

Reasoning about Norms Revision

Davide Dell'Anna, Mehdi Dastani, Fabiano Dalpiaz

Department of Information and Computing Sciences, Utrecht University, The Netherlands

D.DellAnna@uu.nl, M.M.Dastani@uu.nl, F.Dalpiaz@uu.nl



Motivation

Context: normative multi-agent systems, where norms with sanctions are used to control the system and to influence the behavior of autonomous agents without limiting their autonomy.

Problem: misalignment between norms and system objectives if system objectives change during execution.

Proposal: dynamic revision of norms at runtime to ensure the changing system objectives.

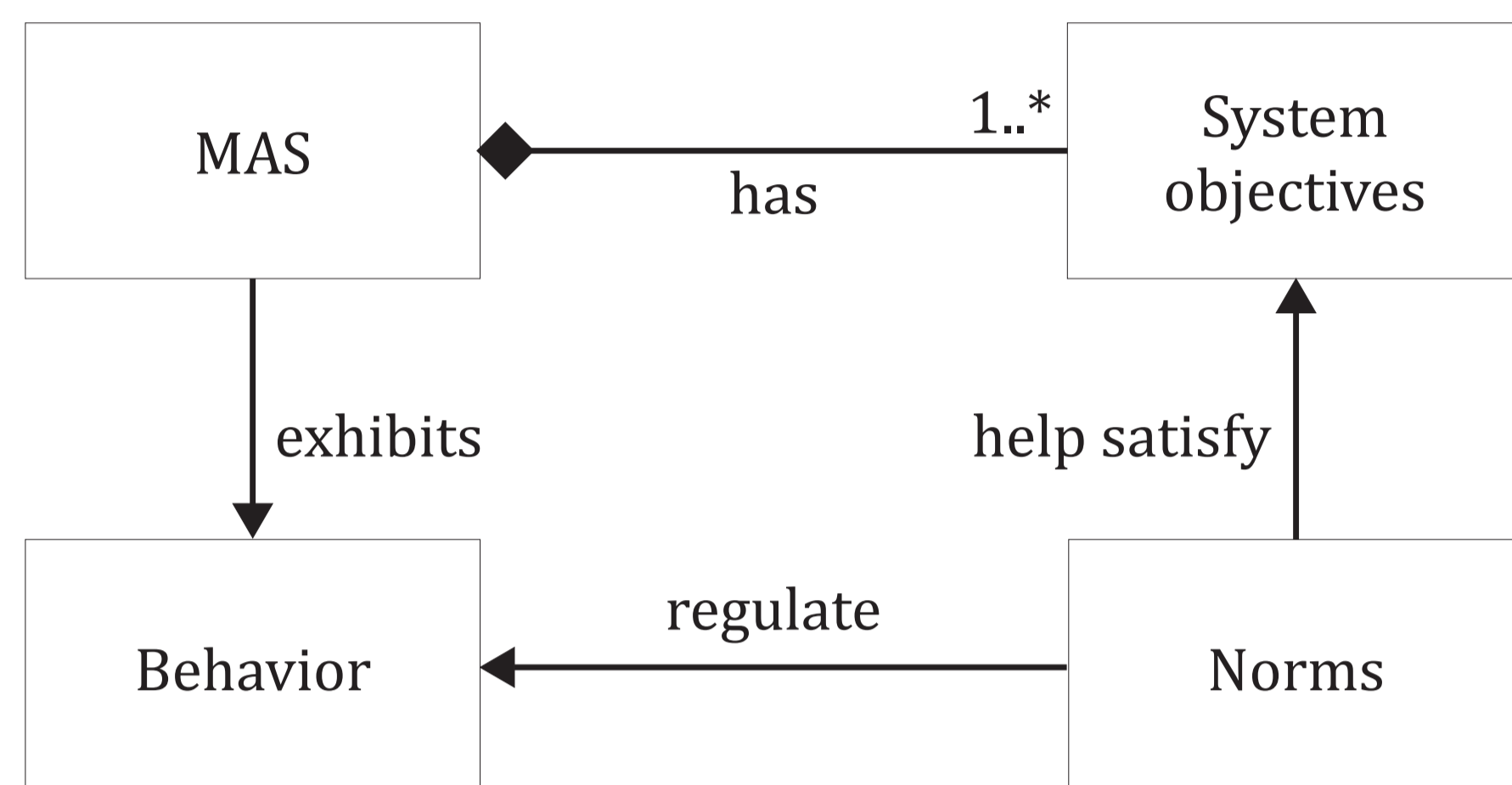


Figure 1: Generic conceptual model of a normative multi-agent system

Runtime Supervision Framework

A runtime supervision framework continuously monitors the execution of a multi-agent system, evaluates its behavior against the currently enforced norms, and intervenes by deciding which norms should be revised.

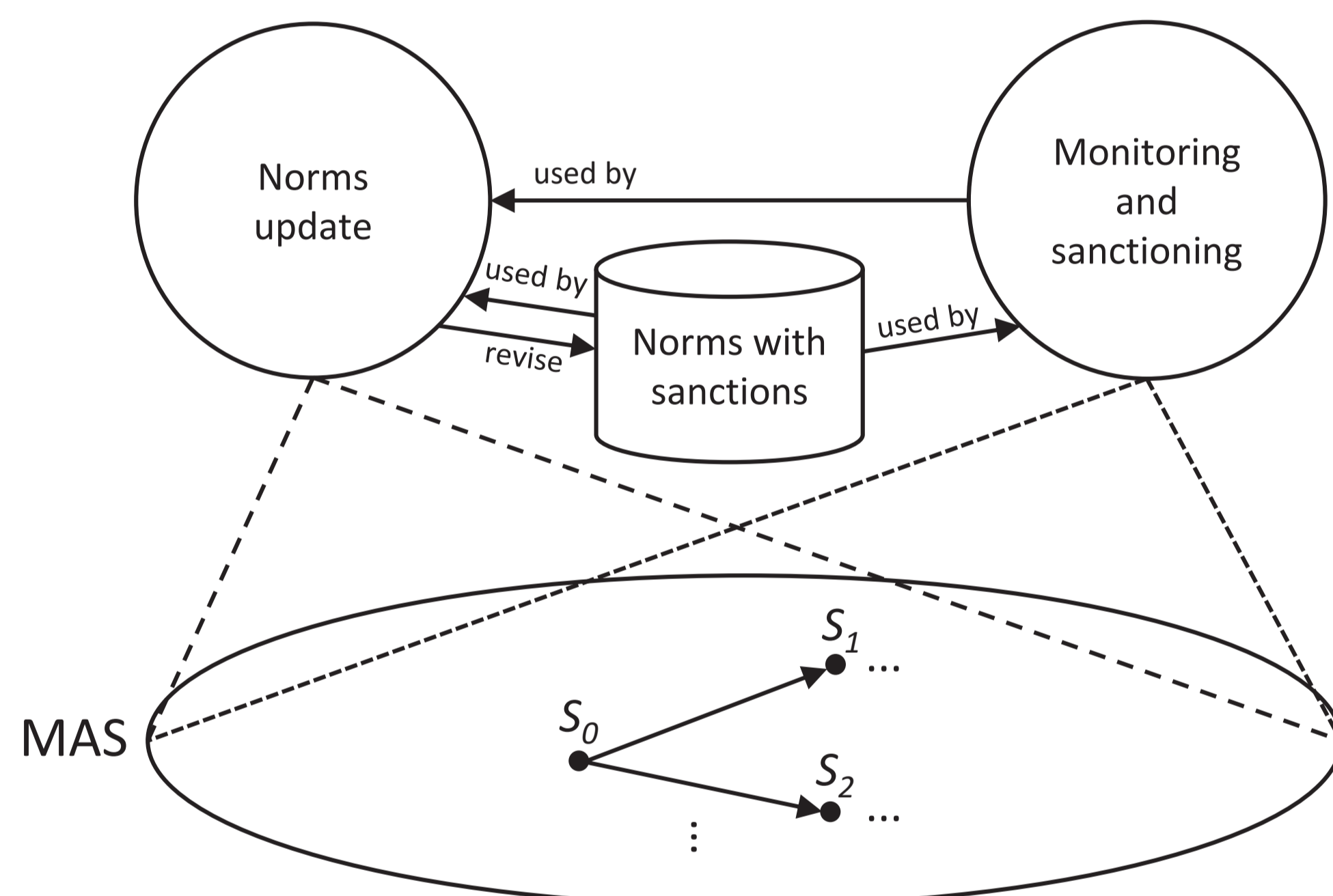
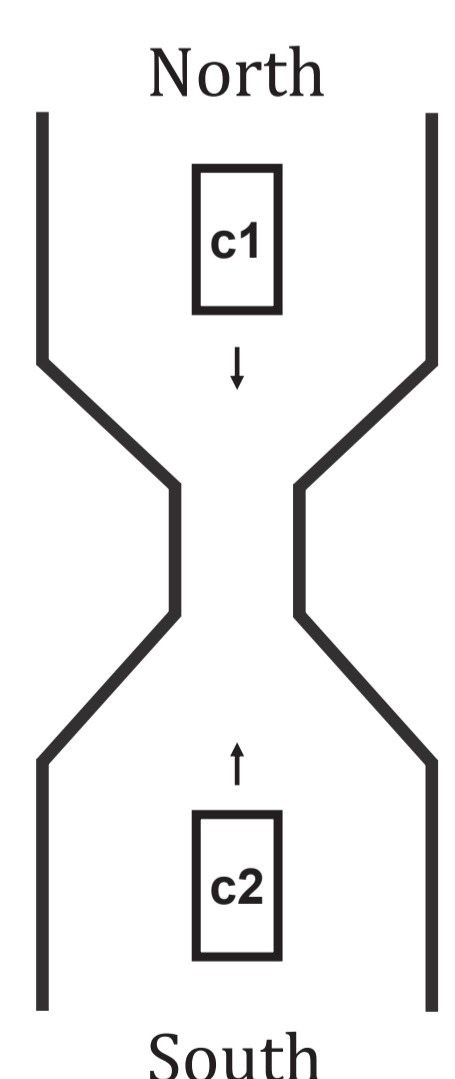


Figure 2: The main components of the proposed runtime supervision framework. The dashed lines represent the scope of the components, S_0, S_1, S_2, \dots are possible states of the MAS.

Illustrative Scenarios

Smart Roads (Narrowing Road)



- System objective: "to keep queues size small".
- Enforced norm N : "if two cars $c1$ and $c2$ are at the opposite ends $c1$ shall move and $c2$ shall wait, otherwise 1000 euros fine".
- During execution the heavy traffic from North during rush hours causes the queue from South to grow too much when N is enforced.
⇒ Norm N is not appropriate for rush hours.

Automated Immigration Service

- System objectives: "to detect potential terrorists and to process all pending applications in adequate time".
- Enforced norm N : "whenever a passenger arrives at the immigration desk: photo, nationality, visa and baggage shall be checked".
- Changes in immigration flows make the number of pending applications to exceed the system's processing capacity.
⇒ Approximation of norm N is required.



Norms Revision

$Viol(M, N)$ is the set of all behaviors of the system M each violating at least one of the currently enforced norms N .

Revision

- Relaxation** of a set of norms N : replacement of N with a new set N^R such that $Viol(M, N^R) \subset Viol(M, N)$.
- Strengthening** of a set of norms N : replacement of N with a new set N^R such that $Viol(M, N^R) \supset Viol(M, N)$.
- Regular alteration**: any other replacement of N with a new set N^R such that either $Viol(M, N^R) = Viol(M, N)$ or both $Viol(M, N^R) \not\subset Viol(M, N)$ and $Viol(M, N^R) \not\supset Viol(M, N)$.

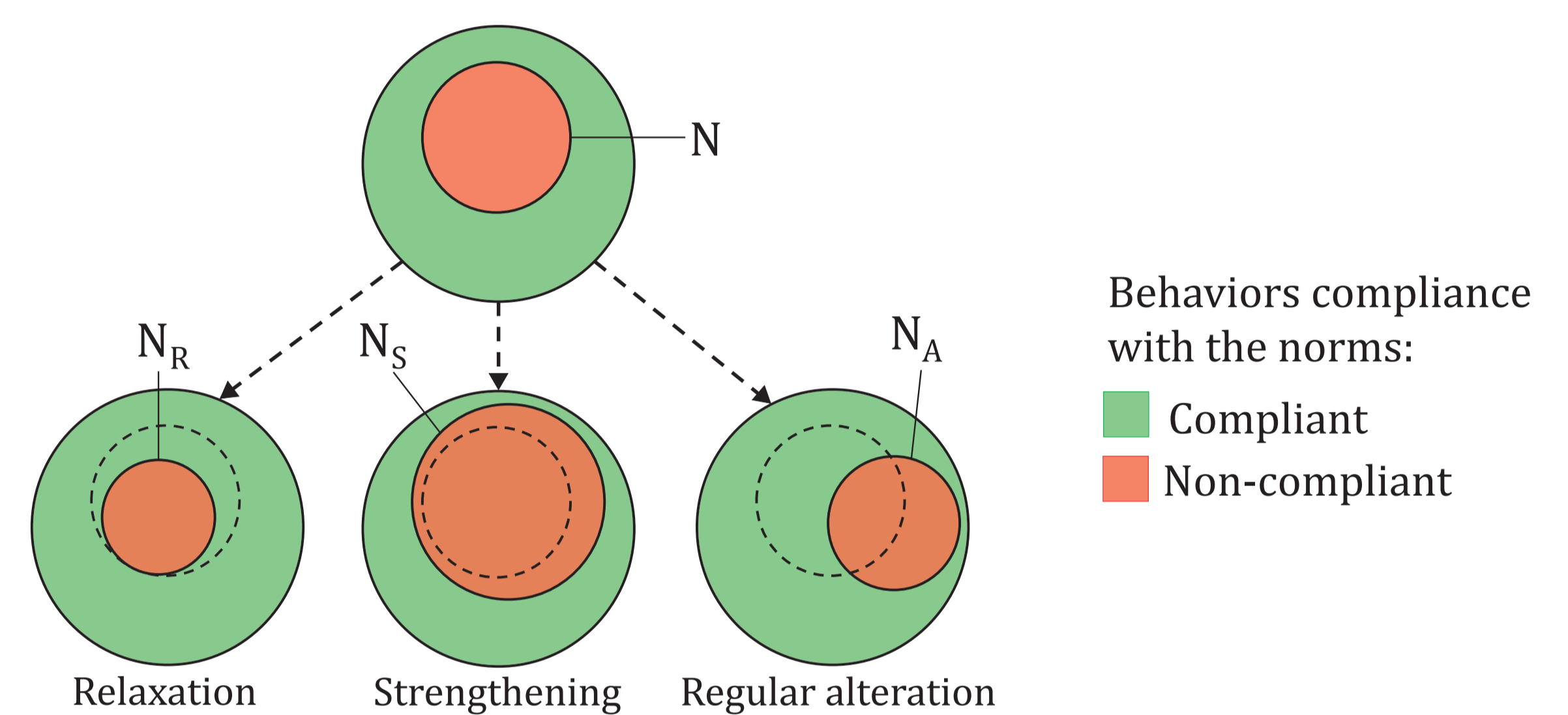


Figure 3: Classification of behaviors with different revisions of norm N . The dashed circles represent the classification with the original norm N .

Sanctioning

Sanctions associated with norms are an alternative means to influence the behavior of agents.

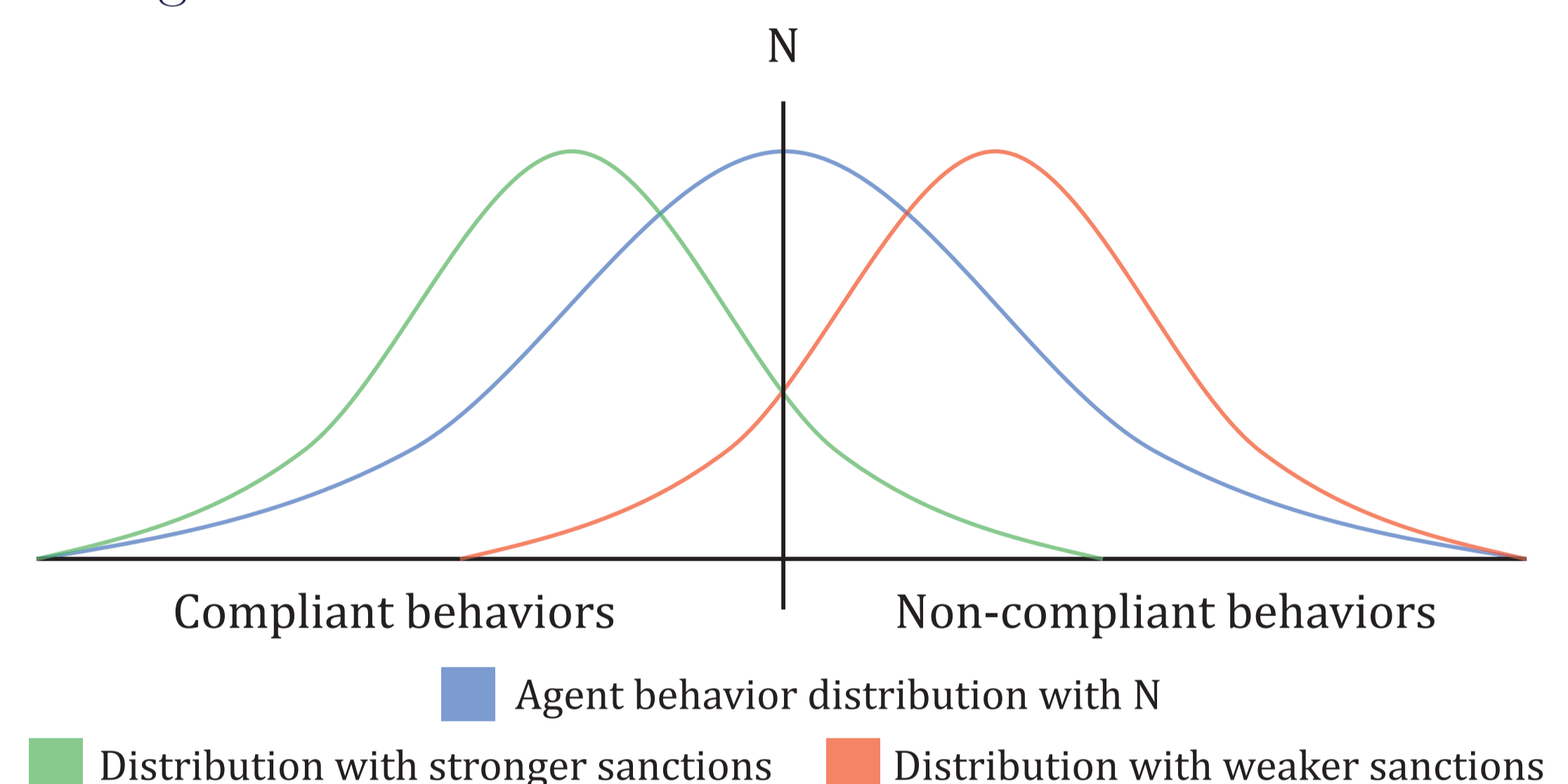


Figure 4: A possible change of agents behavior due to different sanctioning of norm N .

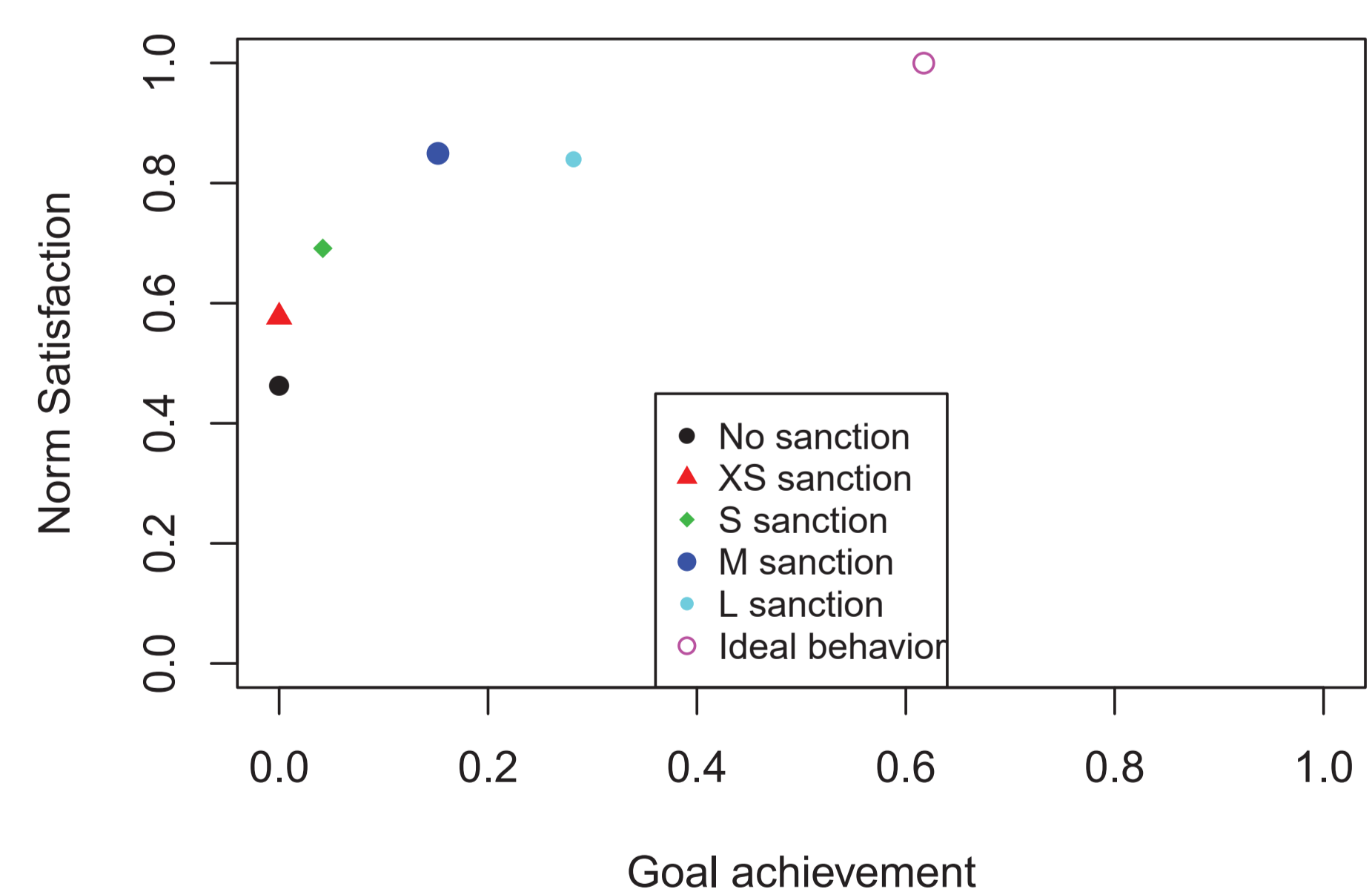


Figure 5: The effect on the probability of goal achievement with different sanctions associated with norm N in the Narrowing Road scenario.

Conclusions and Future Work

Preliminary study of some types of revision of norms to be enacted on a running multi-agent system to enhance its performance. Definition of the concepts of norms revision, relaxation and strengthening.

Future work:

- study of the effects of revision on normative systems.
- formal analysis of the correlation between the enforced norms and the fulfilment of the overall system objectives.
- development of techniques to automatically learn and reason at runtime about this correlation and to automatically suggest and perform a revision.