Post-Doctoral position at INRIA

Robust optimal planning in stochastic timed systems

application to the smart control of urban transportation systems

Location: SUMO team, INRIA Rennes, France
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Duration: 12 months
Salary: around 28000 euros/year (+ benefits of social security)
Application: send resume (including publication list and PhD summary), a copy of most significant papers, motivation letter and a list of professional references

Context:
The SUMO team develops formal methods for the modelling, verification and management of large scale distributed systems. Besides scalability issues, the team focuses on quantitative models and methods, abstraction and approximation techniques, and distributed algorithms.
SUMO is collaborating with leading industrials on regulation techniques for urban train systems. The proposed research will support some of the theoretical developments needed for this collaboration.

Subject:
Smart cities will assume smart transportation systems that can easily react and adapt to sudden changes in their operating modes. Focusing on urban trains, tramways and subways, one can imagine for example sudden crowds forming at some station (in case of rain or of a cultural event), malfunctions that induce delays or missing trains, or simply maintenance requirements that perturb the standard way of running the system. Being able to robustly react to such events assumes that systems are resilient enough, but mostly that they are equipped with high-level control capabilities. One can no longer imagine that human operators will empirically build and implement complex action plans to best react to complex situations. This task must be handed over to the machine, while human operators supervise the system through high-level performance indicators, and pilot it through high-level objectives.

The objective of this postdoc is to contribute to the theoretical foundations of this problem. The focus is placed on planning problems, which consist in organizing actions to drive the system to a desired goal state. In our context, such goals could be the injection of extra trains on a line, a partial line closure, the temporary raise of transportation capacity at some location, etc. The problems we consider are timed, to account for the nominal amount of time needed to execute each action. This means that action plans must decide which chains of actions should be triggered, but also at what time they should occur. The context is also stochastic: action durations can be random, and external perturbations can influence the system. Therefore action plans must also be robust and aim at minimizing failure risks. Finally, several competing objectives may be considered for the planning problem, which embeds the problem in a multi-criteria optimization setting. The algorithms to address the above questions will be either centralized or distributed, either exact or approximate. Several modelling formalisms are envisioned for the above problem, such as stochastic time Petri nets, networks of timed automata, constraint graphs, and others.

The above theoretical developments assume a given model instance, on which algorithms can be run. But in practice, a key difficulty is to obtain the appropriate model corresponding to a given use-case. A second objective of this postdoc is thus to design a methodology to build this model. This encompasses the choice of the appropriate modelling formalism, the selection of relevant use-cases, the automatic instantiation of the model, the resolution of the planning problem, and the back transfer to the application domain. All this work will be done in collaboration with our industrial partners.

Ideal profile: PhD in computer science, oriented to formal methods, quantitative models, algorithmics, abstraction and approximation techniques. Taste and skills for applications are required. According to the profile and tastes of the candidate, this PostDoc topic will be theory oriented or application oriented, but in both cases prototypes of the proposed methods should be developed.

Keywords: formal methods, stochastic system, timed system, optimal planning, multi-criteria optimization, approximation, abstraction, distributed algorithm, urban train regulation

Required skills: PhD in computer science, oriented to formal methods, quantitative models. Taste and skills for applications are required.