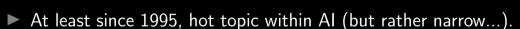
Dealing with Uncertain Arguments in Artificial Intelligence

Fabio G. Cozman Universidade de São Paulo - Brazil

Argumentation and Artificial Intelligence

► Argumentation is a key element of intelligence.

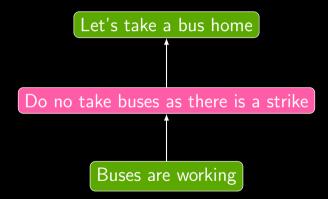
- Related to decision making, persuasion, negotiation...
- Deductive argumentation is just one possibility.



- ▶ Focusing on abstract arguments and their representation.
- Mining them from documents.



An abstract argumentation framework, Dung-style

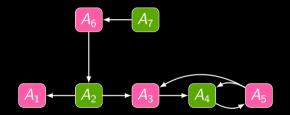


A bit of abstract argumentation, Dung 1995

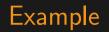
- Arguments and attacks (arguments can be propositional formulas, logic programs).
- Since then: supports, preferences, probabilities, etc.



Playing defense



Admissible: conflict-free, accepted arguments defend themselves.
Complete: conflict-free, set of accepted arguments cannot be enlarged by "defend" relation.
Grounded: complete with minimum number of accepted arguments.
Stable: complete with no undecided arguments.







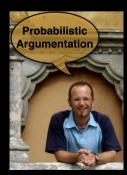
Probabilistic argumentation, Haenni et al 2003...

Probabilistic assumptions and arguments:

$$\mathbb{P}(\mathsf{fever}) = 0.2, \quad \mathbb{P}(\mathsf{rain}) = 0.4.$$

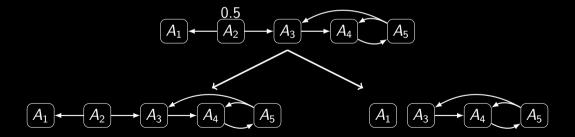
 $\boxed{\neg\mathsf{fever} \land \neg\mathsf{rain}} \to \mathsf{party}.$

Degree of support as the probability that at least one argument implies proposition (interpretation: Dempster-Shafter theory).



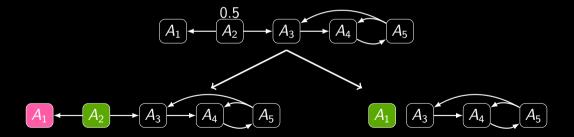
Probabilistic argumentation, Li et al 2011

Here an argument (and perhaps an attack) has a probability that it is in the argumentation graph.

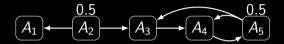


Probabilistic argumentation, Li et al 2011

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Constellation approach

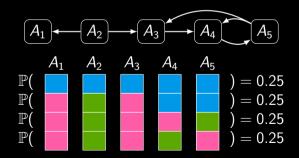


Without independence assumptions, a credal set over arguments (Fazzinga, Flesca, Furfaro 2022).

 Intuition: someone looking at an agent is evaluating her arguments.

Epistemic approach, Thimm 2012

- A probability measure is specified over the set of labelings.
- Example with 5 arguments (5³ possible labelings).



Epistemic approach: credal sets

Attacks impose restrictions on probabilities.

For instance, if B attacks A, we might require

 $\mathbb{P}(A) \leq 1 - \mathbb{P}(B)$. [Property of "coherence" (!)]

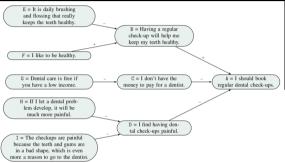
- For a graph with attacks, the set of probability measures that satisfies "coherence" is closed convex.
 - Proposal by Thimm (2012): use maximum entropy solution.

- An argumentation graph is given, together with constraints.
 - For instance: A is accepted iff $\mathbb{P}(A) > 0.5$.
 - ▶ For instance: if *B* attacks *A*, then $\mathbb{P}(B) > 1/2$ implies $\mathbb{P}(A) \leq 1/2$.

▶ We may build the credal set that satisfies constraints.

Epistemic graphs: Hunter, Polberg, Thimm 2020

Argumentation graph and a collection of constraints.



1. This constraint states that if B is believed or C is disbelieved or D is disbelieved, then A is believed and vice versa:

 $(p(B) > 0.5 \lor p(C) < 0.5 \lor p(D) < 0.5) \leftrightarrow p(A) > 0.5$

2. This constraint states that if B is at least moderately believed then A is strongly believed, and if B is at least strongly believed then A is completely believed:

$$(p(B) > 0.65 \rightarrow p(A) > 0.8) \land (p(B) > 0.8 \rightarrow p(A) = 1)$$

3. This constraint states that if D is strongly disbelieved then A is at least moderately believed

$$p(D) < 0.2 \rightarrow p(A) > 0.65$$

4. This constraint states that if F is believed then B is at least moderately believed and if F is disbelieved, then so is B

 $(p(F) > 0.5 \rightarrow p(B) > 0.65) \land (p(F) < 0.5 \rightarrow p(B) < 0.5)$

5. This constraint states that disbelief in C is proportional to belief in G

$$p(G) + p(C) \le 1$$

What are these probabilities?

- Probability/Belief that argument is "true"?
- Probability/Belief that argument is "accepted"?

Probabilistic argumentation, Dung and Thang 2010

Set of independent propositions associated with probabilities, and set of rules.

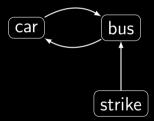
$$\mathbb{P}(A_1)=0.8, \quad \mathbb{P}(A_2)=0.75.$$

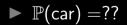
 $A_1, ext{drivingFast} o ext{negligentDriver}$

A prescription to determine attacks amongst arguments.

Argumentation and the credal semantics

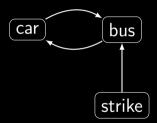
- ► car :- not bus.
- ▶ bus :- **not** car, **not** strike.
- $\mathbb{P}(\text{strike}) = 0.5.$





Argumentation and the credal semantics

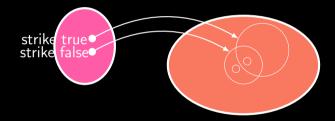
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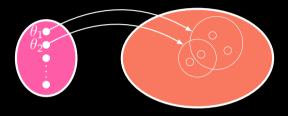
strike	bus	car
true	false	true
false	?	?

$$\underline{\mathbb{P}}(\mathsf{car}) = 0.5, \ \overline{\mathbb{P}}(\mathsf{car}) = 1.0.$$

Understanding the credal semantics



The credal semantics



- ▶ We have a random set.
- Lower probabilities: infinitely monotone Choquet capacity.
- (Inference: IJAR2020; Consistency: KR2022.)

The Blue Amazon

Key region, not well-known.



Short detour: The BLue Amazon Brain (BLAB)



Reporter, Chat, Wiki

BLAB Portugués -		News	•
coast, known as Blue Amazon. Read morel	C SABA MAIS	C SAIBA MAIS	C SAIBA MAIS
and the second		Tabler Oct AD Tabler (c. 22 fallowers)	
3-3	BLAB VO I	Tweets per 051.40 Preparier	E BLAB WHE Q &
ChatBot	000	🔥 Robó Jornalista da Amazônia Asul	Introdução
Um agente especializado na Amazônia Azul	8.48.40	1 OBLAD_Reported	Página Discussão
om agente especializado na Amazonia Azul	Vicé já sabe o que é a Amazônia Azul?	Foi estimada uma quantidade de 17 embarcações no porto de Suape (PE) hoje, dia 18	
	tan Não	de atrit de 2022. Além disso, é esperado que 18 embarcações entrem no porto ao longo dos	
	a street	próximos dias. 🚵	A Amazônia Azul proporciona produtos e serviços
	Tana and the second sec	Fonte: MarineTraffic#AmazonaAzur	essenciais à sobrevivência do homern, representando um
Robô Jornalista	Vicé ja sabe o que é a Amazônia Ana?	Wedebotsdobern 25	património de valor inestimável para a herança do Brasil, além de abrigar uma ampla variedade de seres vivos
Um robô que gera noticias sobre a	Não com	And A Manufacture of the Annual Statement of the	dependentes dela. De acordo com a Primeira Avaliação
Amazônia Azul	8.49.0		Marinha Integrada Global (NAÇÕES UNIDAS, 2016), as
Service And	THE REPORT		áreas costeiras e marivihas bem conservadas contam com diversidade biológica muito maior do que as áreas
	You te explicar então, a su na		convertidas, e seus ecossistemas prestara serviços muito
		A REAL PROPERTY OF A	mais diversos e efetivos (NAÇÕES UNIDAS, 2016).
	8.18-0 Esse é o norme dado à resião do mar		Entretanto, ações que realizamos tanto no continente
Wiki 🔣	que pertence ao Brasil, desde as praias até o oceano. O nome é uma	and the second se	como no oceano têm colocado em risco a integridade da
Uma wiki especializada em temas da	referência à Arnazônia devido à	C) (+ 18 de ate. de 2022	Arrazónia Azul e comprometido o funcionamento de
Amazônia Azul	similaridade em riqueza de recursos vivos, minerais, energéticos e de	Robó Jornalista da Amazónia Azul	seus processos. Diversos ecossistemas presentes nos 10.800 km de nosso litoral Nen sua sobrevivência
in the second second	biodiversidade encontrados nas	COLAD_Reporter	ameaçada em razão da ocupação desordenada, da
	dues regiões. Alto rec	Hoje, dia 18 de abril de 2022, existem 116 embarcações no porto do Rio de Janeiro (RJ)	poluição, do desmatamento, entre outros problemas.
		nesse momento e 34 embarcações apendadas para entrar dentro dos próximos dias. Jai	Diante clisso, faz-se necessário oferecer atenção especial
	Type a message	Desejamos um ótimo día pra todost	às zonas costeiras. Tais áreas representam uma interface
	> >	Ponte: MarineTesTickAmarbriaAnd	entre o continente e o oceano, e os efeitos decorrentes
		wedebotsdobern #,	da ocupação dessas afetam tanto a própria zona costeira
and the second			

Argumentation about ocean and climate

State of affairs:

major iceberg melting in Northern Atlantic , nc	ot increased evaporation in Northern Atlantic	\rightarrow	decrease in water density in Northern Atlantic	
likely:	decrease in water density in Northern Atlantic	\rightarrow	collapse of the Atlantic Meridional Overturning Circulation	•

Modeling through probabilistic facts:

 $\begin{array}{c} \begin{array}{c} \mbox{major iceberg melting}\\ \mbox{in Northern Atlantic} \end{array}, \mbox{not} & \mbox{in Crease in Water density}\\ \mbox{ruleOn}, \end{array} & \begin{array}{c} \mbox{in Northern Atlantic}\\ \mbox{decrease in Water density}\\ \mbox{in Northern Atlantic} \end{array} & \rightarrow \end{array} & \begin{array}{c} \mbox{decrease in Water density}\\ \mbox{in Northern Atlantic}\\ \mbox{Meridional Overturning Circulation}\\ \mbox{(that is, probability = 0.9)} \end{array}$

The Atlantic Meridional Overturning Circulation

- About 18×10^3 tons of water/second.
- It regulates climate.
- ▶ It has weakened.
- It is "very likely" to decline over the next decades.¹
- Its collapse is "*likely*" to reduce precipitation in tropical areas.



¹As discussed by: Intergovernmental Panel on Climate Change, Report 2021 (Chapter 9).

Argumentation mining, etc

- ► Dealing with given arguments is a part of the whole story.
- One must extract arguments/attacks/probabilities from sources.
- ► And there are specific tasks such as argument classification.

- Example: dataset IBMD; BERT-based classifier: 95.7% accuracy.
- ► Looks good! But graph extraction is still a *huge* challenge.

DISPUtool, Villata et al 2019



Home Explore Test Model Legal Notice Contact

DISPUTool A tool for Mining and Exploring arguments in US Presidential Election Debates From 1960 to 2016

Conclusion

- Al research has been interested in flexible representations for uncertainty:
 - Probabilistic logic (many variants).
 - Credal networks, causal reasoning.
- Probabilistic argumentation often relies on credal sets and the like.
 - Abstract argumentation frameworks (constellation/epistemic).
 - Probabilistic assumption-based argumentation.
 - ► A proposal: arguments based on rules and probabilistic facts.