Assumption-based argumentation for selection and composition of services

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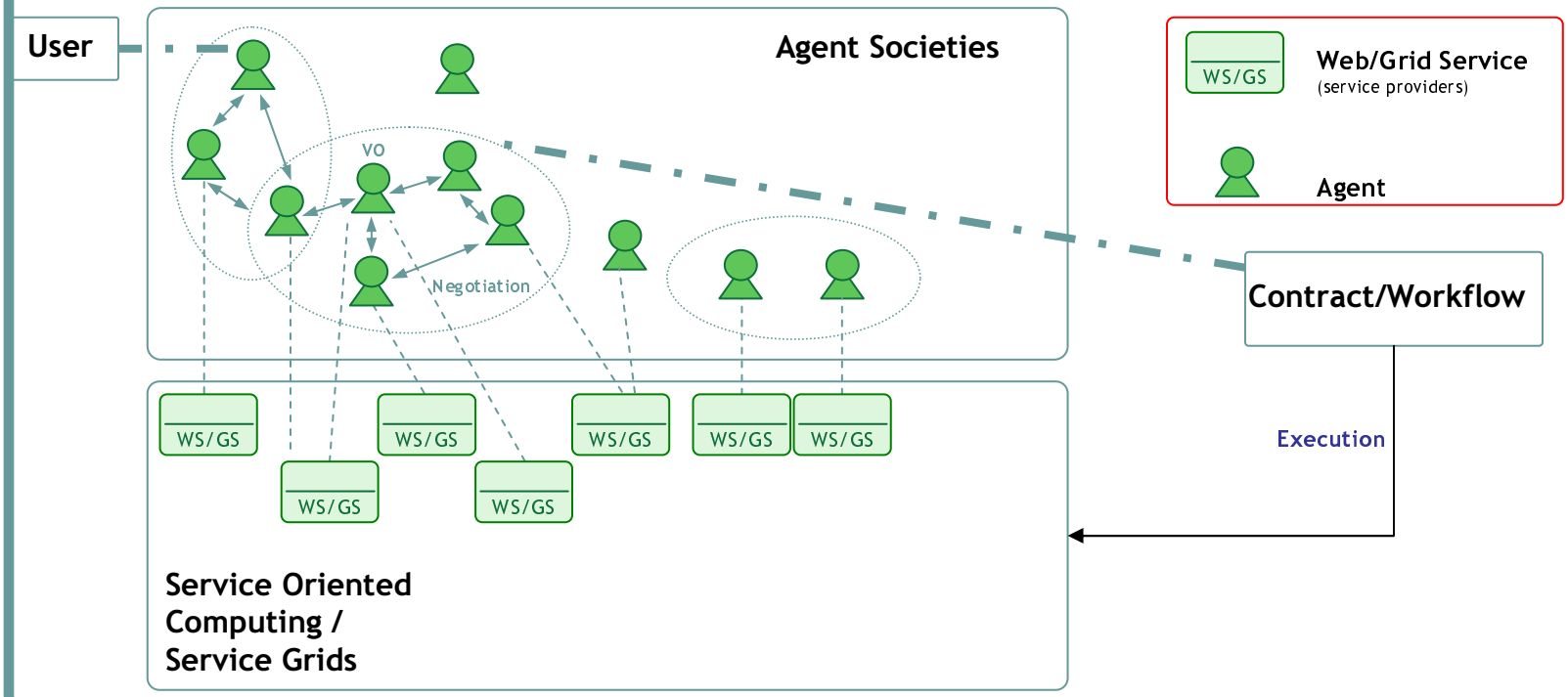
Outline

- Selection and composition of services: two scenarios from 

- Assumption-based argumentation
- Reasoning about
  - Beliefs
  - Goals/Desires
  - Decisions/Intentions
  - Preferences and conflicts
- Conclusions

Service selection and composition: ARGUGRID vision



Service selection and composition: scenarios

- Business migration
  - Select appropriate location
  - Combine several services (constructors, suppliers etc)
- Earth observation:
  - Select appropriate sensors/satellites e.g. for dealing with oil spill
  - Combine sensors/satellites + other services (weather) e.g. for fire monitoring

Service selection and composition: features

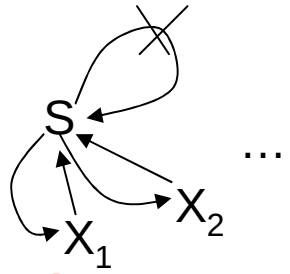
- defeasible, conflicting information/ beliefs (*EO: it will be windy*)
- preferences over *beliefs (I trust weather forecast by A more than by B)*
- mutually exclusive decisions (*sensor S1 or sensor S2*?) for the achievement of *goals (I need images every hour)*
- preferences over *decisions* (*S1 is typically more reliable than S2*) and *goals (quality of images more important then cost*).

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)*

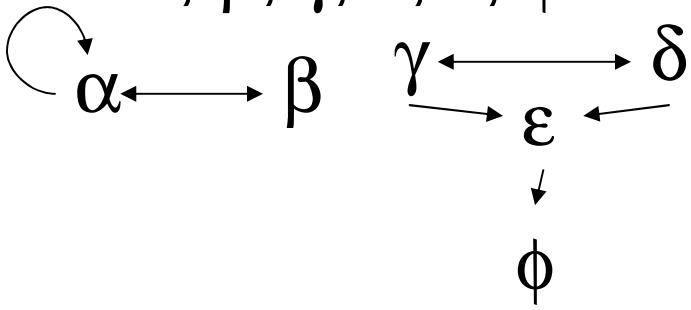


- A subset *S* of *arguments* is
  - *Admissible* iff *S* does not *attack S* and
    S attacks each X that *attacks* S
  - *Preferred* iff *S* is maximally admissible
  - *Grounded* iff *S* is minimal such that it contains every *a* such that *S* attacks every *X* that attacks *a*
  - *Ideal* iff *S*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

  - $\{\beta, \delta, \phi\}$ and $\{\beta, \gamma, \phi\}$ preferred
  - $\{\beta, \phi\}$ sceptical preferred
  - $\{\beta\}$ 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 (ABA)

In assumption-based argumentation frameworks:

- *arguments* defined in terms of:
  - a **deductive system** **(language + 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

ABA 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 ($c \leftarrow P$)
  - $A \subseteq \mathcal{L}$ is a set of candidate assumptions
  - $\bar{a}$ is the contrary of assumption a

ABA 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

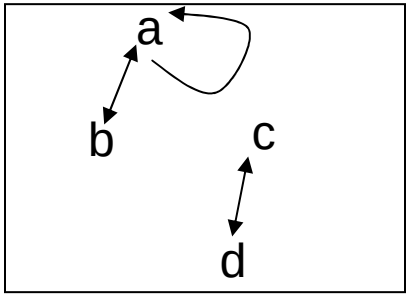
Example

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

- $\mathcal{L}$={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)

Reasoning about beliefs

- An epistemic framework consists of rules
  - $P \rightarrow c$ (basic rules)
  - $P \rightarrow n > m$ (preference rules, n,m rule names)

  wrt some underlying language ($\mathcal{L}_{ag}$) and naming
- E.g.
  - *n1: weather forecast by A says windy* $\rightarrow$ *windy*
  - *n2: weather forecast by B says* $\neg$ *windy* $\rightarrow$ $\neg$ *windy*
  - *n1>n2*

Reasoning about beliefs: ABA

- Mapping onto ABA ($\mathcal{L}$,$\mathcal{R}$,A, $\bar{}$):
  - No preferences:
    - $\mathcal{R}$: (basic) rules in epistemic theory + assumptions: $P \rightarrow c$ becomes $c \leftarrow P, a$
    - A: "applicability of rules" a
    - contrary of a (for "applicability" of $P \rightarrow c$): $\neg c$
    - $\mathcal{L} = \mathcal{L}_{ag}$ + A
    - Every semantics for ABA will do: admissible etc

Reasoning about beliefs: ABA

- Mapping onto ABA ($\mathcal{L}$,$\mathcal{R}$,A, $\bar{}$):
  - With preferences:
    - A: "applicability of rules" as before
    - contrary of *a* (for applicability of rule $n: P \rightarrow c$): $\chi(a)$
    - $\mathcal{R}$: $P \rightarrow c$ becomes

      $c \leftarrow \beta(P \rightarrow c)$ + $\beta(P \rightarrow c) \leftarrow P, a$

      $\chi(a) \leftarrow m > n, \beta(m: P' \rightarrow \neg c)$ (if such m>n is defined)

      $\chi(a) \leftarrow \beta(m: P' \rightarrow \neg c)$ (otherwise)

    - $\mathcal{L} = \mathcal{L}_{ag}$ + A + $\beta(\ldots)$ + $\chi(..)$

    - Every semantics for ABA will do: admissible etc

Reasoning about decisions

- A practical reasoning framework consists of
  - Epistemic rules ($P \rightarrow c$, $P \rightarrow n > m$)
  - Set of potential decisions (mutually exclusive)
  - Set of goals
  - Preference rules for decisions (P → d1>d2)
- E.g.
  - *windy, satellite1* → *good_image*
  - ¬ *windy, satellite1* → *bad_image*
  - ¬ *windy, satellite2* → *good_image*
  - *low_budget* → *satellite1>satellite2*
- Mapping onto ABA:
  - decisions are additional assumptions
  - contrary of decisions are mutually exclusive decisions

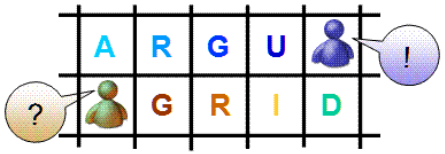
Reasoning about goals

- A (full) practical reasoning framework consists of
  - Epistemic rules ($P \rightarrow c$, $P \rightarrow n > m$)
  - Set of potential decisions (mutually exclusive)
  - Set of goals
  - Preference rules for decisions (P → d1>d2)
  - Preference rules for goals (ranking: P → g1>g2)
- E.g
  - *good_image > bad_image*
- Mapping onto ABA (sketched):
  - As for epistemic rules….example in the paper

Conclusions

- Assumption-based argumentation to support
  - Decision-making in general and
  - For service selection and composition
- Benefits:
  - Semantic-independent
  - Computational model/tool: CaSAPI (Credulous and Sceptical Argumentation: Prolog Implementation) http://www.doc.ic.ac.uk/~dg00/casapi.html
- Limitations:
  - Treatment of decisions/goals only sketched
  - Formal properties
  - preferences can be dealt with only if assigned over incompatible items (rules, goals etc) – last link
  - Preferences from statistical information?

Acknowledgements



EU-funded, IST Framework VI

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Royal Academy of Engineering/Leverhulme Foundation Senior Research Fellowship