Strategic Reasoning for the Resolution of Assignment Problems in Goal- and Actor-Oriented Requirements Engineering

Christophe Chareton

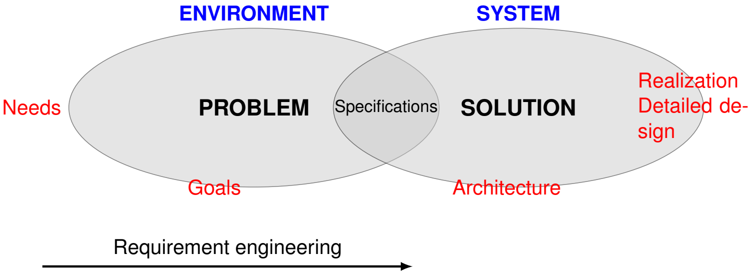
Onera, Toulouse

December 18, 2012

Outline

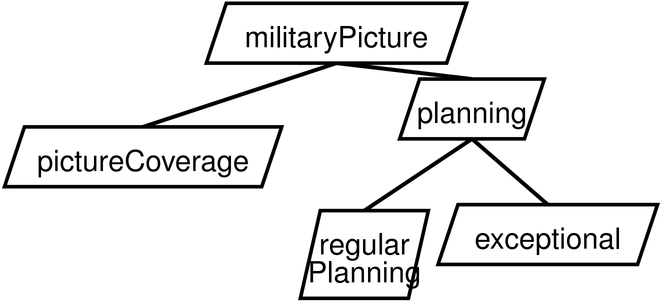
Current section

Requirements engineering



- Identify requirements
- Derive specifications from functional requirements
- We concentrate on modeling languages

Goals

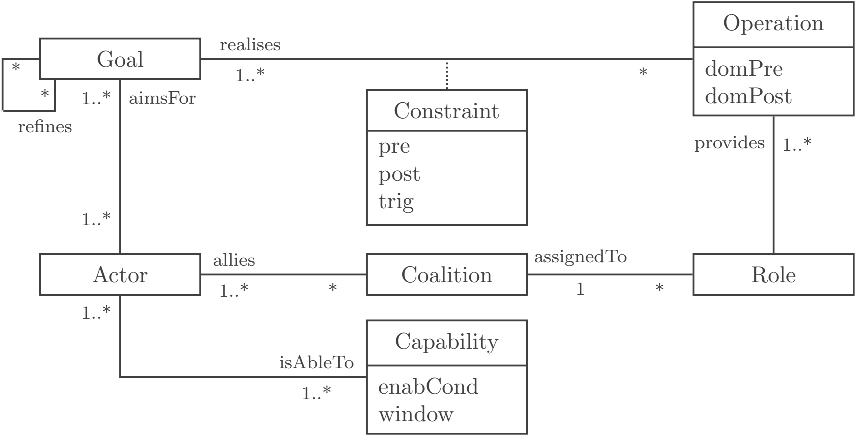


- Formalize the goal's refinement description down to specifications of transitions of the system: Kaos
- Care the realizability of the goals trough assignments of roles to actors: Tropos-i*

Motivations for KHI :

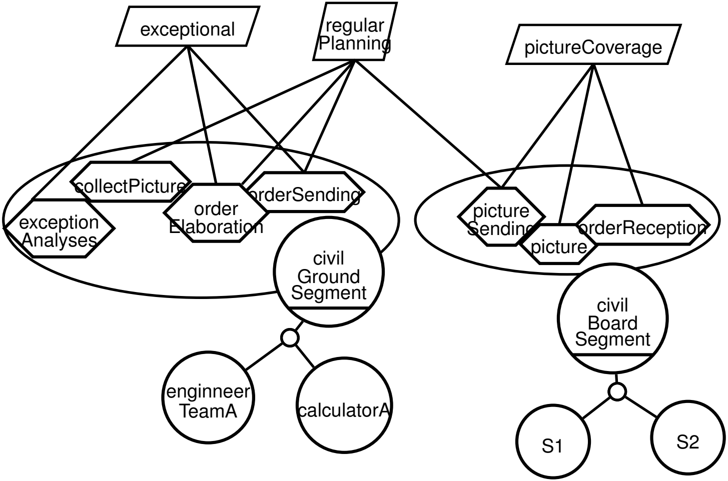
- Unify in a single language :
  - The relation pursued goals-operations and its dynamic aspects (KAOS)
  - Intentional agents and the confrontation between available agents (actors) and required agents (roles) (TROPOS-I*)
- Give a semantic treatment of the capabilities af actors and being able to discuss their ability to play roles: the **assignment problems**

Metamodel



Goal
realises
1..*
*
Operation
domPre
domPost
*
*
refines
1..*
aimsFor
Constraint
pre
post
trig
provides
1..*
1..*
Actor
allies
1..*
*
Coalition
assignedTo
1
*
Role
1..*
Capability
enabCond
window
isAbleTo
1..*

Leaf goals, operations, roles and assignment



Expression of K_{HI} in the logic *USL*

We build USL in three successive steps:

- $\text{Cond}_{K_{HI}}$: a set of comparisons of values between variables and constants
- The LTL language whose atoms are in $\text{Cond}_{K_{HI}}$: $\text{LTL}_{K_{HI}}$
- Introduction of three operators for strategy treatment:
  - $$\langle\langle x \rangle\rangle \varphi$$
    There is a strategy x such that $\varphi(x)$
  - $$(A \rhd x)\varphi$$
    If agents in A play along strategy for x then φ
  - $$(A \not\rhd x)\varphi$$
    If agents in A do not play anymore along strategy for x then φ

We get a generalization of SL (Fabio Mogavero, Aniello Murano, Giuseppe Perelli, Moshe Y. Vardi)

Current section

Preliminary definitions

Definition

- A Non-deterministinc Alternating Transition System (*NATS*) is a tuple $\mathfrak{M} = \langle \Sigma, M, \Pi, \pi, \delta \rangle$ where :
  - M is a set of states, called the domain of the *NATS*, Π is the set of atomic propositions in the language and π is a valuation function, from M to $\mathcal{P}(\Pi)$
  - $\delta : \Sigma \times M \rightarrow \mathcal{P}(\mathcal{P}(Q))$ is a transition function mapping a pair $\langle agent, state \rangle$ to a non-empty family of choices of possible next states.
- A *strategy* is a function σ from $\Sigma \times M$ to $\mathcal{P}(M)$ such that for all $(a, s) \in \Sigma \times M, \sigma(a, s) \in \delta(a, s)$
- A *context* κ is a finite word upon $(\Sigma \times X)^*$, representing the structure of the active bindings.
- A *memory* μ is a partial function from X to *Strat*, storing the memory instanciations for quantified strategies.

Satisfaction relation

Let $\mathcal{M}$ be a *NATS*, then for all memory μ, context κ, state s:

- $\mathcal{M}, \mu, \kappa, s \models \langle\langle x \rangle\rangle \varphi$ iff there is a strategy $\sigma \in \mathit{Strat}$ such that $\mathcal{M}, \mu[x \to \sigma], \kappa, s \models \varphi$
- $\mathcal{M}, \mu, \kappa, s \models (A, x \triangleright \varphi)$ iff for all λ in $\mathit{out}(\mu, \kappa[A \to x]), \mathcal{M}, \mu, \kappa[A \to x]\lambda \models \varphi$
- $\mathcal{M}, \mu, \kappa, s \models (A, x \not\triangleright \varphi)$ iff for all λ in $\mathit{out}(\mu, \kappa[A \leftarrow x]), \mathcal{M}, \mu, \kappa[A \leftarrow x]\lambda \models \varphi$

Current section

Local correctness

Local Correctness is the property of a model such that each of its role can be invidually played by its assigned coalition.

Definition (LC)

Let $\mathcal{K}$ be an instance of KHI, then the assignment is locally correct, written LC(*assignedTo*), if

$$\mathcal{G}_{\mathcal{K}}, \emptyset, \emptyset, s \models \bigwedge_{r_i \in roles} \langle\langle x_{r_i} \rangle\rangle (r_i.assignedTo.allies, x_{r_i}) [\![r_i]\!]$$

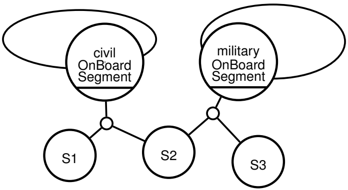
Global correctness

Global Correctness is the property of a model such that each coalition assigned roles can play them coherently altogether?

Definition (GC)

Let $\mathcal{K}$ be an instance of KHI, then the assignment is globally correct, written GC(*assignedTo*), if

$$\mathcal{G}_{\mathcal{K}}, \emptyset, \emptyset, s \models \langle\langle x \rangle\rangle \bigwedge_{r \in roles} (r.assignedTo.allies, x)[\![r]\!]$$



Positive interaction

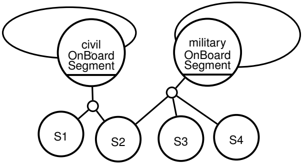
Positive interaction is the relation between roles r_1 and r_2 such that coalition assigned r_1 helps coalition assigned r_2 to play it when itself playing r_1. Two modalities:

- Possibility

Definition (PPI)

Let $\mathcal{K}$ be an instance of KHI. Then for all roles r_1 and r_2 in $\mathcal{K}$, r_1 *possibly interacts positively with* r_2, written $\mathrm{PPI}(r_1, r_2)$ if

$$\mathcal{G}_{\mathcal{K}}, \emptyset, \emptyset, s \models \langle\langle x \rangle\rangle(r_1.assignedTo.allies, x)([\![r_1]\!] \wedge \langle\langle y \rangle\rangle(r_2.assignedTo.allies, y)[\![r_2]\!])$$



Positive interaction

Positive interaction is the relation between roles r_1 and r_2 such that coalition assigned r_1 helps coalition assigned r_2 to play it when itself playing r_1. Two modalities:

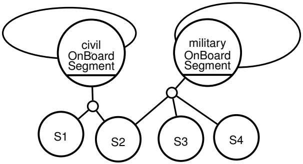
- Necessity

Definition (NPI)

Let $\mathcal{K}$ be an instance of KHI. Then for all roles r_1 and r_2 of $\mathcal{K}$, r_1 *necessarily interacts positively with* r_2, written $\mathrm{PPI}(r_1, r_2)$ if

$$\mathcal{G}, \emptyset, \emptyset, s \models$$

$$[\![x]\!](r_1.assignedTo.allies, x)([\![r_1]\!] \rightarrow \langle\!\langle y \rangle\!\rangle(r_2.assignedTo.allies, y)[\![r_2]\!])$$



Current section

Interests of the approach:

Our language gives ...

- ... a semantic for:
  - The dynamics of operations inherited from KAOS
  - A concept of intentional actors : each one pursues its own goals
  - A distinct concept of roles : agents as required entites
  - The expression of several problem of assignments problems
- ... an algorithm to check the relative assignment solutions

Further works

- Identify laking actors : in case there is no possible assignment of roles to present actors, non-assignable roles are the actors to introduce by the machine.
- Further characterizations of strategies:
  - Ensure a role *rl* assigned to an actor *a* does not contradict its pursued goals
  - Compare the efficiency of different strategies in case they do not fully ensure the satisfaction of the roles.

Thank you for your attention

Any question?