Automatic Metaphor-Interpretation in the Framework of Structural Semantics

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Abstract. Given that metaphors can be important parts of arguments and that the common methods for evaluating literal claims and arguments are not (directly) applicable to metaphorical ones, several questions arise: In which way are metaphors important? How do metaphorical premises of an argument support its conclusion? What is an adequate evaluation procedure for metaphorical claims and arguments? In this paper we will give answers especially to the first and second question and indicate how an answer to the third question might look like. Metaphors in arguments—so our analysis—introduce some very general assumptions about the domain of investigation and these general assumptions—spelled out explicitly—are in support of the conclusion of the argument. To render our analysis more precisely we will outline an implementation of automatic metaphor recognition and interpretation with the help of structural semantics. By applying such an implementation it is aimed at reducing the question of evaluation to that one of evaluating by logical or probabilistic means literal arguments.

Keywords: metaphorical argumentation, automatic metaphor recognition, automatic metaphor interpretation, structural semantics

1 Objective

"Religious beliefs are viruses of the mind."—this is a popular metaphor used to argue against religious belief. Metaphors often play an important role in such arguments. They are not only used to attack, e.g., opposing claims, but also to explain why a phenomenon as, e.g., religion has a specific property—here: is so wide spread and firmly established in society as well as significantly involved in cultural processes. In order to analyse such arguments properly, one is in need of an evaluation method for metaphorical arguments. In this paper we are going to sketch a first approach by assuming a reductive stance towards the evaluation of metaphorical arguments. As a reductive stance we propose to first translate metaphorical arguments to literal ones and then analyse them by the ordinary means of logic and probability theory. In especially we are going to sketch our intermediate results on:

- Metaphor recognition
- Metaphor interpretation
- Automation of metaphor recognition and interpretation

2 Analyzing Metaphorical Claims and Arguments

Metaphorical claims and arguments are used quite frequently, even in scientific contexts. The common methods for evaluating literal claims and arguments are not (directly) applicable to metaphorical ones. So one needs an evaluation procedure for metaphorical claims and arguments. Such a procedure may be reduced to classical evaluation procedures for arguments with expressions in literal meaning as follows:

1. Analyze the metaphorical expressions. Outcome of this process is a list of expressions possibly used as metaphors.
2. Find out implicit claims (hidden assumptions). Here we get as outcome a reduced list of such expressions and a list of claims using this expressions.
3. Reconstruct the metaphorical claim or argument. The Outcome of this process is a list of claims containing expressions in literal use only.
4. Evaluate the reconstructed claim or argument using common methods. This is just the standard procedure of evaluating arguments with literally used expressions only.

What is needed for evaluation of metaphorical arguments in the first place, is a method of analyzing and interpreting metaphors which is the main objective of this paper. With 'literal' we mean here the possibly manyfold meaning of an expression that is listed in natural language dictionaries. We intend here only a very rudimentary treatment and incorporation of such meanings, as is present, e.g., in word clouds.

2.1 Simple Accounts of Analyzing Metaphors

Traditional accounts of analyzing metaphors are, e.g., the so-called *substitutional view* (cf. [6] and [3]):

- Metaphors of the form 'X is Y' can be reduced to literal statements of the form 'X is Z, where 'Z' is a literal substitute of 'Y'.
- The metaphor is primarily about X.

and, e.g., the so-called *comparison view* (cf. [4]):

- Metaphors of the form 'X is Y' can be reduced to literal statements of the form 'X is like Y (in being Z)'.
- The metaphor is just as well about X as about Y.

Problems of the substitutional view are to be found in an adequate characterisation of synonymity as is needed in order to figure out adequate substitutivity. Problems of the comparison view lie in the question of how to interpret the likeness-relation between the relata. For this reason more sophisticated accounts were introduced.

2.2 More Sophisticated Accounts of Analyzing Metaphors

A little bit more sophisticated is the so-called *interaction view* of [1]. According to this view, metaphorical usage of language makes some

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implications expressing interactions between the relata. A heuristics to figure out the literal meaning of an expression is as follows:

1. A metaphor of the form 'X is Y' is given.
2. Construct a list of associated commonplaces w.r.t. the secondary subject:
   - C('Y') = $\langle$'Y is Y_1',. . ., 'Y is Y_m'$\rangle$
3. Construct from CP('Y') a list of implications by transferring the commonplaces of the secondary subject 'Y' to the primary subject 'X' by help of an interpretation function I.
   - I('X','Y') = $\langle$'X is Y_1',. . ., 'X is Y_m'$\rangle$
4. Select a list of relevant implications from I('X','Y') by means of an appropriate strategy:
   - RI('X','Y') = $\langle$'X is Y_{i_1}',. . ., 'X is Y_{i_k}'$\rangle$
5. Then 'X is Y_{i_1} and . . . and Y_{i_k}' is a possible interpretation (paraphrase) of the metaphor 'X is Y'.

A problem of the interaction view is this: It is not clear how to figure out the commonplaces w.r.t. a subject and then figure out a set of relevant implications. Also the heuristics presented here starts from a situation where metaphors are already identified. So we would like to offer a new account for metaphor recognition and interpretation that makes Black's presupposed concepts more explicit.

To sum up: Problems of the traditional accounts are:

- The substitutional and the comparison view are too vague and non-constructive.
- Black's interaction account is more adequate. But: If automated, it requires a large amount of manual intervention. There is no general method of determining commonplaces and selecting relevant implications.

Our account aims at the following task:

- To develop an adaption of the interaction account that can be automated so that it does only little or not at all require manual intervention.

For this purpose we want to use structural semantics.

3 Automatic Metaphor Interpretation

Automatic metaphor interpretation is a field of linguistics and computer science, concerned with software based analysis of metaphors. There are two main tasks of automatic metaphor interpretation ([cf. 8, p.1029]):

1. Automatic metaphor recognition
2. Automatic metaphor interpretation

Both tasks are closely connected: Simplified speaking, a metaphorical expression in a context is an expression used not in its literal meaning in the context. To give an interpretation of a metaphorical expression is to paraphrase it with expressions used in their literal meanings ([cf. 8]).

3.1 Metaphor Recognition

What does it mean that an expression in a context is not used in its literal meaning?

Definition 1 (very general criterion) *An expression is a metaphorical expression in a context iff*

1. *the context is assumed to be semantically perfect and*
2. *if the expression is used in its literal meaning, then the context is obviously semantically imperfect.*

E.g.: 'Achilles was a lion in the battle.'. If we take 'Achilles' to be understood in its literal meaning, i.e. talking about a human, and also 'lion' in its literal meaning, i.e. talking about a non-human animal, then the sentence (context) is obviously wrong (semantically imperfect). Hence, at least one of the expressions is a metaphorical one.

There are three very central notions used in the criterion:

- 'context'
- 'semantical perfectness'
- 'obviousness'

The context in our example was a sentence. But there are many more other types of contexts possible:

- bottom-up, e.g.: arguments, argument hierarchies
- top-down, e.g.: term-forming expressions (e.g. definite descriptions, functors), predicate-forming expressions (e.g. lambda-expressions) etc.

Depending on the context there are different types of semantical perfectness/imperfectness:

- arguments: valid/invalid, strong/weak
- sentences: true/false, adequate/inadequate, etc.
- term-forming expressions: referential/non-referential

With the help of our general characterization we can provide a systematic formal categorization of metaphors:

1. Propositional metaphors. With sub-species, e.g.:
   (a) Identity metaphors: $t_1 = t_2$ ('Juliet is the sun.')
   (b) Monadic predicative metaphors: $P^1(t)$ ('Juliet is brilliant.')
   (c) Polyadic predicative metaphors: $P^n(t_1, \ldots, t_n)$ ('Juliet is Romeos manna.')
   (d) General subjunctive metaphors: $\forall x(Px \rightarrow Qx)$ ('Religions are viruses.')
2. Term-forming metaphors. With sub-species, e.g.:
   (a) Metaphorical names: c ('Romeo' for a charming man)
   (b) Metaphorical functors: $f^n(t_1, \ldots, t_n)$ ('the heart of his beliefs')

One notion still has to be clarified: 'obviousness'. 'Obviousness' seems to be necessary in order to distinguish semantical imperfectness through metaphors from semantical imperfectness in general. E.g., to claim 'All birds can fly.' is just false, not speaking metaphorically. There are different degrees of the obviousness of semantical imperfectness:

D1 Semantical imperfectness through mixing up categories (sometimes also expressed as stating something which is neither true nor false). E.g. 'Colorless green ideas sleep furiously.'
D2 Semantical imperfectness through logical or definitional falsity. E.g. 'Sophia Loren is a star and not a star.' or 'Soldiers are machines.'
D3 Semantical imperfectness through contradicting commonplaces. E.g. 'Achilles was a lion in the battle.'

⋮

We assume that obviousness of semantical imperfectness up to the degree D3 is characteristic for metaphors. I.e.: An expression that is not recognizable in a context as a metaphorical expression up to the knowledge of commonplaces counts as being literally used in the context. To illustrate this assumption, let's take our example 'All birds can fly.'!

- '...flies' is defined on a set containing also birds, so there is no mixing up of categories. D1: passed...
- The claim is neither logically nor definitionally false (the dictionary just states: 'Birds can fly in general.' which doesn't contradict the claim.) D2: passed...
- The claim also doesn't contradict commonplaces since 'to fly' is even a connotation of 'being a bird'. D3: passed...

If we consider our example 'Achilles was a lion in the battle.', it turns out that at least one expression is used metaphorically:

- '...is a lion' is defined on a set containing animals (including humans), so there is no mixing up of categories. D1: passed...
- The claim is not logically false, but definitionally (the dictionary states two opposing characteristics for 'lion' and 'man' (as genus of 'Achilles'), namely 'non-human' and 'human') D2: not passed...

Our choice of semantical imperfectness up to the degree D3 is motivated by the intended automation which is based on dictionaries and semantical networks and not on "world knowledge" in general. Whether this choice suffices to identify adequately a huge set of metaphorical claims remains an empirical question settled by investigations of performances of our heuristics.

The criterion provided here does not allow us to figure out which expression is the metaphorical one. Someone could speak, e.g., about the Achilles of Homer's *Iliad*, fighting bravely the Trojans. But someone could, e.g., according to our analysis speak also about a lion fighting against a rival as bravely as Achilles did. But this kind of ambiguity, as is mentioned, e.g., also in [cf. 2, p.483,p.485], can be resolved by a non-compositional analysis of the statement in question. The question of identifying the target and the source can be decided only with respect to a broader context.

In order to decide this question, we expand our framework and use some important parts of the semiotical theory *structural semantics*, which was invented in 1966 by Algirdas Julien Greimas ([cf. 7, part.V, section on Greimas]). This is no unconventional choice since the framework of structural semantics is commonly used in literary theory for interpreting literature and importantly also for interpreting metaphors in literature.

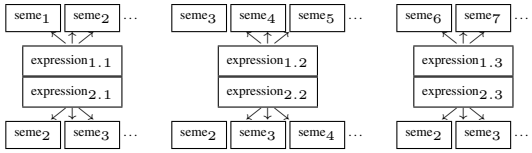
There are two important notions of structural semantics needed for our automatized metaphor recognition (and later on: interpretation):

- Seme: "The seme is the minimal unit of semantics, whose function is to differentiate significations." ([7, p.317])
- Isotopy: "Greimas defines isotopy as the principle that allows the semantic concatenation of utterances" where the "iterativity (recurrence) of contextual semes, which connect the semantic elements of discourse (sememes), assures its textual homogeneity and coherence." ([7, p.317])

Very simplified speaking one can say that:

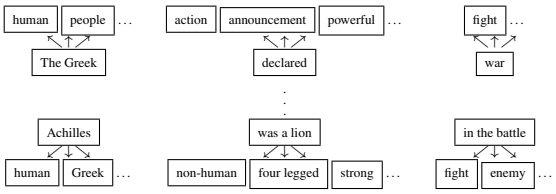
- Semes are the minimal semantical units that are mapped to expressions.
- If an expression is used in a text, then the semes of the expression are set.
- The more a seme is set within a text, the more dominant it is in the text (iteration increases dominance).
- The most dominant semes within a text are the isotopes of the text.

Example:



Isotopies: $seme_2$ and $seme_3$

Let's take 'Achilles was a lion in the battle.' with some more context:



Isotopies: 'human', 'fight'

As can be seen, one seme of 'Achilles' is an isotopy, whereas no seme of 'lion' is an isotopy. Since expressions are used normally literally (default), it is likely that metaphorical expressions do not contain isotopies.

We therefore expand the conditions of the criterion for metaphor recognition within the framework of structural semantics:

Definition 2 (more detailed criterion) *An expression is a metaphorical expression in a context iff 1, 2 (of definition 1 above) and:*

3. *No seme of the expression is an isotopy with respect to the overall context. (In comparing expressions one may take the degree of dominance of the expressions' semes for a comparison.)*

The framework of structural semantics is not only useful for the identification of metaphors, but also for their interpretation. In the following we will provide a short sketch of metaphor interpretation in this framework.

3.2 Metaphor Interpretation

Once we have identified metaphors, the question arises of how to paraphrase them in a way such that the paraphrase is non-metaphorical. Just to replace the metaphorical expression by all its semes is inadequate, since this would just make the semantical imperfectness still more obvious (D3⇒D2⇒D1⇒). E.g.:

- If we replace the metaphorical expression 'lion' ...
- ... in the sentence 'Achilles was a lion in the battle.' ...
- ... by its semes 'non-human', 'four legged', 'strong', 'animal' etc. ...
- ... then we end up indeed with a purely literal paraphrase, ...
- ... but on cost of inadequacy:
- 'Achilles was a non-human four legged strong animal in the battle.'

What is needed is some kind of relevance filter, dropping out 'non-human', 'four legged', 'animal' and keeping 'strong'. Here again the *iteration increases dominance* principle of structural semantics is of

some use: The more dominant a seme of a metaphorical expression is within the overall context, the more likely it is to be of relevance.

If the overall context does not increase a seme's degree of dominance, then the seme is less likely to be recognised as a relevant part of a metaphor. And also the other way round: The more dominant a seme is, the easier it is to be recognised as a relevant part of a metaphor. So, for the interpretation of a metaphor one just has to replace the metaphorical expression by the dominant semes to get a literal paraphrase.

3.3 A Fundamental Proviso

Quite common is the point of view that a reductive stance as ours is fundamentally wrong since linguistically and psychologically seen a relation of reduction should be assumed at most the other way round: It is not the literal meaning of an expression we should start of, but a metaphorical one (cf., e.g., [5]). Also Cohen and Margalit claim, e.g., that "it is psychogenetically more illuminating to view literal patterns of word-use as the result of imposing certain restrictions on metaphorical ones, than to view metaphorical patterns as the results of removing certain restrictions from literal ones" ([2, p.470]). Heading into this direction by arguing against the possibility of reducing metaphorical expressions to literal ones, Cohen and Margalit argue as follows—[cf. 2, p.471] (simplified and slightly changed):

1. The meaning of a complex expression is determined by the meaning of its components alone, where the meanings of the basic components are described in dictionaries. (Principle of compositional semantics)
2. Hence: The meaning of a metaphorical expression is either described in a dictionary directly or is determined by meanings of its components described in a dictionary. (1)
3. Dictionaries usually record the current use of expressions whereas metaphors are usually innovative, i.e. an expression's metaphorical usage is new. (general assumption)
4. Hence: The meaning of a metaphorical expression is neither described in a dictionary directly, nor is it determined by—in such a way described—components (otherwise it wouldn't be innovative). (3)
5. Hence, metaphors cannot be analysed compositionally. (1, 2–4)

This argument may be seen as counterargument to a reductive stance of metaphors to literal expressions by identifying compositionality with reducibility. Again simplified speaking, Cohen and Margalit propose instead of such a reduction the following analysis—[cf. 2, pp.476ff]: The meaning of an expression is learned inductively by uttering combinations of expressions and taking into account the affirmative or negative responses of trained language users. In doing so one may figure out that, e.g., generally 'shout at me' may go together with 'Peter', but not, e.g., with 'car'. So, we end up with a semantical hypothesis like 'shout' names or describes an action involving as variables a loud tone etc. and is affected, e.g., by the live/non-living variable (according to general usage non-living entities don't shout). Metaphorical usage of 'shout', as, e.g., in 'The car shouted at me.' consists then just in "removing any restrictions in relation to certain variables from the appropriate section or sections of its semantical hypothesis" ([cf. 2, p.482]). So, the psychological relation seems to be as follows:

- Expressions are learned by such combinations and taking into account affirmative or negative feedback.
- Learning of an expression consists in figuring out the relevant variables and putting restrictions on them.
- By this we end up with literal meaning(s) of an expression.
- Speaking in metaphors consists just in relaxing such restrictions again, i.e. in going some steps back in the whole process.

We think that our account is not in contrast to this point of view. Regarding Cohen and Margalit's argument above our approach also denies compositionality, but we still stick to reducibility: According to our theory the correct interpretation of a metaphorical statement is not only based on the meaning of its components alone. Rather it is based on the meaning of its components and the contextually dominant-set semes. By this Cohen and Margalit's claim about the fundamental ambiguity of statements like 'That old man is a baby.' also remains for our approach: "Either its subject is literal and its predicate metaphorical, or vice versa" ([cf. 2, p.483]). Considering the statement alone, 'That old man is a baby.' may be paraphrased adequately by 'That old man behaves like a baby.' or 'That small little thing with this face wrinkled like an old man is a baby.'. But considering it with respect to a context with dominant-set semes as, e.g., the semes of 'experienced', 'wise' etc. in the former and that of 'tiny', 'newborn' etc. in the latter case allows for a disambiguation.

So, to sum up the proviso one may say that our approach also denies the adequacy of compositional reduction, but not that of context-dependent reduction.

3.4 Heuristics for an Automatic Analysis

For automatic metaphor recognition and interpretation in a similar line as described in [10], [9] we used syntactic and semantic databases—at this time only for a text corpus in German (Canoo, Duden, in the future: GermaNet). The flow diagram can be summarized as follows:

- *Basic analysis*
  1. Get the syntactical information of the expressions! (Canoo)
  2. Transform the expressions into their normal form: Nom.Sg/Inf! (Canoo)
  3. Extract the semes of the expressions! (GermaNet)
  4. Extract the connotations of the expressions! (Duden)
- *Metaphor recognition*
  1. Check whether there are any opposing semes or connotations! (Synonym- and Antonym-Databases)
  2. If so, check which semes are more dominant! (Preceding Analysis)
- *Metaphor interpretation*
  1. Extract the most dominant semes! (Preceding Analysis)
  2. Transform them into the syntactical form of the metaphorical expression! (Canoo)
  3. Replace the metaphorical expression by a concatenation of these transformations!

4 Conclusion

In this paper we indicated how two main tasks of theories on metaphors, namely metaphor recognition and metaphor interpretation, may be approached by an automatized analysis. For this purpose the so-called *interaction account* of metaphors served as rough model; we suggested to explicate the key-concepts of this model, i.e.

the concept of 'commonplace' and 'implication', by help of structural semantics: Commonplaces are connections between the semes of an expression and implications are figured out by a dominance operation of the context acting on the metaphorical statement under investigation. Furthermore dominance is operationalized via counting the iteration of semes. The theory is currently implemented into *Perl* for an application on a German text corpus. The implementation is still carried out and it is tried to be expanded on English text corpora too.

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