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Author One[a,c,1], **Author Two**[b,1,2], **and Author Three**[a]

[a]Affiliation One; [b]Affiliation Two; [c]Affiliation Three

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Humans interpret metaphors, like *Time is a thief* or *My lawyer is a shark*, with relative ease, incorporating contextual knowledge to determine which aspects of the predicate (*thief, shark*) are true of the subject (*time, my lawyer*). One theory of the process underlying metaphor interpretation, proposed by Grice (?), is that a listener reasons about an informative speaker (who in turn reasons about the listener) to update their beliefs about the subject and the relevant dimensional of meaning.

This reasoning process can be modeled probabilistically in the *Rational Speech Acts framework* (?). However, previous instantiations of these models have required a hand-specified semantics, restricting the generality of the model and the scope of empirical investigation into the effectiveness of pragmatic reasoning for metaphor interpretation.

We present a method to combine empirically learned word embeddings with a Rational Speech Acts model of metaphor. This allows us to interpret open domain predicative and adjectival metaphors without manually stipulating the denotations of the words they contain. We find a significant preference in human judgments for our model over a comparable word embedding model without explicit pragmatic reasoning.

Keyword 1 | Keyword 2 | Keyword 3 | ...

Metaphor presents a compelling theoretical challenge for the understanding of meaning in natural language. On hearing (**??**) in a context where the subject, Jane, is known to be a consultant, a listener might infer that Jane is not literally a soldier, but rather that she shares certain attributes with soldiers (perhaps determination, endurance, or ruthlessness). Jane is a soldier The *Gricean* view of metaphor takes the meaning conveyed by (**??**) in a given context to be the result of a process of *pragmatic reasoning*, about a speaker who is trying to communicate truthfully, informatively, and relevantly. That is, the listener attempts to jointly deduce what Jane must be like and what aspect of Jane is plausibly relevant, such that the speaker would have chosen the predicate *soldier* over other alternatives.

Modeling metaphor Obtaining metaphorical interpretations for utterances like (**??**) is within the scope of a formalization of Gricean reasoning, the *Rational Speech Acts* (RSA) framework (**?**). This framework models pragmatic interpretation and production of language via probabilistic models of speakers and listeners, who reason about each other in a nested fashion, with the assumption of cooperativity and a shared semantics.

?) extend the framework by introducing a new model, , which is able to interpret metaphors. It does so by the mechanism of *projection functions*[*] which dictate the dimension of the world that the speaker cares about communicating. This, in turn, allows for a model of a listener which jointly determines the state of the world (e.g. what Jane is like) and the aspect of the world the speaker cares to communicate (e.g. Jane's determination). Crucially, this listener assumes an informative speaker: one whose choice of utterance maximizes the probability of communicating the world w to the speaker's model of the listener, up to the projection q.

This model provides an account of predicative metaphors (those of the form *A is a B*) and adjective-noun (AN) metaphors (like *fiery temper*). However, in order to generate predictions from the model, previous instantiations of the model have required the manual construction of a semantics for the words involved, restricting the model's scalability.

.1. Our contribution. By adapting an RSA model of non-literal meaning to a word embedding (distributional) semantics, we obtain a system capable of interpreting open domain predicative and adjectival metaphors, without the need for hand-specified word meanings. This adaption requires a generalization of projection functions to a vector space setting, and a novel inference algorithm to calculate the now continuous posterior distribution of . This permits what is to our knowledge the first open domain evaluation of an RSA model of pragmatic reasoning. We show that our model of metaphor interpretation significantly outperforms a baseline which uses a word embedding semantics without explicit pragmatic reasoning.

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[*]These are often referred to in RSA literature as *Questions under Discussion*.

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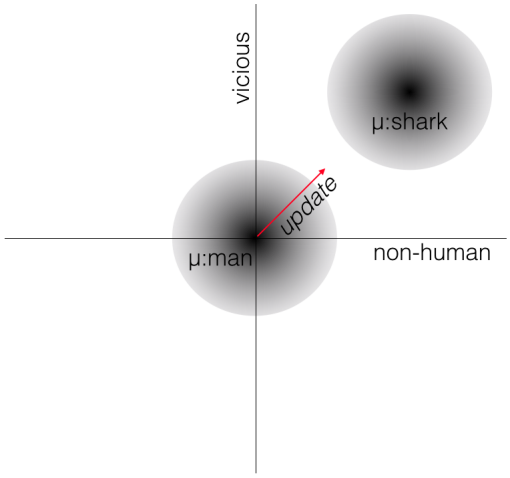

Fig. 1. Placeholder image of a frog with a long example caption to show justification setting.

Table 1. Comparison of the fitted potential energy surfaces and ab initio benchmark electronic energy calculations

Species	CBS	CV	G3
1. Acetaldehyde	0.0	0.0	0.0
2. Vinyl alcohol	9.1	9.6	13.5
3. Hydroxyethylidene	50.8	51.2	54.0

nomenclature for the TSs refers to the numbered species in the table.

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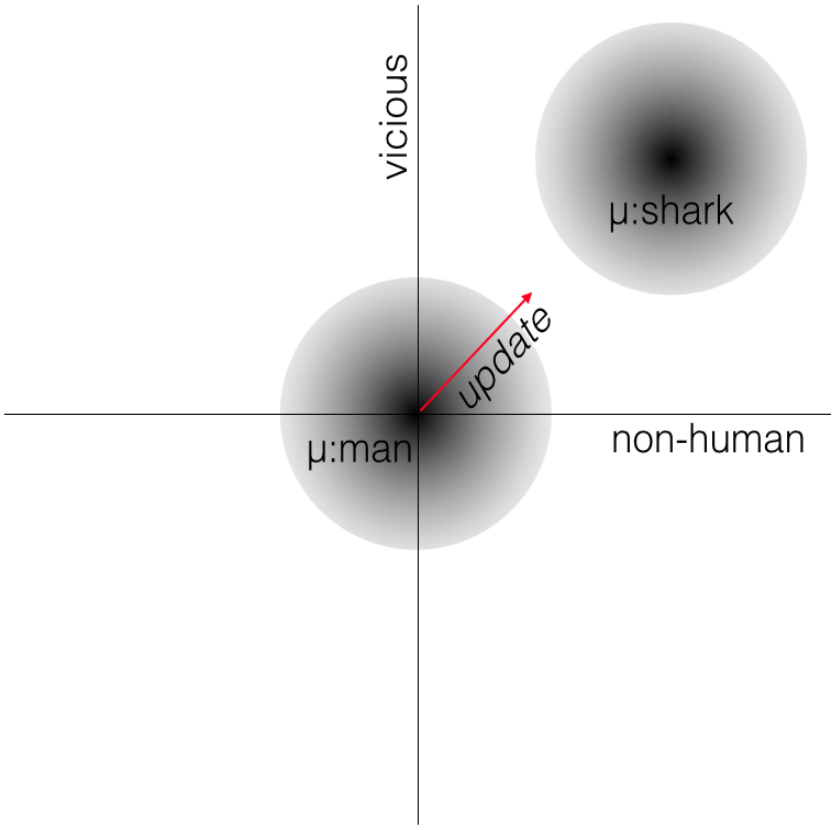

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$$\begin{aligned}(x+y)^3 &= (x+y)(x+y)^2 \\ &= (x+y)(x^2+2xy+y^2) \\ &= x^3+3x^2y+3xy^3+x^3.\end{aligned} \quad [1]$$

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1. Grice HP (1975) Logic and conversation. *1975* pp. 41–58.
2. Frank MC, Goodman ND (2012) Predicting pragmatic reasoning in language games. *Science* 336(6084):998–998.
3. Kao JT, Bergen L, Goodman N (2014) Formalizing the pragmatics of metaphor understanding. in *CogSci*.