Outline

- Facts, States of affairs, Infons and Worlds
- Situoids and Situations
- Comprehensibility and Wholes
- (Situoids as part of reality)
- (Links to Situation Theory)
- Situoids and Modality

Introduction

- Use of GFO (General Formal Ontologies)
- Include Situation Theory in GFO
- A justification of the concepts of Situation Theory is needed in order to accomplish this
- Use of Brentano Time in GFO

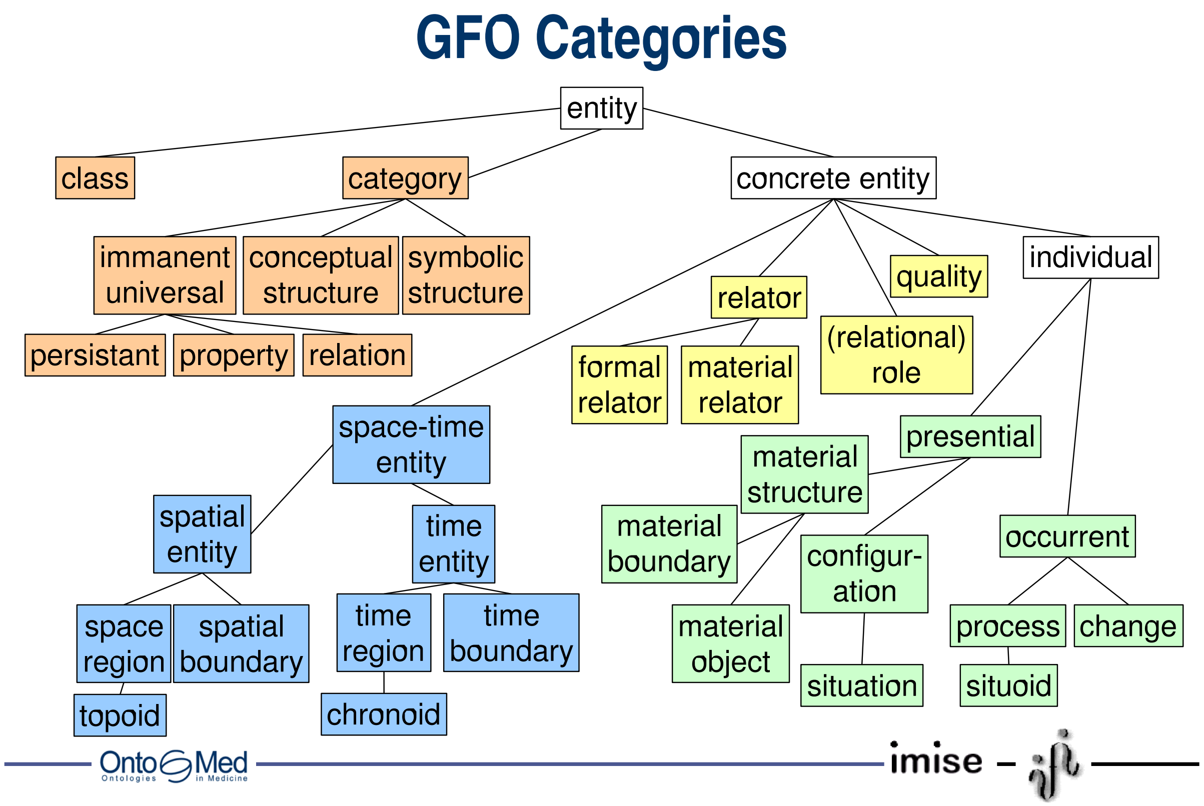

Figure 1: Hierarchy of Top-Level categories in GFO

Ontology of Situation Theory

- Individuals IND
- Relations REL^n
- Spatial Locations LOC
- Temporal Locations TIM
- Situations SIT
- Types TYP
- Parameters PAR
- Infons (states of affairs, facts)INF
- Polarity POL

States of Affairs (SOAs)

A state of affairs is a combination of objects (things). The configuration of objects produces states of affairs. In a state of affairs objects fit into one another like the links of a chain. In a state of affairs objects stand in a determinate relation to one another. (Wittgenstein, TLP)

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Definition 1 *If an n-ary relation R holds among entities $a_1, ..., a_n$, then $a_1, ..., a_n$ and the relator $r :: R$ are all constituents of the state of affairs consisting in R's holding among its relata and we write $<< r :: R, a_1, ..., a_n >>$.*

NEGATIVE SOAS

- $<< Rabbit, BugsBunny; 0 >>$ is a negative SOA
- Interpretation: Either “BugsBunny’s being a non-rabbit” or the absence of the SOA $<< Rabbit, BugsBunny >>$ (non-existence of a specific configuration of things)
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Consider $<< Believes, K, << OnTable, Cup >>>>$.

What happens, if the Cup is not on the table?

INFONS

Infons are abstract entities, that contain information about SOAs, and therefore about (parts of) reality.

Infons are based on *pictural states of affairs* and a function $picSOA \mapsto \{0, 1\}$. They contain information *about* (the SOAs in) some part of the world.

Definition 2 *A pictural state of affairs is a state of affairs. It consists of a relator* $r :: R$ *with a set of arguments* $Arg(R)$ *and an assignment function* $a : Arg(R) \mapsto Entity$*. It is noted* $<< R, a >>$ *or* $<< R, a_1, ..., a_n >>$ *if it is clear that* $a_1, ..., a_n$ *are assignments.*

Definition 3 *An infon consists of a pictural state of affairs* ψ *and a function* $f : picSOA \mapsto \{0, 1\}$*. Let* $\psi =<< R, a >>$*, then we note an appropriate infon* $<< R, a; p >>$ *where* $p \in \{0, 1\}$*.*

CORRESPONDANCE OF INFONS AND SOAS

Definition 4 *Let* $s = << r :: R, x_1, ..., x_n >>$ *be a SOA,* $\psi = << p :: P, arg_1, ..., arg_n >>$ *be a pictural SOA and let* a *be the assignment function of* ψ*. Then* s *and* ψ *correspond,* $corr(s, \psi)$*, iff* $R = P$ *and* $a(arg_1) = x_1, ..., a(arg_n) = x_n$*.*

Let $i = << P, a; p >>$ *be an infon. Then* s *and* i *correspond, iff* $corr(s, << P, a >>>>$ *or* $<< P, a >>= s$*.*

Pictural SOAs need to be pictures *of* some SOA. Whether there are SOAs without any corresponding pictures if an open question.

$corr^+$ is the transitive closure of $corr$. Every non-empty $X \subseteq SOA$ has a $corr^+$ minimal element in SOA, and the minimal element is no picSOA ($corr$ is well-founded).

Possible Worlds plus more

- Possible worlds are viewed as states of how the world may be. They are accessible by an agent.
- States of affairs may be perceived by an agent in a multiple number of possible worlds (picSOAs are formed).
- Infons contain information about the existence of SOAs in a part of any possible world (situation).
- The existence of a "real", actual world is acknowledged, and the agent is *in* this world. She perceives of other worlds as alternative realities in her mind.

SOAs and their relation to time

- SOAs may have a temporal extension.
- May SOAs exist at a time-boundary as well as during a time interval?
- What about states of affairs relating abstract entities?
- To be honest: The relation of SOAs to time is not fully analyzed.

SITUOIDS

“A situoid is, intuitively, a part of the world that is a coherent and comprehensible whole and does not need other entities in order to exist.” (Herre) Situoids are parts of reality that can be comprehended as a whole.

- Situoids have temporal parts, they are occurents.
- Situations are projections of a situoid on its time boundary, they are endurants.
- Situoids are framed by a (connected) chronoid and a (connected) topoid.
- Situoids (and situations) may support information about SOAs, and make an infon factual ($s \models \psi$).
- Axioms similar to Situation Theory

Existencial dependance

Entity A is ex. dep. on entity B iff it is logically impossible for A to exist if B does not exist. Category C is ex. dep. on category D iff for every instance of C it is logically impossible to exist if not at least one instance of D exists.

- Situoids are existentially dependant on states of affairs.
- There is no "empty" situoid (one without any states of affairs)
- Are states of affairs ex. dep. on situoids?
- Are states of affairs necessarily in some situoid?

Comprehension and Comprehensibility

- Three levels: theoretical, configurational, categorical
- Theoretical: Comprehension of a number of entities as instances of the same law, formula, generalization, in virtue of their possession of certain common characteristics
- Configurational: "The ability to hold together a number of elements in nice balance." (Pascal); refers to the understanding of a number of entities as elements of a single complex of concrete relations.
- Categorical: "to hold together a number of things as examples of some category, and in fact a system of categories incapable of abstraction from each other." (Plato)

More comprehension

- Categorical c. refers to the attempt to order knowledge of the world into a single object of understanding
- Categorical c. is different from theoretical c.: hypotheses (formed in theor. c.) are meaningful independant of each other, while categories depend on their interconnection; categorical connections are not falsifiable by experience, because they give form to experience itself (Kant)
- Theoretical comprehension (particular – universal), Configurational comprehension (particular – particular), Categorical comprehension (universal – universal)

Comprehending situoids

Comprehension of situoids includes:

- being able to identify individual situoids given a universal
- knowledge of the interactions of this universal with other categories
- Being able to identify a universal u with $s :: u$, given a situoid s
- Being able to identify the relationship of a situoid s with other entities in some integrated whole

Wholes and Gestalten

Conditions for "wholes" from a gestalt-theoretical perspective:

1. The whole must possess some attribute in virtue of its status as a whole, an attribute peculiar to it and characteristic of it as a whole.
2. The parts of the whole must stand in some special and characteristic relation of dependence with one another. They must satisfy some special condition in virtue of their status as parts of a whole.
3. The whole must possess some kind of structure in virtue of which certain specifically structural characteristics pertain to it.

Wholes 2

The three conditions for wholes have to be satisfied regarding a special decomposition.

Definition 5 *Let w be a specific object and Pt a specific part-of relation, then the class D of Pt-parts of w is a decomposition of w if every Pt-part of w has some Pt-part in common with at least one element of D.*

A quality Q is unshared of a whole w (regarding a decomposition D and part-of relation Pt), if Q is inhered by w but by no Pt-part of w belonging to D, shared if inhered by all Pt-parts of w.

A quality is D-underivable, if it is inhered by w, but is no logical consequence of a set of Pt-parts of D (decomposition of w).

Wholes 3

A quality (or attribute) is D-G-T-underivable, if it is (intuitively) underivable regarding decomposition D from a set of qualities G by means of a theory T. D-G-T-underivable attributes are simply called "underivable".

The existence of such an attribute in situoids is the first condition for its being regarded as "whole", and it corresponds to the first Ehrenfeldcriterion: "The whole is more than the sum of its parts."

Wholes and dependence systems

An (quantitative) attribute f of a part p_1 is called ϕ-dependant upon some class G of attributes of the objects p_i, if the f-value of p_1 in every state of affairs of the kind $<< R, p_1, p_2, ..., p_n >>$ is related by ϕ to the values of the attributes in G of p_i.

The second condition for “wholes” requires the existence of dependence relations of this kind for the parts of the whole.

Wholes and their structure

Structure of wholes involve:

- The parts of the whole.
- A domain of positions in some kind of topological structure.
- An assignment assigning the parts to positions of the domain.

Definition 6 *A complex is characterized by*

1. *A set G of types of parts (universals)*
2. *A topologically structured space X, the domain of positions*
3. *An assignment f of exactly one element of G to each X-position*

WHOLES (LAST)

- Different complexes may have the same structure; they are related by transformations.
- The possession of attributes that are invariant under those transformations is required by the third condition for wholes
- This condition corresponds to the second Ehrenfeldcriterion.

WORLDS

Definition 7 *Let S be the set of all situoids. Let $T \supseteq S$ be the set of all parts of reality. The relation $\leq$ defines a partial order on T. Every maximal element of the $\leq$-order on T is called a world.*

We require that every totally ordered subset A of T has a unique upper bound m in T.

A (consistent) partition (Γ, Δ) of the set of all infons Σ defines a world.

Modality

Definition 8 *A classification $A = (S, \Sigma, \models)$ is a set of situoids S, a set of infons Σ and the relation $\models \subseteq S \times \Sigma$.*

A Boolean classification is $A = (S, \Sigma, \models, \wedge, \neg)$ with $\wedge$ and $\neg$ defined on infons.

Let Γ, Δ be sets of infons. Then $s \models \Gamma \Rightarrow \Delta$ if: If $s \models \gamma$ for all $\gamma \in \Gamma$, then $s \models \delta$ for some $\delta \in \Delta$.

Rules as in LK are used for sequents.

MODALITY 2

Definition 9 *An information context* $C = (A, \Rightarrow, N)$ *is a classification* A*, a relation* $\Rightarrow$ *relating sets of infons, and finally a set* $N \subset S$ *of situoids (called "normal" situoids).* N *is closed under identity, weakening, global cut. In a boolean information context,* N *is also closed under* $(\wedge L)$*,* $(\wedge R)$*,* $(\neg L)$ *and* $(\neg R)$*.*

- Σ represents the "relevant" issues
- $\Rightarrow$ represents the information present
- N are the situoids supporting this information

Modality 3

Let C be an information context.

1. A possible world is a binary partition (Γ, Δ) of the infons in C, Ω the set of all worlds.
2. The possible world of a situoid s is the partition (Γ_s, Δ_s) where $\Gamma_s = \{\gamma \in \Sigma | s \models \gamma\}$ and $\Delta_s = \Sigma - \Gamma_s$, denoted $world(s)$.
3. A possible world $w \in \Omega$ is realized by situoid s if $world(s) = w$.
4. A world $w = (\Gamma, \Delta)$ is impossible, if $\Gamma \Rightarrow \Delta$, otherwise possible.
5. A situoid s is possible iff $world(s)$ is possible.

Modality 4

Let $A = (S, \Sigma, \models)$ be a fixed classification, and $C_1 = (A, \Rightarrow_{C_1}, N_1)$ and $C_2 = (A, \Rightarrow_{C_2}, N_2)$ be information contexts. Then $C_1 \sqsubseteq C_2$ iff (1) for all sets of infons Γ and Δ, if $\Gamma \Rightarrow_{C_1} \Delta$, then $\Gamma \Rightarrow_{C_2} \Delta$ and (2) for all $s \in S$, if $s \in N_2$ then $s \in N_1$.

Definition 10 *An informational modal framework M is a classification $A = (S, \Sigma, \models)$ and an information context $C_s = (A, \Rightarrow_s, N_s)$ for each situoid $s \in S$ satisfying: If $world(s) = world(s')$ then $C_s \sqsubseteq C_{s'}$ and $C_{s'} = C_s$. All $t \in N_s$ are called s-normal. All worlds possible relative to C_s are called s-possible.*

MODALITY 5

- Propositions are sets of worlds.
- A possible world w' is accessible from world w provided that for some situoid s with $world(s) = w$, w' is s-possible.
- Given a proposition p, let $\diamond p = \{w \in \Omega |$some world $w' \in p$ is accessible from w.

Future Research

➜ Analyze the relation of states of affairs to time.

➜ Investigate the use of situoids as "contexts", that is, as entities that provide information about the background of an event (situoid) and may influence the action of an agent

➜ Investigate the use of situoids as linguistic contexts within GFO (as in Situation Semantics)

➜ Use situoids in GFO to model existing approaches to "context" (McCarthy, Bouquet, Guha, Lenat, Burac)