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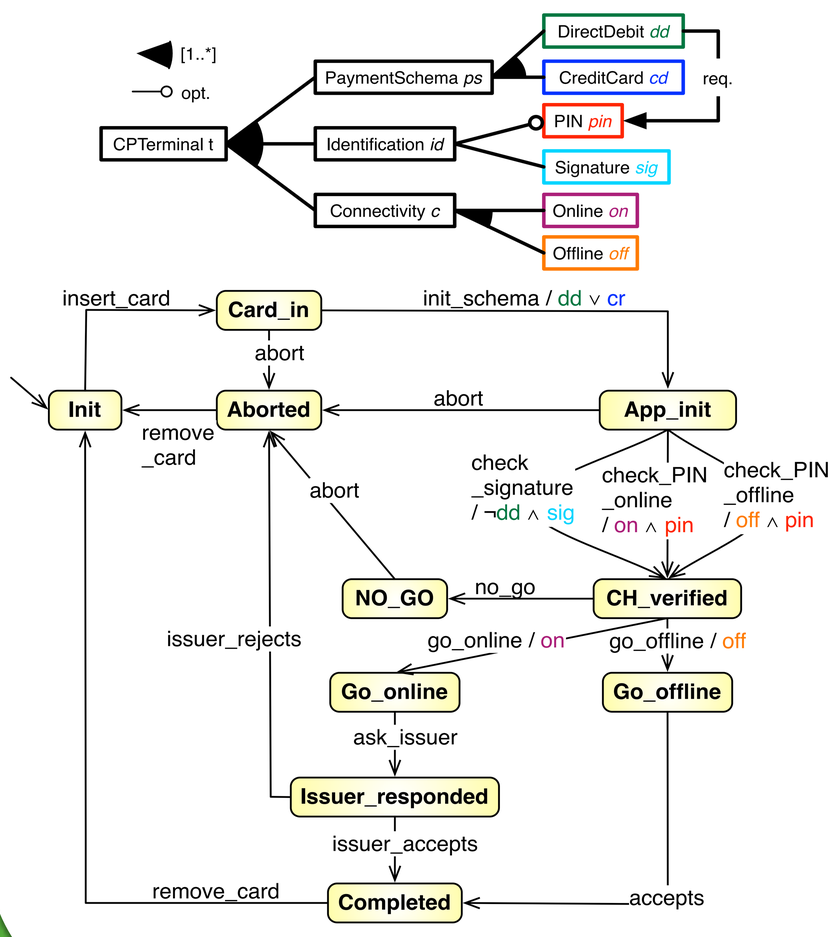
Behavioral Model-Based Testing of Variability Intensive Systems

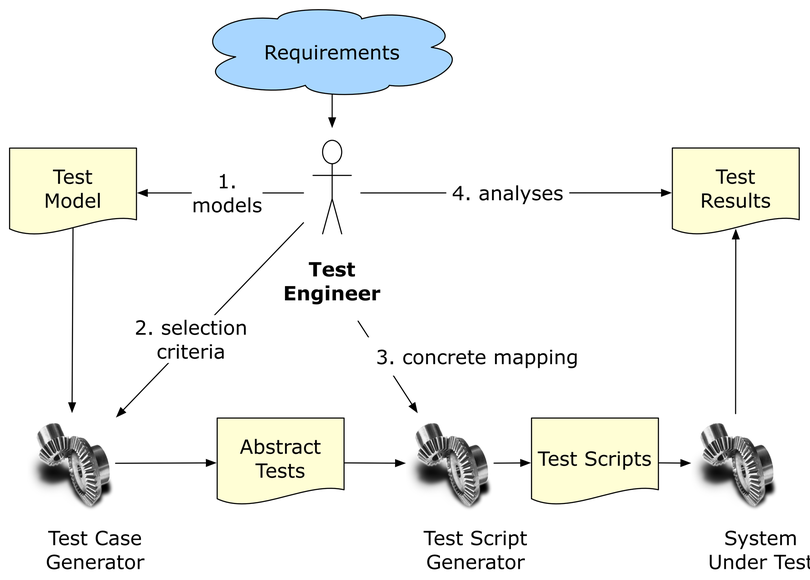
Xavier Devroey, Gilles Perrouin, Pierre-Yves Schobbens, Patrick Heymans

- Focus on **Variability-Intensive Behavioural** Models (software product lines, plugin-based systems, etc.)
- Formal Foundations (**Featured Transition Systems**) suitable for **Analysis** and **Checking**
- Combining **Model-checking** and **Test-case Generation** techniques in **VIBeS Framework**
- Cover various **Testing Activities** (test-case seleciton, prioritization, mutation assessment, etc.)

Test Model

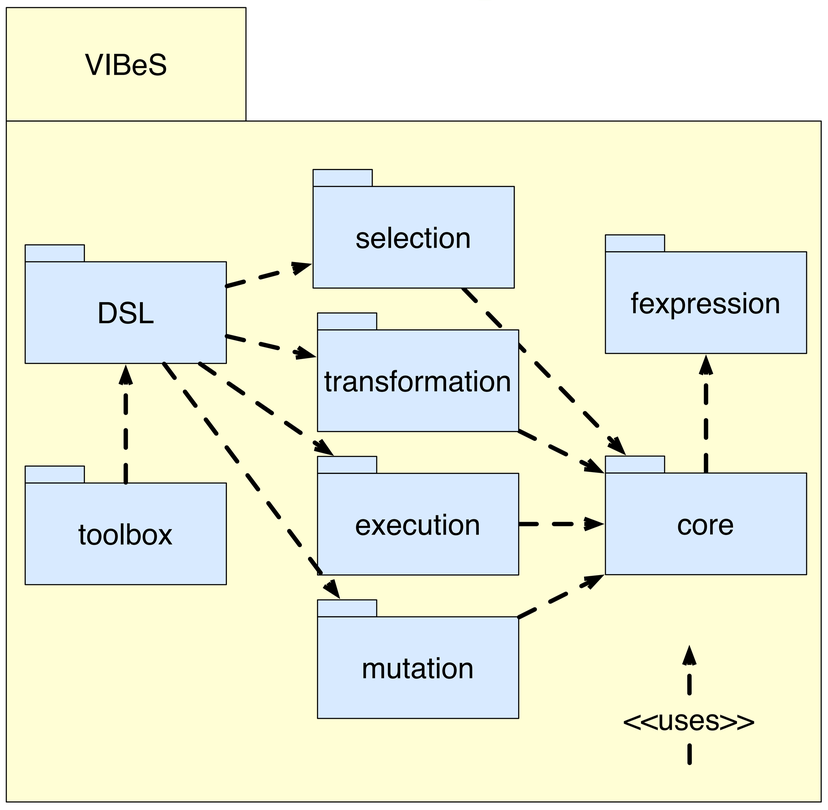


Model-Based Testing Process



1. Models definition (Java DSL)
2. Selection criteria definition
   - Maximizing
     - Structural coverage (state, transition, paths, ...) [2,3]
     - Usage coverage (based on a usage model) [4]
     - Dissimilarity measure (based on distance def.)
     - Number of mutants killed by the tests [1]
   - Minimizing
     - Number of test cases in the test set [3]
     - Number of valid configurations needed by the test set [3]
3. Concrete mapping definition (*TBD*)
4. Tests results analysis (*TBD*)

Variability Intensive system Behavioural teSting Framework



Models Def.

Featured Transition System Java DSL

```
public class CPTerminalFts extends
   FeaturedTransitionSystemDefinition {
@Override
protected void define() {
  initial("i");
  from("i").action("insert_card")
     .to("CardIn");
  from("cardIn").action("init_schema")
     .fexpr("dd || cr").to("App_init");
  ...
}}
```

Feature Model

Boolean Conjunctive Normal Form (CNF) in DIMACS format used as input to SAT and BDD solvers

Selection Criteria Def.

Structural coverage

```
FeaturedTransitionSystem fts =
  new CPTerminalFts().getTransitionSystem();

SolverFacade solver =
  new Sat4JSolverFacade(dimacsFile);

TestSet set = allStatesSelection(fts, solver);
```

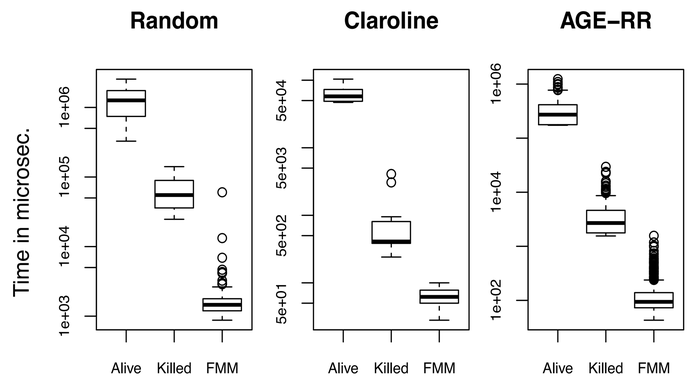
Dissimilarity measure maximization

```
...
set = dissimilarLocalMaximumDistance(fts,
  solver, nbrTestCases, time);
...
set = dissimilarGlobalMaximumDistance(fts,
  solver, nbrTestCases, time);
```

Model Based Mutation Testing

- **Goals**: Quality Assessment (QA)
  - **Tester**: QA of a **set** of abstract test cases
  - **Researcher**: QA of a test case **selection method**
- Mutant = Test Model with injected fault(s)
- Result of the application of a **mutation operator**
  - Act. Exchange, State Missing, Trans. Dest. Exchange, etc.
- **Execution** of the test cases on the mutants
- Mutation score = $\frac{\text{Number of mutants detected}}{\text{Total number of mutants}}$

Mutant Execution using Featured Mutants Model



Future Work

- **Higher order** and **equivalent** mutants detect./gen.
- **Test cases** generation using counter examples in ProVeLines FTS **model checker**
- Abstract test cases **concretization**
- Empirical assessment on an **industrial case study**

Bibliography

[1] Devroey, X., et al. (2014). **A Variability Perspective of Mutation Analysis**. In *Vision & Challenges @ FSE'14*. Hong Kong: ACM.

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[3] Devroey, X., et al. (2014). **Coverage Criteria for Behavioural Testing of Software Product Lines**. In *ISoLA'14*. Corfu, Greece: Springer.

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