Argumentation in ARGUGRID

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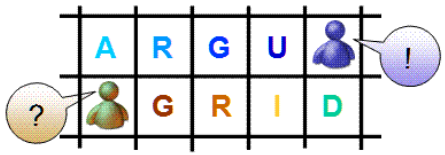
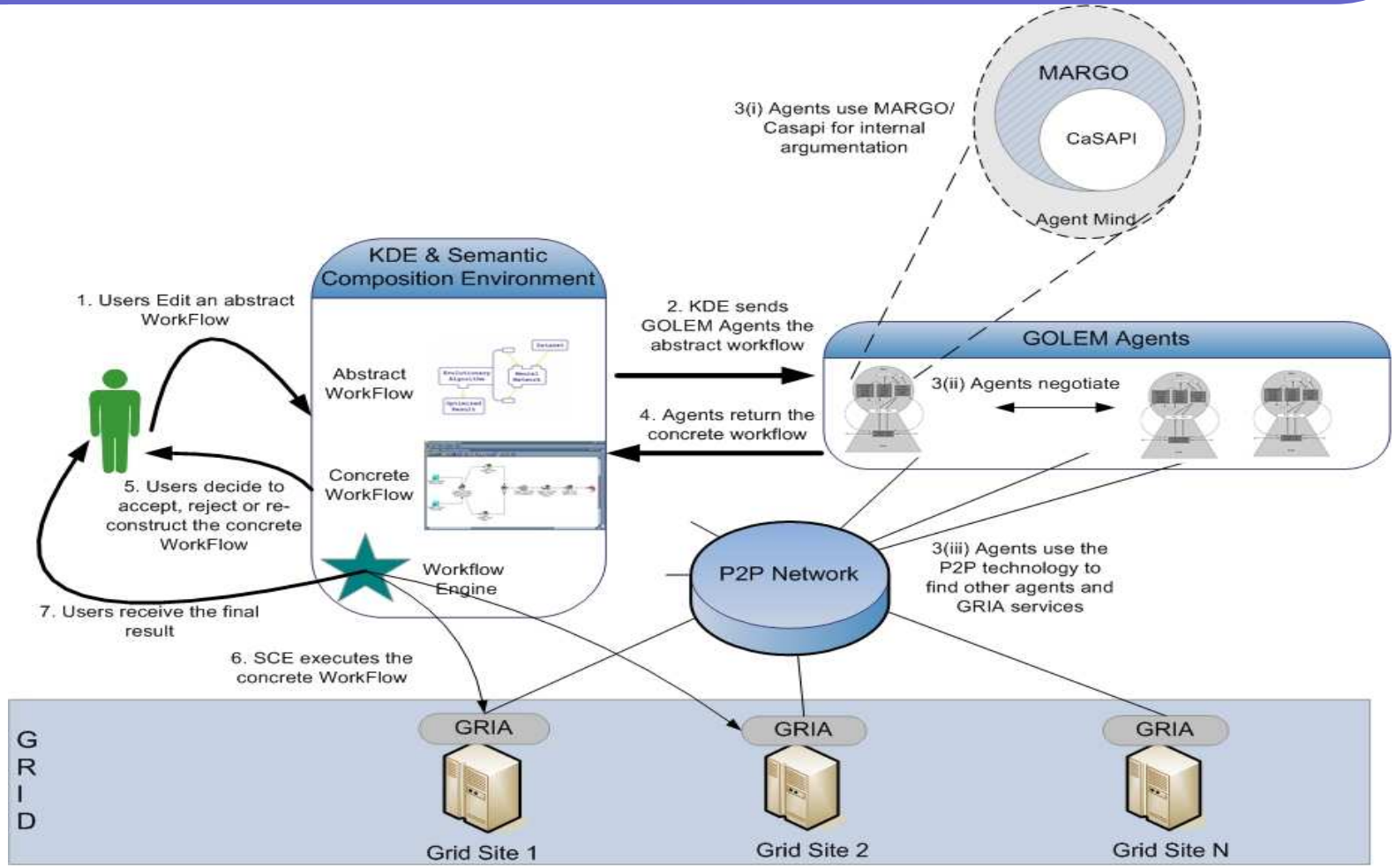


http://www.argugrid.eu/

Outline

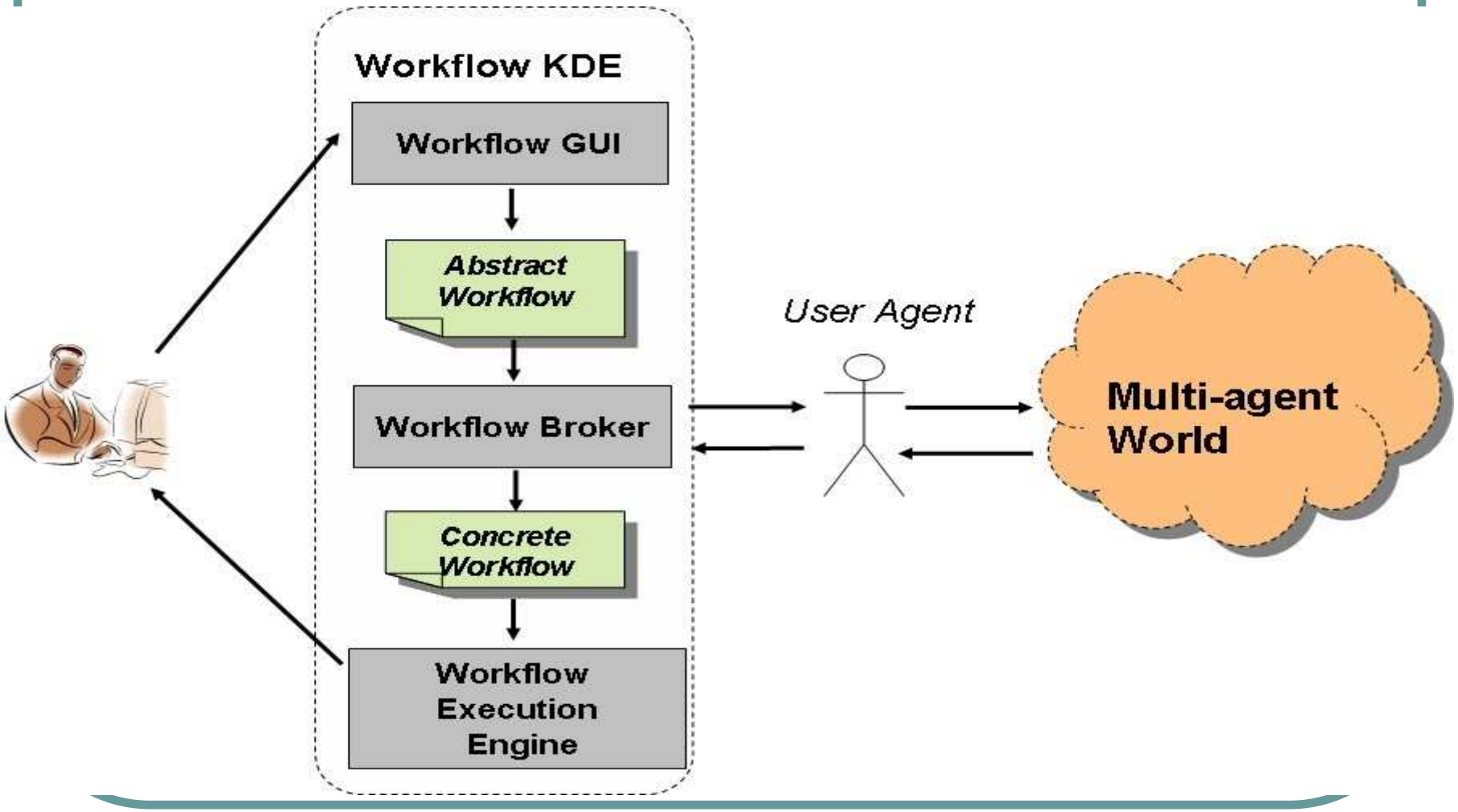
- ARGUGRID: overall picture, components, scenarios
- The case for argumentation: decision-making and negotiation
- Assumption-based argumentation, Dispute derivations, CaSAPI system
- Decision-making and contract negotiation

ARGUGRID: the "big picture"



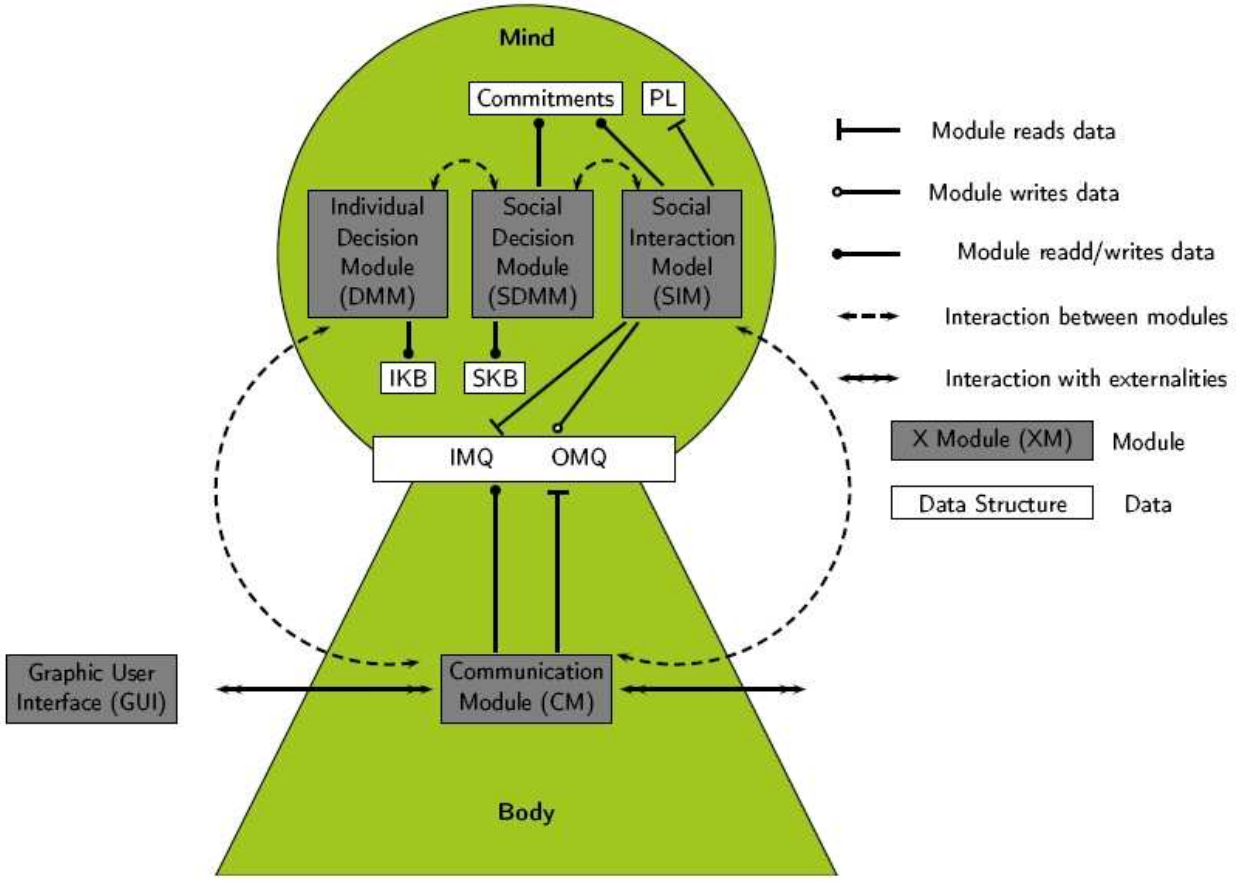
Thanks to Leonidas Liberopoulos, ICCS, Greece

A workflow perspective

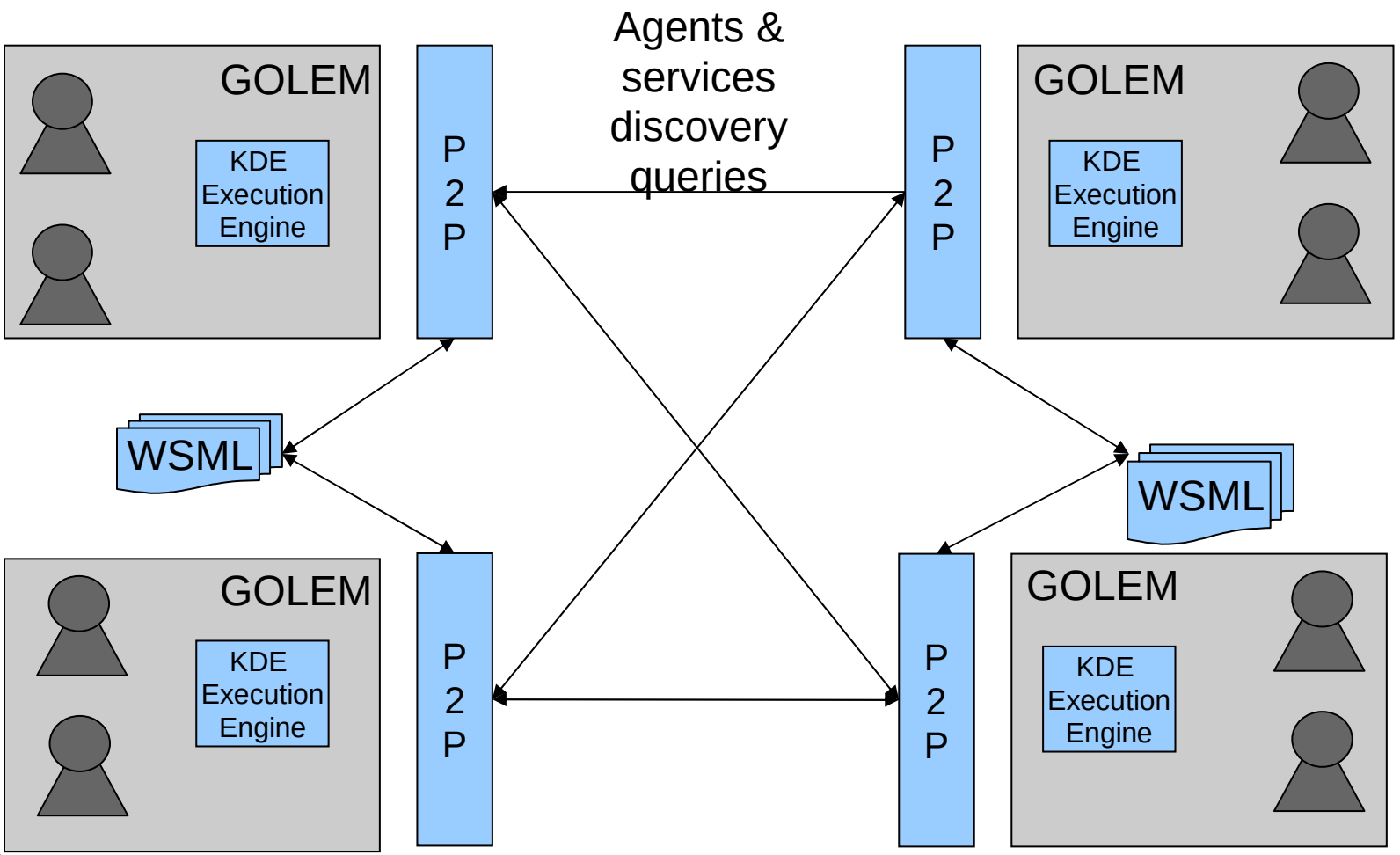


Thanks to InforSense LTD, UK

An agent perspective



A multi-agent perspective: GOLEM

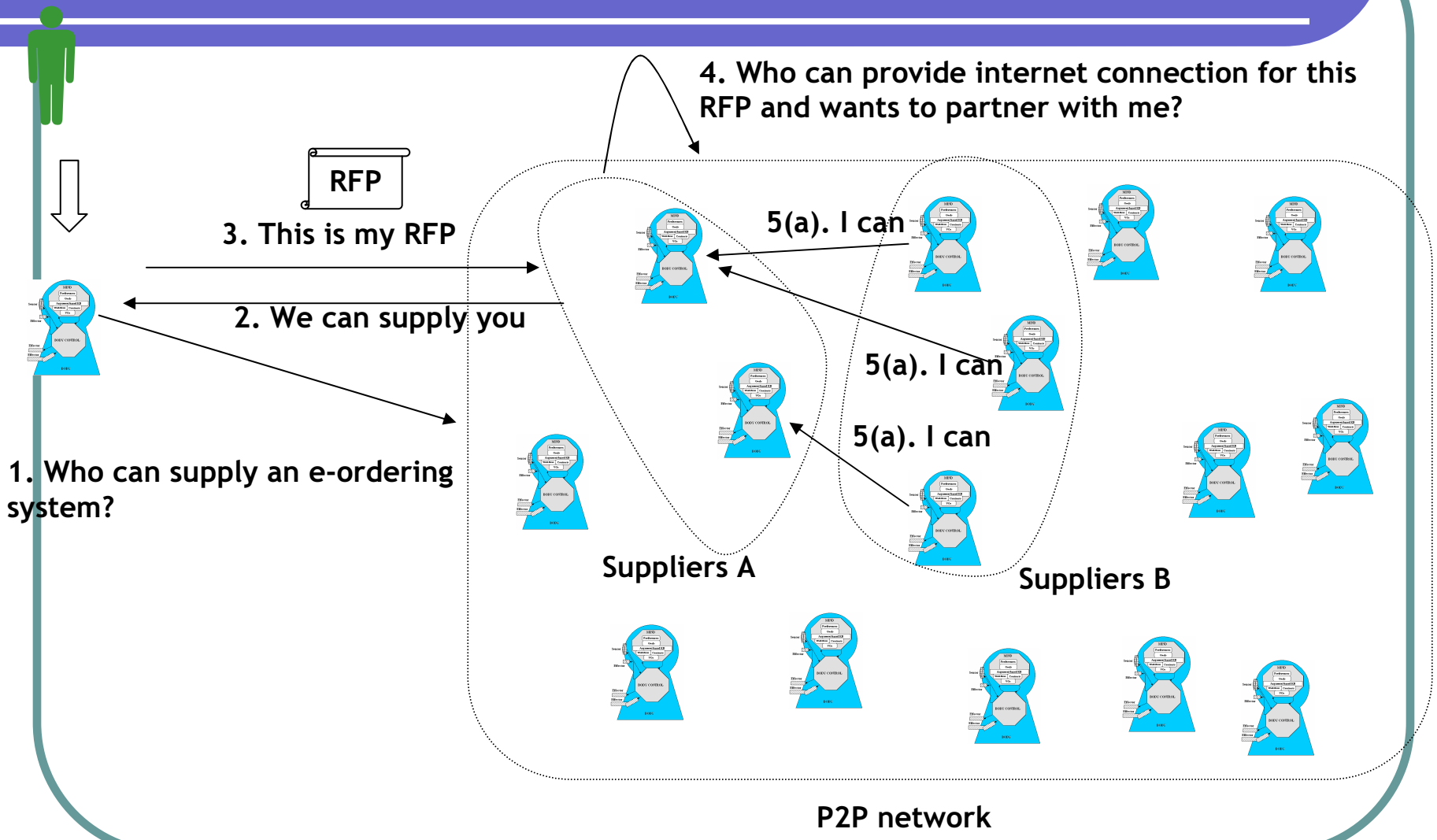


Thanks to Stefano Bromuri and Kostas Stathis, RHUL, UK

Scenarios

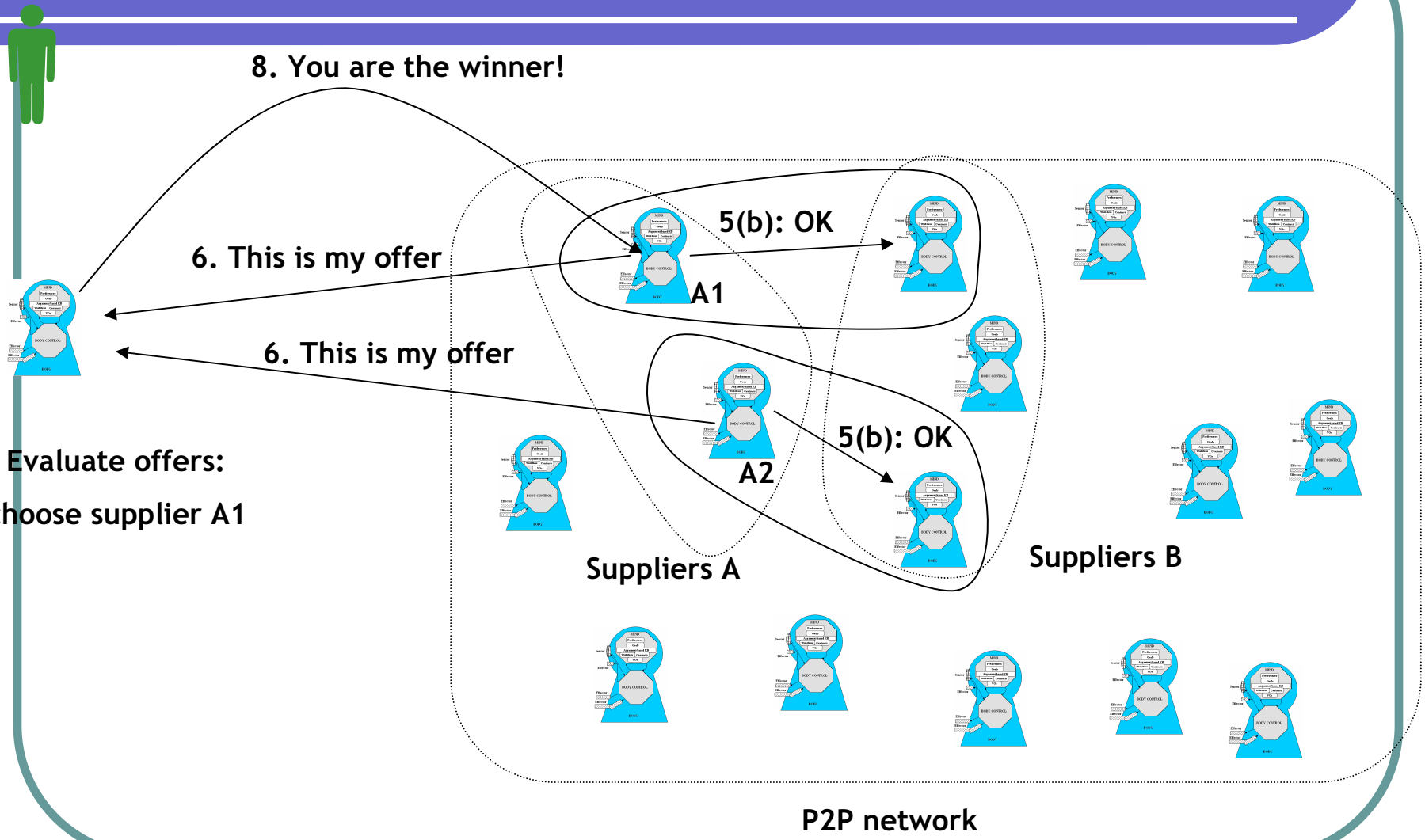
- Business migration **(AIT – academic)**
  - Select appropriate location
  - Combine several services (constructors, suppliers etc)
- Earth observation **(GMV – industrial)**
  - Select appropriate sensors/satellites e.g. for dealing with oil spill
  - Combine sensors/satellites + other services (weather) e.g. for fire monitoring
- E-procurement **(CosmoONE – industrial)**

E-procurement: a specific case (1/2)



Thanks to cosmoONE Hellas Market-site S.A, Greece

E-procurement: a specific case (2/2)



Thanks to cosmoONE Hellas Market-site S.A, Greece

Scenarios: features

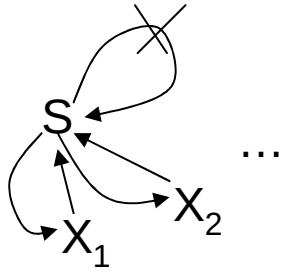
- defeasible, conflicting information/ beliefs (*EO: it will be windy*)
- preferences over *beliefs (I trust weather forecast by A more than by B)*
- mutually exclusive decisions (*sensor S1 or sensor S2*?) for the achievement of *goals (I need images every hour)*
- preferences over *decisions* (*S1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

The case for argumentation

- Decision-making/practical+epistemic reasoning
  - Alternative decisions
  - Contradictory beliefs
  - Preferences
    - Morge&Mancarella, ArgMAS07 : MARGO
    - ABA, CLIMAVIII: CaSAPI
- Negotiation
  - Justification
  - Persuasion

Computational argumentation

- Needed to support platform and scenarios!
- 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
    - …

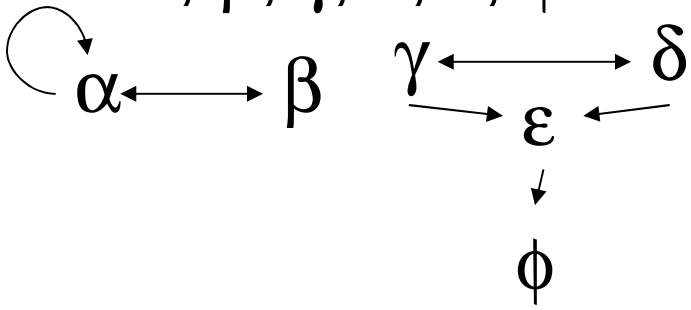


- Several computational mechanisms

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

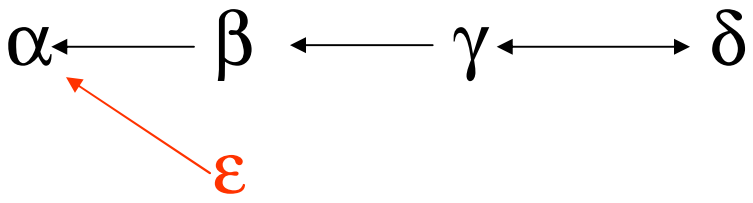
Abstract argumentation: different semantics

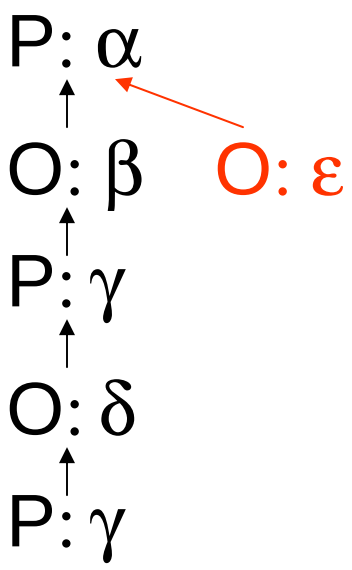
- Ideal semantics is more sceptical than the sceptical preferred semantics*:*
  - arguments: α; β; γ; δ; ε; ϕ
  - attacks: 

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

Abstract argumentation: computation

- Framework:
  - arguments: $\alpha; \beta; \gamma; \delta ; \varepsilon$
  - attack:





~~{α,γ} is admissible!~~

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

Pros and cons of abstract argumentation

- A lot of work to identify arguments and attacks:
  - α: *"John is guilty because he was seen with the murder weapon by a reliable witness …."*
  - β: *"but the witness is not reliable because …."*
- Overlapping between arguments ignored
  - α: *"A because B and C …."*
  - β: *"but not B because D…."*
  - γ: *"but not D because C and E …."*

Assumption-based argumentation (ABA)

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 $s \leftarrow s_1,\ldots,s_n$
  - $A \subseteq \mathcal{L}$ is a set of candidate assumptions
  - $\bar{a}$ is the contrary of assumption a

ABA arguments and attacks

- *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

(undermining attacks –

but rebuttal attacks can be obtained too)

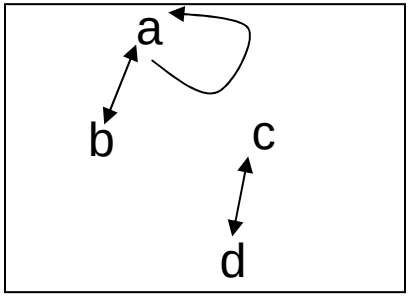
Example

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

- $\mathcal{L}$={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

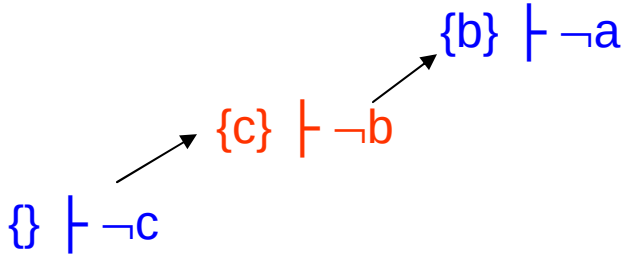
{b,d} and {b,c} preferred

Assumption-based argumentation: computation

- (various kinds of) dispute derivations:
  - Dispute between proponent and opponent
  - Construction of arguments/identification of attacks
  - Outcomes:
    - the initial claim is “acceptable” (e.g. preferred/admissible) or not
    - Assumptions supporting the arguments by the proponent (if acceptable)
    - Assumptions supporting arguments by the opponent and chosen by the proponent to be counter-attacked (if acceptable)

Dispute derivations: example

- $\mathcal{R}$={¬a ← b; ¬b ← c; ¬c}
- ā= ¬a; $\bar{b}$= ¬b; $\bar{c}$= ¬c



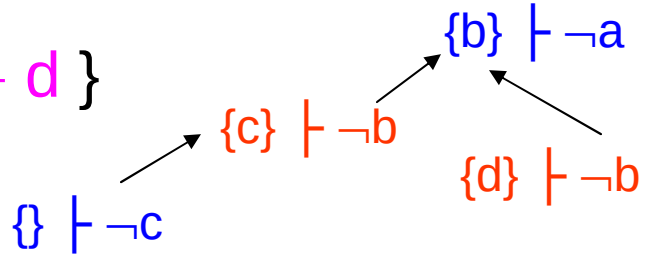
Is ¬a "acceptable"?

Proponent	Opponent	Assumptions supporting Proponent	Culprits chosen in Opponent
{¬a}	{}	{}	{}
{b}	{}	{b}	{}
{}	{{¬b}}	{b}	{}
{}	{{c}}	{b}	{}
{¬c}	{}	{b}	{c}
{}	{}	{b}	{c}

Yes!

Dispute derivations: example (cntd)

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



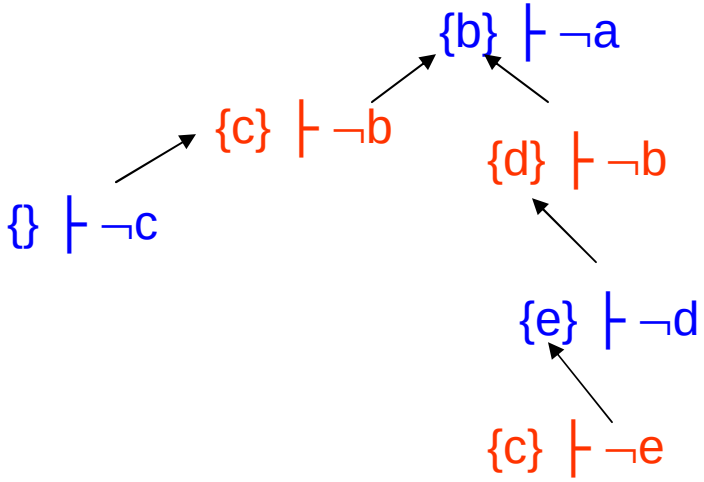
Is ¬a "acceptable"?

Proponent	Opponent	Assumptions supporting Proponent	Culprits chosen in Opponent
{¬a}	{}	{}	{}
{b}	{}	{b}	{}
{}	{{¬b}}	{b}	{}
{}	{{c}, {d}}	{b}	{}
{¬c}	{{d}}	{b}	{c}
{¬d}	{}	{b}	{c}

No!

Dispute derivations: filtering

Overlapping between arguments *not* ignored:



Filtering of culprits by culprits

Various other forms of filtering to exploit overlapping between arguments

Assumption-based argumentation: implementation

- CaSAPI (Credulous and Sceptical Argumentation: Prolog Implementation)

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

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

- 3 kinds of dispute derivations, verbose or silent output, 1 or all answers
- Version 2 (assumptions)
- Version 3 and Version 4 (assumptions and arguments) – only for computing admissible extensions for now

demo

Decision-making for e-procurement

- ABA:
  - features of product/service to purchase
  - description of (un)certain features in offers
  - links from features to business strategic benefits for the buyer

e.g. b1(S) ← f1(S),f3(S),f4(S)
f1(s1)
f3(s1) ← option3
f4(s1) ← guarantee1,clause3

- Agent use argumentation to evaluate pros and cons of offers from different supplies, in terms of granted benefits and guarantees

e.g. {option3,guarantee1,clause3} |- b1(s1)
s1 can challenge s2 wrt b1 (does b1(s2) hold?)

- CaSAPI : selects the best offers using admissibility semantics + returns optimal contracts to user (as defence set)

e.g. if s2 fails to provide b1(s2), then s1 is the best supplier and the contract returned is {s1,option3,guarantee1,clause3}

Contract negotiation

- Two agents, a buyer and a seller, each using
  - an ABA describing
    - how to achieve “structural” goals (e.g. for buyer house with 2 toilettes) and “contractual” goals (e.g. for buyer max £450K)
    - Uncertainties
    - Defeasible rules
  - Ranking of goals (preferences)
- Two-phase negotiation:
  1. Sceptical preferred semantics (equivalent to minmax preference for structural goals) for deciding options
  2. Negotiation protocol (of alternating offers and counter-offers) leading to agreement (using a Nash equilibrium strategy)

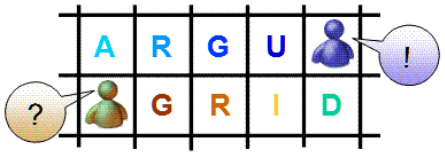
Conclusions

- Argumentation tool for various Dung-style (credulous and sceptical) semantics in ABA
- Deployed to support
  - decision making in agents and negotiation (e-business in ARGUGRID)
  - conflict-resolution in normative agents (Gaertner&Toni, ArgMAS07 : BDI-like agents)
- Ongoing:
  - Interfaces (preferences, decisions)
  - Graph-based visualisation of abstract arguments + attacks
  - Applications
- Future work:
  - Full comparison of CaSAPI with other systems
  - Full first-order version of CaSAPI
  - Multi-party disputes using CaSAPI?
  - Further applications (Bioinformatics? Medical decision-making? Security?)

Limitations

- Gathering of information ($\mathcal{R}$, A, etc)?
- Automatic compilation into assumption-based argumentation frameworks (preferences, decisions, argumentation schemas)?
- Scalability ?
- Contract negotiation very preliminary

Acknowledgements



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