An Argumentative Model for Service-Oriented Agents

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ARGUmentation as a foundation for the semantic GRID

- **Provide a new model for argumentative agents populating and evolving within a trusted grid.**
- Provide a new model for the specification, creation, operation and dissolution of **Virtual Organizations** over the grid using argumentation.
- Design an architecture for the semantic grid to support argumentative agents and VOs.
- Develop a grid-based platform to support the implementation of models and architecture and assess the approach.
- Experiment with and evaluate the models, architecture and platform in the context of concrete applications for e-business.

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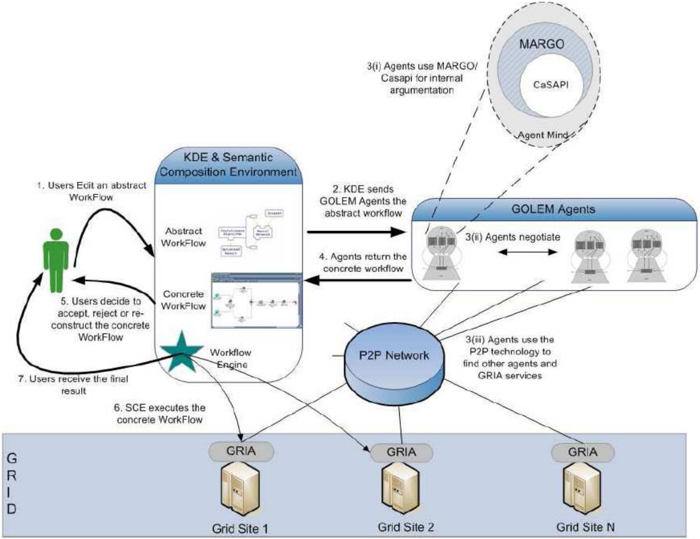
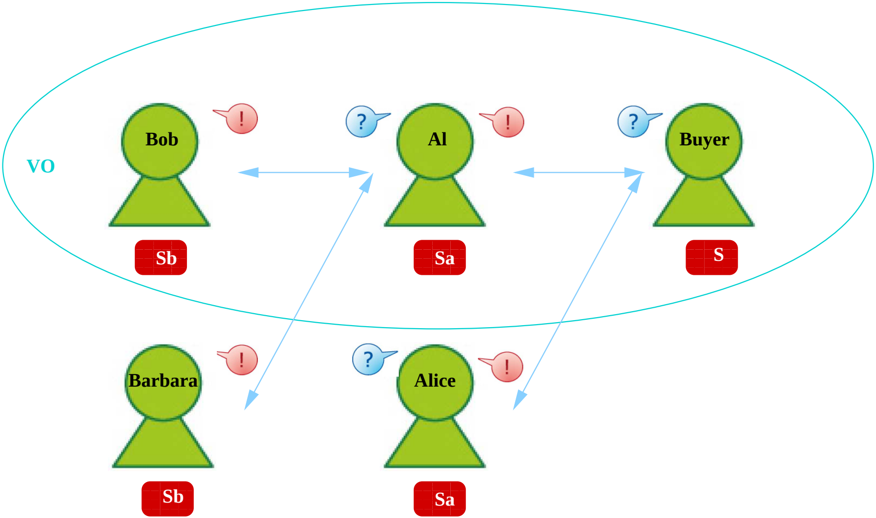
Global Picture of the ARGUGRID platform



Plan

- ARGUGRID
- Use case
- Argumentation framework for decision making
- Agents' architecture
- Case study
- Deployment
- Conclusions

E-procurement [ARGUGRID D1.2]

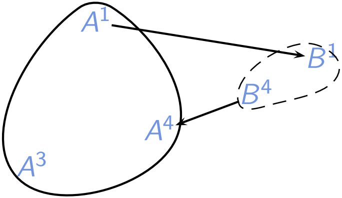


Deliberative steps for e-procurement

step #	description	dialogue type
step 1	find potential providers	information-seeking
step 2	get providers' features	information-seeking
step 3	create shortlist	n/a
step 4	get services' quotes	information-seeking
step 5	choose winner	n/a
step 6	negotiate specific terms	argumentation-based negotiation

Arguments as reasons supporting claims which can be disputed by other reasons.

1. Which service and provider ?
2. The service $S_b(c)$ provided by Bob.
3. Why ?
4. good_deal because of cost.
5. Why not $S_b(e)$?
6. ...



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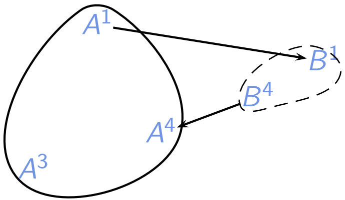
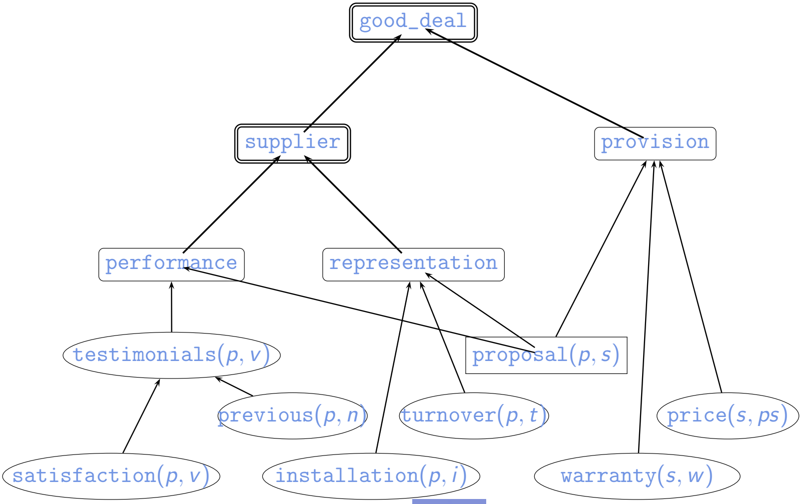


In [Morge ARGMAS 07]

- Argumentation framework and semantics by admissibility.
- Decisions are taken if supported by admissible arguments.
- Need for extensions (handle user's representation/preferences).
- Implemented by MARGO (http://margo.sourceforge.net).

A model of multi-criteria decision problems with incomplete knowledge



Knowledge, Goals, Decisions, and Priority

A **decision framework** is a tuple $\mathcal{D} = \langle \mathcal{L}, \mathcal{A}sm, \mathcal{I}, \mathcal{T}, \mathcal{P} \rangle$, where:

- $\mathcal{L}$ is the **object language** which captures the statements about the decision problem;
- $\mathcal{A}sm$, is a set of sentences in $\mathcal{L}$ which can be assumed, called **assumptions**;
- $\mathcal{I}$ is the **incompatibility relation**, i.e. a binary relation over atomic formulas which is asymmetric. It captures the mutual exclusion between the statements;
- $\mathcal{T}$ is the **theory** expressed as a set of statements in $\mathcal{L}$;
- $\mathcal{P} \subseteq \mathcal{T} \times \mathcal{T}$ is a (partial or total) preorder over $\mathcal{T}$, called the **priority** relation, which captures the uncertainty of beliefs, the priority amongst goals, and the expected utilities of the decisions.

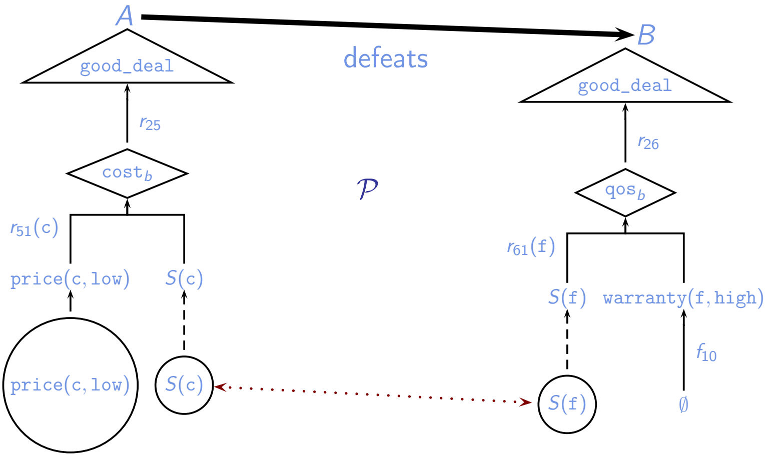
Goal rules, decision rules, and epistemic rules

$\mathtt{r}_{012}$: good_deal ← supplier, provision
$\mathtt{r}_{01}$: good_deal ← supplier
$\mathtt{r}_{134}$: supplier ← performance, representation
$\mathtt{r}_{256}$: provision ← $\mathtt{cost}_b$, $\mathtt{qos}_b$
$\mathtt{r}_{25}$: provision ← $\mathtt{cost}_b$
$\mathtt{r}_{26}$: provision ← $\mathtt{qos}_b$
$\mathtt{r}_{02}$: good_deal ← provision

$\mathtt{f}_1$: testimonials(Bob, high) ←
$\mathtt{f}_2$: turnover(Bob, 5) ←
$\mathtt{f}_3$: installation(Bob, 100) ←
$\mathtt{f}_4$: price(d, high) ←
$\mathtt{f}_5$: warranty(d, low) ←
$\mathtt{f}_6$: price(c, low) ←
$\mathtt{f}_7$: warranty(c, high) ←
$\mathtt{f}_8$: price(e, low) ←
$\mathtt{f}_9$: warranty(e, low) ←
$\mathtt{f}_{10}$: price(f, high) ←
$\mathtt{f}_{11}$: warranty(f, high) ←

$\mathtt{r}_{21}(p, s)$: performance ← proposal(p, s), testimonials$(p, \mathtt{high})$
$\mathtt{r}_{31}(p, s)$: representation ← proposal(p, s), turnover(p, t), $t > 2$M euros
$\mathtt{r}_{32}(p, s)$: representation ← proposal(p, s), installation(p, i), $i > 50$
$\mathtt{r}_{51}(p, s)$: $\mathtt{cost}_b$ ← proposal(p, s), price$(s, \mathtt{low})$
$\mathtt{r}_{61}(p, s)$: $\mathtt{qos}_b$ ← proposal(p, s), warranty$(s, \mathtt{high})$

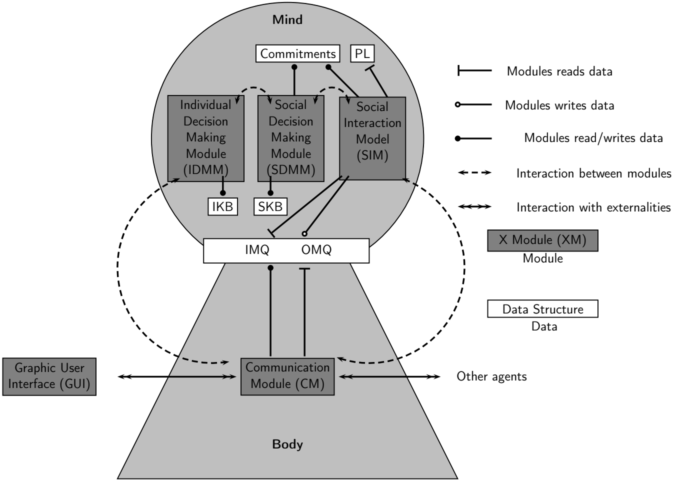
Interaction between tree arguments



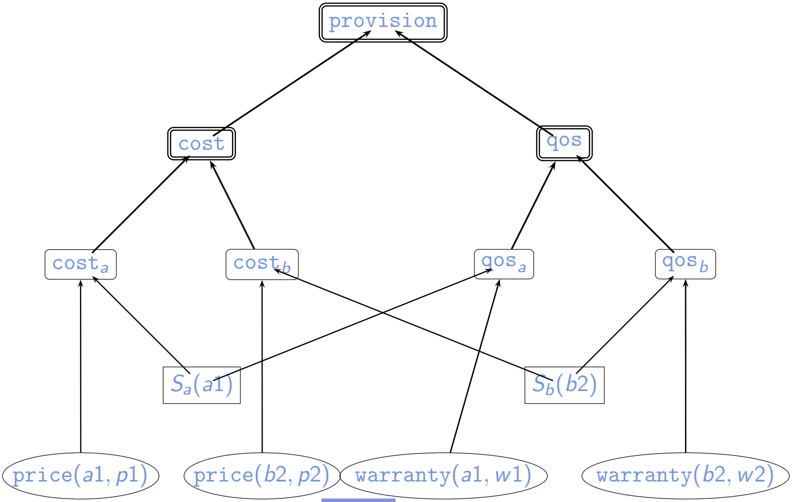
$\mathrm{suppsz}(A) = 2$

$\mathrm{suppsz}(B) = 1$

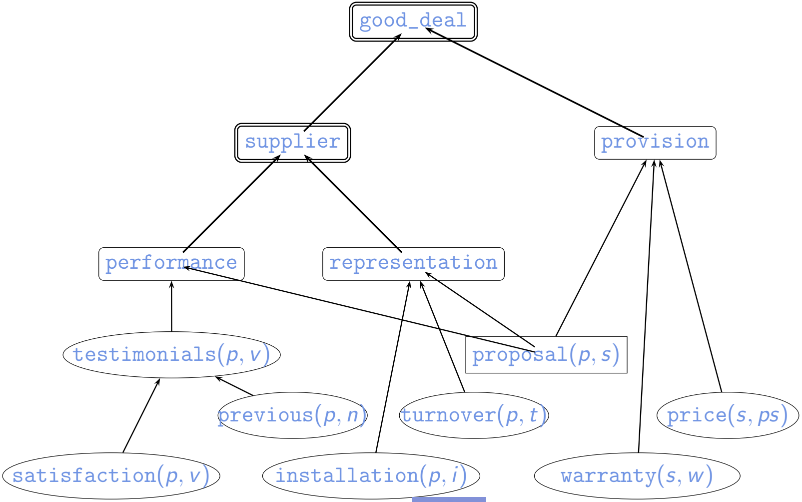
3 Modules for decisions, communication, and negotiation



The reasoning about the kind of services which can be provided or requested



Reasoning about the concrete instances of services which can be provided/requested



Drive the communication

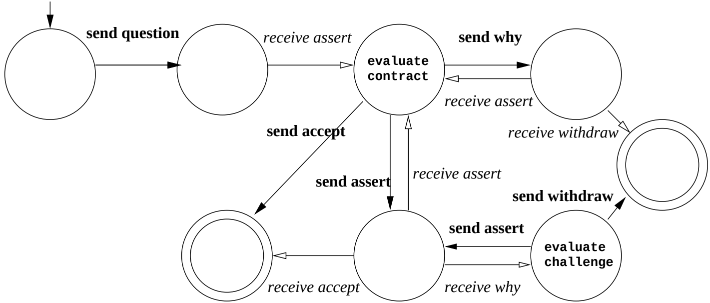
Information seeking dialogue

M_k	S_k	H_k	A_k	R_k
M_0	Al	Bob	$\mathtt{question}(\theta, S_b(x), [\mathtt{price}_b(x,p)])$	θ
M_1	Bob	Al	$\mathtt{assert}(\theta, S_b(c), [\mathtt{price}_b(c,pc), \mathtt{low} \leq pc \leq \mathtt{medium}])$	M_0
M_2	Bob	Al	$\mathtt{assert}(\theta, S_b(e), [\mathtt{price}_b(e,pe), \mathtt{low} \leq pe \leq \mathtt{medium}])$	M_0
M_3	Bob	Al	$\mathtt{assert}(\theta, S_b(d), [\mathtt{price}_b(d,pd), \mathtt{medium} \leq pd \leq \mathtt{high}])$	M_0
M_4	Bob	Al	$\mathtt{assert}(\theta, S_b(f), [\mathtt{price}_b(f,pf), \mathtt{medium} \leq pf \leq \mathtt{high}])$	M_0

Negotiation dialogue

M_k	S_k	H_k	A_k	R_k
M_0	Al	Bob	$\mathtt{question}(\mathrm{good\_deal}, S_b(x), \emptyset)$	θ
M_1	Bob	Al	$\mathtt{assert}(\mathrm{good\_deal}, S_b(d), \emptyset)$	M_0
M_2	Al	Bob	$\mathtt{assert}(\mathrm{good\_deal}, S_b(c), \emptyset)$	M_1
M_3	Bob	Al	$\mathtt{why}(\mathrm{good\_deal}, S_b(c), \emptyset)$	M_2
M_4	Al	Bob	$\mathtt{assert}(\mathrm{cost}_{\mathtt{Al}}, S_b(c), \emptyset)$	M_3
M_5	Bob	Al	$\mathtt{assert}(\mathrm{good\_deal}, S_b(e), \emptyset)$	M_1
M_6	Al	Bob	$\mathtt{accept}(\mathrm{good\_deal}, S_b(e), \emptyset)$	M_5

Negotiation protocol for the requester



Corresponding pseudo-code representation:

```
IF receive assert(G,D,K) from interlocutor
THEN
  update commit(interlocutor,D);
  IF SDMM.evaluate(G,D,K) THEN
       send accept(G,D,K) to interlocutor;
       commit(me,D);
  ELSE IF SDMM.evaluate(G,D2,K) & D2!=D & D2=new() THEN
            send assert(G,D2,K) to interlocutor;
            commit(me,D2);
  ELSEIF send why(G,D,K) to interlocutor;
```

Implementation of the SIM: LCC [Robertson ICLP 04]

Lightweight Coordination Calculus includes:

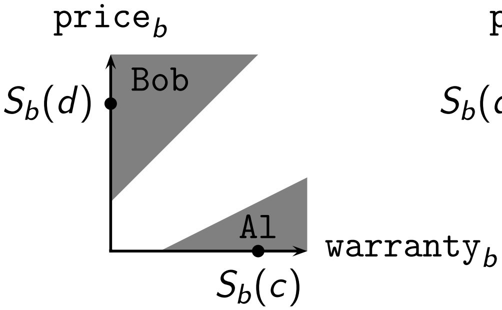
- a boot strap mechanism that initiates the protocol/role/participants;
- preconditions mechanism to prompt the SDMM;
- post condition mechanism to update the commitments.

$\mathbf{a(requestor(}g_0\mathbf{,}c\mathbf{,}K\mathbf{),}ag_1\mathbf{)::=}$
$question(g_0, c, K) \Rightarrow a(provider(g_0, c, K), ag_2)$ then
$\mathtt{commit}(ag_2, [g_0, c_1, K_1]) \leftarrow (assert(g_0, c_1, K_1) \Leftarrow a(provider(g_0, c, K), ag_2))$ then
$a(evaluator(g_0, g_0, c_1, K_1), ag_2)$.

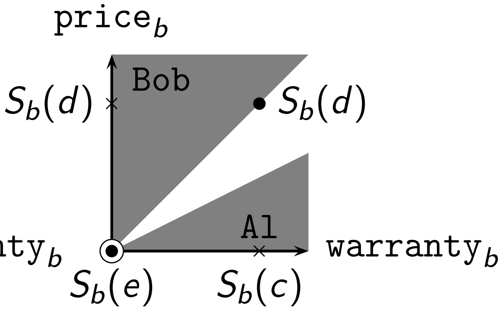
$\mathbf{a(provider(}g_0\mathbf{,}c\mathbf{,}K\mathbf{),}ag_2\mathbf{)::=}$
$question(g_0, c, K) \Leftarrow a(requestor(g_0, c, K), ag_1)$ then
$(assert(g_0, c_1, K_1) \Rightarrow a(requestor(g_0, c, K), ag_1)) \leftarrow$
$(evaluate\_contract(g_0, c_1, K_1))$ and
$\mathtt{commit}(ag_2, [g_0, c_1, K_1])$ then
$a(proponent(g_0, g_0, c_1, K_1), ag_2)$.

Acceptability space of participants

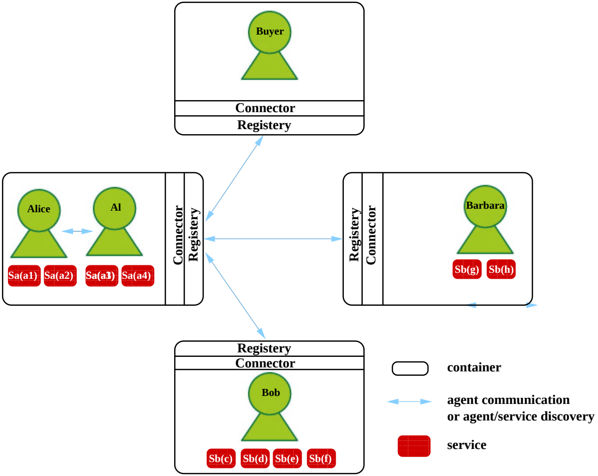
After M_3



At the end



GOLEM Platform [Bromuri and Stathis EEMMAS'07]



Take away

- A modular approach of the agent with Knowledge, Goals, Decisions, and Priorities:
  - IDMM, agent reasoning about how to achieve its individual goals;
  - SDMM, social reasoning based on collaboration;
  - SIM, conformance to social norms of the agent society.
- In the ARGUGRID project:
  - IDMM *via* MARGO;
  - SDMM *via* MARGO;
  - SIM *via* LCC.
- The MAS platform GOLEM.
- An industrial "real-world" scenario.

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