

”PageRank“ for Argument Relevance

Henning Wachsmuth, Benno Stein, Yamen Ajjour
henning.wachsmuth@uni-weimar.de

**Bauhaus-Universität
Weimar**

www.webis.de

The future of search

ArguAna



death penalty good or bad



Pro death penalty

#1 Retribution

<http://www.bbc.co.uk> (36 other sources...)

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

#2 Deterrence

<http://www.debate.org> (15 other sources...)

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

#3 Prevention of re-offending

<http://www.bbc.co.uk> (25 other sources...)

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

Con death penalty

#1 Execution of the innocent

<http://www.bbc.co.uk> (81 other sources...)

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

#2 Right to live

<http://www.amnesty.org> (102 other sources...)

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

#3 Failure to deter

<http://www.procon.org> (24 other sources...)

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

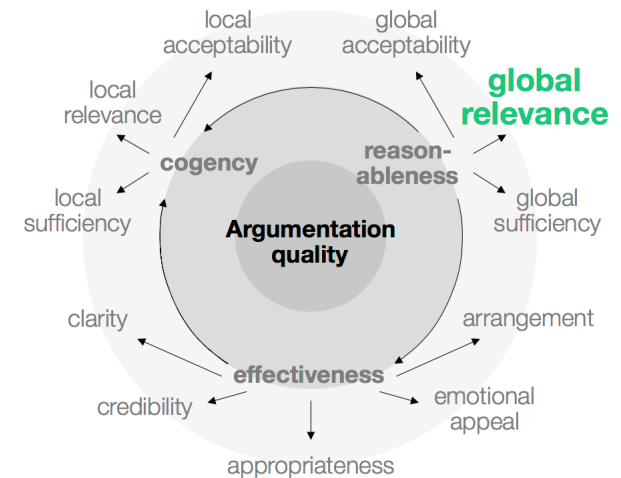
Mining of relevant arguments

▪ **Argument mining**

- Identifies arguments in natural language text
- Does not assess relevance

▪ **Argument relevance**

- Contribution to conclusion on an issue (Walton, 2006)
- Often perceived subjectively



” The death penalty legitimizes an irreversible act of violence. As long as human justice remains fallible, the risk of executing the innocent can never be eliminated. ”

” The death penalty doesn’t deter people from committing serious violent crimes. The thing that deters is the likelihood of being caught and punished. ”

▪ **Research question**

- Can we develop an “objective” relevance measure?

Argument relevance at web scale

- **Exploit web scale for objective relevance**

- Ignore content and inference of argument (for now)
- Decide relevance structurally



Benno Stein

” Why not adapt PageRank to arguments? “

Page et al. (1999)
” PageRank, a method for rating web pages objectively and mechanically, effectively measuring human interest. “

Conclusion
Premises



Conclusion
Premises

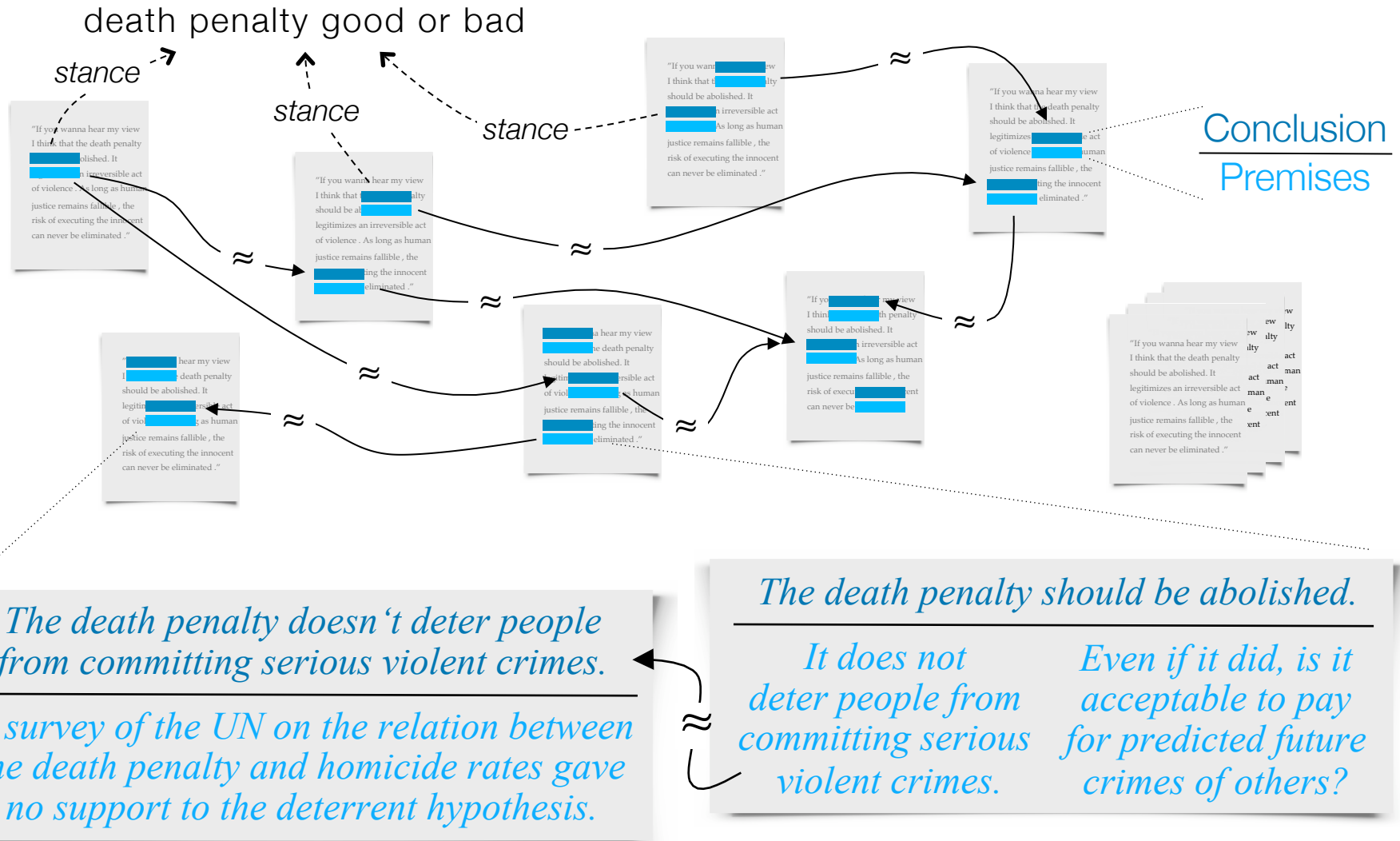
- **Key hypothesis**

- Relevance of a conclusion depends on what other arguments across the web use it as a premise
- Author cannot control who "cites" a conclusion in this way

- **Assume perfect argument mining technology**

- Build argument graph for the web
- Adapt PageRank algorithm to arguments

The web as an argument graph



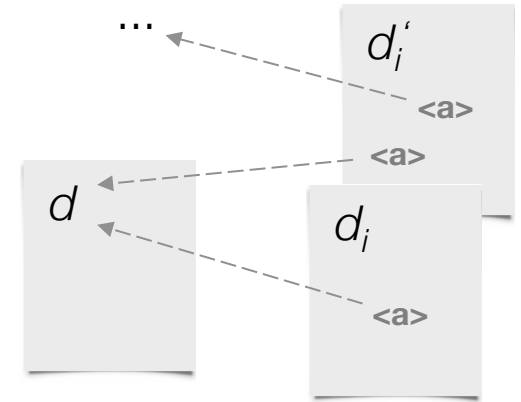
PageRank for argument relevance

- **Original PageRank score** of a web page d (Page et al., 1999)

same score for each page

$$p(d) = (1 - \alpha) \cdot \underbrace{\frac{1}{|D|}}_{\text{ground relevance}} + \alpha \cdot \underbrace{\sum_i \frac{p(d_i)}{|D_i|}}_{\text{recursive relevance}} \text{ page } d_i \text{ links to } d$$

pages d_i links to

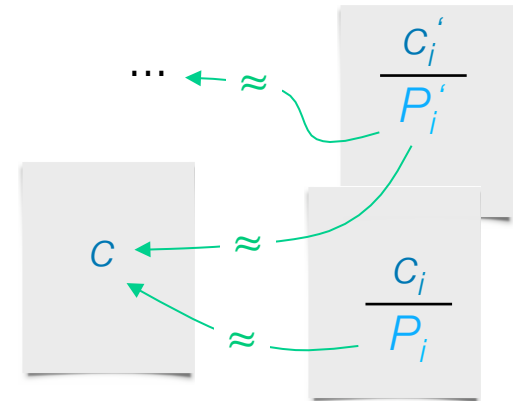


- **Adapted PageRank score** of an argument unit c

PageRank of page d containing c

$$\hat{p}(c) = (1 - \alpha) \cdot \underbrace{\frac{p(d) \cdot |D|}{|A|}}_{\text{ground relevance}} + \alpha \cdot \underbrace{\sum_i \frac{\hat{p}(c_i)}{|P_i|}}_{\text{recursive relevance}} \text{ conclusion } c_i \text{ uses } c \text{ as premise}$$

premises of c_i



- **Argument relevance** is aggregation of premise scores
 - Minimum, average, maximum, or sum

A large ground-truth argument graph

available at
www.arguana.com

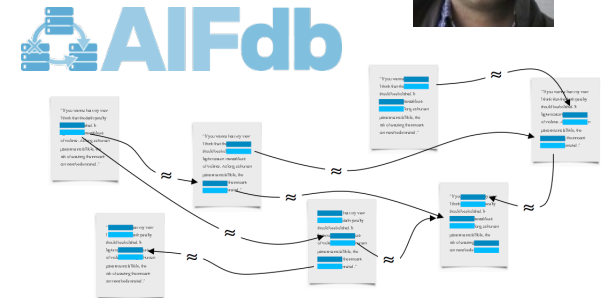
- **No use of argument mining here**

- Evaluation of PageRank without noise

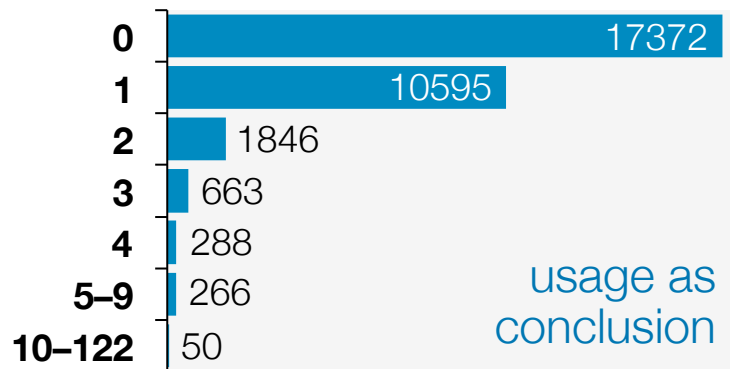
- **Construction of a ground-truth argument graph**

- 57 argument corpora at www.aifdb.org
- Merged all arguments except for duplicates
- Units assumed to match if they span the same text
- Computed PageRank for each unit

Yamen Ajjour



- **17,877 arguments with 31,080 different units**



Benchmark argument relevance rankings

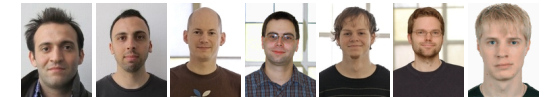
available at
www.arguana.com

- **No objective relevance judgments available**

- Use average judgments as a proxy

- **Filtering of general claims from the graph**

- 3113 conclusions with >1 argument, 498 with premises used multiply
- 70 classified as claims of general interest by 2 annotators (Cohen's $\kappa = .69$)
- 32 have 2–6 "real" arguments (Cohen's $\kappa = .63$)



Thanks to our group!

- **Creation of relevance rankings for the 32 claims**

- 110 arguments ranked by 7 annotators (mean Kendall's $\tau = .36$, highest $\tau = .59$)



"Strawberries are the best choice for your breakfast meal."

1st
(1.43)

"Berries are superfoods because they're so high in antioxidants without being high in calories, says Giovinazzo MS, RD, a nutritionist at Clay health club and spa, in New York City."

Impact of PageRank

▪ Evaluation of unsupervised ranking approaches

PageRank
of premises

\hat{p}

Frequency
of premises

Σ

Similarity
of units

$c \sim P$

Sentiment
of premises



Number
of premises

$|P|$

Random
ranking



each for minimum, average, maximum, and sum aggregation

▪ Experiment on ground-truth graph

- Rank arguments with each approach
- Correlate with benchmark rankings

▪ Results

- PageRank with sum aggregation best
- Consistently outperforms frequency
- Notable correlation despite ignorance of content and inference

best results for each ranking approach

#	Dimension	τ	best	worst
1	PageRank	0.28	15	3
2	Number	0.19	6	1
3	Sentiment	0.12	12	4
4	Frequency	0.10	11	9
5	Similarity	0.02	9	10
6	Random	0.00	8	7

Towards argument search engines

■ Contributions

- Approach to assess argument relevance structurally
- Dataset with argument rankings
- First empirical evidence that relevance depends on the reuse of conclusions



■ Major open challenges...

- Arguments must be mined robustly from the web
- Identification of reuse is hard
- PageRank only for relevant candidates

ArguAna death penalty good or bad

Pro death penalty

- #1 Retribution**
https://www.bbc.co.uk/1/health/2014/08/140821_death_penalty_uk.shtml
Real justice requires people to suffer for their wrongdoing in a way adequate for the crime.
- #2 Deterrence**
<https://www.gabrielis.org/15/other-sources...>
By executing convicted murderers, would-be murderers are deterred from killing people.
- #3 Prevention of re-offending**
https://www.bbc.co.uk/1/health/2014/08/140821_death_penalty_uk.shtml
Those executed cannot commit further crimes. Imprisonment does not protect sufficiently.

Con death penalty

- #1 Execution of the innocent**
https://www.bbc.co.uk/1/health/2014/08/140821_death_penalty_uk.shtml
As long as human justice remains fallible, the risk of executing the innocent can never be eliminated.
- #2 Right to live**
<https://www.amnesty.org/102/other-sources...>
Everyone has an inalienable human right to live, even those who commit murder.
- #3 Failure to deter**
https://www.bbc.co.uk/1/health/2014/08/140821_death_penalty_uk.shtml
There is no scientific proof that executions have a greater deterrent effect than life imprisonment.

■ ... but web scale helps

- Prefer precision over recall
- Start with reliable sources and limited domains
- Refine argument graph step by step

