Assumption-based argumentation for closed and consistent defeasible reasoning

Francesca Toni

Department of Computing
Imperial College London

Outline

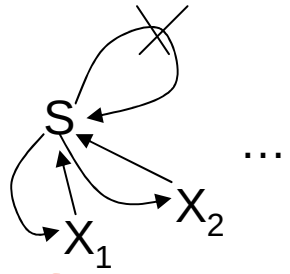
- Assumption-based argumentation
- Defeasible reasoning
- Properties: closedness and consistency
- Generalised assumption-based argumentation for properties
- Conclusions

Argumentation

- It allows the evaluation of "*possible conclusions*" by considering reasons for and against (the conclusions and their support)
- It is useful to resolve conflicts (within or across "agents")
- It helps understanding several problems:
  - in Philosophy, Logic, Law, Artificial Intelligence, Computer Science, etc
  - e.g. dispute resolution, decision-making, defeasible reasoning

Abstract argumentation (Dung AIJ95)

Given framework: *(arguments,attack)*



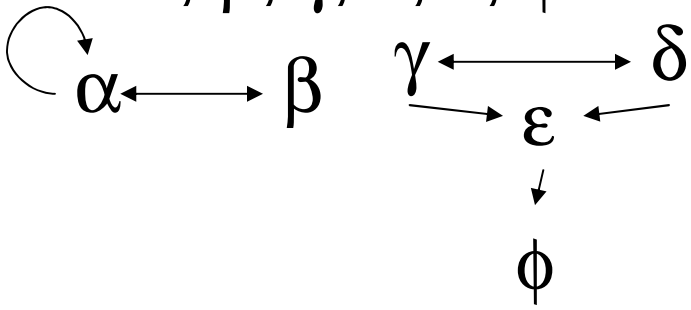
- A subset *S* of *arguments* is
  - *Admissible* iff *S* does not *attack S* and
    S attacks each X that *attacks* S
  - *Preferred* iff *S* is maximally admissible
  - *Grounded* iff *S* is minimal such that it contains every *a* such that *S* attacks every *X* that attacks *a*
  - *Ideal* iff *S* is admissible and contained in each preferred set
  - …

Abstract argumentation: different semantics

- Framework:
  - arguments: α; β; γ; δ
  - attack: 

  - {} grounded
  - {β, δ} and {β,γ} (admissible and) preferred
  - {β} sceptical (all) preferred and ideal

Abstract argumentation: different semantics

- Ideal semantics is more sceptical than the sceptical preferred semantics*:*
  - arguments: α; β; γ; δ; ε; ϕ
  - attacks: 

  - {β, δ, ϕ} and {β, γ, ϕ } preferred
  - {β, ϕ} sceptical preferred
  - {β} ideal

Pros and cons of abstract argumentation

- Many instances/applications: non-monotonic reasoning, games etc
- Intuitive semantics/computation: game/dispute, “last word wins”
- A lot of work to identify arguments and attacks
- Overlapping between arguments ignored

Assumption-based argumentation

In assumption-based argumentation frameworks:

- *arguments* defined in terms of:
  - a **deductive system** **(rules)**
    - e.g. laws/regulations, policy rules, argumentation schemas
  - a set of candidate **assumptions**
    - e.g. uncertain/unsupported beliefs, decisions, “names” of rules
- *attacks* defined in terms of:
  - a notion of **contrary** of assumptions
    - e.g. Negation, alternative decisions, exceptions to rules

Assumption-based argumentation formally

- An assumption-based argumentation framework is $(\mathcal{L},\mathcal{R},A,\bar{\ })$ where
  - $(\mathcal{L},\mathcal{R})$ is a deductive system
    - $\mathcal{L}$ set of sentences
    - $\mathcal{R}$ set of inference rules
  - $A \subseteq \mathcal{L}$ is a set of candidate assumptions
  - $\bar{a}$ is the contrary of assumption a

Assumption-based argumentation formally (cntd)

- *arguments* are *tight* deduction supported by sets of assumptions
- an argument α *attacks* another argument β if the conclusion of α is the contrary of one of the assumptions supporting β

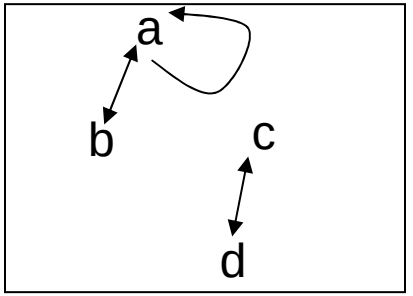
Example

$(\mathcal{L},\mathcal{R},A,\bar{\ })$:

- $\mathcal{L}$={a, b,c,d, ¬a, ¬b, ¬c, ¬d }
- $\mathcal{R}$={¬a ←a; ¬a ← b; ¬b ← a; ¬c ← d; ¬d ← c}
- A={a,b,c,d}
- $\bar{a}$= ¬a; $\bar{b}$= ¬b; $\bar{c}$= ¬c; $\bar{d}$= ¬d

{a} ├ ¬a attacks itself
{b} ├ ¬a attacks {a} ├ ¬b, etc

{a} attacks itself
{b} attacks {a}, etc



All arguments supported by subsets of {b,d} and {b,c} are preferred

{b,d} and {b,c} preferred

Assumption-based argumentation: computation

- (various kinds of) dispute derivations
- CaSAPI (Credulous and Sceptical Argumentation: Prolog Implementation)

http://www.doc.ic.ac.uk/~dg00/casapi.html

http://casapi.sourceforge.net/ (soon)

Defeasible reasoning

- Abstraction of many useful forms of reasoning, e.g. in law
- Defeasible framework is <S,D> with
  - S and D sets of rules, D not empty
  - S strict rules (beyond dispute)
  - D defeasible rules (can be disregarded)
  - (rules are of the form $B_1,\ldots,B_m \rightarrow B_0$)

Properties of defeasible reasoning via argumentation

- Given "acceptable" set of arguments Acc and conclusions it supports Conc
  - Acc is closed iff for every $B_1,\ldots,B_m \rightarrow B_0$ in S if $B_1,\ldots,B_m$ is in Conc then B_0 is in Conc
  - Acc is consistent iff for not L, both L and $\neg$L are in Conc
- Most argumentation approaches to defeasible reasoning do not satisfy these properties [Caminada&Amgoud05,07]

Generalised assumption-based argumentation

- Instead of contrary of assumptions, non-empty set of pairs (X,Y):
  - At least one assumption in X
  - X,Y non-empty (for simplicity)
  - X culprits to be withdrawn, X+Y incompatible
- In conventional frameworks
  - X is assumption
  - Y is contrary of assumption

Generalised assumption-based argumentation

- Generalised notion of attack: A attacks B iff there exists (X,Y) and x in X such that
  - x in B
  - (subsets of) B supports X-{x}
  - (subsets of) A supports Y

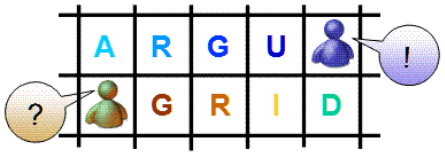
Defeasible reasoning in generalised assumption-based argumentation

- Given <S,D> obtain $(\mathcal{L},\mathcal{R},A,\bar{\ })$
  - Assumptions are names of rules in D
  - $\mathcal{R}$ are rules in S + rules in D with names as additional premises
  - The generalised contraries, for all L, are all
    - (K, {¬L }), where $K \subseteq A$ is obtained from L by reasoning backwards with the rules until only assumptions are found

Conclusions

- Generalisation of assumption-based argumentation to support
  - Closed and consistent defeasible reasoning
  - Under any argumentation semantics
- Ongoing:
  - Generalise generalisation of assumption-based arg
  - Extension of CaSAPI to support generalisation
  - Automatisation of mapping of defeasible reasoning into generalised assumption-based argumentation
  - Study of other forms of defeasible reasoning (preferences, defeaters)

Acknowledgements



EU-funded, IST Framework VI

www.argugrid.eu

Royal Academy of Engineering/Leverhulme Foundation Senior Research Fellowship