Fragility and Robustness in Multiagent Systems

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Robustness: an important property of software systems

System and Software Engineering Vocabulary ISO/IEC/IEEE 24765

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Robustness refers to a system property

A property of a system is robust if it is invariant with respect to a set of perturbations [Alderson and Doyle, 2010].

- **reliability** as robustness to component failure
- **efficency** as robustness to lack of resources
- **scalability** as robustness to change to the size and complexity of the system as a whole
- **modularity** as robustness to structured component rearrangements
- **evolvability** as robustness of lineages to changes on long time scales

Robustness: the role of feedback

The availability of feedback is seen as crucial in gaining robustness [Alderson and Doyle, 2010].

Feedback

A piece of information, some facts that are obtained retroactively, that objectively concern an execution of interest, and that are passed from one component to another.

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Significance and quality of feedback

are crucial in making a system robust: [Alderson and Doyle, 2010].

- only information that is functional to the desired kind of robustness
- only information that comes from reliable source

Fragility in MAS: the role of feedback

- The **agents' autonomy** is an enabler of the system's adaptability, which is crucial to achieve robustness
  - However, adaptability requires the system to be equipped with the ability to produce proper feedback, propagate it, and process it, so to enable the selection and enactment of behavior that is appropriate to cope with the situation
- The **normative system** enables the exploitation of the agents' autonomy, creating expectations on their activities, which is crucial to achieve system robustness
  - However, agents may fail the expectations (the obligations). Whenever sanctions are not accompained by feedback and feedback handling mechanisms, they do not provide a means that support robustness

Accountability as a means for robustness in MAS

- The current design methodologies for MAS fall short in addressing robustness in a systematic way at design time.

Accountability

We exploit the notion of **accountability** [Garfinkel, 1967, Grant and Keohane, 2005, Dubnick and Justice, 2004, Baldoni et al., 2016, Baldoni et al., 2019] as a mechanism for building feedback/reporting frameworks, similarly to what is often done in human organizations [Sustainable Energy for All Initiative, , Zahran, 2011].

Accountability

It is the relationship between two parties:

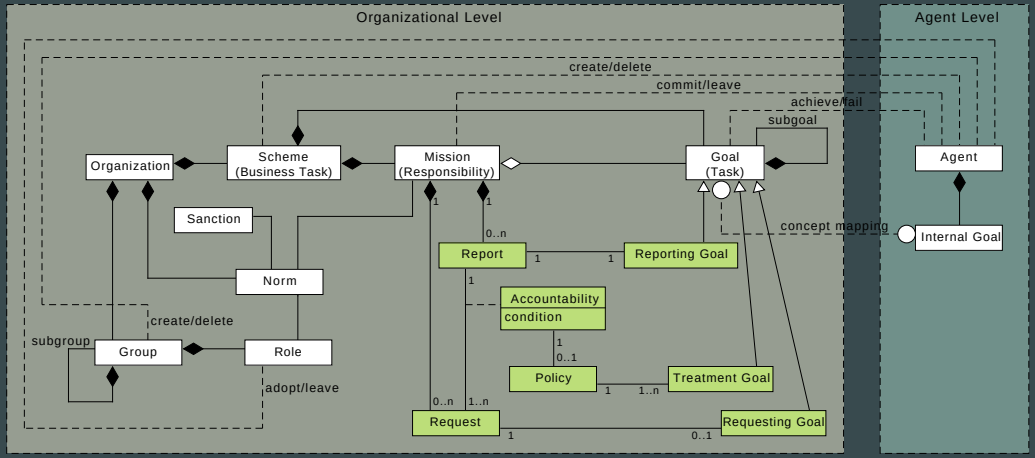
- one of the parties (the "account taker" or *a-taker*) can legitimately ask, under some agreed conditions, to the other party an account about a process of interest
- the other party (the "account giver" or *a-giver*) is legitimately required to provide the account to the a-taker

The two dimensions of accountability

1. normative dimension (*expectation*), capturing the legitimacy of asking and the availability to provide accounts, yielding expectations on the agents' behavior
2. structural dimension (*control*), capturing that, for being accountable about a process, an agent must have control over that process and have awareness of the situation it will account for

Exemplification in JaCaMo

The enhanced conceptual model.



Conclusions

- Accountability can be a design tool for achieving robustness
- In JaCaMo, by properly difining norms, it is possible to issue automatic obligations on reports and treatment goals (policy)
- A base for capturing a wide range of non-functional requirements

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