



ABSTRACT ARGUMENTATION

Introduction to Formal Argumentation I

* slides adapted from Stefan Woltran's lecture on Abstract Argumentation

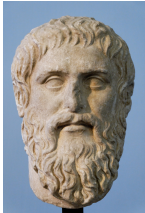
Sarah Gaggl

ICCL Summer School 2016

Outline

- 1 Argumentation in History
- 2 Argumentation Nowadays
- 3 Introduction
- 4 Abstract Argumentation

Argumentation in History

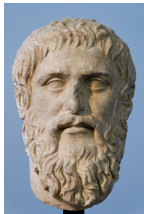


Plato's Dialectic

The dialectical method is discourse between two or more people holding different points of view about a subject, who wish to establish the truth of the matter guided by reasoned arguments.

The Republic (Plato), 348b

Argumentation in History



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Leibniz' Dream

“The only way to rectify our reasonings is to make them as tangible as those of the Mathematicians, so that we can find our error at a glance, and when there are **disputes among persons**, we can simply say: Let us calculate [**calculemus**], without further ado, to see who is right.”

Leibniz, Gottfried Wilhelm, The Art of Discovery 1685, Wiener 51



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Argumentation Nowadays

Abstract Argumentation [Dung, 1995]

- In **abstract argumentation frameworks (AFs)** statements (called **arguments**) are formulated together with a relation (**attack**) between them.
- **Abstraction** from the **internal structure** of the arguments.
- The **conflicts** between the arguments are **resolved** on the **semantical level**.



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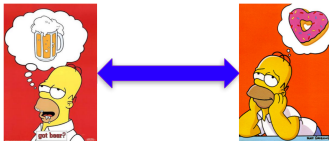
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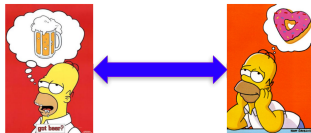
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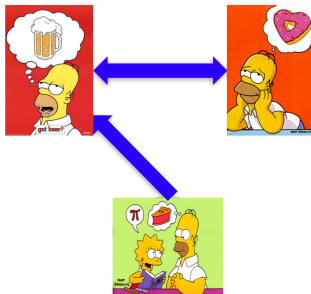
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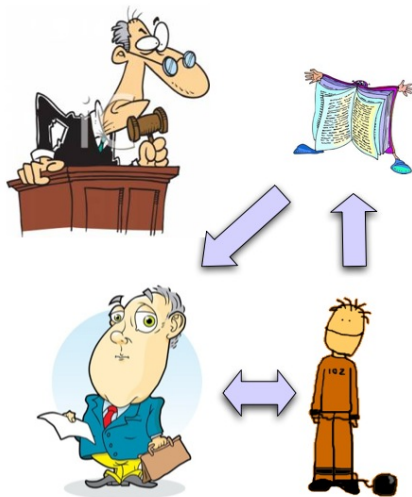
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Legal Reasoning



Decision Support



Social Networks



Roadmap for the Lecture

- Wednesday
 - Introduction
 - Abstract Argumentation Frameworks
 - Semantics
- Thursday
 - Computational Complexity
 - Intertranslatability
 - Notions of Equivalence
- Friday
 - Argumentation and Answer-Set Programming (ASP)
 - Abstract Dialectical Frameworks (ADFs)

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Introduction

Argumentation:

... the study of processes “concerned with how assertions are **proposed**, **discussed**, and **resolved** in the context of issues upon which several **diverging opinions** may be held”.

[Bench-Capon and Dunne, Argumentation in AI, AIJ 171:619-641, 2007]

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Formal Models of Argumentation are concerned with

- representation of an argument
- representation of the relationship between arguments
- solving conflicts between the arguments (“acceptability”)

Introduction (ctd.)

Increasingly important area

- “Argumentation” as keyword at all major AI conferences
- dedicated conference: **COMMA**, **TAF**A workshop; and several more workshops
- specialized journal: **Argument and Computation** (Taylor & Francis)
- two text books:
 - Besnard, Hunter: *Elements of Argumentation*. MIT Press, 2008
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Handbook of Formal Argumentation HOFA

- <http://formalargumentation.org>
- Volume 1 to appear in 2017

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 - Syntax
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The Overall Process

Steps

- Starting point: knowledge-base
- Form arguments
- Identify conflicts
- Abstract from internal structure
- Resolve conflicts
- Draw conclusions

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Example

$$\Delta = \{s, r, w, s \rightarrow \neg r, r \rightarrow \neg w, w \rightarrow \neg s\}$$

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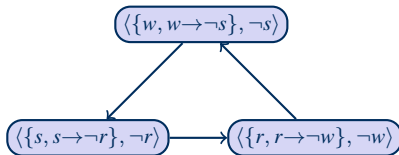
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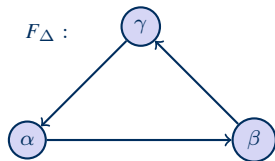
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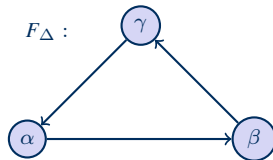
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$$\Delta = \{s, r, w, s \rightarrow \neg r, r \rightarrow \neg w, w \rightarrow \neg s\}$$



$$\begin{aligned} \text{pref}(F_{\Delta}) &= \{\emptyset\} \\ \text{stage}(F_{\Delta}) &= \{\{\alpha\}, \{\beta\}, \{\gamma\}\} \end{aligned}$$

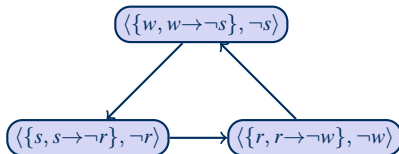
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Example

$$\Delta = \{s, r, w, s \rightarrow \neg r, r \rightarrow \neg w, w \rightarrow \neg s\}$$



$$Cn_{pref}(F_{\Delta}) = Cn(\top)$$

$$Cn_{stage}(F_{\Delta}) = Cn(\neg r \vee \neg w \vee \neg s)$$

The Overall Process (ctd.)

Some Remarks

- Main idea dates back to Dung [1995]; has then been refined by several authors (Prakken, Gordon, Caminada, etc.)
- Separation between logical (forming arguments) and nonmonotonic reasoning (“**abstract argumentation frameworks**”)
- Abstraction allows to compare several KR formalisms on a conceptual level (“calculus of conflict”)

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Main Challenge

- **All Steps** in the argumentation process are, in general, **intractable**.
- This calls for:
 - careful complexity analysis (identification of tractable fragments)
 - re-use of established tools for implementations (reduction method)

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Approaches to Form Arguments

Classical Arguments [Besnard & Hunter, 2001]

- Given is a KB (a set of propositions) Δ
- argument is a pair (Φ, α) , such that $\Phi \subseteq \Delta$ is consistent, $\Phi \models \alpha$ and for no $\Psi \subset \Phi$, $\Psi \models \alpha$
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Other Approaches

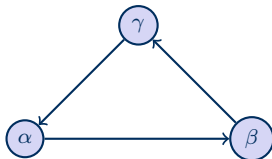
- Arguments are trees of statements
- claims are obtained via strict and defeasible rules
- different notions of conflict: rebuttal, undercut, etc.

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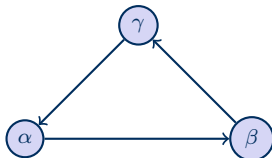
Dung's Abstract Argumentation Frameworks

Example



Dung's Abstract Argumentation Frameworks

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Main Properties

- Abstract from the concrete content of arguments but only consider the relation between them
- Semantics select subsets of arguments respecting certain criteria
- Simple, yet powerful, formalism
- Most active research area in the field of argumentation.
 - “plethora of semantics”

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Definition

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- A is a set of arguments
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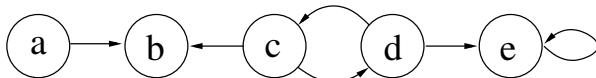
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Example

$F = (\{a, b, c, d, e\}, \{(a, b), (c, b), (c, d), (d, c), (d, e), (e, e)\})$



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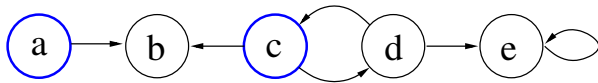
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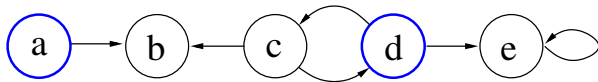
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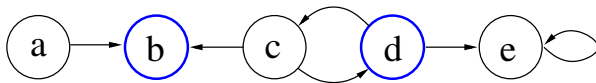
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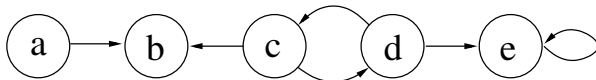
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Basic Properties (ctd.)

Admissible Sets [Dung, 1995]

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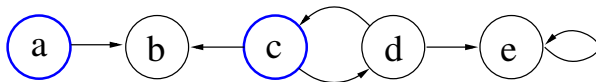
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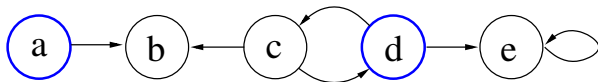
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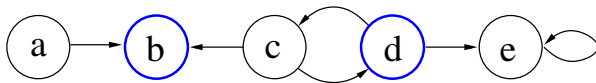
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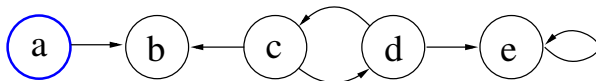
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Basic Properties (ctd.)

Dung's Fundamental Lemma

Let S be admissible in an AF F and a, a' arguments in F defended by S in F .
Then,

- 1 $S' = S \cup \{a\}$ is admissible in F
- 2 a' is defended by S' in F



P. Baroni and M. Giacomin.

Semantics of abstract argument systems.

In *Argumentation in Artificial Intelligence*, pages 25–44. Springer, 2009.



T.J.M. Bench-Capon and P.E.Dunne.

Argumentation in AI,

AIJ 171:619-641, 2007



P. M. Dung.

On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming and n-person games.

Artif. Intell., 77(2):321–358, 1995.