Synthesizing Multi-View Models of Software Systems

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Outline

Introduction

A multi-view modeling framework

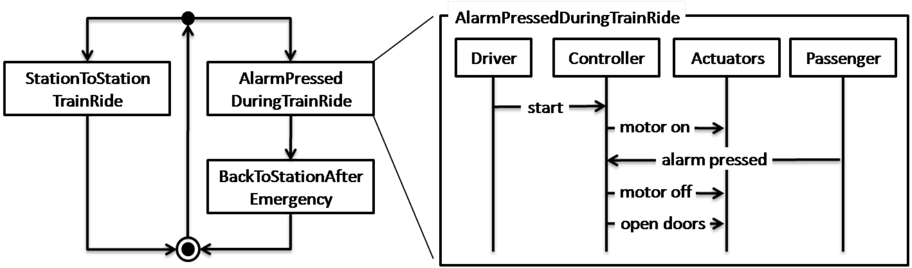
Abstract

Acts as a background chapter about the models we use, their syntax and semantics. Contributions shared with Damas thesis.

Outline

- Event-based Behavior Models
  - Message Sequence Charts (MSC) for instance behaviors
  - Labeled Transition Systems (LTS) for class behaviors
- State-based abstractions
  - Capturing state information with Fluents
  - Guards in behavior models
  - Decorations on behavior models
- Intentional models as goal graphs on fluents
  - Goals and Fluent Linear Temporal Logic (FLTL)
  - Linking FLTL and LTS: property and tester automata

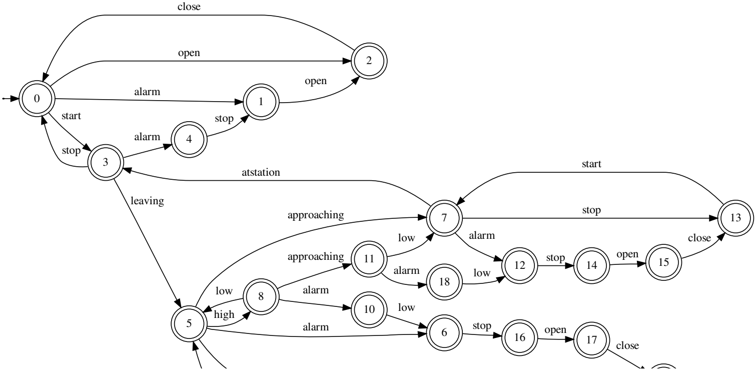
Message Sequence Charts for instance behaviors



MSC (right) and high-level MSC (left)

- Syntax of MSC and hMSC is described in [ITU96]
- Semantics of MSC and hMSC is defined in terms of Labeled Transition Systems, following [UKM03]
- We also allow a hMSC node to be refined as a finer-grained hMSC

Labeled Transition Systems for class behaviors



Labeled Transition Systems

- Syntax and Semantics defined in [MK99]
- Each agent behavior is defined by a LTS. The system behavior is defined by LTS composition
- MSCs are admissible traces in the system LTS [UKM03]

Capturing state information with Fluents

Fluents capture the system state through the occurrence of events [Mil89]

$$fluent\ Fl =< init_{Fl}, term_{Fl} > initially\ Init_{Fl}$$

where $init_{Fl}$ and $term_{Fl}$ are disjoint set of events rendering the fluent *true* and *false*, respectively

Example

$fluent\ moving =< start, \{stop, emergency\ stop\} > initially\ false$
$fluent\ doors\_closed =< close, \{open, emergency\ open\} > initially\ true$

Guards in Behavior Models

Summary

Guards can be formally used in hMSC and LTS, leading to guarded hMSC (g-hMSC) and guarded LTS (g-LTS)

- A guard is a boolean expression on fluents
- Structured forms for hMSC and LTS, avoiding state/trace explosion
- Relax the assumption of fluent initial values being known for all instances

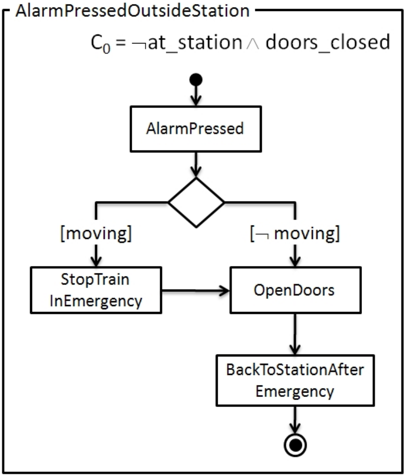
Related publication

Damas C., Lambeau B., Roucoux F. and van Lamsweerde A., *Analyzing Critical Process Models through Behavior Model Synthesis*, in Proc. ICSE'2009: 31th International Conference on Software Engineering, Vancouver, Canada, May 16-24, 2009.

Guards in hMSC, i.e. g-hMSC

Summary

- *Decision nodes*: outgoing transitions are labeled by boolean expressions on fluents
- Initial condition C_0 stating an invariant on the initial state
- Trace semantics through guarded LTS and LTS
- Automated checking of guards: *non overlapping*, *completeness* and *reachability*

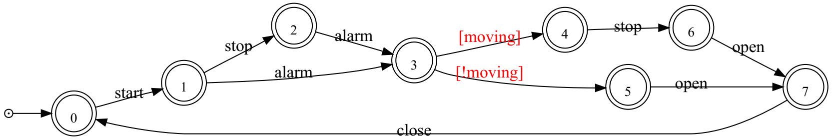


Guards in LTS, i.e. g-LTS

Summary

- A g-LTS transition is labeled by an event or a guard
- Initial condition C_0 stating an invariant on the initial state
- A trace is accepted by a g-LTS if three conditions hold: *trace inclusion*, *admissible start* and *guard satisfaction*

Example



- $C_0 = \neg moving \wedge doors\_closed$
- The event trace (*start alarm open*) is not accepted due to the *guard satisfaction* condition

Deductive synthesis of LTS models from guarded hMSCs

Chapter Outline

- From guarded hMSC to guarded LTS
- From guarded LTS to pure LTS
- Model analysis perspectives of deductive synthesis

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