

# Argumentative KGP agents for service composition

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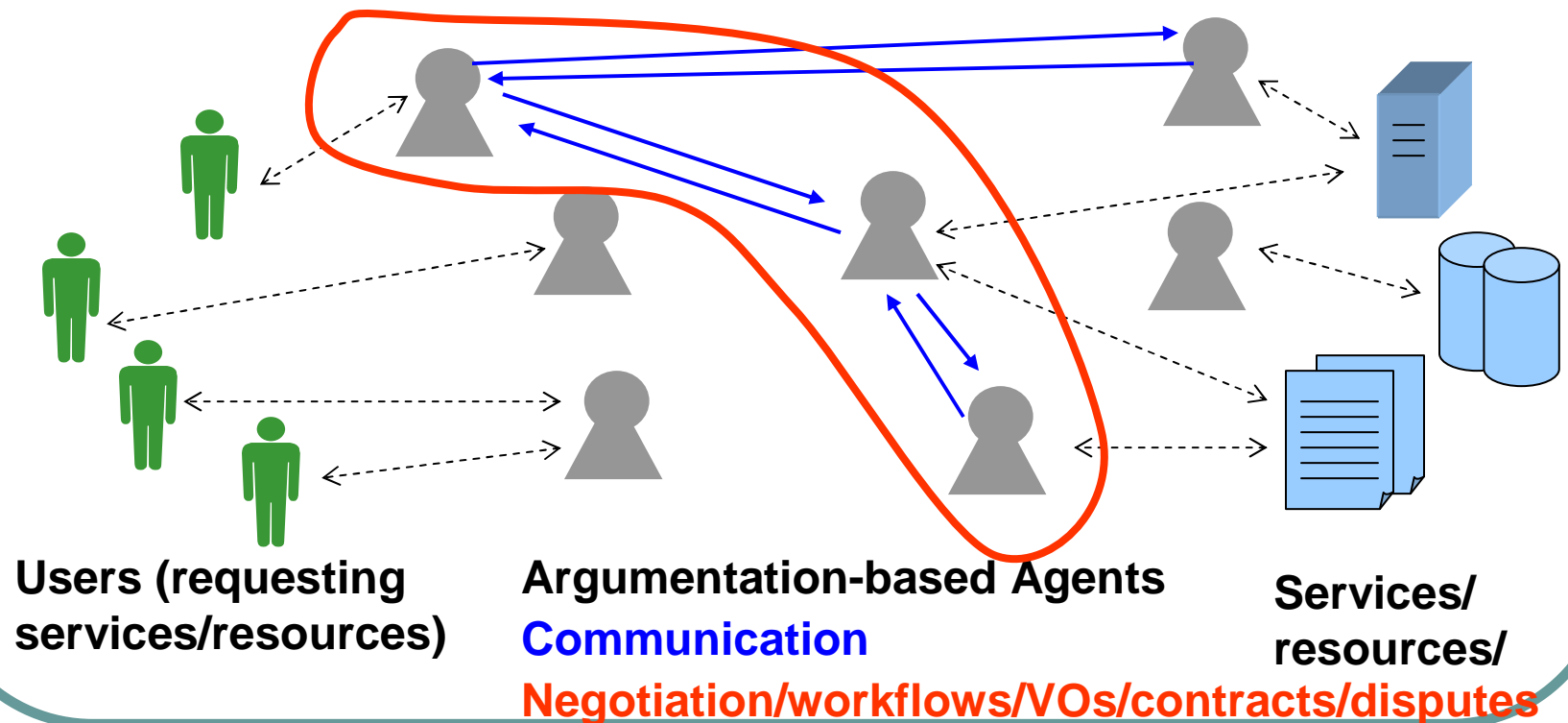
<http://www.argugrid.eu>

# Outline

- Setting: agent-based service-oriented architectures (and concrete scenarios - ARGUGRID)
- The case for argumentation: decision-making, contract negotiation
- KGP agents: standard and argumentative

# Setting

- Agent-based *semantic grid/service-oriented architecture*



# Scenarios

- Earth observation
  - Select appropriate sensors/satellites e.g. for dealing with oil spill
  - Combine sensors/satellites + other services (weather) e.g. for fire monitoring
- E-procurement
  - Select (combinations of) appropriate products/service to be purchased
  - Features of products/services influence business strategic benefits for the buyer

# Analysis of (EO) scenarios

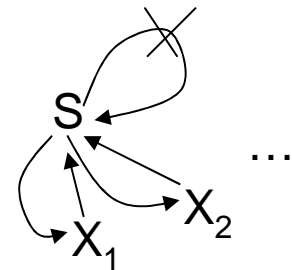
- defeasible, conflicting information/ **beliefs** (*it will be cloudy; it won't be cloudy; if cloudy then radar sensors*)
- mutually exclusive **decisions** (*sensor s1 or sensor s2?*) for the achievement of **goals** (*I need images every hour*)
- **preferences** over beliefs (*I trust weather forecast by abc more than by xyz*), over decisions (*s1 is typically more reliable than s2*), over goals (*quality of images more important than cost*)
- **negotiation** (*I need images every hour for a week, can I get a special price?*)

# The case for argumentation

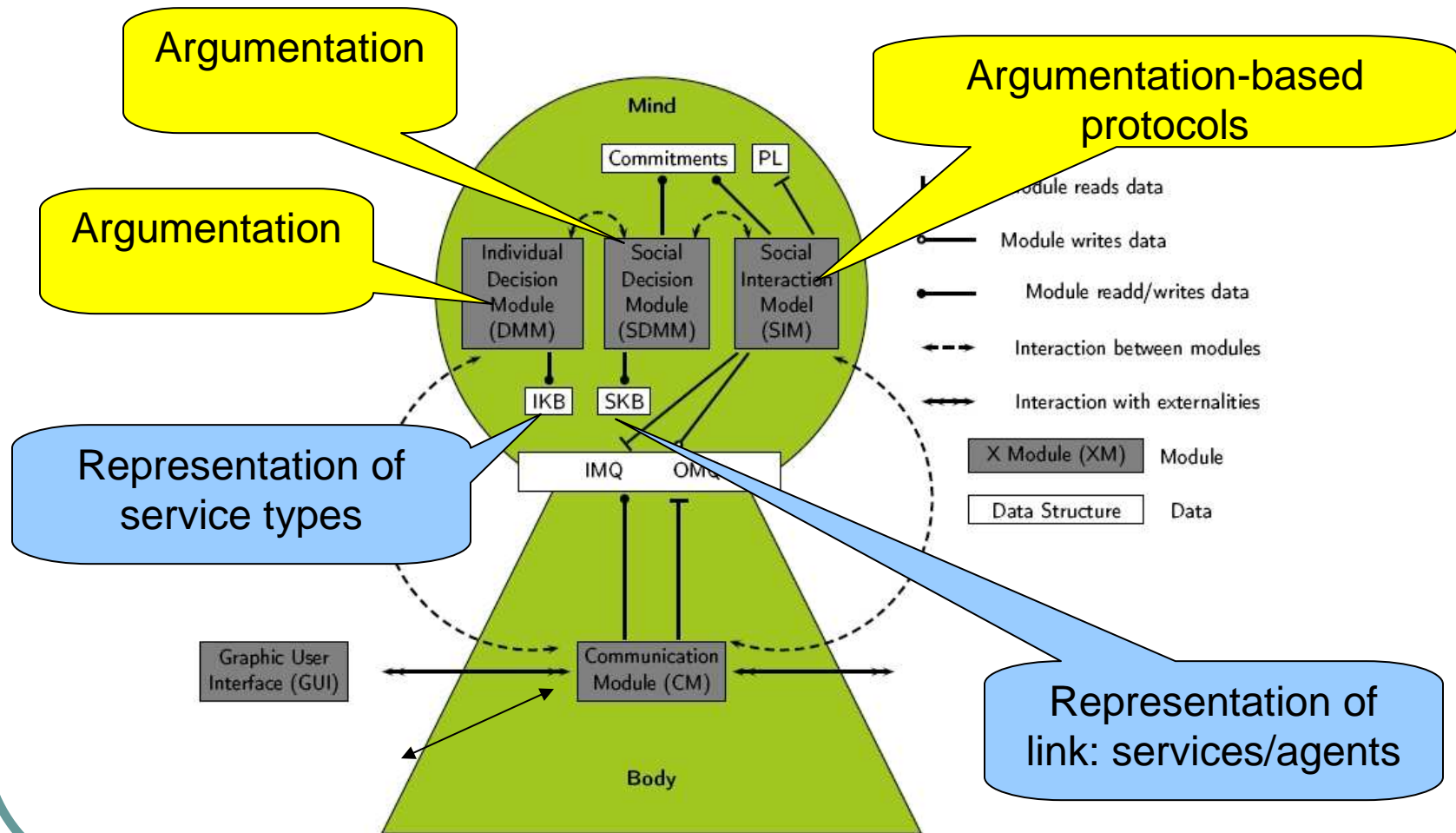
- Decision-making:
  - Alternative decisions, e.g.
    - Requestors: Which (combination of ) services? From which providers? (Which protocol for asking? Which registries?)
    - Providers: Which request to accept? etc
  - Conflicting beliefs. Defeasible rules.
  - Preferences
- Negotiation
  - Justification of decisions
  - Persuasion
  - Increase the chance of success while striving for privacy

# (Dialectical) argumentation (Dung AIJ95)

- Abstractly: 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
    - ...
- Concretely:
  - arguments built from facts/rules
  - attack  $\sim$  conflict/inconsistency/contradiction



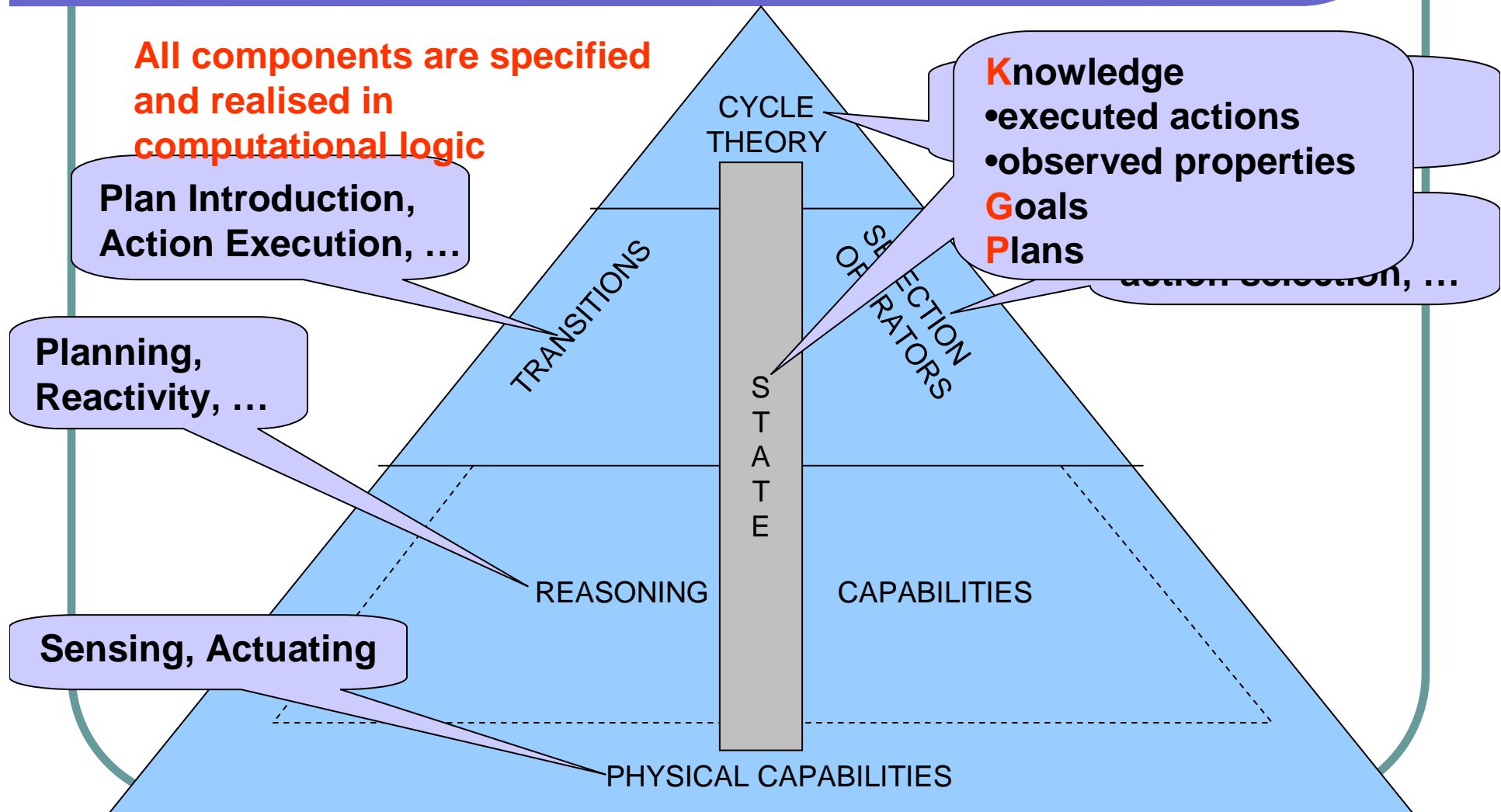
# ARGUGRID agents



# Outline revisited

- Setting: agent-based service-oriented architectures (and concrete scenarios - ARGUGRID)
- The case for argumentation: decision-making, contract negotiation
- KGP agents: standard and argumentative

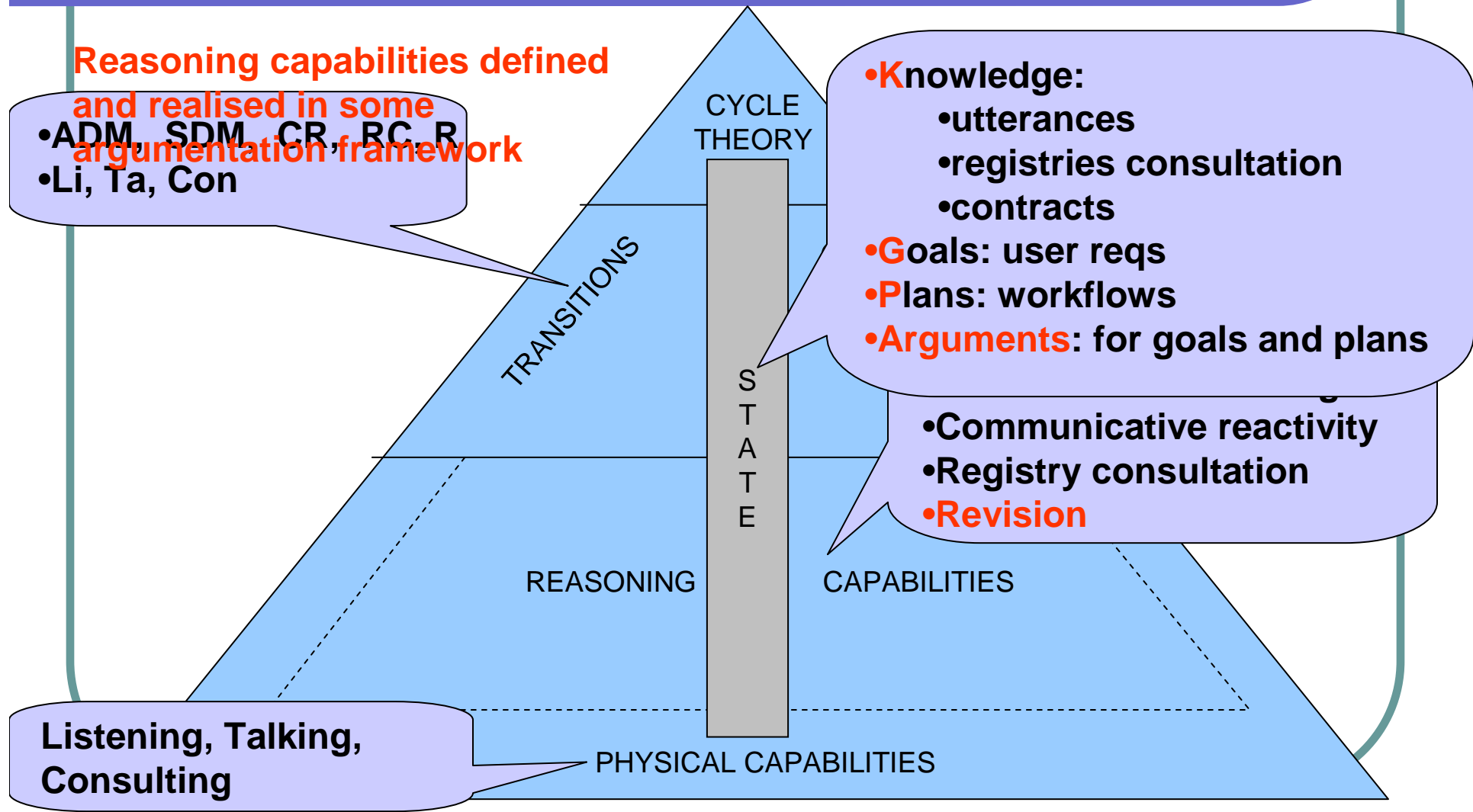
# (Standard) KGP agents (ECAI04)



# (Standard) KGP agents

- Agent behaviour is given by
  - a sequence of state-changing transitions (“calling” 0/1/many capabilities)
  - with inputs provided by selection operators
  - as “decided” by the cycle theory
- For example
  - ↪ plan for a chosen goal
  - ↪ execute some chosen actions in the plan
  - ↪ observe the environment (possibly “actively”)
  - ↪ reassess your goals/react to any changes ...

# Argumentative KGP agents



# Workflows and contracts

- *Abstract workflows* (with annotations) – outcome of **abstract decision making** reasoning capability
  - satellite(S1, I1) & processing-software(S2, I1,I2) & jpeg-format(I2)
  - computer-system(S1) & internet-provider(S2)
- *Concrete workflows* (with annotations) – outcome of **social decision making+registry consultation** reasoning capabilities
  - satellite(meteosat, I1) & processing-software(such-and-such,I1,I2)
  - computer-system(abc) & internet-provider(wind)
- *Contracts*: workflows + “contractual features” (e.g. cost, delivery date) – outcome of **communicative reactivity** reasoning capability

# Utterances and communication

- Utterances:  $U(S,R,C,T)$ 
  - U may be *request, why, because* etc
  - S (speaker) and R (receiver) are agent names
  - C is the content
  - T is the time (e.g. an integer)
- Protocols/policies determine the **communicative reactivity** reasoning capability

# Registries

- Registry query language, e.g.
  - *consult( agent-such-and-such, registry-such-and-such, Query)*
  - Query may be “is there a satellite providing jpeg images”?
- Determine the **registry consultation reasoning capability**

# Decision-making for e-procurement

- ABA:
    - features of services to purchase
    - uncertain/customisable features in services on offer
    - links from features to benefits for the buyer
    - “control information”
  - e.g. *rules* may include ( $s_5, s_8$  concrete services)
    - $f_1(s_5)$        $f_2(s_8)$
    - $f_2(S) \leftarrow$  **guarantee(S)**      ← *assumptions*
    - $b(S) \leftarrow f_1(S), f_2(S),$  **choose(S)**      ← *assumptions*
    - $\text{not-choose}(s_5) \leftarrow b(s_8),$  **not-b(s<sub>5</sub>)**      ← *assumptions*
    - $\text{not-choose}(s_5) \leftarrow$  **choose(s<sub>8</sub>)**      ← *assumptions*
- with *contrary of*:  $\text{choose}(s_5) = \text{not choose}(s_5)$   
 $\text{not-b}(s_5) = b(s_5), \dots$

# Decision-making for e-procurement

- ABA framework

$f_1(s_5)$     $f_2(s_8)$     $f_2(S) \leftarrow \text{guarantee}(S)$   
 $b(S) \leftarrow f_1(S), f_2(S), \text{choose}(S)$     $\leftarrow \text{contrary: not choose}(S)$   
 $\text{not-choose}(s_5) \leftarrow \text{choose}(s_8)$   
 $\text{not-choose}(s_8) \leftarrow b(s_5), \text{not-b}(s_8)$     $\leftarrow \text{contrary: } b(s_8)$

- arguments

1:  $\{\text{choose}(s_5), \text{guarantee}(s_5)\} \vdash b(s_5)$   
2:  $\{\text{choose}(s_8)\} \vdash \text{not-choose}(s_5)$   
3:  $\{\text{choose}(s_5), \text{guarantee}(s_5), \text{not-b}(s_8)\} \vdash \text{not-choose}(s_8)$

- attacks: 2 attacks 1, 3 attacks 2

- admissible arguments =  
optimal choice+contracts (customisable features)

# Decision-making for e-procurement

- arguments

1.  $\{\text{choose}(s_5), \text{guarantee}(s_5)\} \vdash \text{benefit}(s_5)$

“choosing some concrete offer (of a service) will provide some given benefit if that offer is extended with some additional (contractual) feature” .....argument in favour of a specific offer ( $s_5$ )

2.  $\{\text{choose}(s_8)\} \vdash \text{not-choose}(s_5)$

“choosing some offer (of a service) is a reason against choosing some other offer” .....argument against of a specific offer ( $s_5$ )

3.  $\{\text{choose}(s_5), \text{guarantee}(s_5), \text{not-benefit}(s_8)\} \vdash \text{not-choose}(s_8)$

“choosing some (suitably extended) concrete offer (of a service) giving some benefit is a reason against choosing some other offer without that benefit”

- attacks: 2 attacks 1, 3 attacks 2

- “admissible” arguments =  
optimal choice+contracts (customisable features)

# Contract negotiation

- Two agents, a buyer and a seller, each using
  - an argumentation framework describing
    - how to achieve “structural” goals (e.g. which satellite) and “contractual” goals (e.g. cost)
    - Uncertainties
    - Defeasible rules
  - Ranking of goals (preferences)
- Two-phase negotiation:
  1. (Sceptical preferred) argumentation semantics (equivalent to minmax preference for structural goals) for deciding services
  2. Negotiation protocol (of alternating offers and counter-offers) leading to agreement (using a Nash equilibrium strategy)

# Conclusions

- Sketch of argumentative KGP model
- Applications and implementation are ongoing
- Further work needed:
  - Formal definition of capabilities and cycle theory
  - Choice of underlying argumentation framework
  - Definition of protocols/policies for negotiation
  - Contract negotiation (versus SLAs) + VOs
- Future work:
  - dispute resolution
  - trust-mediated negotiation