Internship topic: Uniform sampling of timed patterns for cyber-physical systems test generation

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Validation techniques for cyber-physical systems are essential for ensuring correct operations of safety-critical applications. Current validation techniques for these systems are costly if high confidence in the results is expected and can still fail to identify all of the significant system behavioural patterns, which can have a detrimental effect on safety and performance. When no bug is revealed, the information about the degree of correctness would be of great interest to the designer. This information can be provided in terms of a test coverage measure or confidence interval.

In cyber-physical system models, input signals can represent either uncontrollable disturbances from the external environment in which the system operates, or some control signals that are fed to the system. In the latter case, these signals are often controlled, that is they satisfy some properties or preconditions. In the former case, input signals must also belong to a class of functions describing realistic disturbances or meaningful input stimuli. The properties we are interested in this project are expressed using STL (Signal Temporal Logic) or timed automata, formalisms useful for describing real-time constraints or temporal patterns of behaviours. Exhaustive exploration of all possible behaviours is infeasible in practice, our test-based approach makes use of random sampling and provides statistical guarantees of the results.

The goal of the project is to apply recent results on uniform random generation of behaviours of timed automata [1] to test generation for cyber-physical systems [2]. In particular, we focus on the problem of generating signals satisfying an STL formula with a good coverage. The concrete objective of this internship is to study and implement algorithms to solve this problem. The implementation could be based on the existing tool-chain described in [1] and available online at http://www.prismmodelchecker.org/files/qest16/.

**Required Skills** Candidates should have some background in formal methods and embedded systems. Good programming skills are desirable.

**References**