Metaphor, Inference and Domain Independent Mappings

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Abstract

In this paper we provide a formalization of a set of default rules that we claim are required for the transfer of information such as causation, event rate and duration in the interpretation of metaphor. Such rules are domain-independent and are identified as invariant adjuncts to any conceptual metaphor. Furthermore, we show the role that these invariant mappings play in a discourse framework for metaphor interpretation.

Keywords

Metaphor Interpretation, Computational Semantics and Pragmatics

1 Introduction

It is generally accepted that much of everyday language shows evidence of metaphor [13]. We assume the general view that metaphor understanding involves some notion of events, properties, relations, etc. that are transferred from a source domain into a target domain. In this view, a metaphorical utterance conveys information about the target domain. We are particularly interested in the metaphorical utterances that we call *map-transcending*. Consider the following example:

(1) "McEnroe starved Connors to death."

We do not address in this paper the issue of when an utterance is to be considered metaphorical. Instead, we aim to offer an explanation of how a metephorical utterance such as (1) can be interpreted. If we infer, using our knowledge about McEnroe and Connors, that (1) is used to describe a tennis match, it can be understood as an example of the conceptual metaphor (or, in our terminology, 'metaphorical view') DEFEAT AS DEATH. However, this metaphorical view would not contain any relationship that maps the specific *manner* of dying that constitutes *starving to death* (we say that "starving" is a map-transcending entity as it goes beyond known mappings). Yet one could argue that the *manner* in which Connors's death was caused is a crucial part of the informational contribution of (1).

A possible solution would be to create a new view-specific mapping for the form of killing corresponding to *starving to death*, but such enrichment of mappings would be needed for many other verbs or verbal phrases that refer to other *ways* of "killing". For example, Levin [15] provides a list (by no means exhaustive) of twenty five verbs of killing, each of which would need a specific mapping when occurring in a metaphorical utterance. Thus, finding adequate mappings could become an endless and computational intensive process. Moreover, there are cases in which we may not find a plausible mapping for a map-transcending entity. Consider the following description of the progress of a love affair:

(2) "We're spinning our wheels."

It is not very clear what could be a target correspondent for 'spinning wheels'; the unavailability of a correspondent would therefore prevent the source to target transfer of information needed. Thus, as a first requirement, an account of metaphor interpretation ought to explain what extra information that map-transcending entities provide and it should provide a viable (computational) mechanism to explain how this transfer of information occurs. A second requirement arises when we consider the fact that metaphor is a highly contextual phenomenon:

(3) Sam is a pebble.

Asher and Lascarides [1] claim that it is not possible to calculate the meaning of an utterance such as (3) on the basis of the domain information about pebbles, but that it is possible to process it if it is discourse related to other utterance such as in the discourse "John is a rock but Sam is a pebble". Specifically, they argue that inferring the *Contrast* discourse relation would help us to work out the metaphorical meaning of (3)).

A similar point is made by Hobbs [10]:

(4) John is an elephant.

Which Hobbs argue can only be interpreted if we add extra information such that the example now consists of:

(5) Mary is graceful but John is an elephant.

Hobbs also infers *Contrast* in order to work out the meaning of "John being an elephant" as oppose to "Mary being graceful". We claim that in some cases, the inference of some rhetorical relation does not provide all the information we need to interpret the metaphor:

(6) Mary is a fox and John is an elephant.

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We can infer a *Coordination* discourse relation (we follow Gómez Txurruka on this point [18]) to account for the conjunction of the two segments. However, it seems that inferring Coordination would not be enough to address the fact that the information conveyed by (6) may be related to attributes of Mary (e.g., being cunning) and John (possessing a good memory).

Discourse-based approaches to metaphor such as [10] and [1] do not account for map-transcending entities, but they usually assume that there is some straightforward correspondence between the concepts in the source and target domains. Moreover, we will argue that the inference of discourse relations is not enough to interpret some utterances. At the same time, a computational account of metaphor should address the occurrence of metaphor in discourse.

Previous work [19] has shown evidence that there are metaphorical aspects (relations between events such as *causation* and event properties such as *rate* and *duration*) that, subject to being called, invariantly map from source to target whatever metaphorical view is being used. We refer to these type of mappings as View-Neutral Mapping Adjuncts or VNMAs. The VNMAs are a central component of the ATT-Meta approach and AI System to metaphor interpretation previously presented by our group [5].

Next section briefly describes the ATT-Meta approach focusing on source domain inferencing and VNMAs. Section 4 describes a number of VNMAs that are used to interpret various metaphorical utterances. In section 5 we discuss the main components to be included in a semantic account of metaphor. We then propose to adapt the SDRT framework to our purposes of providing a formal account of metaphor interpretation based on the ATT-Meta approach. Section 6 presents some conclusions and discussion on further work.

2 VNMAs in ATT-Meta

ATT-Meta [5] is an AI System and approach to metaphor interpretation that, apart from providing functionalities such as uncertainty and conflict handling [3], introduces two features central to the interpretation of metaphorical utterances such as (1) and (2): Instead of attempting the creation of new mappings to extend an existing metaphorical view, ATT-Meta employs query-driven reasoning within the terms of the source domain using various sources of information including *world* and *linguistic knowledge*. In our approach, this reasoning takes place in a special, protected computational context that we call the "pretence context". We use the term 'reality' to refer to the space outside the pretence where propositions are about reality as the understander sees it. The nature of source domain reasoning in metaphor interpretation has not previously been adequately investigated, although a few authors have addressed it to a limited extent [7, 9, 16, 17].

Currently ATT-Meta implements the VNMAs by means of view-specific rules, but we plan to implement them as default production rules. The first step towards that goal is to provide a formalization of these mappings and to clarify the role they play in metaphor interpretation. In order to do so, we embed them in a semantic framework for metaphor interpretation inspired by Segmented Discourse Representation Theory [2] tailored to capture the main aspects of the ATT-Meta approach. In this sense, it is not an aim of this paper to propose an SDRT-based account of metaphor but instead adapt its semantic representation structures to represent the ATT-Meta view on metaphor understanding. Other authors seem to have merely assumed the existence of a special type of invariant mappings similar to the VNMAs [13] but they do not address the issue explicitly, aside from the early work of Carbonell [7].

We claim that by using VNMAs and source domain reasoning an addressee of (3) may reach an interpretation without necessarily needing a *Contrast* relation to guide the reasoning. In our case, linguistic knowledge and within-pretence reasoning about 'pebbles' establish that they are small, and a very frequent association of unimportant entities with "small size" allows the defeasible inference that something is low, inferior, limited in worth (see Wordnet or any other lexical database). Using a Value-Judgment VNMA to express that "Levels of goodness, importance, etc., assigned by the understander in the source domain map identically to levels of goodness, etc.", we can convey the meaning that Sam is limited in worth (worthless). Of course, the interpretation of (3) will vary if we change the discourse context.

Following this, in (5) and (6), the information conveyed by these aspects might be transferred from source to target by a VNMA that captures agents' attributes. It may well be possible that studying the interaction between VNMAs and discourse relations may allow us to naturally extend the study of metaphor to discourse. This point and the interaction (if any) between VNMAs and rhetorical relations in the interpretation of metaphor exceeds the purposes of this paper. In any case, it seems that information relative to events rate, duration, value-judgement, etc., cannot be solely captured by means of rhetorical relations.

3 Within-pretence Inference and Invariant Mappings

Let us go back to example (1):

(1) "McEnroe starved Connors to death."

Assuming a commonsensical view of the world and if (1) is being used metaphorically to describe the result of a tennis match, a plausible target interpretation would be that McEnroe defeated Connors by performing some actions to disable, make disfunctional or deprive him of his usual playing style. In the ATT-Meta approach, within-pretence inferencing produces a proposition to which we may apply a mapping to transfer that information. An important feature of the pretence space is that it takes the meaning of source domain utterances as *literal*, namely, in this case, when ATT-Meta performs source domain inference it assumes that McEnroe *starved* Connors to death in a biological sense. As a first attempt and leaving some

details aside, the logical form (in the pretence) of the *direct meaning* of (1) may be represented as follows (without taking into account temporal issues):

(i) $\exists x, y, e(McEnroe(x) \wedge Connors(y) \wedge starve-to-death(e, x, y))$

This says that there is an event of x starving y to death. As indicated above it is not enough to interpret (3) given that its correspondent proposition in the target would be expressed by this formula:

(ii) $\exists x, y, e(McEnroe(x) \wedge Connors(y) \wedge defeat(e, x, y))$

However, by saying "McEnroe starved Connors to death" instead of simply "McEnroe killed Connors" the speaker is not merely intending to convey that McEnroe defeated Connors, but rather something related to the manner in which Connors was defeated. Given that "starving to death" is a form of killing, this phrasal verb can lexically be analyzed as a causative and therefore decomposed into two different events e_1 and e_2; Connors's death and its cause e_1. By refining the analysis through within-pretence reasoning we can capture the fact that some of action of McEnroe caused Connors's death:

(iii) $\exists x, y, e_1, e_2(McEnroe(x) \wedge Connors(y) \wedge starve(e_1, x, y) \wedge dead(e_2, y) \wedge cause(e_1, e_2))$

Note that by factoring out "starving to death" in this way we not only distinguish the cause from the effect but doing so allows us to establish a relation between "death" in the pretence to "defeat" in reality using the known mapping in DEFEAT AS DEATH (and possibly "starving" to "McEnroe's playing" although we will not pressure this issue here). Now, by means of lexical information provided by "starving" (e.g., Wordnet) we can infer in the pretence that McEnroe deprived Connors of a necessity, namely, of the food required for his normal functioning. In other words, Connors was made *disfunctional* or *disabled*. This fits well with the interpretation of (1) where McEnroe's playing deprived Connors of the ability to play as he usually does. The result of within-pretence inferencing may be represented by the following proposition:

(iv) $\exists x, y, e_1, e_2(McEnroe(x) \wedge Connors(y) \wedge starve(e_1, x, y) \wedge disable(e_1, y) \wedge dead(e_2, y) \wedge cause(e_1, e_2))$

The inferencing within the pretence can conclude that McEnroe *caused* Connors's death by *disabling* him. Now, the existing mapping DEFEAT AS DEATH could be applied to derive, outside the pretence, that Connors's death corresponds to Connors's defeat, but no correspondences are yet available to account for the fact that McEnroe *caused* the *defeat* of Connors by depriving him of his normal play, or in other words, by *disabling* him.

In the ATT-Meta approach, the mappings of *caused* and *disabling* discussed above are accomplished by a type of default mappings that we specify as two aspects of the Causation VNMA (causation and (dis)enablement respectively). VNMAs account for the mapping of aspects of the source domain that do not belong to a specific metaphorical view but that often carry an important informational contribution (or even the main one) of the metaphorical utterance.

Summarizing, the following processes, amongst others, are involved in the understanding of map-transcending utterances: 1) Construction of within-pretence domain meaning of the utterance. 2) Placing of it in the pretence context. 3) Source-domain reasoning within the pretence cocoon, using the direct meaning constructed in 1) with world and linguistic knowledge about the source domain. 4) Transfers by application of specific mappings in metaphorical views and often invariant mappings specified as VNMAs. The remaining of the paper focuses on the characterization and formalization of VNMAs from a semantic point of view.

4 Description of VNMAs

By using VNMAs and within-pretence inferencing, we do not need to extend the mappings in the metaphorical view to include information about "depriving of a necessity", "food" or "causing Connors's death". VNMAs transfer those properties or relations between mappees that are *view-neutral*. Moreover, VNMAs are *parasitic* on the metaphorical views in the sense that they depend on some mappings to be established for the VNMA to be triggered. That is why VNMAs are merely "adjuncts". VNMAs can also be understood as pragmatic principles that guide the understanding of metaphor by transferring aspects of the source domain that remain invariant.

In example (1), the information with respect to the "starving" of Connors is carried by the (Dis)enablement VNMA. Specifically, we will discuss the following set of VNMAs (others are described in [6, 19]):

4.1 Causation/Ability

The idea is that there are relationships and properties (causation, (dis)enablement, etc.) between two events or entities that identically transfer from the pretence to the reality. We use the $\mapsto$ symbol to express that this mapping is a default.

Causation/Ability VNMA: "Causation, prevention, helping, ability, (dis)enablement and easiness/difficulty relationships or properties of events between events or other entities in the pretence, map to those relationships between their mappees (if they have any) in the reality." The relevant invariant mappings for the interpretation of (1) could be represented as follows:

Causation: $\forall e_1, e_2(cause(e_1, e_2)_{pret} \mapsto cause(e_1, e_2)_{rlt})$

(Dis)Enablement: $\forall e_1, x(disable(e_1, x)_{pret} \mapsto disable(e_1, x)_{rlt})$

As an additional note, the specific mapping of each event or state variable does not depend on the VNMA but on the metaphorical view in play. For example,

if we consider the contemporary situation in which McEnroe and Connors are tennis pundits on TV, we may need a metaphorical view such as ARGUMENT AS WAR to interpret the utterance "McEnroe starved Connors to death". In other words, VNMAs do not themselves establish the mappees between the pretence and the reality.

4.2 Rate

Rate: "Qualitative rate of progress of an event in the source domain maps identically to qualitative rate of progress of its mappee. E.g., if an event progresses slowly (in the context of the everyday commonsensical world), then its mappee progresses slowly (in the target context)".

Consider the following utterance:

(7) My car gulps gasoline.

Briefly, the metaphorical view involved is MACHINES AS CREATURES, that maps biological activity to mechanical activity. The within-pretence reasoning may be performed along the following lines: It can be inferred in the pretence that gasoline helps the car to be alive, therefore, it helps the car to be biologically active. The Causation/Ability VNMA (which deals with helping) combined with the above metaphorical view provide the target domain contribution that gasoline helps the car to run. Given that we can assume that an act of gulping is normally moderately fast the use of the Rate VNMA allows us to conclude that the car's use of gasoline is moderately fast. The logical form of this VNMA is could be expressed as follows:

Rate: $\forall e, r(rate(e, r)_{pret} \mapsto rate(e, r)_{rlt})$

If the rate an event e in the pretence is r, then the rate maps to the mappee event in the reality, that is, it also has rate r; r refers to the qualitative rate of progress or duration of an specific event e.

4.3 Time-Order

Time-Order: "The time order of events in a source domain is the same as that of their mappee events, if any".

Time-order is quite useful for map-transcending examples such as

(8) McEnroe stopped hustling Connors.

We might infer in the pretence that McEnroe was once hustling Connors which would be transferred by the Time-Order VNMA. For the formalization of this VNMA, we say that if event e_1 precedes event e_2 in the pretence, then the mappee events in the reality exhibit the same ordering.

Time-Order: $\forall e_1, e_2(precede(e_1, e_2)_{pret} \mapsto precede(e_1, e_2)_{rlt})$

4.4 Value-Judgement

Value-Judgement: "Level of goodness, importance or other types of value assigned by the understander to states of affairs in the source domain map identically to levels of goodness, etc., of their mappee states of affairs, if any."

(9) That is a gem of an idea.

We could argue that a metaphorical view IDEAS AS OBJECTS is used to interpret this example. However, this view does not provide correspondences for mapping the fact that we see 'gems' as valuable or precious. Instead of trying to find correspondents to map different types of objects to different types of ideas we assume that it is possible to infer in the pretence that gems are valuable and this value judgement about objects that are gems is transfer by the Value-Judgement VNMA. This mapping is expressed by the following formula:

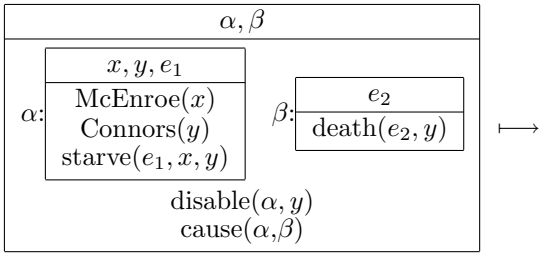
Value-Judgement: $\forall e, v(value(e, v)_{pret} \mapsto value(e, v)_{rlt})$

5 Invariant Mappings in a Semantic Framework

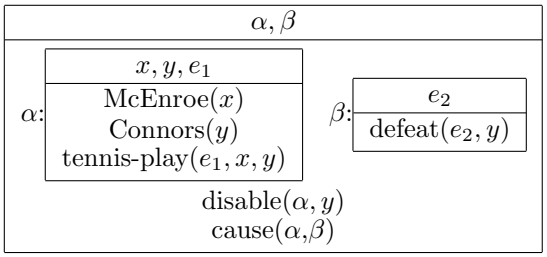
Embedding the VNMAs in a semantic framework for metaphor interpretation is useful as a first step towards their implementation as default rules in the ATT-Meta system, but it is also interesting in its own right to show the contribution that the ATT-Meta approach can make towards a semantics of metaphor. In the somewhat simplified discussion on the within-pretence reasoning and mappings necessary to interpret metaphorical utterances such as (1), we have not stressed the fact that actually the source domain reasoning performed by the ATT-Meta system is query-driven. Although in previous sections we used various sources of contextual information to license certain within-pretence inferences, we have only considered isolated metaphorical utterances, and metaphor understanding has been illustrated as a process of forward reasoning from the direct meaning of utterances (in the pretence) and then the application of various metaphorical mappings to the result of source domain reasoning to arrive at the informational contributions in the target or reality. Moreover, other possible inferences that could be drawn were ignored without specifying any principles or criteria whereby the reasoning could be guided towards the particular informational contributions discussed. The notion of discourse-query-directed reasoning provides such a guidance. When analyzing previous examples, we assume that the surrounding discourse context supplies queries that guide source domain reasoning in broadly the reverse order to that in which we described them in section 3 (see [4] for a detailed description of query-directed reasoning in ATT-Meta). Other authors such as Hobbs [9] and Asher and Lascarides [1] also acknowledge the importance of context-derived reasoning queries play an important role in the interpretation of metaphorical utterances.

We are not claiming that query-directed reasoning may be the only type of reasoning involved in the processing of metaphor, but it seems to be particularly important in the processing of connected discourse. Although the ATT-Meta system at present works with single-sentence utterances (albeit with the aid of discourse-query-directed reasoning), an aim for future versions is to extend it to the processing of *discourse*, and the semantic framework will need to allow for this. Furthermore, we have been using some other sources of information that interact in the processing of the utterance: a) *View-specific mappings* provided by the relevant metaphorical view; b) *Contextual information* about causes, time-order, rates, etc., necessary for reasoning in the pretence; c) Relations between events such as *causation* and *(dis)enablement* that are inferred in the pretence; d) *VNMAs* that transfer invariant aspects from pretence to reality. A suitable semantic approach should therefore need to include at least these five components.

Metaphor is a highly contextual phenomenon, and one of the most interesting semantic approaches that model context are dynamic semantics such as Discourse Representation Theory [12] which views meaning as a *relation* between the contexts that compose a discourse. If we view pretence and reality as contexts, the meaning relation would consist of the metaphorical mappings (VNMAs and *central mappings*). Furthermore, we are interested in representing relations between events in the pretence context such as causation, enablement, etc. An extension of DRT, SDRT [2] provides an intuitive representation of natural language semantics based on the idea that meaning is a relation between input and output contexts. Following this, we can think of representing the pretence space as a Segmented Discourse Representation Structure (SDRS) representing the result of within-pretence inference which can be mapped by using various view-specific and invariant mappings to reality. In other words, we can see the pretence SDRS as the input for what the ATT-Meta system does when interpreting metaphor – it will reason with it, producing an output of inferred reality facts which we may also represent by means of an SDRS. The result of reasoning in the pretence context to interpret (1) would now looks as follows:



Note that the VNMAs would by default transfer aspects such as causation and disenablement from pretence to reality producing an output which could also be represented as a SDRS:



Therefore, α and β are labels for DRSs representing events e_1 and e_2 respectively, whereas $\longmapsto$ represents the mappings (VNMAs and central mappings) needed in the interpretation of the metaphorical utterance. This semantic representation integrates the systematicity of mapping invariantly certain aspects of metaphorical utterances by formulating them as relations between events in the pretence that can be represented as relations and properties of DRSs. For this purpose we need to modify the construction rules of SDRSs to be able to infer properties and relations involving individuals $(x, y, \ldots)$ and not only DRSs' labels such as α and β. In addition to this, we need to capture the interaction of the various sources of information used (linguistic knowledge, world knowledge, etc.) to infer the relations such as *causation* and *disenablement* in the pretence. Thus, we partially adopt SDRT formal framework to represent ATT-Meta's within-pretence reasoning, event relations, event properties and VNMAs with the purpose of developing a unified semantic account of metaphor interpretation.

5.1 Context and Knowledge

Within-pretence reasoning partially relies on inferences provided by the discourse context and linguistic and world knowledge. In the ATT-Meta system the world knowledge roughly corresponds to source domain knowledge. On the one hand, we have been using our commonsensical knowledge about McEnroe and Connors to interpret example (1) as metaphorically describing a tennis match. On the other hand, linguistic knowledge is used to *pretend* that the direct meaning of the metaphorical utterance is true, which allows us to derive *causation* and *disenablement*. Thus, we assume that the understander possess some knowledge about the world that provides information about "starving someone to death".

- If e_2 where y dies and e_1 where x starves y are connected, then by default, e_1 *causes* e_2.
- If e_2 where y dies and e_1 where x starves y are connected, then by default, e_1 *disables* y.

Furthermore, common sense about causation tells us that "if e_1 causes e_2 then e_2 does not occur before e_1". If we consider example (7) again, we may need the following knowledge to infer within the pretence that the drinking is fast.

> If e where x gulps, then by default, x in e gulps moderately fast.

Asher and Lascarides use Commonsense Entailment which is a type of non-monotonic logic to formalize

knowledge axioms and to provide mechanisms for conflict resolution between them. We adopt a similar notation to represent discourse update (see [2] for details on the discourse update function) so that defeasible knowledge about causation, enablement, temporal order, etc., helps to infer event relations and properties in the pretence.

Let us suppose that in a context (pretence) $pret_1$ [1] we want to attach some event denoted by β to α, such that $\langle pret_1, \alpha, \beta\rangle$ (see Asher and Lascarides [2] for details on discourse update function). Thus, some of the source domain knowledge about causation in (1) would be represented as follows:

$$\langle pret, \alpha, \beta\rangle dies(connors, ev(\beta)) \quad \wedge$$
$$starves(mcenroe, connors, ev(\alpha))$$
$$\rightsquigarrow cause(ev(\alpha), ev(\beta))$$

The operator $\rightsquigarrow$ means that the rule is defeasible, and $ev(\alpha)$ stands for "the event described in α"; although $ev(\alpha)$ is quite similar to the notion of main eventuality *me* defined by Asher and Lascarides [2], we do not commit to other assumptions of their theory. We can then infer in the pretence a *causation* relation between α and β if the event represented in α normally causes β:

Causation: $\langle pret, \alpha, \beta\rangle \wedge (cause(ev(\alpha), ev(\beta)) \rightsquigarrow causation(\alpha, \beta)$

Note that 'cause' refers to the epistemic notion of one event causing another, whereas 'causation' refers to an inferred semantic relation between segments of discourse. In order to include properties (and not only relations) in this framework, we assume a conceptualist point of view and consider that properties such as rate or value-judgement denote *concepts* (fast, slow, good, bad) which may correspond to the absolute rate in a commonsensical view of the world. Its representation in our semantic framework could be defined by adding an extra-clause to the definition of DRS-formulae:

- If P is a property symbol and α and r are an episode label and a property label respectively, then $P(\alpha, r)$ is an DRS-formula (see [2] for the complete definitions of DRS-formulae and SDRS construction).

Thus, a rule encoding contextual knowledge to infer rate in the pretence would look as follows (note that when considering event properties we only need to consider one DRS α in our rules, even though a discourse usually consists of one or more DRSs):

$$\langle pret, \alpha\rangle gulps(car, gasoline, ev(\alpha)) \quad \rightsquigarrow$$
$$fast(ev(\alpha))$$

Supported by this rule we can then infer an event property in the pretence for its subsequent transfer to reality via the Rate VNMA (when the Rate VNMA is instantiated):

Rate: $\langle pret, \alpha\rangle (fast(ev(\alpha)) \rightsquigarrow rate(\alpha, fast)$

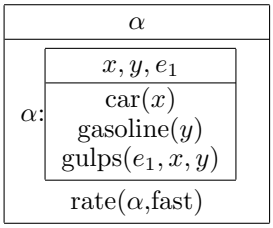
[1] We use subscripts to stress the fact that there could be more than one pretence context [14].

5.2 VNMAs revisited

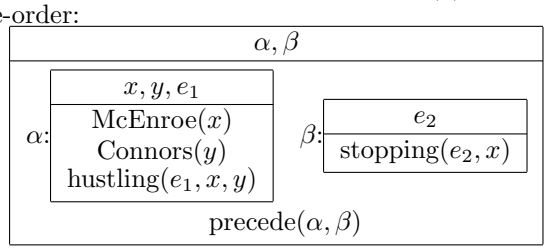
Section 4 described several VNMAs and showed their contribution to the analysis of four different metaphors. VNMAs are considered to be default mapping rules that transfer relations and properties from pretence contexts to reality. Furthermore, we claim that VNMAs are adjunct to central mappings provided by the metaphorical view(s) (DEFEAT AS DEATH, IDEAS AS OBJECTS) used in the utterance context.

We use the VNMAs introduced in section 4 and the above points about within-pretence inferencing and contextual knowledge to offer SDRT-based semantic representations of analysis for examples (7) and (8) based on the ATT-Meta approach to metaphor. We leave out any details not directly relevant to the discussion on VNMAs.

We claimed in section 4 that the transfer to reality of the within-pretence information relative to how fast the car uses gasoline (derived from linguistic knowledge about "gulp") was performed via a Rate VNMA. The following (partial) picture of a discourse captures this:



'Fast' refers to a commonsensical concept in the pretence related to the rate of "gulping". From here, the Rate VNMA would transfer $rate(\alpha, fast)$ to reality. We do not represent the correspondent representation for the sake of brevity. Note that we are only considering the aspects directly involved in the use of Rate VNMA, and as such we do not include the discourse in which an utterance such as (7) may occur. We follow the same process with respect to example (8) involving time-order:



Summarizing, the semantic framework outlined in this section consists of:

- DRSs and SDRSs consisting of events, individuals, states, etc. They can be thought of as situations or as representation structures as in dynamic semantics. A context consists of one or more DRSs, DRSs relations and properties.
- Event relations and properties such as *causation*, *rate*, *time-order*, *value-judgement*, etc inferred in the pretence for the systematic transfer of certain type of information conveyed by metaphorical utterances. The transfer of this type of information via VNMAs is a contribution of the ATT-Meta approach to metaphor interpretation [6, 19].

6 Concluding Remarks

This paper investigates the formalization and semantic representation of the ATT-Meta approach to metaphor interpretation. The ATT-Meta approach is backed up by a powerful implementation that performs sophisticated reasoning to interpret metaphorical utterances. We have focused on description and formalization of several VNMAs, mappings for the systematic transference of invariant aspects from source to target. We have shown how a dynamic semantic approach can be adapted for these purposes to offer an unified semantic representation of ATT-Meta's view of metaphor interpretation.

Map-transcending entities pose a problem for several analogy-based approaches to metaphor interpretation, both from a computational and a theoretical point of view. With respect to the computational approaches, theories of metaphor interpretation based on analogy [8, 11] usually require a conceptual similarity between the source and the target domains. Map-transcending entities need to be mapped by extending on the fly the metaphorical views with new correspondences. We have argued that this strategy is both computationally expensive and in some cases, plainly impossible.

Formal semantic approaches [2] do not account for metaphorical utterances including map-transcending entities. Other works [7, 9, 16, 17] have addressed source domain reasoning to a limited extent, but its role in metaphor interpretation has not previously been adequately investigated. Moreover, map-transcending entities pose a problem for analogy-based approaches to metaphor interpretation [8], which usually require a conceptual similarity between the source and the target domains.

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