

Using word embeddings to identify key oppositions in natural texts on climate change

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Pirates now call themselves purveyors...the man who has committed a crime has "made a mistake"...the man who has "made a mistake" is "guilty of a crime", and a man who has committed a theft has either "taken" or "ravaged".
 - Aristotle, *Rhetoric*, III, ii

Abstract

Important issues often polarise opinion. Climate change, for example, has many fervent believers but also many fervent sceptics. In a hyperconnected world, more information does not always serve to resolve such polarity. One reason is that what opponents say is often not as important as how they say it. This poster presents a method for leveraging word embeddings to identify key differences in word selection in a pair of opposed texts on the topic "Is Human Activity Primarily Responsible for Global Climate Change?" from ProCon.org.



Despite a wealth of scientific data, climate change is a "polarising" issue. One reason for disagreement is systematically different use of signs (esp. language) by believers and deniers. Understanding these differences can bring the two sides closer to the facts.

Background

In any disputed issue, there is considerable common ground. Those who believe in climate change (the Pro camp) agree on many core facts with deniers (the Con camp). Embroidered around this core, however, are points of difference. These are encoded in lexical choices that reflect different interpretations. Such differences are known in semiotics as oppositions, and a key tool of semiotics is opposition analysis, which seeks to identify how signs (such as words) are substituted within sign systems. The method presented here is an extension of natural language processing that attempts to discover oppositions. The operational basis for this is my own theory of *finite semiotics*.

Oppositions can be antonyms such as "heat" and "cooling" but can be more subtle and surprising. For example, "climate change" and "global warming" are highly opposed in the results, as are "researcher" and "professor". These near synonyms say a lot about each side's thinking.

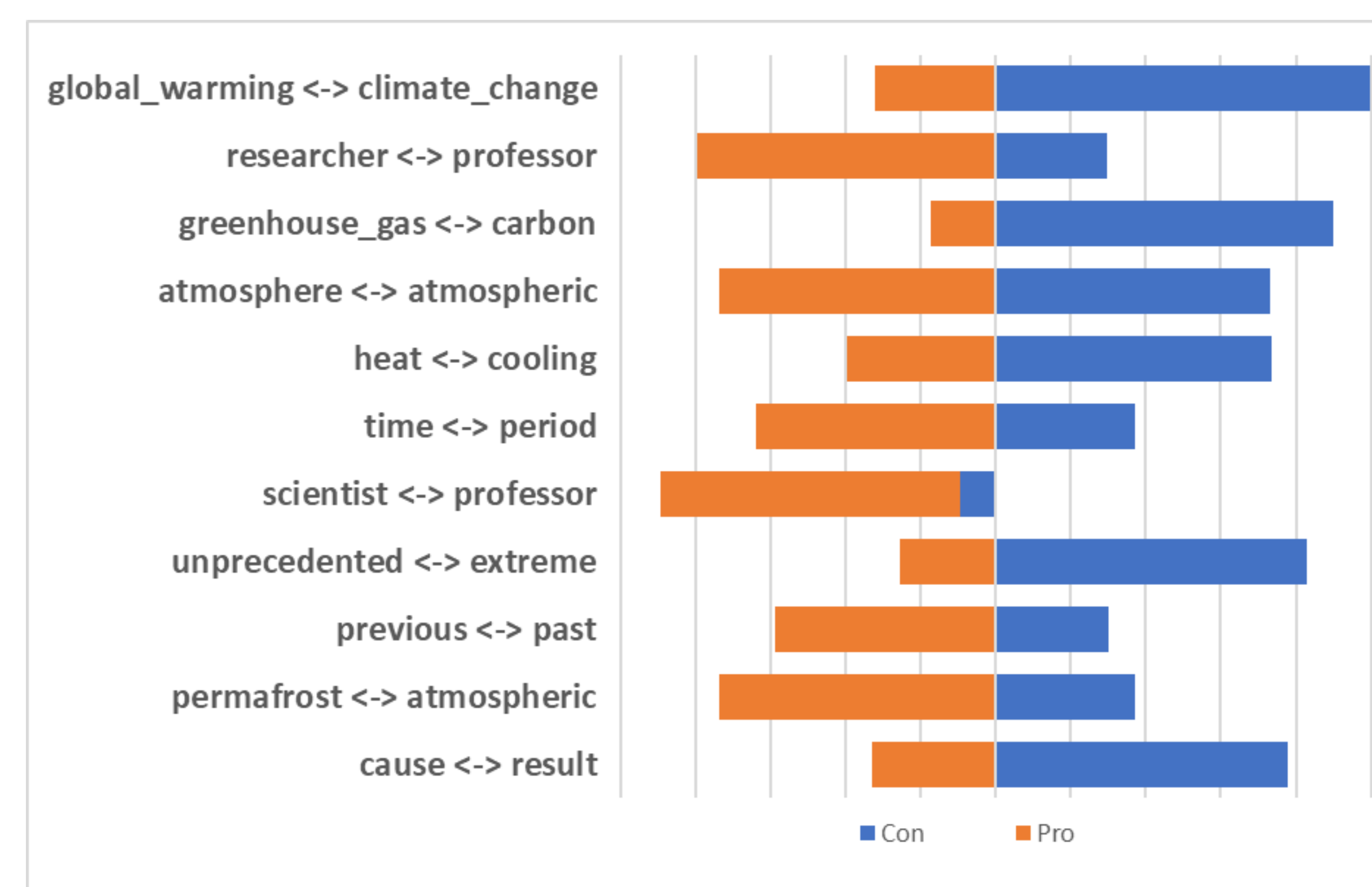
Method

The corpus of Pro and Con texts was preprocessed to remove case and stopwords and stem. Important multi-word terms such as "climate_change" were preserved. These steps were then performed:

- **Step 1** The prominence of terms in each set of texts was calculated. In the climate change example, simple term frequency (tf) was used, but tf-idf or any suitable method according to purpose could be used.
- **Step 2** The relative prominence of each term was calculated by deducting its prominence score in the Pro texts from its score in the Con texts. Thus if "global" had a tf of 0.003 in Pro and 0.001 in Con, its relative prominence was 0.002.
- **Step 3** A weighted opposition score O was derived for each pair of Pro and Con terms by multiplying the relative prominence (r) by the context similarity from word embedding cosine similarity. Thus, for two terms s_1 and s_2 , with relative prominences r_{s_1} and r_{s_2} , the formula is:

$$O_{s_1s_2} = (r_{s_1} - r_{s_2}) \cdot \text{sim}(s_1, s_2)$$

The pairs with the highest opposition scores are key to understanding how each side of an issue presents its arguments. The results for climate change can be presented as a type of oppositional DNA:



The pairing and ranking of terms can be presented in the form of an oppositional DNA that summarizes the key differences in lexical choices of the two sides of an issue. The length of the bars indicates the relative prominence of each term in these highest ranked pairs.

What the results mean

The results of the computational opposition analysis can be put into words as: "In contexts where the Pro side tends to use X the Con side tends to use Y". It is clear from the climate change results, therefore, that:

- Believers prefer to talk about "global warming" while deniers prefer the more neutral term "climate change"
- Believers prefer to talk about "researchers" and "scientists" while deniers prefer the more authoritative term "professor"
- Believers prefer "greenhouse gas" while denier's prefer "carbon"
- Believers more often use "unprecedented" than "extreme"

What the results can be used for

The results provides clues for those interested in the debate to delve deeper and discover more about its rhetoric. This can help them to craft messages that will better resonate with a certain side, something relevant to advertising. Another use is in identifying potential for miscommunication and response triggering. Finally, a use yet to be explored is in detecting fake news, which may exhibit anomalous oppositions.

Conclusion

Only a small group of polarised texts was used to illustrate the method and produce these example results. A much larger dataset – gleaned perhaps from a large sentiment analysis corpus – would enrich the insights. In addition, the method of computational opposition analysis would benefit from being deployed for a strategic task with a clear outcome to target, such as convincing one side to change its position on a particular issue or act in a particular way. The potential exists to use the method as the core of a system for real-time, adaptive, online persuasion in marketing or text generation.

For more detail and references, please refer to Shackell and Sitbon (2019) "Computational opposition analysis using word embeddings: a method for strategising resonant informal argument" in *Argument & Computation*, vol. 10, no. 3.

Acknowledgements

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