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# EasyModel: A Refinement-based Modeling and Verification Approach for Self-Adaptive Software

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# Abstract


- Recently, the software size and complexity is increasing, and the running environment and user requirements are frequently changing, which leads to further demands for software self-adaptation ability. The self-adaptive software (SAS) can timely deal with the above dynamic changes by adjusting its structures or behaviors. An early modeling and formal verification of SAS can improve its reliability and alleviate development difficulty. However, the SAS systems are difficult to model and verify because of the high system complexity.

# Objective

Our research aim is to aid software designers in reducing modeling and verification difficulty of SAS systems and improving system reliability, by constructing a refinement-based modeling and verification approach for SAS systems.

# Method

We present EasyModel (ease modeling difficulty), a methodology that integrated the intuitive UML model with the stepwise refinement Event-B model. Concretely, EasyModel: (i) creates a UML profile called AdaptML that can realize an explicit description of SAS characteristics, (ii) proposes a refinement modeling mechanism for SAS systems that can deal with system modeling complexity, (iii) offers a model transformation approach and bridges the gap between design model and formal model of SAS systems, and (iv) presents an efficient formal verification method that can provide guarantees for the correct behavior of SAS systems.

# Results

- We validate the EasyModel approach with an example application and a subject-based experiment. The results demonstrate that the EasyModel approach can satisfy modeling requirements of SAS systems, and can effectively reduce modeling and formal verification difficulty of SAS systems.

# Conclusions

- The results show that the EasyModel approach can incorporate the intuitive merit of UML and the correct-by-construction merit of Event-B. Besides, this idea of combining extended UML with Event-B model also provides a reference for the modeling and formal verification of other similar complex information systems, such as cyber-physical systems.