

Computational Argumentation – Part I

Introduction to Computational Argumentation

Henning Wachsmuth

henningw@upb.de

Learning goals

▪ Concepts

- The need for processing argumentation
- Some general aspects of argumentation
- Benefits and challenges of computational argumentation



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▪ Methods

- First idea of the analysis and synthesis of arguments



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▪ Associated research fields

- Argumentation theory
- Natural language processing



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▪ Within this course

- First overview of the topics covered in this course



Outline

I. Introduction to computational argumentation

II. Basics of natural language processing

III. Basics of argumentation

IV. Argument acquisition

V. Argument mining

VI. Argument assessment

VII. Argument generation

VIII. Applications of computational argumentation

IX. Conclusion

a) Introduction

b) Argumentation

c) Computational argumentation

d) Tasks in computational argumentation

e) Conclusion

Welcome to the post-factual age!

It was January 22, 2017...

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



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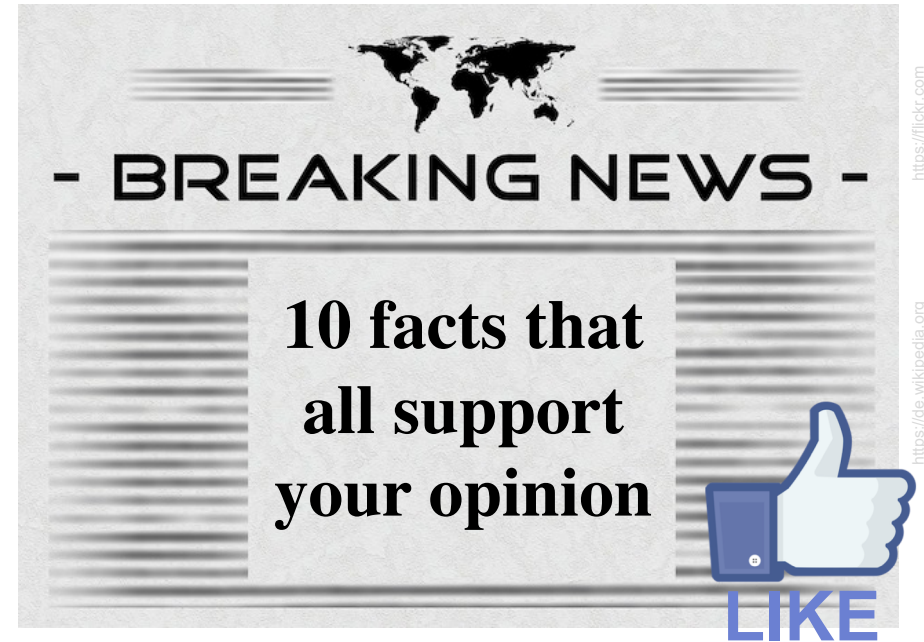
How could we end up there?

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?

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

Where truth is unclear, we need to compare *arguments*

Can computers help?

Example: Project Debater

<https://www.youtube.com/watch?v=nJXcFtY9cWY>



Next section: Argumentation

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Why do people argue?

■ Causes of argumentation

(Freeley and Steinberg, 2009)

- A (possible) conflict of interests or positions
- No (clearly) correct answer or solution
- So: **Controversy**



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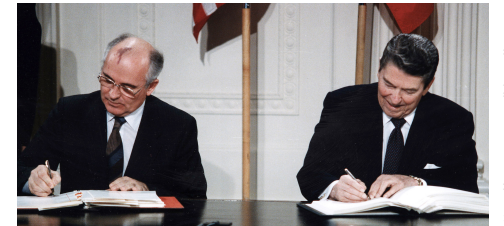
■ Goals of argumentation

(Tindale, 2007)

- **Persuasion**
- Agreement
- Justification
- Deliberation
- ... and similar



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What is argumentation?

▪ **Argument**

- A claim (conclusion) supported by reasons (premises) (Walton et al., 2008)
- Conveys a stance on a controversial issue (Freeley and Steinberg, 2009)

Conclusion
Premises

Conclusion *The EU should allow rescue boats 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.*

- Most natural language arguments are defeasible (Walton, 2006)
- Often, some argumentative units are implicit (Toulmin, 1958)

▪ **Argumentation**

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

Conclusion
Premises

Monological vs. dialogical argumentation



Monological argumentation

Italy, Malta, Germany, and France agreed a plan at the end of September to share responsibility for hosting asylum seekers and migrants rescued in the central Mediterranean. [...]

However, the plan does not address the underlying issues with EU migration policy that have led to the increased death rate – namely the Europe-wide criminalisation of humanitarian support for asylum seekers and refugees and the EU's policy of border externalisation. [...]

Dialogical argumentation



Alice. *The EU should allow rescue boats in the Mediterranean Sea, to save the innocent refugees.*

Bob. *So naïve... having such boats makes even more people die trying. I'm against.*

Alice. *Well, I actually read that rescue boats haven't led to any increase yet.*

Argumentative genres

▪ Written monolog

- Persuasive essays
- Opinionated articles/editorials
- Argumentative blog posts
- Customer and scientific reviews
- Scientific articles
- Law texts

... among others

▪ Written dialog

- Comments to news articles
- Social media posts
- Online forum discussions
- eMail threads
- Online debates

... among others

▪ Spoken monolog (possibly transcribed)

- Political speeches
- Law pleadings

... among others

▪ Spoken dialog (possibly transcribed)

- Classical debates
- Everyday discussions

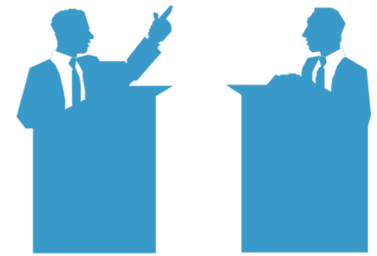
... among others

▪ Notice

- The focus in this course is on *written* argumentation, i.e., argumentative texts.

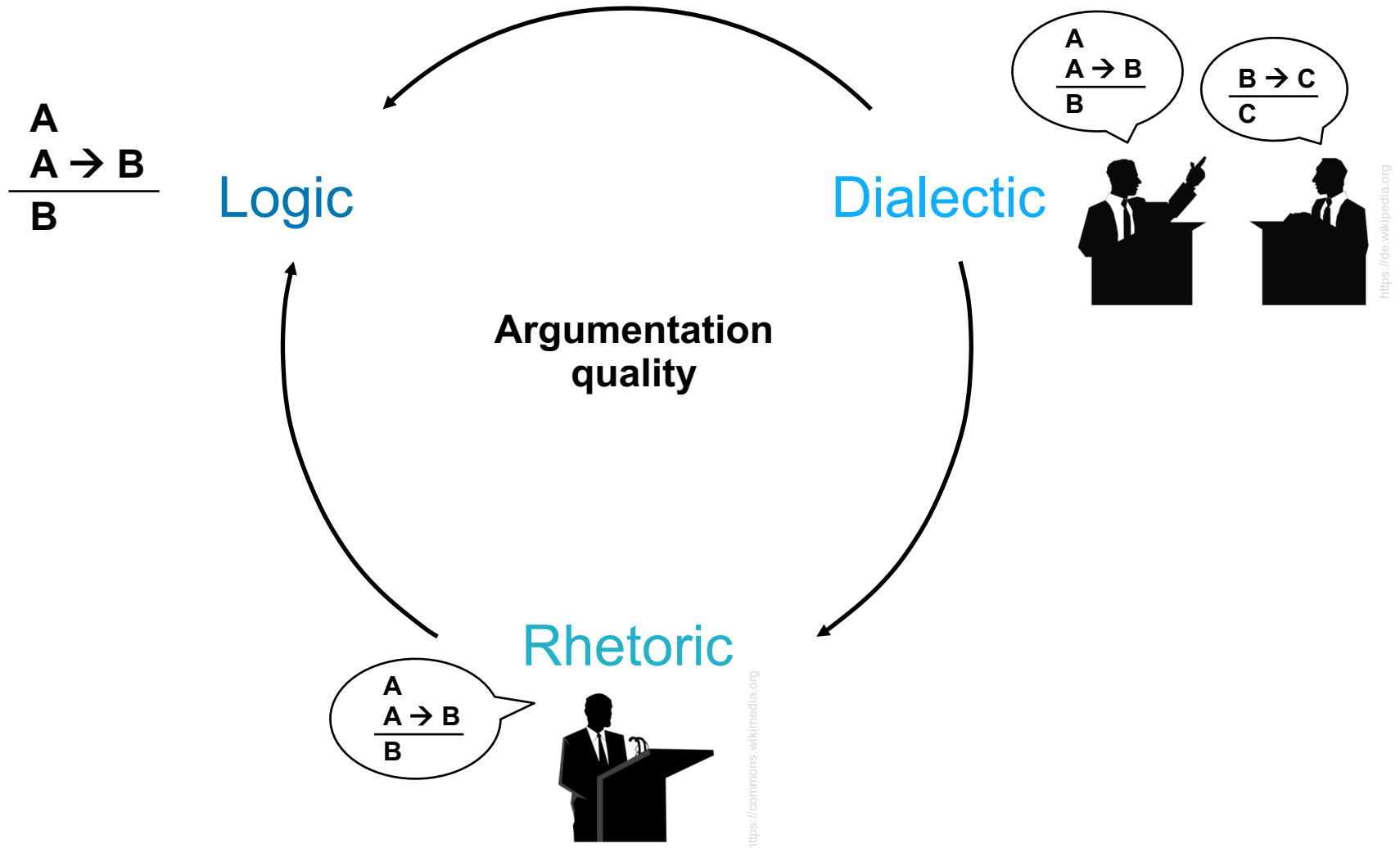


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What is *good* argumentation?



Who is involved in argumentation?

▪ Author (or speaker)

- Argumentation is connected to the person who argues.
- The same argument is perceived differently depending on the author.

*” The EU should allow rescue boats.
Many innocent refugees will die if
there are no rescue boats. “*



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▪ Reader (or audience)

- Argumentation often targets a particular audience.
- Different arguments and ways of arguing work for different readers.

*” According to a recent UN study, the
number of rescue boats had no effect
on the number of refugees who try. “*



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IX. Conclusion

a) Introduction

b) Argumentation

c) Computational argumentation

d) Tasks in computational argumentation

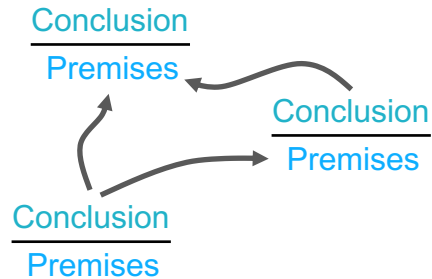
e) Conclusion

What is computational argumentation?

■ Computational argumentation

- The computational analysis and synthesis of natural language arguments
- Several different tasks, usually tackled with data-driven methods

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$$(1 - \alpha) \cdot \frac{p(d) \cdot |D|}{|A|} + \alpha \cdot \sum_i \frac{\hat{p}(c_i)}{|P_i|}$$



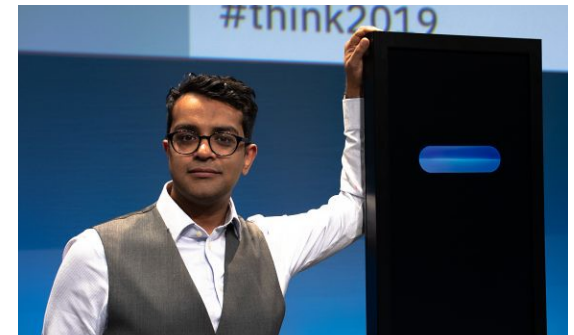
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■ Main research aspects

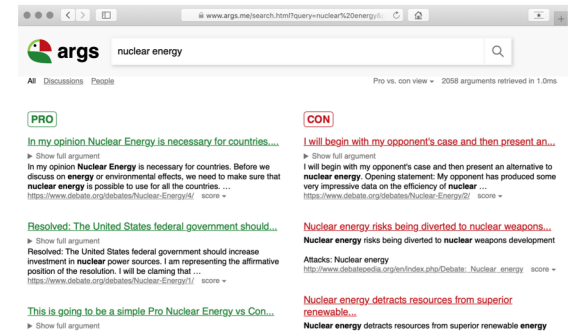
- **Models** of arguments and argumentation
- **Computational methods** for analysis and synthesis
- **Resources** for development and evaluation
- **Applications** built upon the models and methods

Applications of computational argumentation

- **Debating technology** (Slonim et al., 2021)
 - **What.** Present arguments for controversial issue and argue for a stance towards the issue
 - **Why.** Support decision making
- **Argument search** (Wachsmuth et al., 2017)
 - **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



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(Wambagsans and Rietsche, 2019)

Argument search: args.me



nuclear energy



All [Discussions](#) [News](#) [People](#)

Pro vs. con view ▾ 2018 arguments retrieved in 168.0 ms

PRO

[We're dependent on thermal power and fuels so nuclear...](#)

► Show full argument

We're dependent on thermal power and fuels so **nuclear energy** will be a useful hand of help. ... 1:<http://www.forbes.com>... 2:<http://www.cancer.gov>... <https://www.debate.org/debates/Nuclear-Energy/4/> score ▾

[The most up-to-date study, conducted at the Forsmark...](#)

► Show full argument

The most up-to-date study, conducted at the Forsmark **nuclear** power facility in Sweden during 2005, shows that the plant was producing only 3.10 grams of CO2 per kilowatt per hour [1]. ... Sources: [1] ... <https://www.debate.org/debates/Nuclear-Energy/1/> score ▾

[Thermal energy causes the global warming which is the...](#)

► Show full argument

Thermal **energy** causes the global warming which is the most important world discussion and the most dangerous natural disaster of our generation. ... I wish my best lucks to my opponent 1.<http://www.fi.edu>... ... <https://www.debate.org/debates/Nuclear-Energy/4/> score ▾

CON

[There are high protocol, likely classified, to protect...](#)

► Show full argument

There are high protocol, likely classified, to protect the integrity of **nuclear** facilities in developed nations. ... Thank you! <https://www.debate.org/debates/Nuclear-Energy/2/> score ▾

[Nuclear energy risks being diverted to nuclear weapons...](#)

► Show full argument

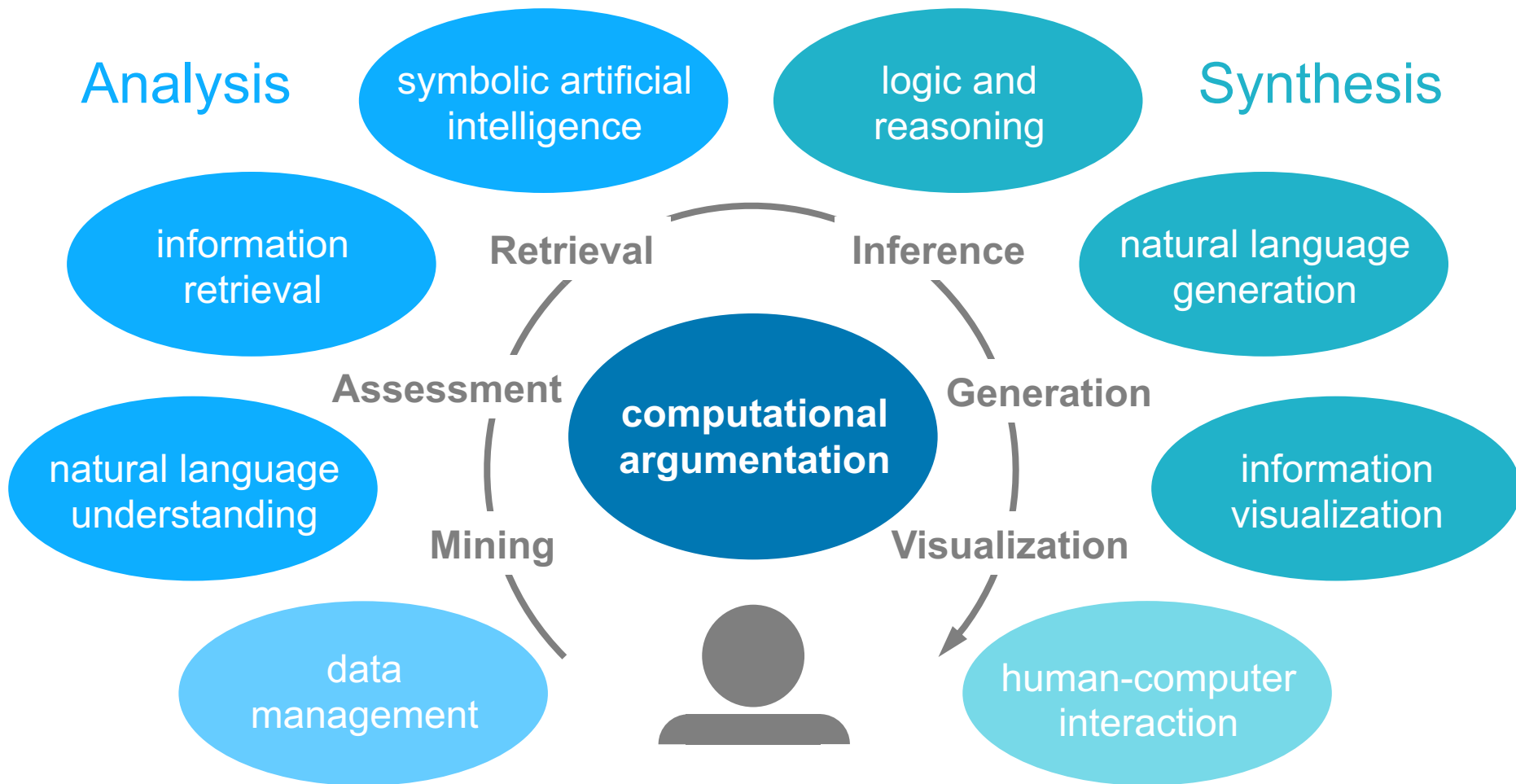
Nuclear energy risks being diverted to **nuclear** weapons development http://www.debatepedia.org/en/index.php/Debate: Nuclear_energy score ▾

[Nuclear energy detracts resources from superior renewable...](#)

► Show full argument

Nuclear energy detracts resources from superior renewable **energy** http://www.debatepedia.org/en/index.php/Debate: Nuclear_energy score ▾

Analysis and synthesis tasks

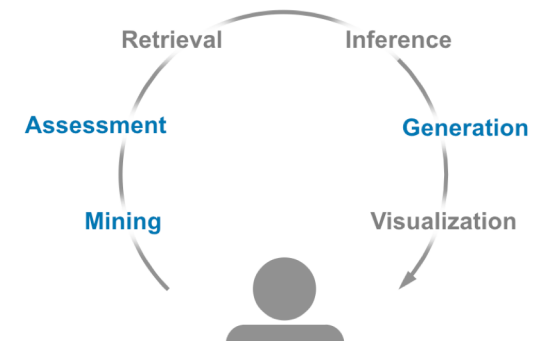
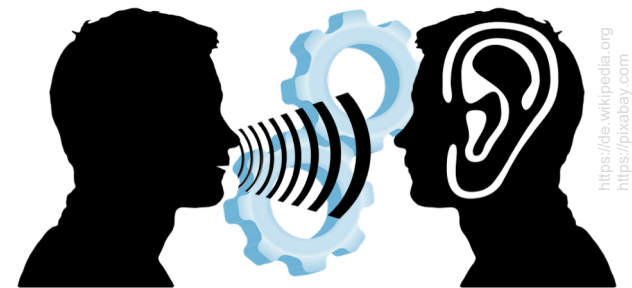


A natural language processing perspective

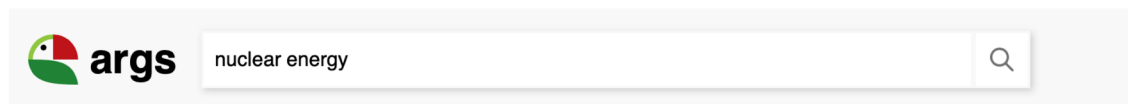
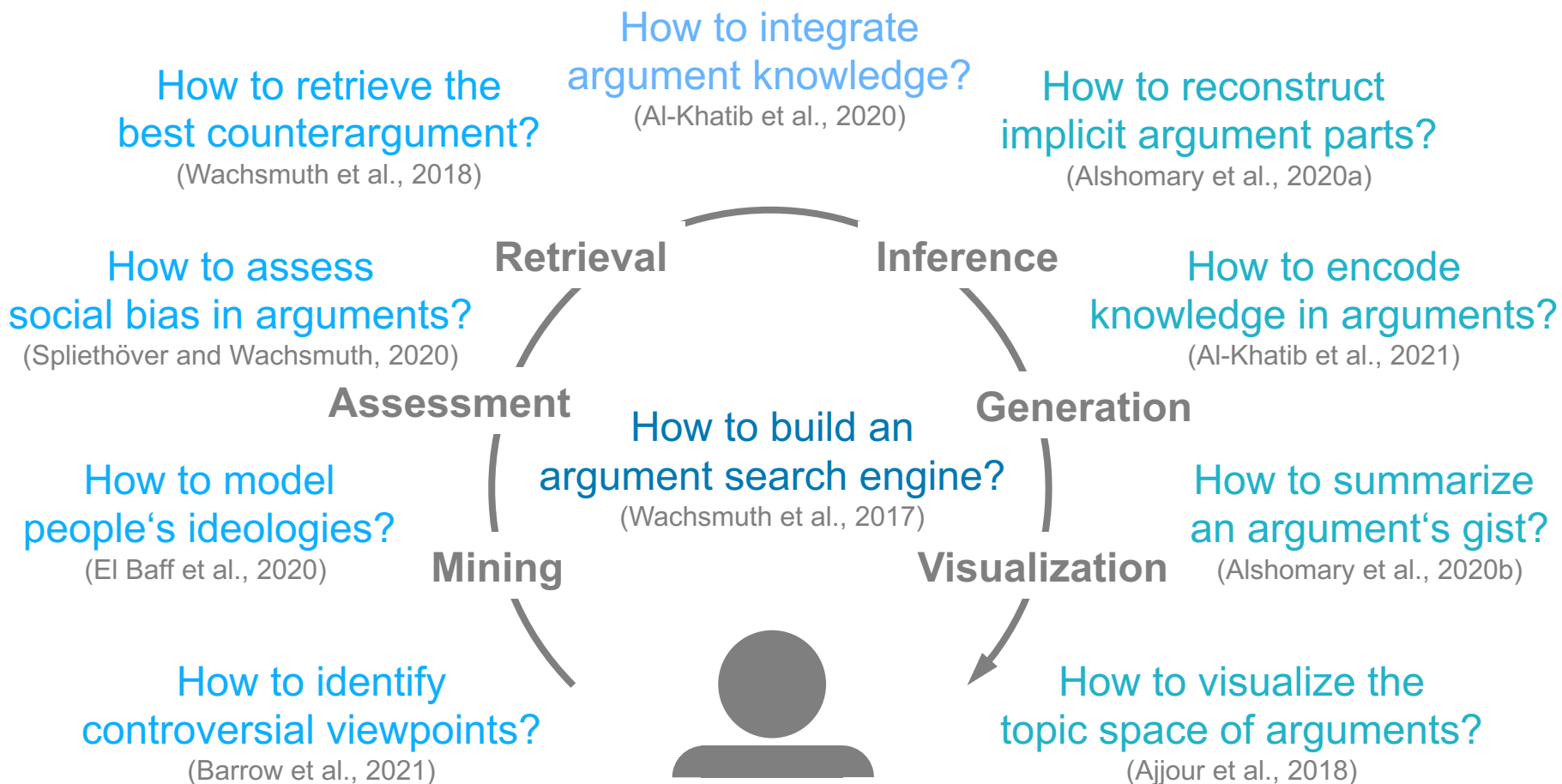
- **Natural language processing (NLP)** (Tsuji, 2011)
 - Algorithms for understanding and generating speech and human-readable text
 - From natural language to structured information, and vice versa
- **Computational linguistics** (see <http://www.aclweb.org>)
 - Intersection of computer science and linguistics
 - **Technologies** for natural language processing
 - **Models** to explain linguistic phenomena, based on knowledge and statistics
- **Main NLP tasks in computational argumentation**
 - **Mining** arguments and their relations from text
 - **Assessing** various properties of arguments
 - **Generating** arguments and argumentative texts

Often, not all tasks need to be tackled in applications

Analysis
Synthesis



(Our) Research on computational argumentation



Next section: Tasks in Computational Argumentation

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Overview of NLP tasks in computational argumentation

▪ **Argument(ation) mining**

1. Segmenting a text into argumentative units
2. Classifying the types of units
3. Identifying relations between units or arguments

... along with variations of these

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

▪ **Argument(ation) assessment**

4. Classifying an argument's stance on an issue
5. Classifying an argument's scheme
6. Scoring or comparing argumentation quality

... along several other assessed properties

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



▪ **Argument(ation) generation**

7. Summarizing argumentative texts
8. Synthesizing argumentative units for an issue
9. Synthesizing arguments and longer texts

... along with related non-argumentative language

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

Task 1: Segmenting a text into argumentative units

▪ Unit segmentation

- **Argumentative units.** Text segments with an argumentative function
Usually, the premises and conclusions of arguments
- **Task.** Given a text, split it into argumentative units and other parts

non-argumentative

argumentative

*” If you wanna hear my view, I think that **the EU should allow rescue boats in the Mediterranean Sea.** **Many innocent refugees will die if there are no rescue boats.** **Nothing justifies to endanger the life of innocent people.**”*

▪ How does it work?

- Usually, tokens are classified in context using supervised sequence labeling
- Rather reliable within different narrow genres (F_1 0.72–0.82) (Ajjour et al., 2017)
- Unsolved across genres

Task 2: Classifying the types of units

▪ Unit type classification

- **Unit types.** Roles in an argument, or claim and evidence types
Examples: (1) Roles: Thesis, conclusion, premise; (2) evidence types: Statistics, testimony, anecdote
- **Task.** Given an argumentative unit, assign one type from a set of types

Conclusion

” If you wanna hear my view, I think that **the EU should allow rescue boats in the Mediterranean Sea.** **Many innocent refugees will die if there are no rescue boats.** **Nothing justifies to endanger the life of innocent people.**”

Premise

Premise

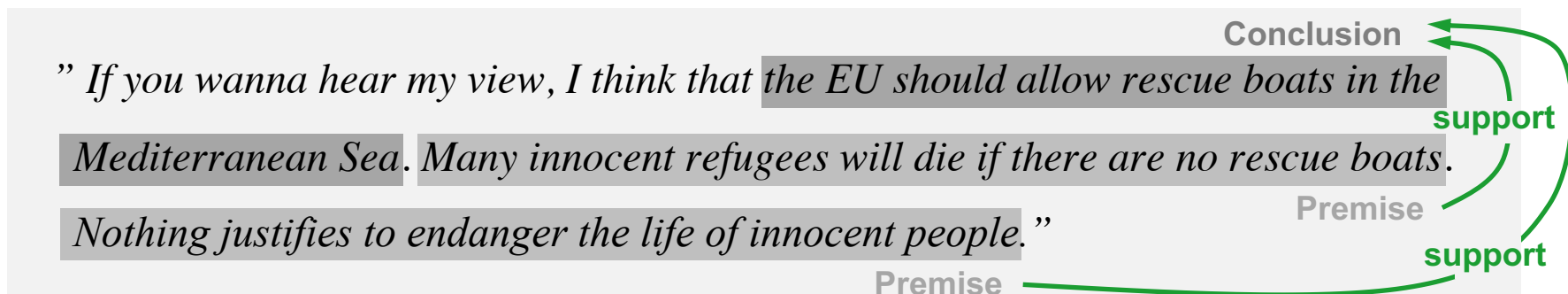
▪ How does it work?

- Usually approached with supervised text classification
- Reliable on ”explicit” argumentation, such as in essays (F_1 0.87) (Stab, 2017)
- Rather reliable on genres such as news editorials (F_1 0.77) (Al-Khatib et al., 2017)
- Minority classes may be problematic, though

Task 3: Identifying relations between units or arguments

▪ Relation identification

- **Argumentative relations.** Premise to conclusion, or argument to argument
Usually, support or attack, partly more fine-grained subtypes
- **Task.** Given two units/arguments, what relation holds between them, if any



▪ How does it work?

- Diverse techniques from standard classification to graph-based optimization
- Semi-reliable for explicit argumentation (F_1 0.73) (Stab, 2017)
- Unsolved for "hidden" argumentation, even hard for humans (Al-Khatib et al., 2017)

Task 4: Classifying an argument's stance on an issue

■ Stance classification

- **Stance.** Someone's position towards a target, such as an issue or claim
Stance is pro or con, sometimes also none or neutral
- **Task.** Given a unit/argument, classify the stance it conveys on a given target
Conceptual overlap with relation classification

Pro towards rescue boats

Conclusion

” If you wanna hear my view, I think that *the EU should allow rescue boats in the Mediterranean Sea.* *Many innocent refugees will die if there are no rescue boats.* *Nothing justifies to endanger the life of innocent people.*”

Premise

Premise

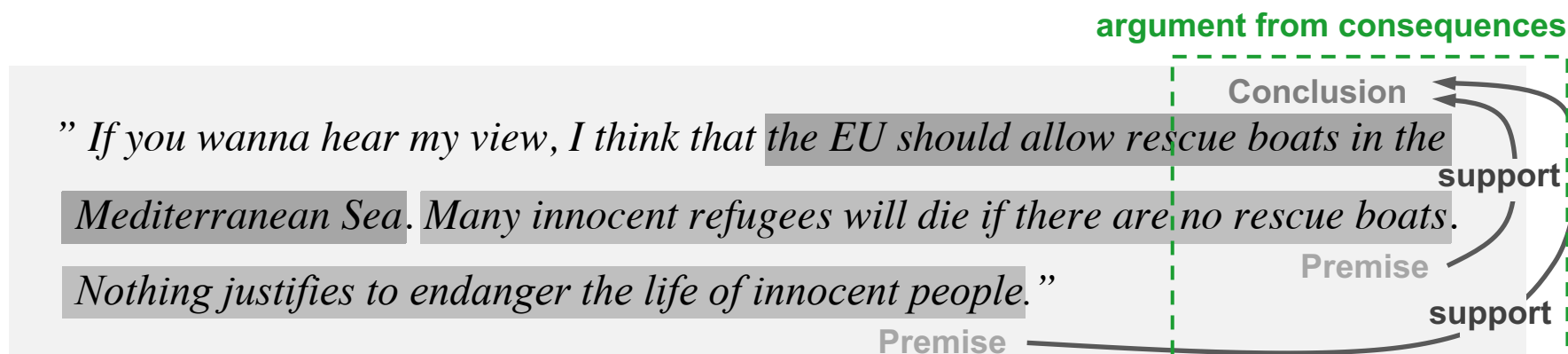
■ How does it work?

- Usually supervised classification, partly exploiting dialogue structure, knowledge bases for target matching, ...
- Issue-specific approaches with $F_1 \sim 0.70\text{--}0.75$ (Hasan and Ng, 2013)
- Open-topic worse (0.65), but works for confident cases (0.84) (Bar-Haim et al., 2017)

Task 5: Classifying an argument's scheme

▪ Scheme classification

- **Argumentation scheme.** Form of inference from premises to conclusion
Several schemes exist, such as argument from cause to effect, expert opinion, analogy, ... (Walton et al., 2008)
- **Task.** Given conclusion and premises, assign a scheme from a scheme set



▪ How does scheme classification work?

- Usually supervised one-against-others classification
So far, only done for a small set of very frequent schemes
- Some schemes easy, e.g., *argument from example* (accuracy 90.6)
- Others hard, e.g., *argument from consequences* (62.9)
(Feng and Hirst, 2011)

Task 6: Scoring or comparing argumentation quality

Argument quality assessment

- **Argument quality.** Logical, rhetorical, or dialectical strength of an argument
- **Scoring task.** Given a unit/argument, rate it on a given scale
- **Comparison task.** Given two units/arguments, decide which one is better

Various quality dimensions considered

cogent?

effective?

reasonable?

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

Premise

acceptability: 4 / 5

acceptable?

clear?

relevant?

Premise

more acceptable than

"It's the main job of the EU to save people's lives, no matter whether they belong here."

How does it work?

- Several techniques, from supervised learning to graph-based analyses
- Very diverse results, general feasibility open
- Inherent subjectiveness is a main problem

Task 7: Summarizing argumentative texts

- **Text summarization in general**

- **Extractive vs. abstractive.** Filtering important text segments or reformulating a text in new words or paraphrases
- **Single vs. multi.** Summary for one or for multiple input texts

- **Argumentation summarization**

- **Task.** Given one or more argumentative texts, create a text summarizing them

”If you wanna hear my view, I think that the EU should allow rescue boats in the Mediterranean Sea. Many innocent refugees will die if there are no rescue boats. Nothing justifies to endanger the life of innocent people.“



”Without rescue boats, many innocent refugees will die.“

- **How does that work?**

- Extractive approaches rather *analyze*, e.g., to rank units (Alshomary et al., 2020b)
- Abstractive approaches often learn to rewrite texts (Wang and Ling, 2016)

Task 8: Generating argumentative units for an issue

- **Text generation in general**

- **Data-to-text.** Phrase a new text with data from a knowledge base
- **Text-to-text.** Rewrite a given text into another text

- **Unit generation**

- **Task.** Given an issue, generate an argumentative unit discussing it
The unit could convey a stance, frame an aspect, provide evidence, or similar

rescue boats →

”Having rescue boats makes even more people die trying.”

- **How does that work?**

- Approaches vary notably, due to differences in generation tasks
- **Example data-to-text.** Recycle topics and predicates in new claims, using parsing and classification (precision 0.7–0.8) (Bilu and Slonim, 2016)
- **Example text-to-text.** Reconstruct conclusion from argument’s premises, using neural sequence-to-sequence models (accuracy 0.42) (Gurcke et al., 2021)

Task 9: Synthesizing argumentative texts

▪ Argument synthesis

- **Synthesis.** The complement to analysis; covers generation, composition, etc.
- **Task.** Given a stance on an issue and a pool of argumentative and other units, phrase a text with arguments supporting the stance

Units may also be retrieved or generated on-the-fly. Other variations of the task also exist.

**Pro towards
rescue boats**



” If you wanna hear my view, I think that the EU should allow rescue boats in the Mediterranean Sea. Many innocent refugees will die if there are no rescue boats. While having such boats may make even more people die trying, nothing justifies to endanger the life of innocent people. Got it? “

▪ How does that work?

- Compose premises and conclusions in learned ways (El Baff et al., 2019)
- More advanced approaches retrieve and rephrase units (Hua et al., 2019)
- Conditioned neural models may generate new texts (Alshomary et al., 2021)

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a) Introduction

b) Argumentation

c) Computational argumentation

d) Tasks in computational argumentation

e) Conclusion

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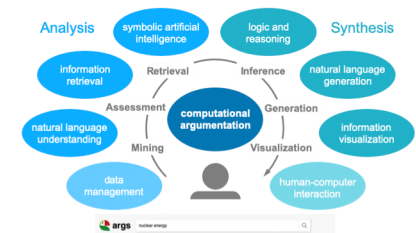
■ Argumentation

- Of ever increasing importance in the "post-factual age"
- Arguments along with rhetorical and dialectical aspects
- Used to persuade or agree with others on controversies



■ Computational argumentation

- Computational analysis and synthesis of arguments
- Important applications, such as argument search
- So far (and here), natural language processing in the focus



■ Main tasks in computational argumentation

- Mining of argumentative units, roles, and relations
- Assessment of stance, reasoning, quality, ...
- Generation of units, arguments, and argumentation

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



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