

Just because you're right  
doesn't mean i'm wrong, you  
just haven't seen life from my  
position.

Timișoara Deep Learning Meetup

# Towards an Argument Search Engine for the Web

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Henning Wachsmuth

<https://cs.upb.de/css>

March 6, 2020

# Introducing myself

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- **What am I doing?**
  - 2009 – 2015: PhD student at Paderborn University, Germany  
Natural language processing
  - 2015 – 2018: PostDoc at Bauhaus-Universität Weimar, Germany  
Computational argumentation
  - Since 2018: Junior professor at Paderborn University  
Computational social science
- **Why am I here?**



# Outline

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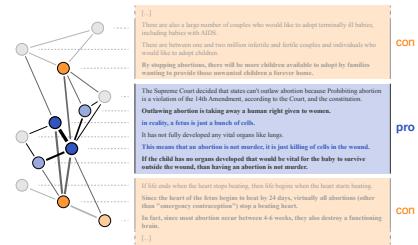
- **Introduction to computational argumentation**



- **An argument search engine for the web**



- **Selected research around argument search**



- **Discussion and conclusion**



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# Introduction to computational argumentation

# Welcome to the post-factual age!

Remember January 22, 2017

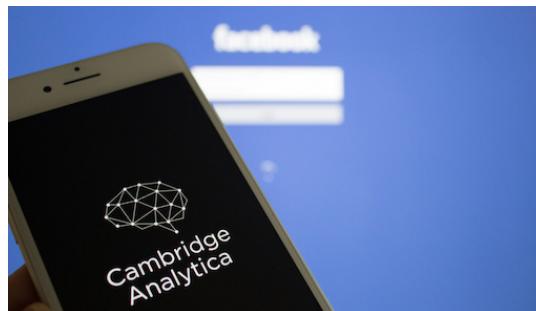
<https://www.youtube.com/watch?v=VSrEEDQgFc8> (1:36 – 2:05)



<https://flickr.com>



<https://flickr.com>



<https://flickr.com>

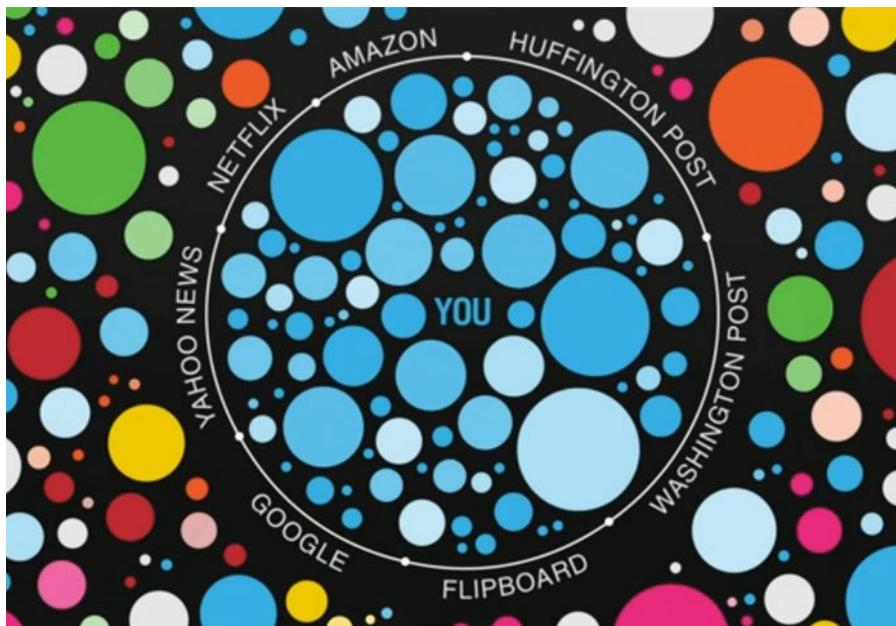


<https://de.wikipedia.org>

# How could we end up there?

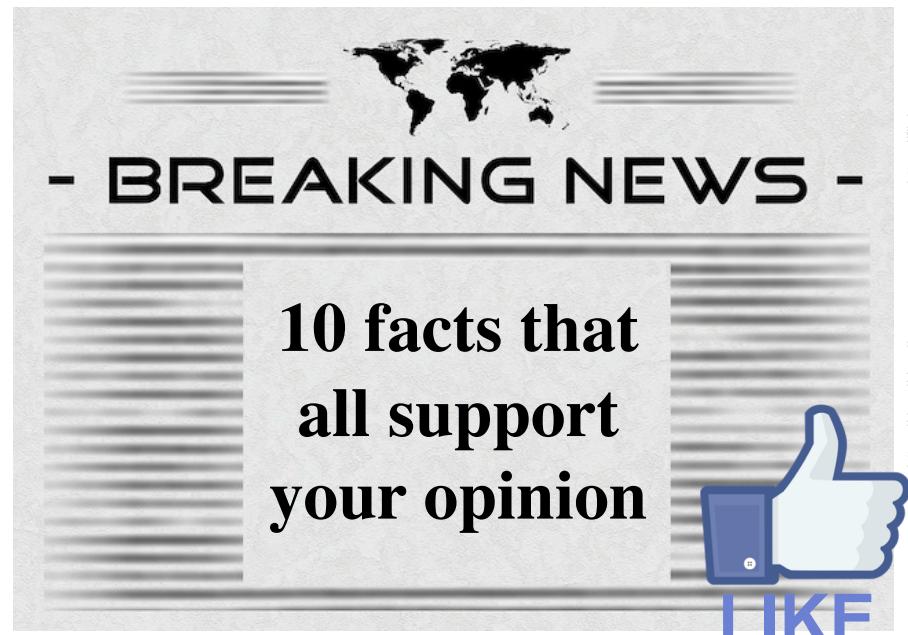
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## Filter bubbles



We get what fits our past behavior

## Echo chambers



We like to get what fits our world view

# So what does that mean?

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**Forming opinions in a self-determined manner**  
is one of the great problems of our time

Where truth is unclear, we need unbiased access to *argumentation*

# What is argumentation?

- **Argument**

- A claim (conclusion) supported by reasons (premises)
- Conveys a pro or con stance on a controversial issue

Conclusion

Premises

**Conclusion** *The EU should allow sea patrols in the Mediterranean Sea.*

**Premise 1** *Many innocent refugees will die if there are no rescue boats.*

**Premise 2** *Nothing justifies to endanger the life of innocent people.*

- **Argumentation**

- The usage of arguments to persuade, agree, deliberate, or similar
- Also includes rhetorical and dialectical aspects

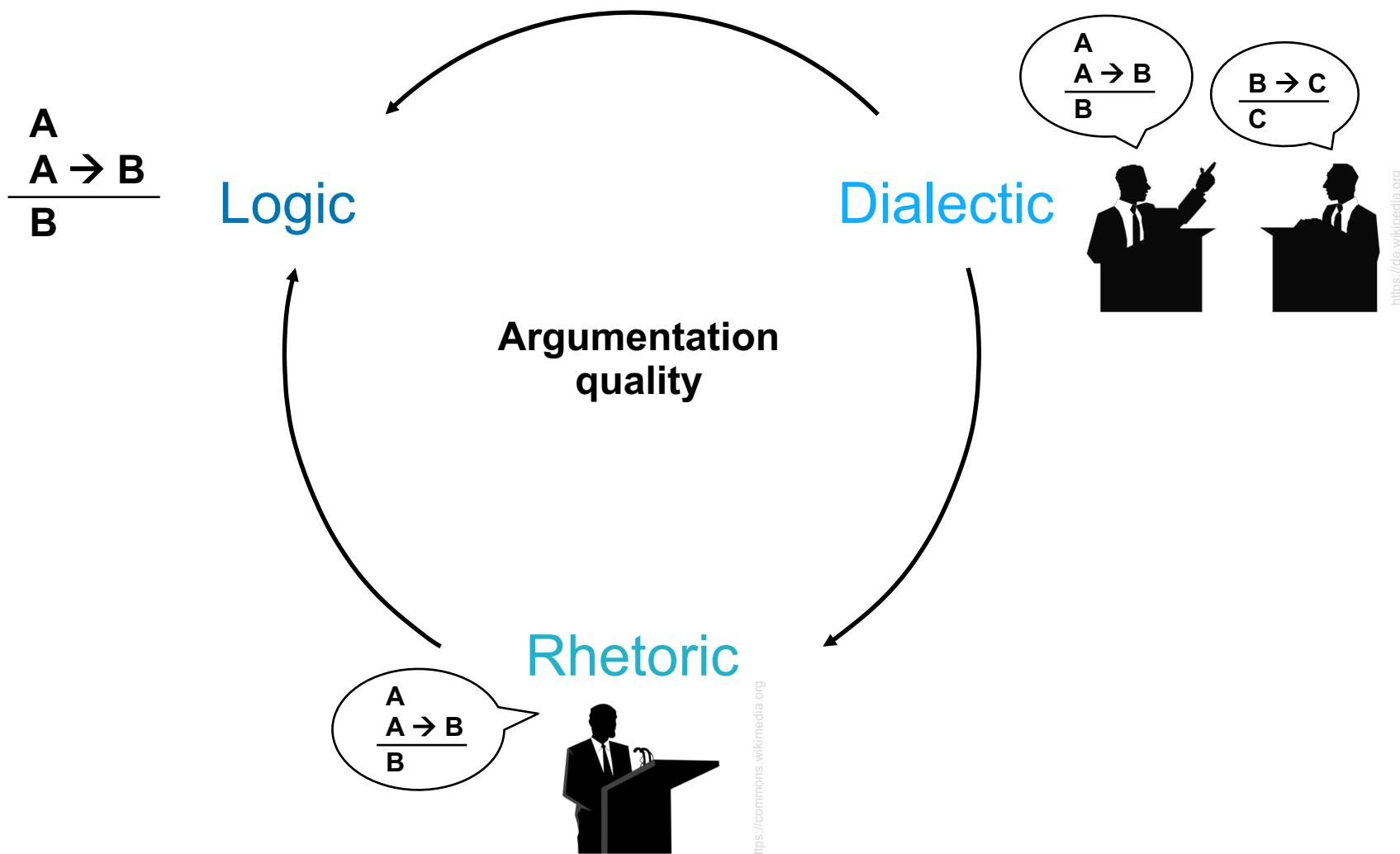


- **Argumentation is pervasive**

- In politics and the media
- In work and private life



# What is good (and bad) argumentation?



# What is computational argumentation?

- **Computational argumentation**
  - Computational analysis and synthesis of natural language argumentation
- **Mining**
  - Detecting argumentative units and their roles
  - Identifying relations between units or arguments
    - ... along with variations of these
- **Assessment**
  - Classifying an argument's stance towards an issue
  - Scoring or comparing argumentation quality
    - ... along with other assessed properties
- **Generation**
  - Generating argumentative units
  - Composing arguments and argumentative texts
    - ... along with related non-argumentative language

*If you wanna hear my view, I think that the EU should allow sea patrols in the Mediterranean Sea. Many innocent refugees will die if there are no rescue boats.*

*If you wanna hear my view, I think that the EU should allow sea patrols in the Mediterranean Sea. Many innocent refugees will die if there are no rescue boats.*



4 / 5

*Having rescue boats also may have negative effects. Even more people may die trying, believing that they may be rescued.*

# Applications of computational argumentation

- **Decision assistance** (Rinott et al., 2015)
  - **What.** Present arguments for controversial issue and argue for a stance towards the issue
  - **Why.** Support decision making
- **Argument search** (Wachsmuth et al., 2017e)
  - **What.** Find arguments on controversial issues and oppose best pro's and con's
  - **Why.** Support self-determined opinion formation
- **Writing support** (Stab, 2017)
  - **What.** Assess quality of argumentative text and provide feedback to text
  - **Why.** Support learning of argumentative writing



The screenshot shows a web browser displaying the args search engine at [www.args.me/search.htm?query=nuclear%20energy](http://www.args.me/search.htm?query=nuclear%20energy). The search term 'nuclear energy' is entered in the search bar. The results are divided into 'PRO' and 'CON' sections. The PRO section contains a single result: 'In my opinion Nuclear Energy is necessary for countries...'. The CON section contains several results, including 'I will begin with my opponent's case and then present an...', 'I will begin with my opponent's case and then present an alternative to nuclear energy's opening statement: My opponent has produced very impressive data on the efficiency of nuclear...', and 'Nuclear energy risks being diverted to nuclear weapons...'. Below the results, there are links to 'Resolved: The United States federal government should...' and 'This is going to be a simple Pro Nuclear Energy vs Con...'. A sidebar on the right shows a 'Pro vs. con view' with '2058 arguments retrieved in 1.0ms'.

The screenshot shows a tablet displaying a Learning Argumentation Dashboard. The dashboard includes a 'Personal Learning Argumentation Dashboard' section with a pie chart showing '60% of your text is argumentative' and a 'Factual structure' section with a green progress bar at 100%. It also features a 'Detailed feedback on discourse structure' section with a tree diagram of claims and premises, and a 'Your personal Learning Argumentation Dashboard' section with a progress bar from 'Novice' to 'Expert' at 100%. The overall interface is designed to provide users with real-time feedback and analysis of their argumentative writing.

Rosemary  
Adejoh



Yamen  
Ajjour



Khalid  
Al-Khatib



Janek  
Bevendorff



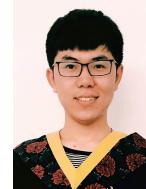
Giuliano  
Castiglia



Jonas  
Dorsch



Fan  
Fan



# An argument search engine for the web

(Wachsmuth et al., 2017e; Ajjour et al., 2018; 2019)



Matthias  
Hagen



Johannes  
Kiesel



Viorel  
Morari



Martin  
Potthast



Jana  
Puschmann



Jianqi  
Qu



Benno  
Stein

# Argument search: Idea



abolish the death penalty



Page 1 of 639 arguments, 326 pro, 313 con (retrieved in 0.4s)

Pro

## #1 No execution of the innocent

<http://www.bbc.co.uk> (11 other sources...)

As long as human justice remains fallible, the risk of executing the innocent can never be eliminated.

## #2 Everyone has a right to live

<http://www.amnesty.org> (22 other sources...)

Everyone has an inalienable human right to live, even those who commit murder.

## #3 Death penalty fails to deter

<http://www.procon.org> (4 other sources...)

There is no scientific proof that executions have a greater deterrent effect than life imprisonment.



Con

## #1 Retribution

<http://www.bbc.co.uk> (6 other sources...)

Real justice requires people to suffer for their wrongdoing in a way adequate for the crime.

## #2 Prevention of re-offending

<http://www.bbc.co.uk> (5 other sources...)

Those executed cannot commit further crimes. Imprisonment does not protect sufficiently.

## #3 Death penalty deters

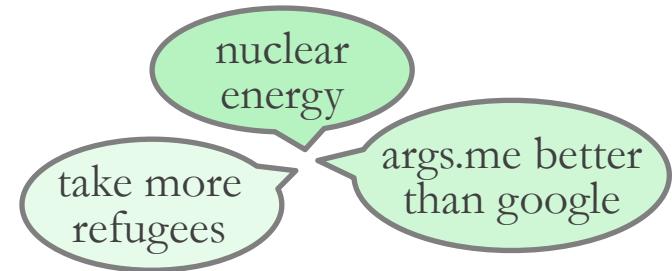
<http://www.debate.org> (10 other sources...)

By executing convicted murderers, would-be murderers are deterred from killing people.

# Argument search: Vision vs. Status Quo

## ▪ Argument search should...

- Help forming opinions on controversial issues
- Make it easy to find relevant arguments
- Not be biased towards either stance



## ▪ Search results should...

- Rank the *best* arguments highest
- Cover various reliable sources
- Cover diverse aspects
- Be as recent as possible

... and much more

## ▪ Our argument search engine...

- Is improvable on all these criteria
- Currently indexes 400k debate portal arguments
- Defines a framework to work towards the vision

The screenshot shows a search interface with the args logo and the query "abolish the death penalty". Below the search bar, it says "Page 1 of 639 arguments, 326 pro, 313 con (retrieved in 0.4s)". The results are divided into "Pro" and "Con" sections. Each section lists numbered arguments with titles, URLs, and brief descriptions.

Side	Argument Number	Title	URL	Description
Pro	#1	No execution of the innocent	<a href="http://www.bbc.co.uk">http://www.bbc.co.uk</a> (11 other sources...)	As long as human justice remains fallible, the risk of executing the innocent can never be eliminated.
	#2	Everyone has a right to live	<a href="http://www.amnesty.org">http://www.amnesty.org</a> (22 other sources...)	Everyone has an inalienable human right to live, even those who commit murder.
	#3	Death penalty fails to deter	<a href="http://www.priocan.org">http://www.priocan.org</a> (4 other sources...)	There is no scientific proof that executions have a greater deterrent effect than life imprisonment.
Con	#1	Retribution	<a href="http://www.bbc.co.uk">http://www.bbc.co.uk</a> (6 other sources...)	Real justice requires people to suffer for their wrongdoing in a way adequate for the crime.
	#2	Prevention of re-offending	<a href="http://www.bbc.co.uk">http://www.bbc.co.uk</a> (5 other sources...)	Those executed cannot commit further crimes. Imprisonment does not protect sufficiently.
	#3	Death penalty deters	<a href="http://www.debate.org">http://www.debate.org</a> (10 other sources...)	By executing convicted murderers, would-be murderers are deterred from killing people.



args.me corpus available at  
<https://webis.de/data/args-me.html>

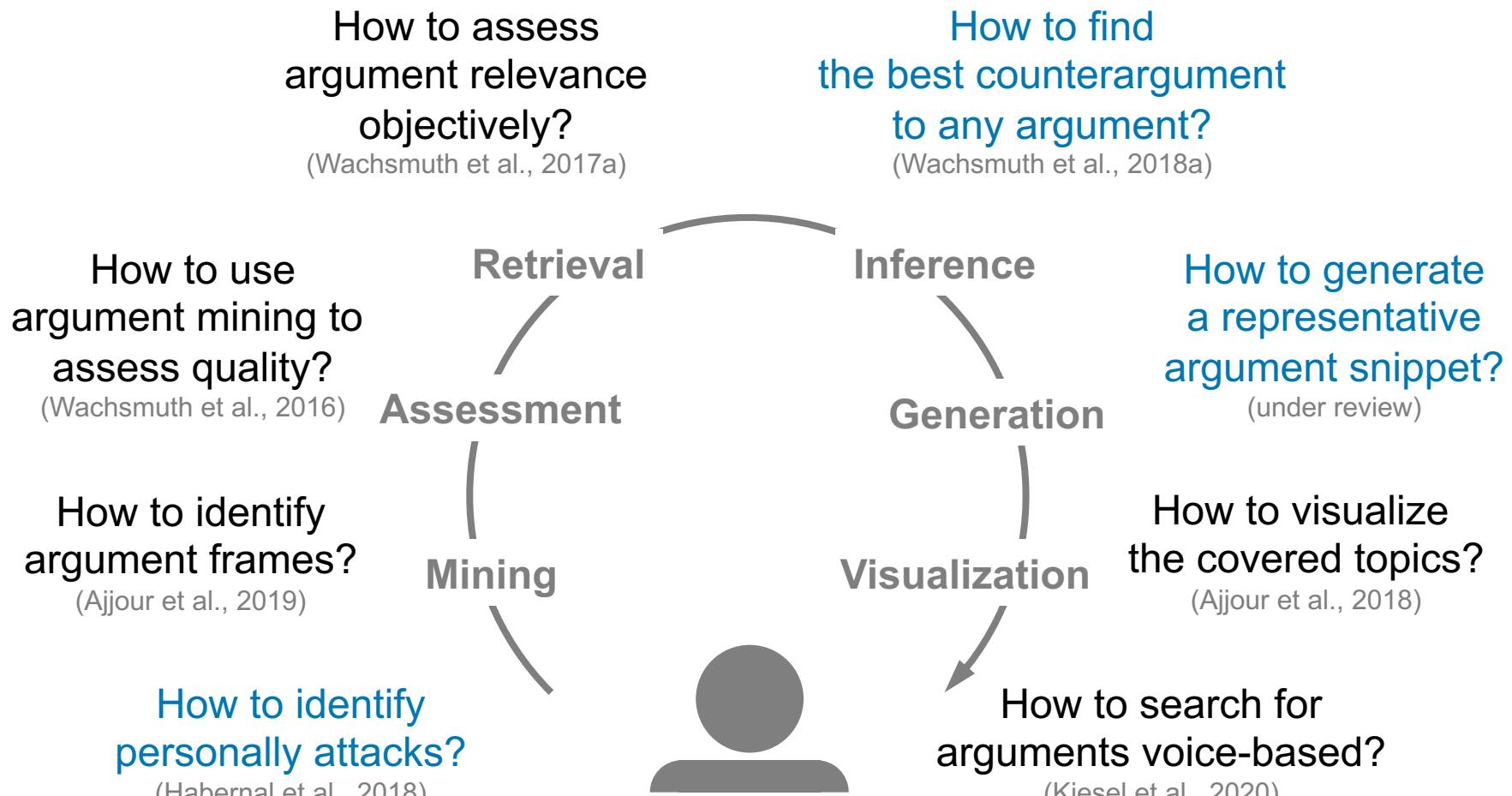
# Argument search: Demo

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<https://args.me>

# Research around argument search



nuclear energy



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Ivan  
Habernal



Benno  
Stein



Iryna  
Gurevych



## How to identify personal attacks?

(Habernal et al., 2018)



# Studying ad-hominem arguments on the web

## ▪ Ad-hominem arguments

- Attacking a person instead of his or her arguments
- 20% of all news comments uncivil (Coe et al., 2014)

That's an ad hominem fallacy  
Calvin!!



## ▪ Research questions

- Can we identify ad-hominem automatically?
- What triggers ad-hominem?

## ▪ Data

- 2M posts from Reddit ChangeMyView
- 3866 posts (0.2%) contain ad-hominem arguments

Ad-hominem is deleted by moderators, but we obtained all comments from them



## ▪ Reddit ChangeMyView (CMV)

- An opinion poster (OP) states a view
- Others argue for the opposite
- OP gives  $\Delta$  to convincing posts

Deltas(s) from OP CMV: Trump has done nothing of substance since being elected to office.

This is kind of a counter to the other post made recently about Trump being a great president.

He pointed out things like the economy, which was growing

# Ad-hominem on ChangeMyView

"Reading comprehension is your friend"

"Ever have discussions with narcissistic idiots on the internet? They are so tiring"

"You still refuse to acknowledge that you used a strawman argument against me"

"little buddy"

"Thank you so much for all your pretentious explanations"

"To say that people intrinsically understand portion size is idiotic."

"You started with a fallacy and then deflected."

"Please dont waste peoples time pretending to know what you're talking about"

"boy"

"Did you even read this?"

"Read what I posted before acting like a pompous ass"

"Do you even know what you're saying?"

"Again, how old are you?"

"You're making the claims, it's your job to prove it. Don't you know how debating works?"

"You're obviously just Nobody with enough brains to operate a computer could possibly believe something this stupid"

"Your second paragraph is fairly idiotic"

"You have no capability to understand why"

"Wow. Someone sounds like a bit of an anti-semite"

"you dumb fuck"

"Your just an asshole"

"Possible lie any harder?"

"How can you explain that? You can't because it will hurt your feelings to face reality"

"You're just a dishonest troll"

"You are just a liar."

"Can you also use Google?"

"Willful ignorance is not something I can combat"

"You're trash at debating."

"You're too dishonest to actually quote the verse because you know it's bullshit"

"sir"

"If you can't grasp the concept, I can't help you"

"You're using troll tactics"

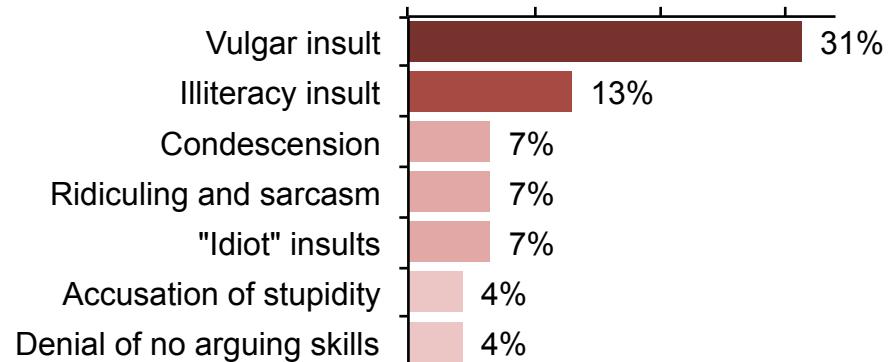
# Can we identify ad-hominem automatically?

## ▪ Distribution of ad-hominem

75% threads with $\leq$ 2 ad-hominems (but some with >50)	49% threads stop after ad-hominem	66% ad-hominem "out of the blue" (but one after 57 posts)	23% ad-hominem against OP	12% ad-hominem from OP
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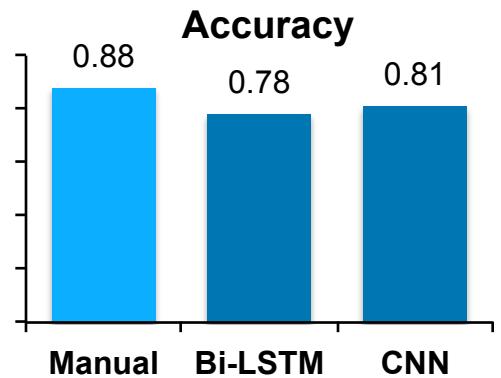
## ▪ Types of ad-hominem

- Ad-hominem annotated in 400 arguments by 7 crowdworkers
- 15 types identified manually in their annotations



## ▪ Identification of ad-hominem

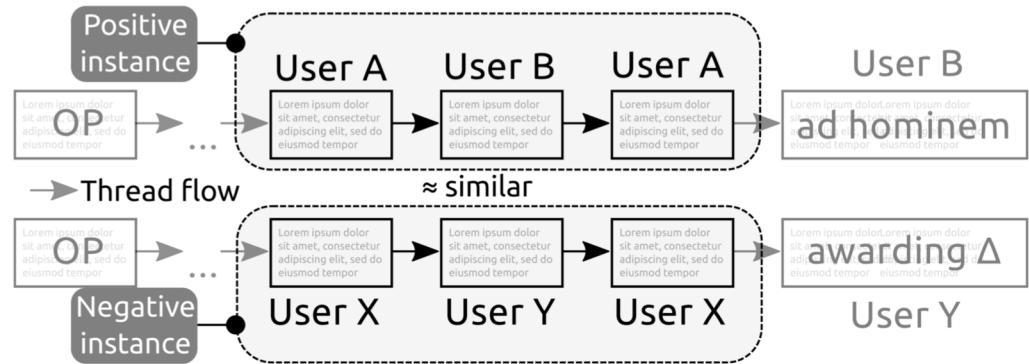
- **Manual.** 100 balanced arguments (50 ad-hominem) classified by 6 workers
- **Automatic.** 7242 balanced arguments classified by 2 neural classifiers (Bi-LSTM & CNN)



# What triggers ad-hominem?

## ■ Prediction of ad-hominem

- Self-attentive LSTM trained on 2852 argument 3-tuples
- Accuracy 0.72
- Manual attention analysis



(OOV\_comment\_begin) If only you would n't rely on [ fallacious ] ( http : OOV ) [ arguments ] ( http : OOV ) to make your point. So no , I do n't realize how stupid and naive I am. All I 've realized is that you are n't actually prepared to have an actual discussion .

(OOV\_comment\_begin) What god do you believe in ? And it 's not a fallacy when it 's very comparable to the most popular gods .

(OOV means out-of-vocabulary)

## ■ Terms with much attention

- Mostly topic-independent rhetorical devices
- A few loaded keywords, such as "rape" or "racist"
- Partly meta about argumentation

vulgar intensifiers  
"... the fuck..."

direct imperatives  
"You should..."

bad argumentation  
"You're grasping at straws"

missing evidence  
"unsupported claims!"

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Shahbaz  
Syed



Benno  
Stein



# How to find the best counterargument to any argument?

(Wachsmuth et al., 2018a)

# How to find the best counterargument to an argument?

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## ▪ Argument

*The feminist cause no longer appeals to women.* (conclusion)

*Many women no longer identify themselves as feminists, associating feminism with man-hating, sex-hating humourlessness, and seeing it as a relic of the 1970s. Modern women are perfectly capable of competing with men on equal terms [...]* (premise)

<https://idebate.org/debatabase/society-gender/house-believes-feminism-still-needed>

## ▪ Counterargument

*Opponents of the feminist movement have always sought to stereotype feminists in order to reduce their support. That this enterprise is often successful is not an argument against feminism [...]*

<https://idebate.org/debatabase/society-gender/house-believes-feminism-still-needed>

## ▪ Disclaimer

- Even the best counterargument might not convince everyone

# Can we also do for that for a topic we don't know?

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## ▪ Argument

*Neo-functionalism proposes a purpose to EU integration. (conclusion)*

*Neo-functionalism proposed building a community Europe, through the concept of spillover the theory proposes economic determinism. Spill-over will eventually lead to a completely integrated Europe with a strong central government [...] (premise)*

<https://idebate.org/debatabase/economy-economic-policy-economy-general-international-europe-philosophy-political>

## ▪ Counterargument

*Neo-functionalism believes in building a community Europe, but then the question is raised, what is the purpose of this new entity? There is no common outlook and getting the major powers of Europe to agree what this should be will be near impossible [...]*

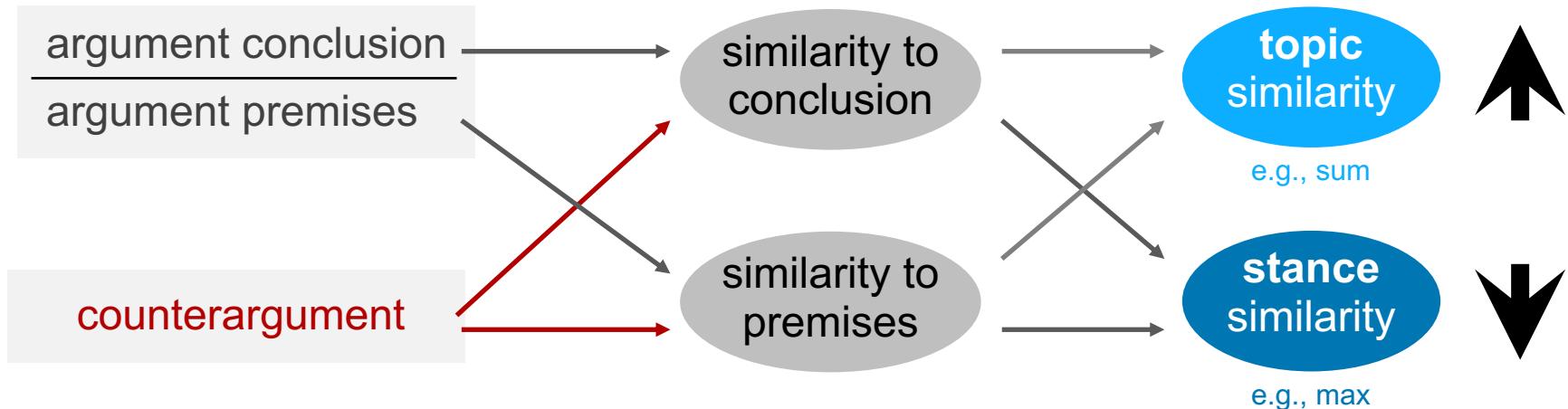
<https://idebate.org/debatabase/economy-economic-policy-economy-general-international-europe-philosophy-political>

## ▪ (Simplifying) Hypothesis

- The best counterargument covers the same aspects with opposite stance

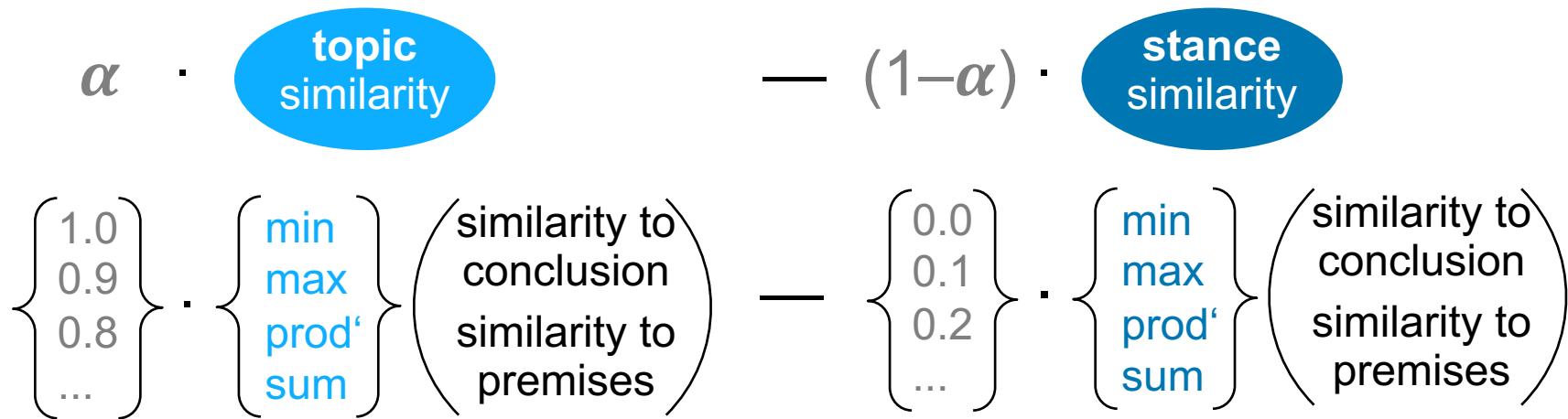
# Measuring simultaneous similarity and dissimilarity

- **Approach**
  - Capture simultaneous **topic similarity** and **stance dissimilarity**
- **Background from theory** (Walton, 2009)
  - A **counterargument** attacks an argument's conclusion
  - ... or the argument's premises
  - ... or the inference from premises to conclusion
- **Infer both similarities from premise(s) and conclusion ... in different ways**



# Ranking counterarguments

- Learning to rank by simultaneous (dis)similarity



- Learn best  $\alpha$  and best **topic-stance** similarity pair on validation set
- Apply best combinations on test set

- Embedding + word similarity

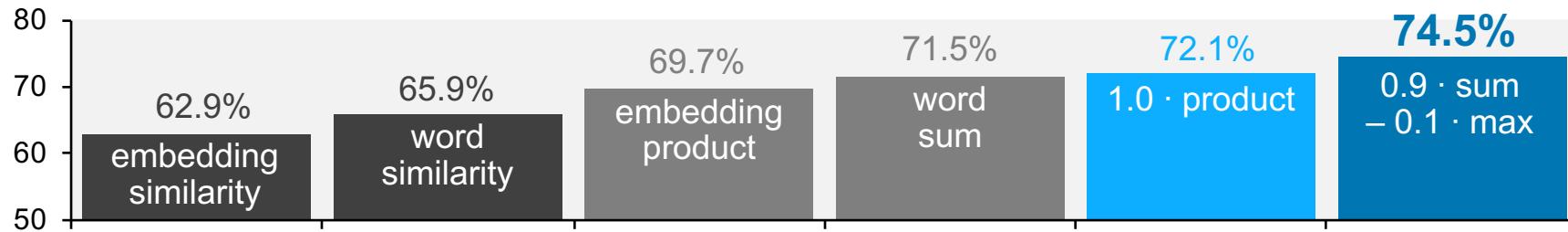
- Embeddings. Word mover's distance on ConceptNet Numberbatch  
outperformed: average word embeddings and GoogleNews-vectors, wiki-news-300d-1M, and crawl-300d-2M
- Words. Manhattan distance on stem 1-grams  
outperformed: Jaccard, Euclidean, and Cosine distance on word, stem, and lemma 1-, 2-, and 3-grams

# Can we rank the best counterarguments highest?

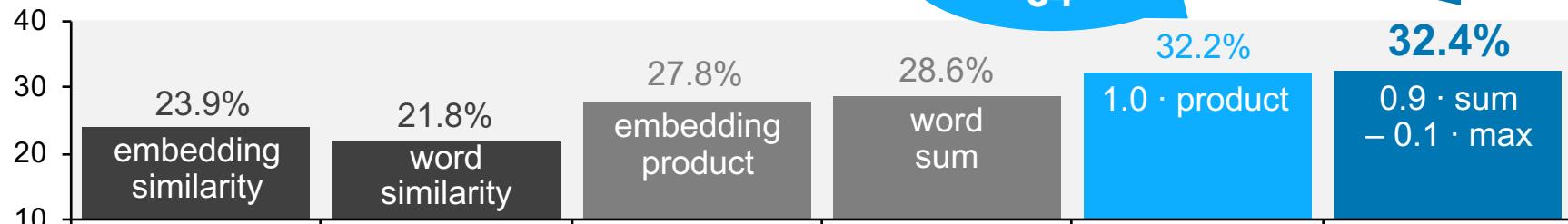
- Evaluation of ranking counterarguments from idebate.org

Selected baseline similarities				Best approaches	
embedding similarity	word similarity	product of embedding similarities	sum of word similarities	$1.0 \cdot \text{product of embedding and word similarities}$	$0.9 \cdot \text{sum} - 0.1 \cdot \text{max of embedding and word similarities}$

- Candidates: All counterarguments with opposite stance (true-to-false ratio 1:3)



- Candidates: All arguments (true-to-false ratio 1:2800)



# Counterarguments on args.me

args nuclear energy 

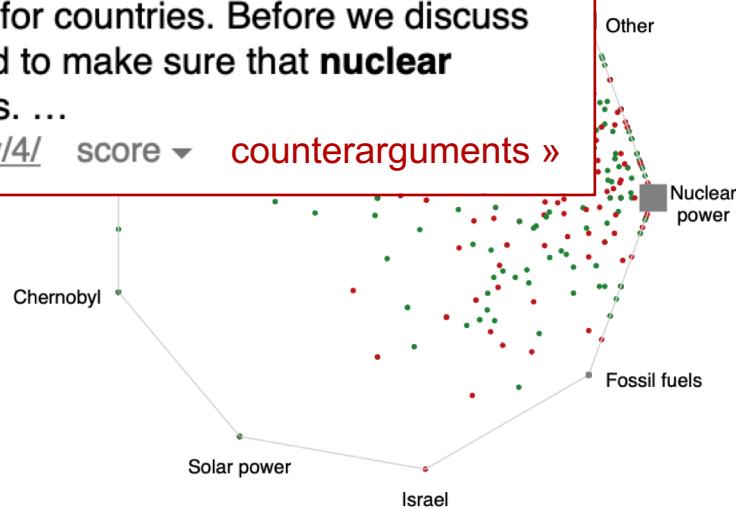
All Discussions People Topic space view ▾ 2058 arguments retrieved in 1.0 ms

**PRO** In my opinion Nuclear Energy is necessary for countries....  
► Show full argument  
In my opinion Nuclear Energy is necessary for countries.... Before we discuss on energy or environmental effects, we need to make sure that nuclear energy is possible to use for all the countries. ...  
<https://www.debate.org/debates/Nuclear-Energy/4/> score ▾ counterarguments »

**PRO** Resolved: The United States should develop nuclear power as part of its energy resolution. I will support this resolution.  
► Show full argument  
Resolved: The United States should develop nuclear power as part of its energy resolution. I will support this resolution.  
<https://www.debate.org/debates/Nuclear-Energy/1/> score ▾

**PRO** This is going to be a simple Pro Nuclear Energy vs Con Nuclear Energy debate.  
► Show full argument  
This is going to be a simple Pro Nuclear Energy vs Con Nuclear Energy. No specific resolution, just the broad subject of using nuclear energy. Burden of Proof - The BoP falls equally on both sides.  
<https://www.debate.org/debates/Nuclear-Energy/2/> score ▾

**PRO** This is going to be a simple Pro Nuclear Energy vs Con Nuclear Energy debate.  
► Show full argument  
This is going to be a simple Pro Nuclear Energy vs Con Nuclear Energy. No



A topic space visualization showing various energy sources and their relationships. The plot features several points connected by lines, forming a network. Labeled points include Chernobyl (top left), Solar power (bottom left), Israel (bottom center), Fossil fuels (bottom right), and Nuclear power (far right). Other unlabeled green dots represent various other energy sources.

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Milad Nick  
Alshomary Düsterhus



# How to generate a representative argument snippet?

(under review)

# Snippet generation for arguments

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- **Snippet**
  - Short text used to assess the relevance of a search result
  - Usually, content excerpt with the query terms
  - **Hypothesis.** Standard snippets not enough for arguments
- **A good argument snippet**
  - Short text that represents the core of an argument
  - Usually, the main claim and the main reason to support the claim
- **Snippet generation for arguments**
  - **Question.** Given an argument, how to generate the best 2-sentence snippet?
  - **Approach.** Query-independent extractive summarization

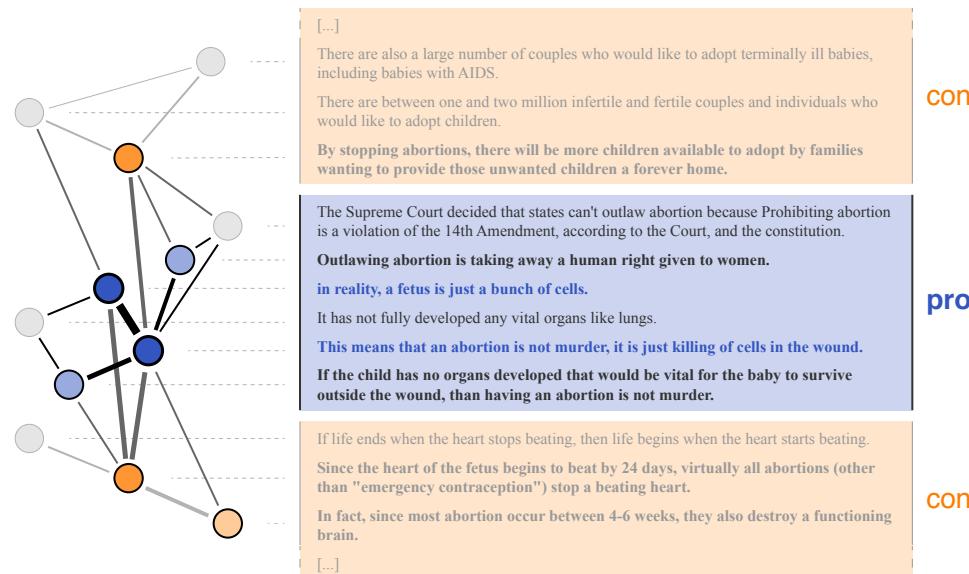
*The Supreme Court decided that states can't outlaw **abortion** because Prohibiting **abortion** is a violation of the 14th Amendment, according to the Court, and the constitution. Outlawing **abortion** is taking away a human right given to women. In reality, a fetus is just a bunch of cells. It has not fully developed any vital organs like lungs. This means that an **abortion** is not murder, it is just killing of cells in the womb. If the child has no organs developed that would be vital for the baby to survive outside the womb, than having an **abortion** is not murder.*

# Approach

- **PageRank** (Page et al., 1999; Erkan and Radev, 2004)
  - Recursive method to assess the importance of a concept in relation to others
  - **Web page.** Important if other important web pages link to it
  - **Sentence.** Important if other important sentences are similar to it
- **PageRank for argument snippets**
  - **Centrality.** Compute PageRank for all sentences in the context of an argument

Similarity based on sentence embeddings; context given by covering web page
  - **Argumentativeness.** Bias the PageRank to sentences that are argumentative

Derived from discourse lexicons
- **Extractive summarization**
  - **Snippet.** The 2 sentences with highest PageRank in their given ordering



# Automatic and manual evaluation

- **Evaluation**
    - **Data.** Expert snippets for 50 args.me results
    - **Automatic.** Accuracy of snippet generation
    - **Manual.** Mean rank of representativeness and readability (from 3 annotators)
  - **Extractive summarization baselines**
    - Random. Selecting any 2 sentences
    - LexRank. Simple PageRank for sentences
    - BertSum. Neural extractive summarization
    - **Expert snippets.** Ground-truth
  - **Existing snippet generation baselines**
    - Lucene. Query-dependent snippet generation
    - args.me. Using the beginning of arguments
- (all snippets cut after 225 characters to mimic application)
- 
- The figure consists of three separate horizontal bar charts, each comparing five methods: Random, LexRank, BertSum, Our (centrality), and Our (centrality+arg.).
- Top Chart:** Compares methods based on their mean rank of representativeness and readability from 3 annotators. The Y-axis lists the methods. The X-axis shows the mean rank. The legend indicates that darker shades represent readability and lighter shades represent representativeness.
  - Middle Chart:** Compares methods based on readability and mean rank. The Y-axis lists the methods. The X-axis shows the mean rank. The legend indicates that darker shades represent readability and lighter shades represent representativeness.
  - Bottom Chart:** Compares methods based on readability and mean rank. The Y-axis lists the methods. The X-axis shows the mean rank. The legend indicates that darker shades represent readability and lighter shades represent representativeness.
- | Method                | Readability (%) | Representativeness (%) | Mean Rank |
|-----------------------|-----------------|------------------------|-----------|
| Random                | 27%             | -                      | -         |
| LexRank               | 36%             | -                      | -         |
| BertSum               | 40%             | -                      | -         |
| Our (centrality)      | -               | 43%                    | -         |
| Our (centrality+arg.) | -               | 44%                    | -         |
| LexRank               | 2.47            | -                      | -         |
| BertSum               | 2.43            | -                      | -         |
| Our (centrality+arg.) | -               | 1.95                   | -         |
| Expert snippets       | 1.66            | -                      | -         |
| Lucene                | 2.17            | -                      | -         |
| args.me               | 1.77            | -                      | -         |
| Our (centrality+arg.) | -               | 1.69                   | -         |

# Example snippets

- **Argument returned to the query "climate change"**

*Climate Change is causing the Earth to warm up measurably, and there are already signs of disaster. I argue that this is happening because there are scientific facts to prove it. Out of 918 peer-reviewed scientific papers on this subject, 0% disagreed that climate change is happening, but in newspaper articles, 53% were unsure. This proves that climate change is happening, but scientists are having trouble conveying the information and other data to the people of the world.*

- **Which snippet best represents the core of the argument?**

**#1.** *Climate Change is causing the Earth to warm up measurably, and there are already signs of disaster... I argue that this is happening because there are scientific facts to prove it...*

**#2.** *Out of 918 peer-reviewed scientific papers on this subject, 0% disagreed that climate change is happening, but in newspaper articles, 53% were unsure... This proves that climate change is happening, ...*

**#3.** *Climate Change is causing the Earth to warm up measurably, and there are already signs of disaster ... reviewed scientific papers on this subject, 0% disagreed that climate ...*

---

## Discussion and conclusion

#5

Can you actually persuade others  
with arguments?

#4

Why do you argue on issues  
where persuasion is unlikely?

#3

When do you form an opinion  
on an issue?

#2

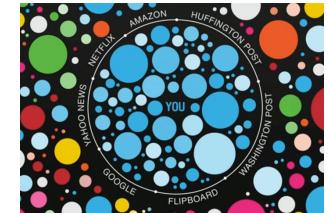
Do you think that  
opinion formation is self-determined?

#1

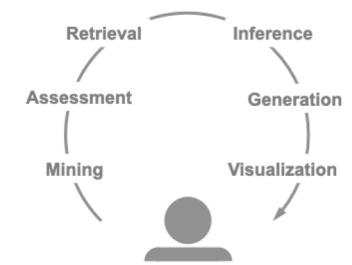
**Do we need  
argument search?**

# Conclusion

- **Opinion formation in the post-factual age**
  - Troubled by echo chambers and alternative facts
  - Unbiased access to arguments required
- **Our approach: An argument search engine**
  - Aims to oppose the best arguments on arbitrary issues
  - Still in an early stage, development cycles slow
- **NLP research around argument search**
  - Finding good arguments, countering and summarizing them
  - Many other mining, assessment, and generation tasks
- **args.me will not "save the world"**
  - Rather, it serves as a vehicle to demonstrate our research
  - We aim to contribute to shaping the path to take



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