Diffusion of Scientific Argumentation

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August 2021 : **210,183** publications and pre-publications on Covid-19.
$\longrightarrow$ political importance of science and argumentative nature.

Goal : Use Abstract Argumentation
to model :

- the construction of scientific
  discourse

- the diffusion of scientific
  information

Ioannidis, J. P., Salholz-Hillel, M., Boyack, K. W., Baas, J. *The rapid, massive growth of COVID-19 authors in the scientific literature.* Royal Society open science, 2021.

Outline

Context and Motivations

Opinion Diffusion

- Opinion diffusion = modelling how people change their minds
- Deffuant model, where opinions are between 0 and 1

$\longrightarrow$ No precision on the **exact** process to change opinion :
argumentation ?
$\longrightarrow$ No notion of truth in most classical models.

Deffuant,G., Huet, S., Amblard, F.. *An individual-based model of innovation diffusion mixing social value and individual benefit*. American Journal of Sociology, 2005.

Social Epistemology

- **Social Epistemology** is concerned with how to model communities of agents who are looking for the "truth", or knowledge defined as justified beliefs.
- Truth = successful representation of the environment or successful strategies

$\longrightarrow$ Truth is of great importance in democracy : to make informed decisions

$\longrightarrow$ Model of scientific communities : a good example of an epistemic community.

Goldman, A.I. *Knowledge in a Social World*. 1999.

Example : Using Zollman Networks

- What about non-scientific agents ? (e.g. policy makers)
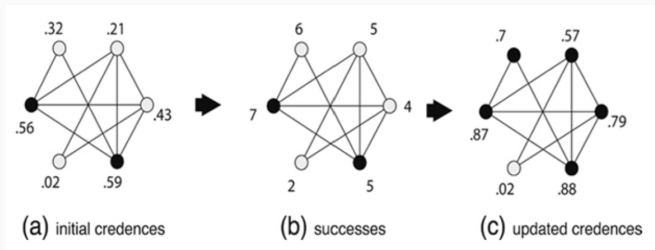- What happens if other interests try to disrupt or bias the production of science ?

**Figure 1:** Example of Bayesian updating in a Zollman network

$\longrightarrow$ We would like to study similar dynamics.

O'Connor, C., Weatherall, J. *The Misinformation Age.* .

Abstract Argumentation Theory

Arguments are abstract: no content is analyzed

A : Earth is at the center of the universe.

B : Galileo's observations contradict the geocentric model.

C : Ptolemy's geocentric model allows us to predict the positions of the stars with accuracy.

D : Copernicus' heliocentric model is simpler and more precise.

→ Attack relation
⇢ Support relation
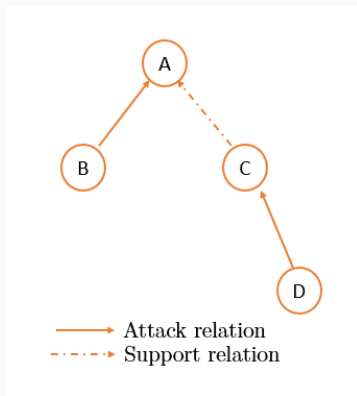
Dung, P. M.. *On the acceptability of arguments and its fundamental role in non-monotonic reasoning, logic programming and n-person games.* Artificial intelligence 1995.

Research Question

Can we use Abstract Argumentation to model the construction
of scientific discourse and the diffusion of scientific information
?

- Model scientists
- Model laypeople and medias

The Model

A Gradual Semantic for Bipolar Graphs
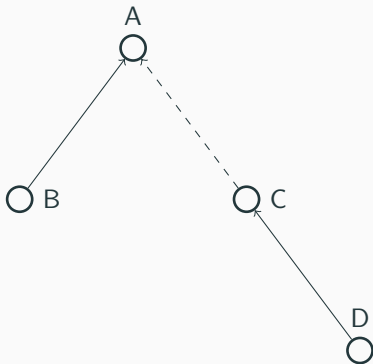
The Euler based semantic

Let x be an argument of a bipolar AAF, and Att the set of the direct attackers of x, $Supp$ the set of its direct supporters.

Then the degree of acceptability of x is :

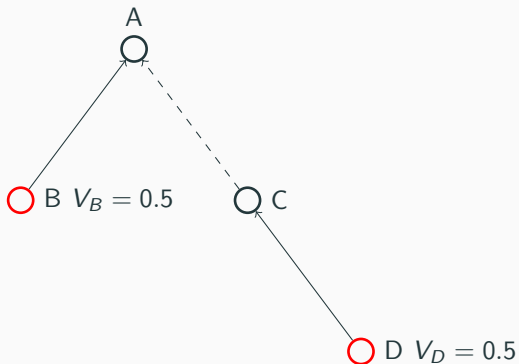$$V_x = 1 - \frac{1 - 0.5^2}{1 + 0.5 e^{\sum_{s \in Supp} V_s - \sum_{a \in Att} V_a}}$$

Amgoud, L. and Ben-Naim, J. *Weighted bipolar argumentation graphs: Axioms and semantics.* IJCAI 2018.

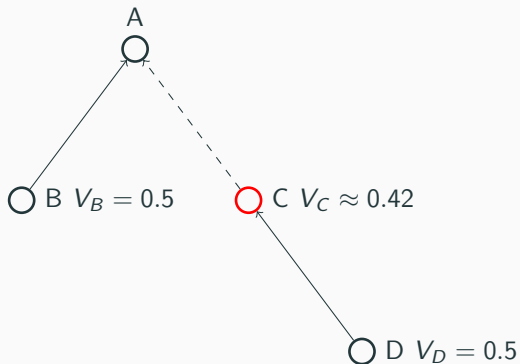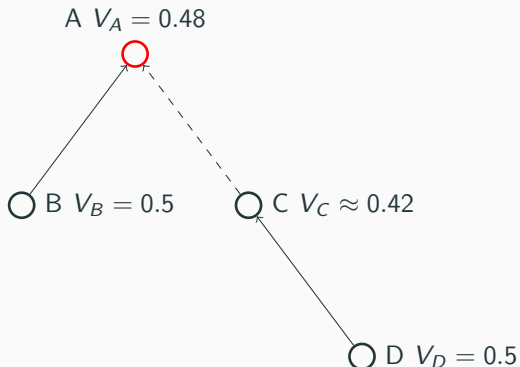Amgoud, L. and Ben-Naim, J. *Weighted bipolar argumentation graphs: Axioms and semantics.* IJCAI 2018.

Amgoud, L. and Ben-Naim, J. *Weighted bipolar argumentation graphs: Axioms and semantics.* IJCAI 2018.

Example : Euler based semantic

A

B $V_B = 0.5$ C $V_C \approx 0.42$

D $V_D = 0.5$

Amgoud, L. and Ben-Naim, J. *Weighted bipolar argumentation graphs: Axioms and semantics.* IJCAI 2018.

A $V_A = 0.48$

B $V_B = 0.5$ C $V_C \approx 0.42$

D $V_D = 0.5$

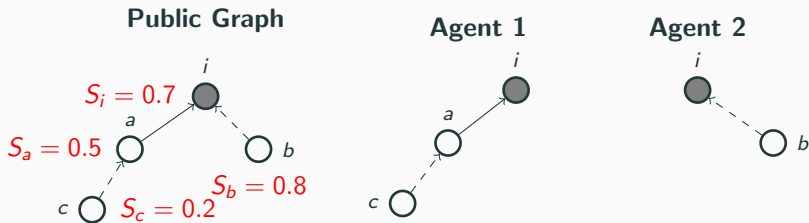Amgoud, L. and Ben-Naim, J. *Weighted bipolar argumentation graphs: Axioms and semantics.* IJCAI 2018.

Issue Oriented Argumentation Graph (IOAG)

Each argument is part of a path towards the **issue** of the graph. The issue is the main question of the debate.

The **value** of the graph is the value of the issue.

Public Graph	Agent 1	Agent 2
i	i	i
$S_i = 0.7$ ⬤	⬤	⬤

Issue Oriented Argumentation Graph (IOAG)

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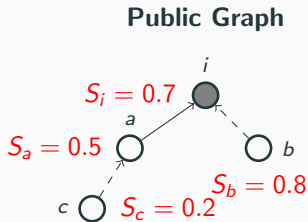
The **value** of the graph is the value of the issue.

Public Graph

$S_i = 0.7$
$S_a = 0.5$
$S_c = 0.2$
$S_b = 0.8$

Agent 1

Agent 2

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Public Graph

$S_i = 0.7$
$S_a = 0.5$
a
$S_c = 0.2$
$S_b = 0.8$

Agent 1

i
a
c

Agent 2
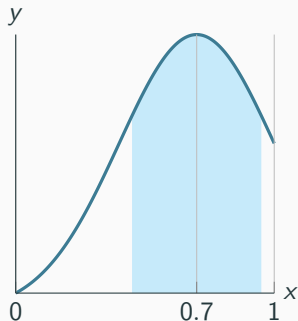
i
b

$V_P \approx 0.48$

$V_1 \approx 0.41$

$V_2 \approx 0.59$

1. **Choice** of one argument.
2. **Experiment** $\longrightarrow$ attack or support + strength of the argument.
3. **Publish** the argument.
4. Other agents can **endorse** it with a fixed probability p_{accept}.
   $\longrightarrow$ Opinions change dynamically.

- Sample result : strength of the argument.
- If within the defined interval : **support** else **attack**.
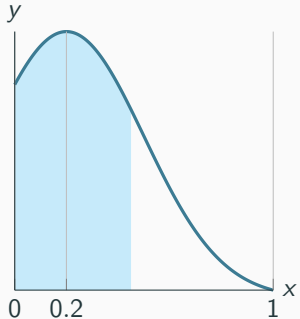
Strong arguments :
$\longrightarrow$ Weaker attacks, stronger supports

- Sample result : strength of the argument.
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Strong arguments :
$\longrightarrow$ Weaker attacks, stronger supports

Weak arguments :
$\longrightarrow$ Stronger attacks, weaker supports

Metrics of Interest

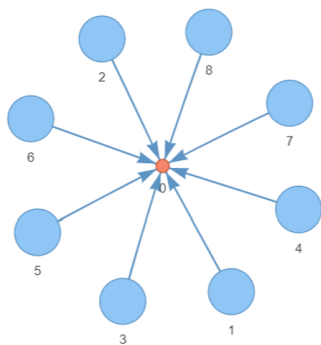- **Collective Epistemic Success**
  - Collective Error : Distance between the outcome of the *PG* and the strength of the issue.
  - Average of Errors : Average of the distance between the opinion of agents and the strength of the issue.
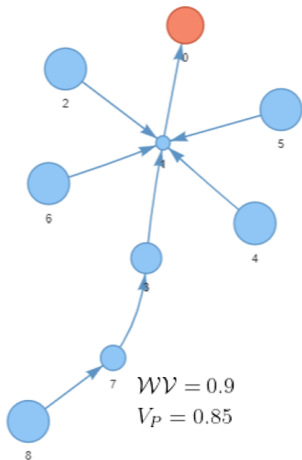
- **Opinion Diversity**
  - Standard deviation of the agent's opinions.

Some preliminary results

$\mathcal{WV} = 0.1$
$V_P \approx 0.111$

$\mathcal{WV} = 0.9$
$V_P = 0.85$

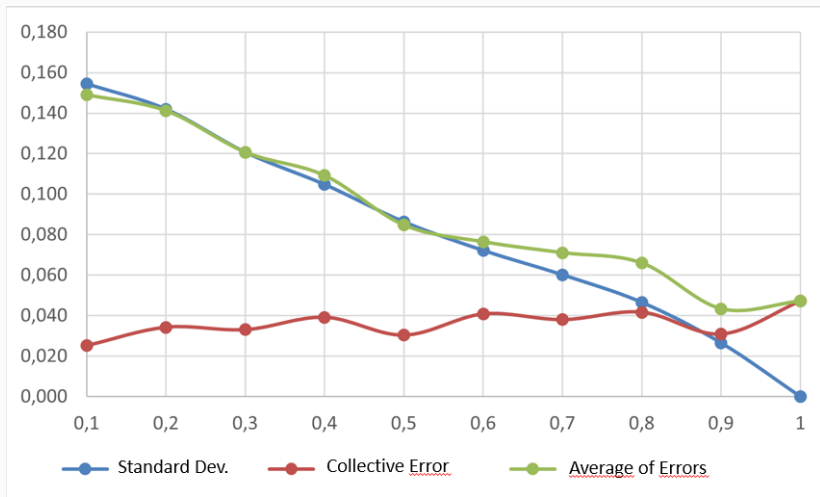**Figure 2:** Example of trees generated by the protocol

Figure 3: Results of the simulations

Conclusion

Conclusion and Future Works

- Theoretical model
- Improvement on a previous model

Future Works

- Implement the model
- Define new classes of agents : laypeople, medias, biased scientists.