contain structured objects supplied by a component function and a replacement operation, [2]. Lunnun's λ-universes come with parameters and abstraction (i.e. absorption), where alphabetic variants are identified. The notion of many sorted λ-universe is used to build a situation theoretical universe of structured objects. In such an universe we need Property 1 and Property 2 to be held.

These properties insist on adding an appropriate application operation within the λ-universes. In [2] the application of an abstract is at the meta-level (see [2, p. 18]). Something more, accepting the types as relations legalized for building infons opens new questions about a special application operation that enables the replacement "in depth" of the informative situations (see Definition 6, Corollary 2, Corollary 3 and Property 6).

Property 4a. If s_1 is a model of a real situation, then it is propositionally informative with respect to every situation s.

Property 4b. If s_1 is a model of a real situation, then it is informative with respect to every situation s.

Definition 7. A situation s' is *strongly informative with respect to a situation* s'' if for any parametric infon $\sigma(\xi)$ and for any assignment θ, filling argument roles of the type $[\xi/(s'' \models \sigma(\xi))]$,

$$(s'' \models \sigma[\theta']) \Leftrightarrow (s' \models \ll [\xi/(s'' \models \sigma(\xi))], \theta; 1 \gg),$$

where the function θ' is defined as in (1).

We do not insist that the situations modelling parts of the world are strongly informative with respect to all situations. But for the calculations of the linguistic meanings in Gr2, [14], it is the case that some situations (described situations) are strongly informative with respect to others (resource situations).

Corollary 2. Let $\sigma(\xi)$ be a parametric infon, where $\xi = \xi_1, \ldots, \xi_n$ is a list of some of the parameters in σ. Let s and s_1 be situations such that s is strongly informative with respect to s_1. Then

$$(s \models \ll [\xi/(s_1 \models \sigma(\xi))], \theta; 1 \gg) \Leftrightarrow (s_1 \models \sigma(\xi)),$$

where θ is the assignment such that $\theta([\xi_j]) = \xi_j$ for each $j \in \{1, \ldots, n\}$.

Definition 8. A type T_1 *involves* a type T_2 with respect to a situation s, written $T_1 \underset{s}{\Rightarrow} T_2$, if for any assignment θ_1 for T_1 exists an assignment θ_2 for T_2 such that

$$(s \models \ll T_1, \theta_1; 1 \gg) \Rightarrow (s \models \ll T_2, \theta_2; 1 \gg).$$

Definition 9. Types T_1 and T_2 are *equivalent with respect to a situation* s, $T_1 \underset{s}{\Leftrightarrow} T_2$, if $T_1 \underset{s}{\Rightarrow} T_2$ and $T_2 \underset{s}{\Rightarrow} T_1$.

Definition 10. A type T_1 involves a type T_2, written $T_1 \Rightarrow T_2$, if for any assignment θ_1 for T_1 and for any situation s_1 exist an assignment θ_2 for T_2 and a situation s_2 such that

$$(s_1 \models \ll T_1, \theta_1; 1 \gg) \Rightarrow (s_2 \models \ll T_2, \theta_2; 1 \gg).$$

Definition 11. Types T_1 and T_2 are *equivalent*, written $T_1 \Leftrightarrow T_2$, if $T_1 \Rightarrow T_2$ and $T_2 \Rightarrow T_1$.

Proposition 1. Let

$$T_1 = [\xi/(s_1 \models \sigma_1(\xi))], \quad T_2 = [\xi/(s_2 \models \sigma_2(\xi))], \quad (s_1 \models \sigma_1(\xi)) \Rightarrow (s_2 \models \sigma_2(\xi)),$$

where s_1 and s_2 are situations, $\sigma_1(\xi)$ and $\sigma_2(\xi)$ are parametric infons, and $\xi = \xi_1, \ldots, \xi_n$ is a list of some of the common parameters in σ_1 and σ_2, i.e. $\{\xi_1, \ldots, \xi_n\} \subseteq \mathrm{Par}(\sigma_1) \cap \mathrm{Par}(\sigma_2)$ (i.e. there is an one-to-one function from $\mathrm{Arg}(T_1)$ onto $\mathrm{Arg}(T_2)$).

Let s be a situation that is informative with respect to s_1 and strongly informative with respect to s_2. Then $T_1 \underset{s}{\Rightarrow} T_2$.

Proof. Let Arg_j be the set of the argument roles in σ_1, filled by the parameter ξ_j, $j \in \{1, \ldots, n\}$. Let Arg'_j be the set of the argument roles in σ_2, filled by the parameter ξ_j, $j \in \{1, \ldots, n\}$. Let θ be an assignment for T_1 such that

$$s \models \ll T_1, \theta; 1 \gg, \quad \text{i.e. } s \models \ll [\xi/(s_1 \models \sigma_1(\xi))], \theta; 1 \gg.$$

Then by Definition 6

$$s_1 \models \sigma_1[\theta'],$$

where θ' is the assignment that is the same as the assignment in σ_1, possibly except for the argument roles in $\mathrm{Arg}_1, \ldots, \mathrm{Arg}_n$, and for each $\mathrm{arg} \in \mathrm{Arg}_j$, $j \in \{1, \ldots, n\}$,

$$\theta'(\mathrm{arg}) = \theta([\xi_j]).$$

By Definition 2 there is an anchor c for $(s_1 \models \sigma_1[\theta'])$ such that $s_1 \models \sigma_1[\theta'](c)$. Let define the anchor c' for $(s_1 \models \sigma_1(\xi))$ that is the same as c, possibly except for the parameters in ξ, and for them it is defined in the following way:

$$c'(\xi_j) = \theta'(\mathrm{arg})(c) \quad \text{for each } \mathrm{arg} \in \mathrm{Arg}_j,\ j \in \{1, \ldots, n\}.$$

Then $\sigma_1[\theta'](c)$ and $\sigma_1(c')$ are one and the same infon[4] and $s_1 \models \sigma_1(c')$. Hence, $s_2 \models \sigma_2(c'')$, where c'' is an extension of c'. Then $s_2 \models \sigma_2(\xi)$.

Let define the assignment θ'', filling the argument roles of the type $T_2 = [\xi/(s_2 \models \sigma_2(\xi))]$ in the following way:

$$\theta''([\xi_j]) = \xi_j \quad \text{for each } j \in \{1, \ldots, n\}.$$

The situation s is strongly informative with respect to s_2, so by Corollary 2

$$s \models \ll [\xi/(s_2 \models \sigma_2(\xi))], \theta''; 1 \gg, \quad \text{i.e. } s \models \ll T_2, \theta''; 1 \gg.$$

Proposition 2. Let

$$T_1 = [\xi/(s_1 \models \sigma_1(\xi))], \quad T_2 = [\xi/(s_2 \models \sigma_2(\xi))], \quad (s_1 \models \sigma_1(\xi)) \Leftrightarrow (s_2 \models \sigma_2(\xi)),$$

where s_1 and s_2 are situations, $\sigma_1(\xi)$ and $\sigma_2(\xi)$ are parametric infons. Let s be a situation that is strongly informative with respect to s_1 and s_2. Then $T_1 \underset{s}{\Leftrightarrow} T_2$.

Corollary 3. Let

$$T_1 = [\xi/(s \models \ll [\gamma/\sigma(\gamma, \xi)], \theta; 1 \gg)] \quad \text{and} \quad T_2 = [\xi/(s \models \sigma(\theta'))],$$

where $\sigma(\gamma, \xi)$ is a parametric infon such that $\gamma = \gamma_1, \gamma_2, \ldots, \gamma_n$ and $\xi = \xi_1, \ldots, \xi_k$ are some of its parameters, each parameter γ_j fills the argument roles of σ that are in the set Arg_j, $j \in \{1, \ldots, n\}$, θ' is the assignment for the argument roles in σ that is the same as the assignment in $\sigma(\gamma, \xi)$, possibly except for the argument roles in Arg_j, and $\theta'(\mathrm{arg}) = \theta([\gamma_j])$ for each $\mathrm{arg} \in \mathrm{Arg}_j$, $j \in \{1, \ldots, n\}$. Then $T_1 \underset{s'}{\Leftrightarrow} T_2$ for any situation s' that is strongly informative with respect to s.

Corollary 4. Let s_1 and s_2 be situations such that s_1 is strongly informative with respect to s_2. Let

$$T_1 = [\xi/(s_1 \models \ll [\gamma/(s_2 \models \sigma(\gamma, \xi))], \theta; 1 \gg)] \quad \text{and} \quad T_2 = [\xi/(s_2 \models \sigma(\theta'))],$$

[4] More precisely, in a model of Situation Theory, like [9], that could be proved by induction with respect to building the infon σ_1.

where $\sigma(\gamma, \xi)$ is a parametric infon such that $\gamma = \gamma_1, \gamma_2, \ldots, \gamma_n$ and $\xi = \xi_1, \ldots, \xi_k$ are some of its parameters, each parameter γ_j fills the argument roles of σ that are in the set Arg_j, $j \in \{1, \ldots, n\}$, θ' is the assignment for the argument roles in σ that is the same as the assignment in $\sigma(\gamma, \xi)$, possibly except for the argument roles in Arg_j, and $\theta'(\mathrm{arg}) = \theta([\gamma_j])$ for each $\mathrm{arg} \in \mathrm{Arg}_j$, $j \in \{1, \ldots, n\}$.

Then $T_1 \underset{s}{\Leftrightarrow} T_2$ for any situation s that is strongly informative with respect to s_1 and s_2.

It is accepted in Situation Semantics that the speakers make claims $(s \models \sigma)$ describing some situation s via the utterances of natural language sentences. The situation s is called *described situation* for the utterance, and $(s \models \sigma)$ — *propositional content of the utterance.* Resource situations are used by the speakers to provide some individuals or information about some individuals needed for describing a situation s as being of certain type, i.e. for the propositional content of the utterance. Which situations are resource situations for an utterance is up to the speaker references. In Gr2, [14], it is accepted that if s is the described situation by an utterance, then it is strongly informative with respect to any resource situation s' for this utterance.

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Received on 02.10.1994