

Self-Adaptive Regulation Mechanisms for a Trustworthy and Sustainable Industry of the Future

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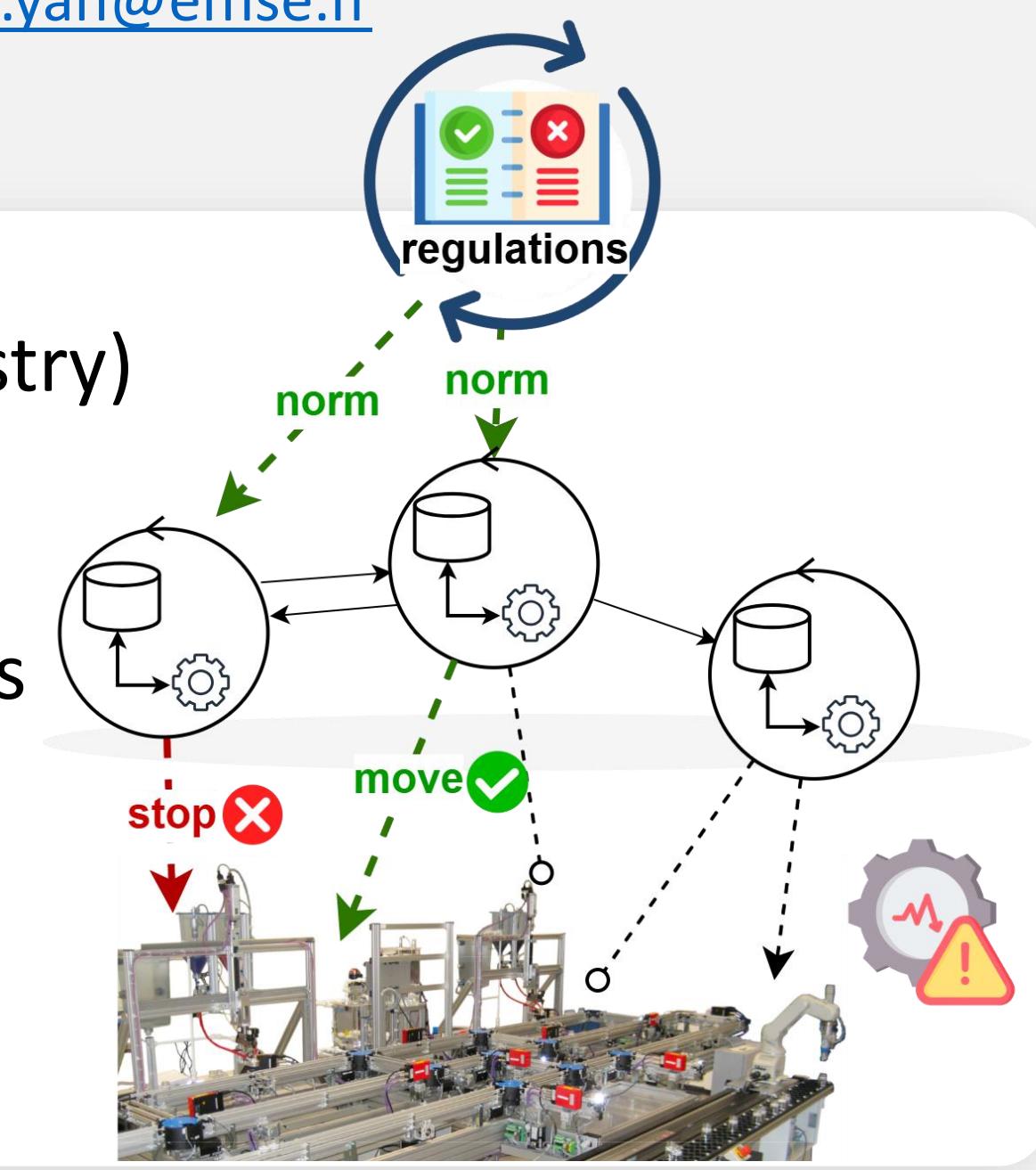
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Motivation & Objective

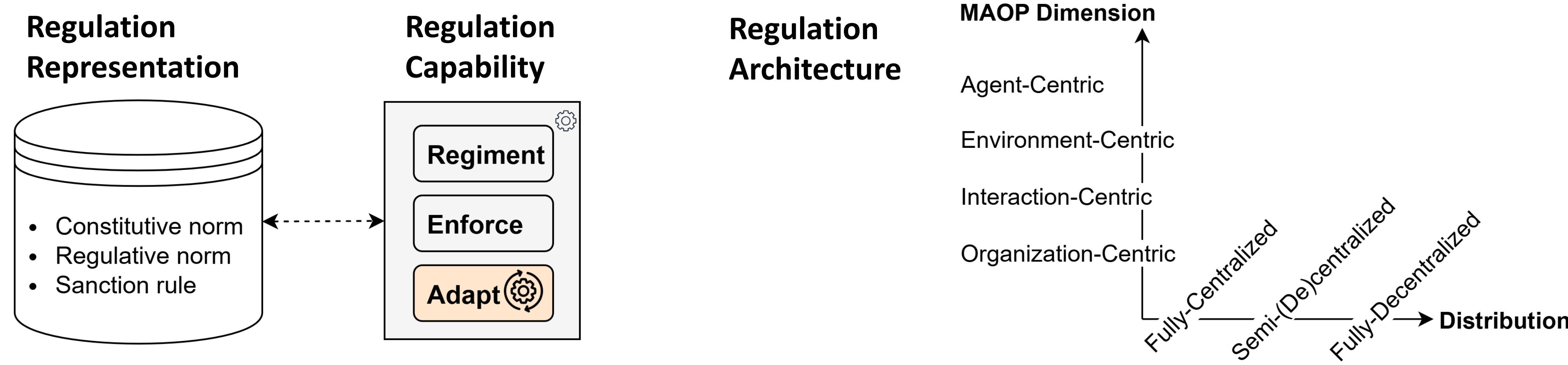
Multi-Agent Systems (MAS) offer the foundations to tackle complex processes in open and dynamic environments (e.g., industry)

→ Regulations are integrated in the normative MAS to guide agents' behaviors, but ensuring that these agents behave in *trustworthy* and *sustainable* ways requires effective **self-adaptive regulation mechanisms** to cope with dynamic environments

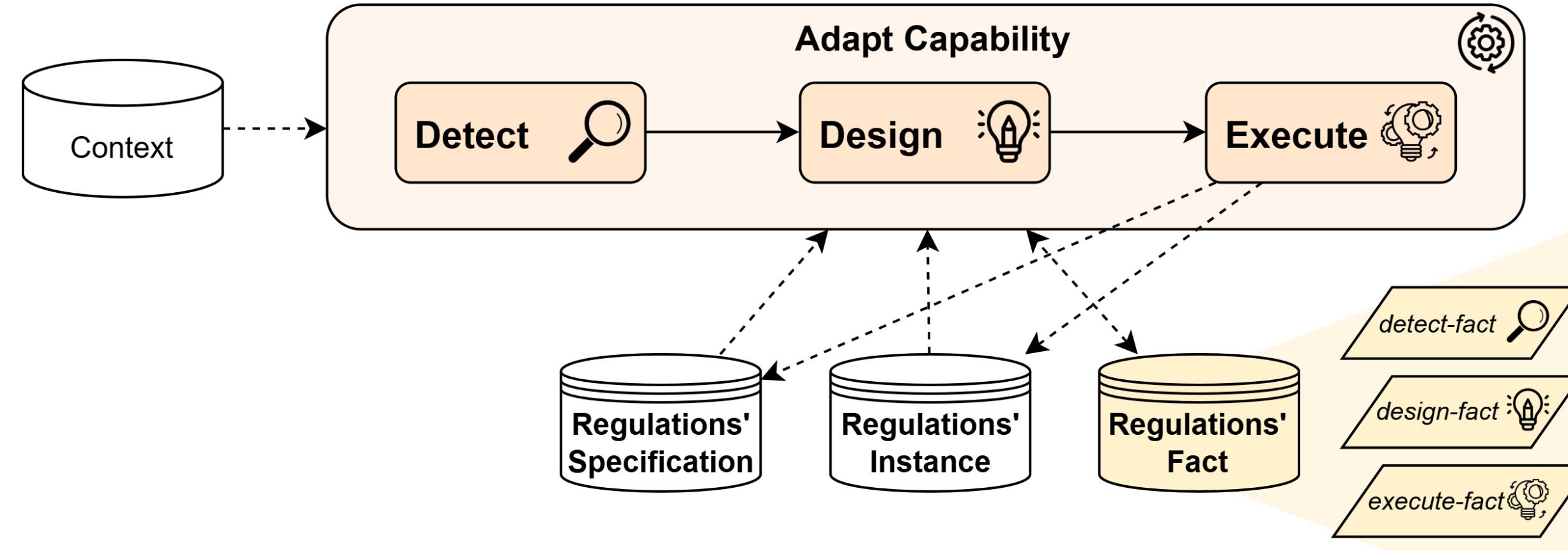
Objective: Design a *self-adaptive regulation management system* in normative MAS



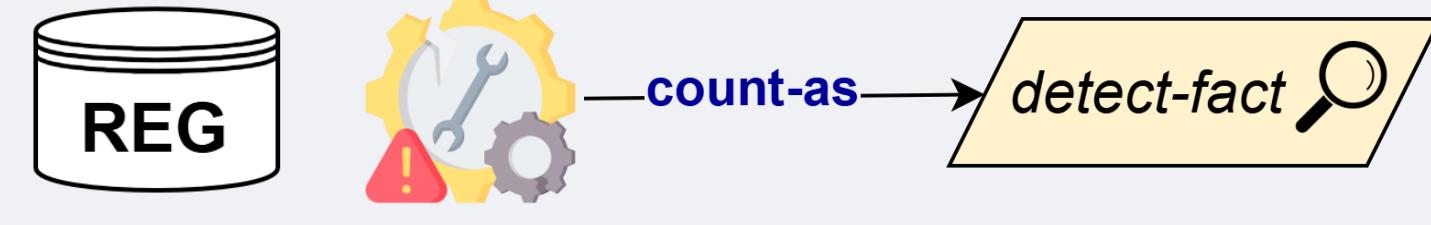
RQ1: What are the core elements of a *regulation management* system? [4]



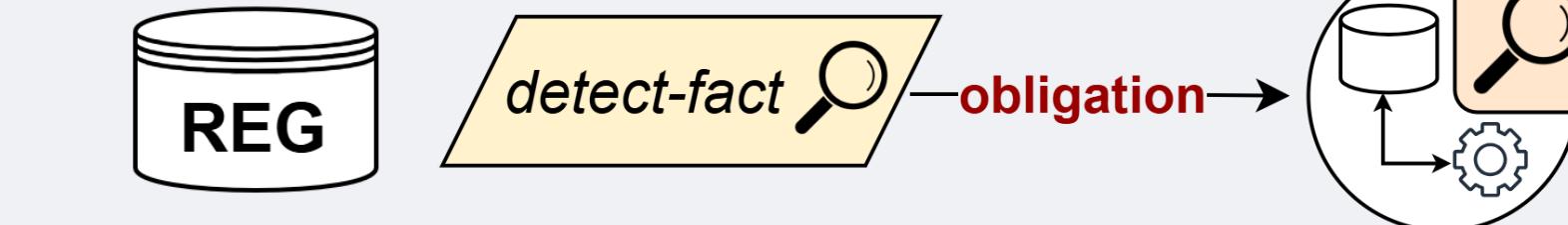
RQ2: What are the core elements for enabling *adaptation* in the regulation management system?



Approach: Use the same regulation management concepts and engine for enabling regulation adaptation



→ **Constitutive norms** for creating *adaptation facts* stating the corresponding adaptation requirement



→ **Regulative norms** for guiding agents in the *adaptation* capabilities of the adaptation process

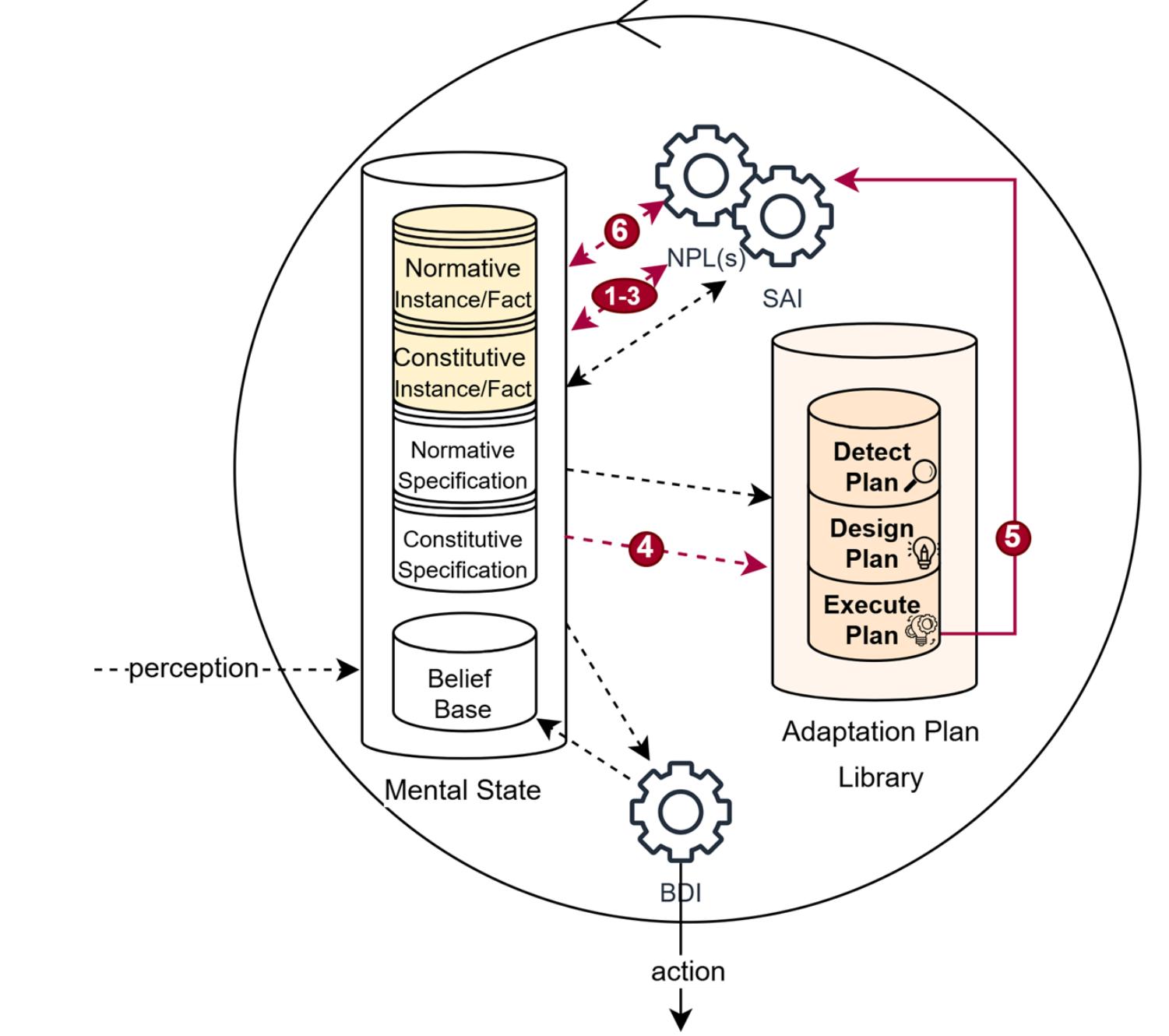
RQ4: How to integrate the self-adaptive regulation management system to support a *sustainable Industry of the Future*?

Regulation Representation

- Situated Artificial Institutions **SAI** [2] for programming constitutive norms
 $id : x \text{ count} \rightarrow y \text{ while } c$
- Normative Programming Language **NPL(s)** [3] for programming regulative norms and sanction rules
 $\text{norm } id : \varphi \rightarrow \psi \text{ [if } \phi : sr_i(\text{args})\text{]}$.
 $\text{sanction-rule } sr_i(\text{args}) : \rho \rightarrow \text{sanction}(\alpha, \gamma)$.

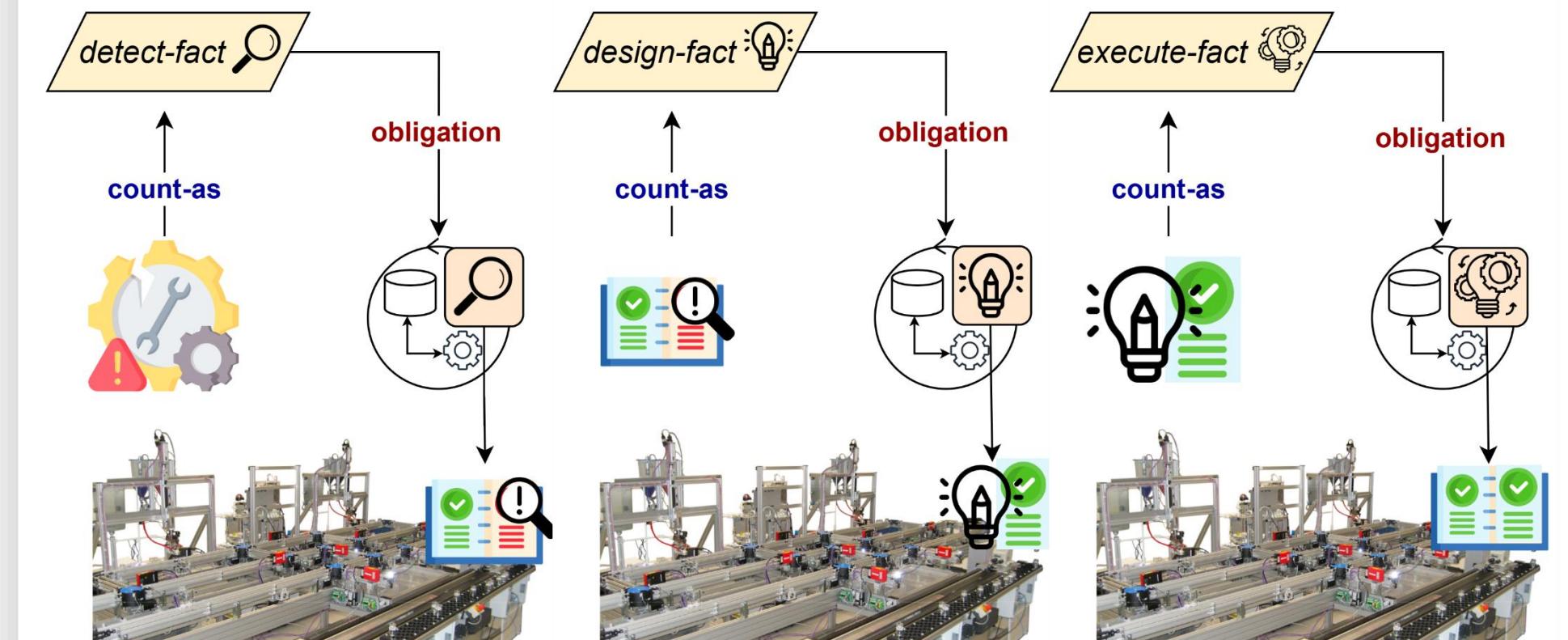
Agent-Centric Regulation

BDI agent architecture in JaCaMo [1] integrated with SAI and NPL(s) engines and the adaptation capability



Regulation Representation → Agent's beliefs
Regulation Capability → Agent's plans (enforce and adapt)

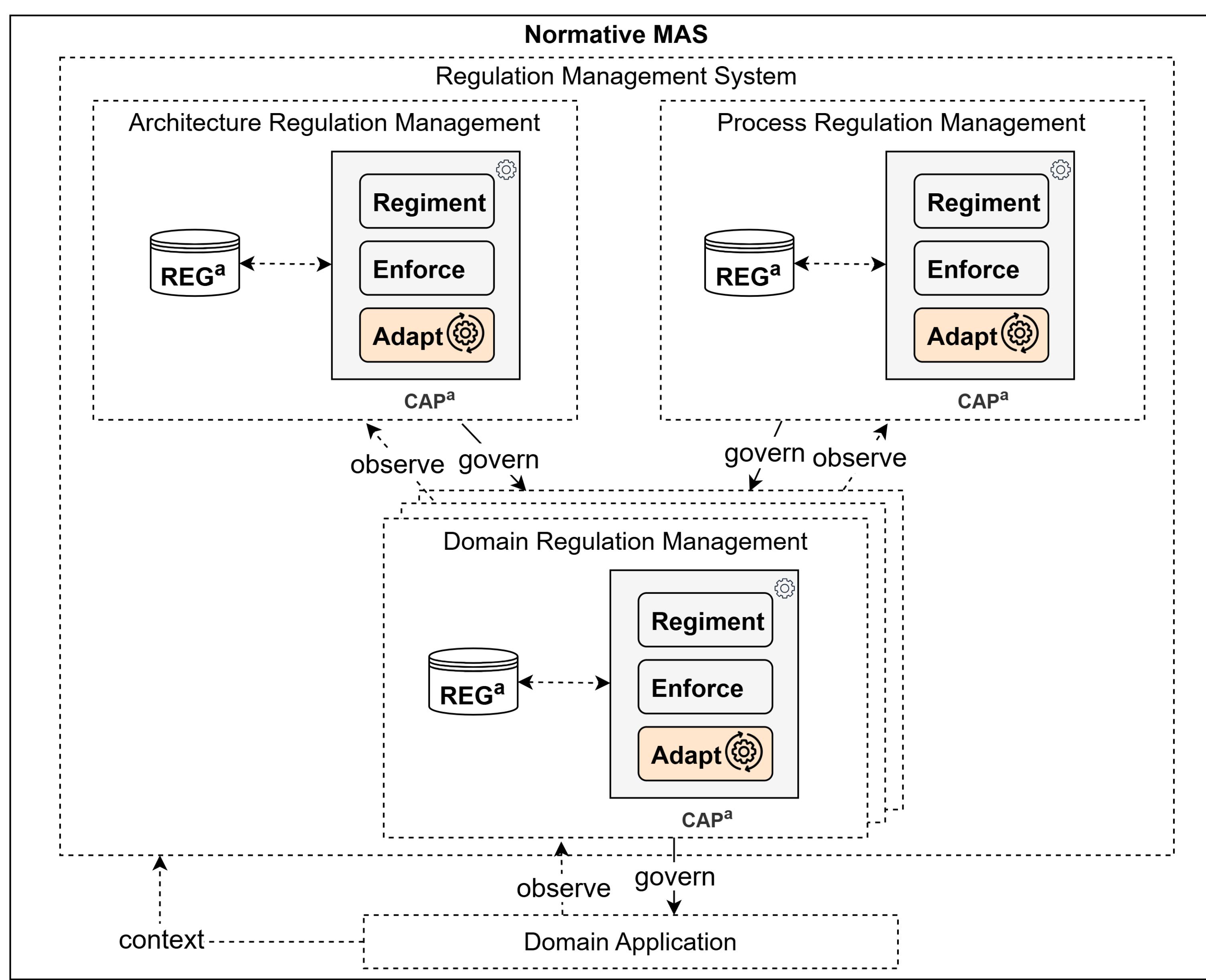
Regulation Adaptation



failure **count-as** **detect-fact**
detect-fact → **obligation**(alice, detect-goal)
detected **count-as** **design-fact**
design-fact → **obligation**(bob, design-goal)
designed **count-as** **execute-fact**
execute-fact → **obligation**(carlos, execute-goal)

Regulation management can be used to govern and **adapt**

- Domain application
- Regulation process
- Regulation architecture



RQ3: How to support *trustworthiness* in the self-adaptive regulation management?

Explaining the agent's mental state at *multiple levels* (i.e., implementation, design, domain) for *different stakeholders* (e.g., developers, designers, end-users) [5]

→ Extend it to **explain** the agent's representation of **regulations** and **regulation management decisions**

Future experiments

- Adaptation of the capability process and architecture
- Explainability

References

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