A JavaPathfinder Extension to Analyze Human Machine Interactions

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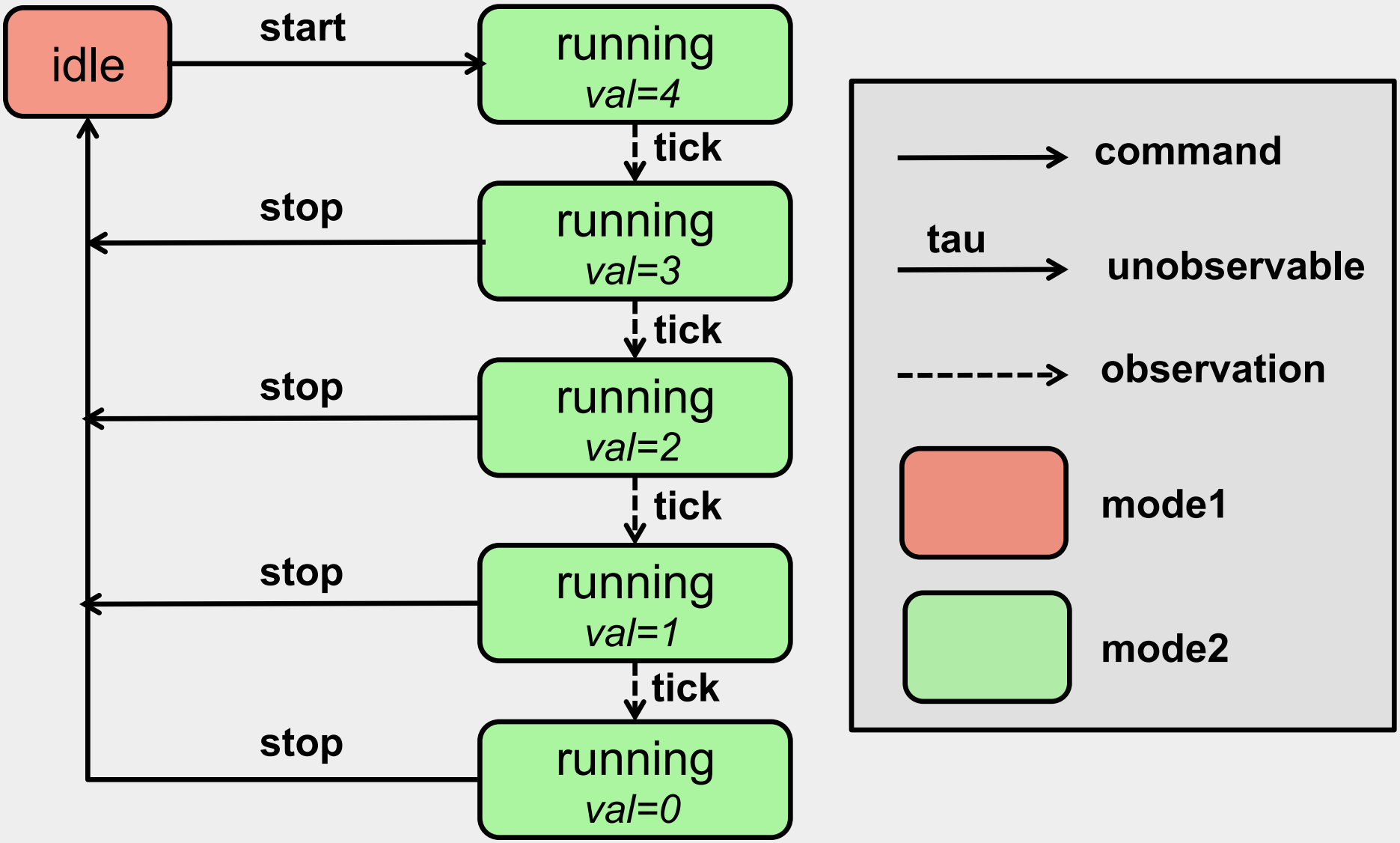
HMI issues

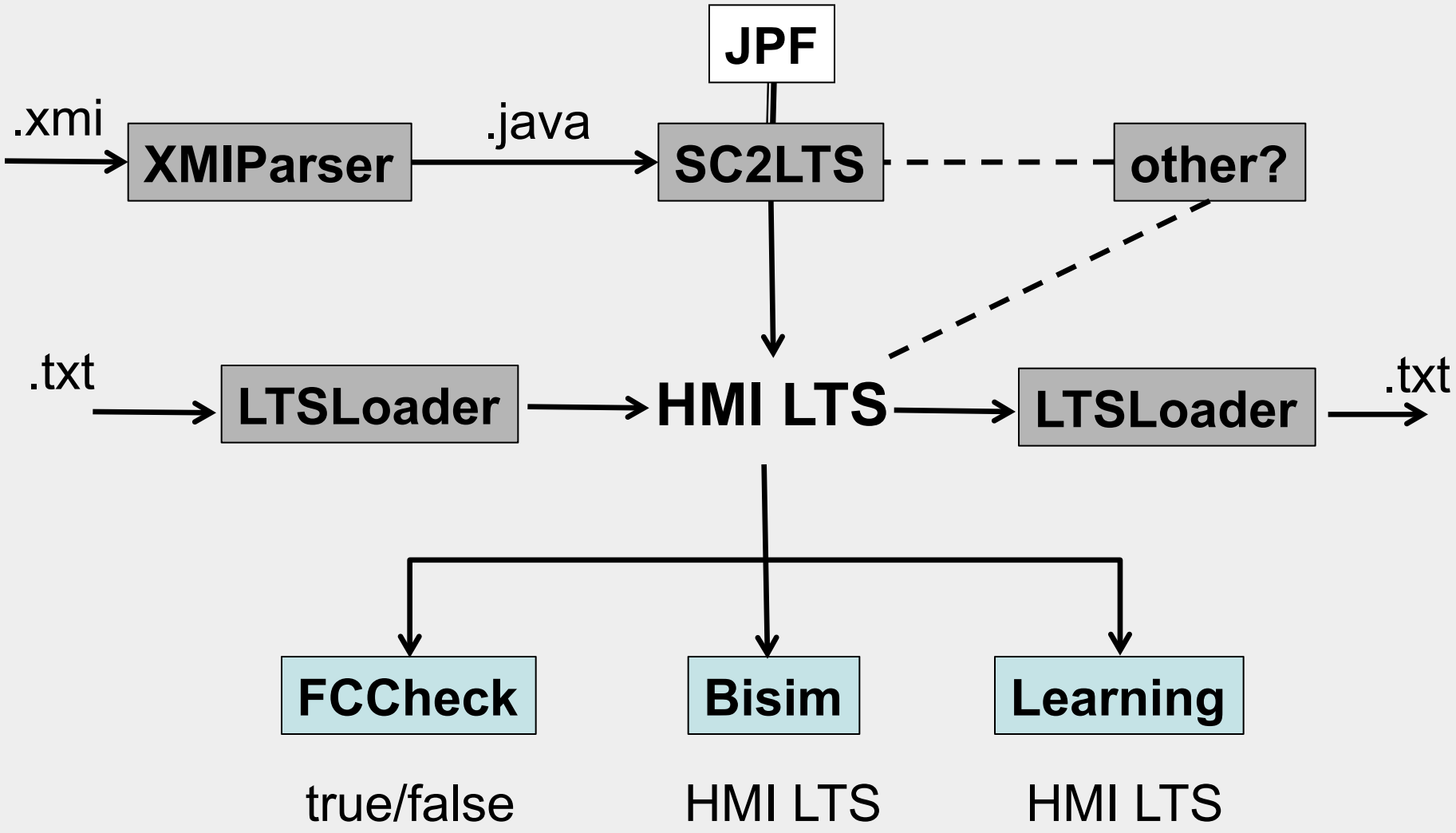
- automation surprises
  - non-determinism, mode confusion
- system abstractions for human operators
  - user / pilot training, procedure generation, test-case generation

- jpf-hmi
  - supports the definition of hmi systems
  - provides a number of hmi-specific analysis capabilities

HMI LTS of a countdown system



jpf-hmi


JPF
.xmi
XMIParser
.java
SC2LTS
other?
.txt
LTSLoader
HMI LTS
LTSLoader
.txt
FCCheck
Bisim
Learning
true/false
HMI LTS
HMI LTS

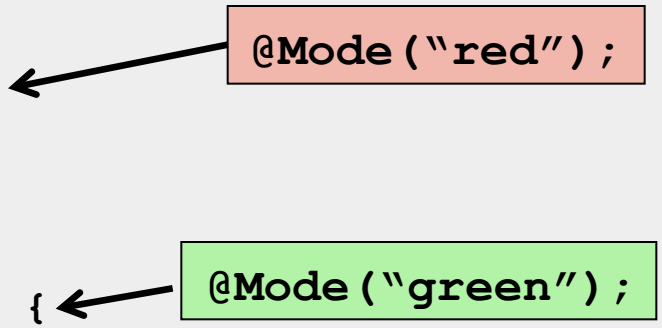
HMI system description

```
public class CountDown extends Model
  @Override
     public List<Action> getActions() {
        List<Action> actions = new ArrayList<Action>();
        actions.addAll(Arrays.asList (
             new Action("start", COMMAND),
             new Action("stop", COMMAND),
             new Action("tick", OBSERVATION)
        ));
        return actions;
     }

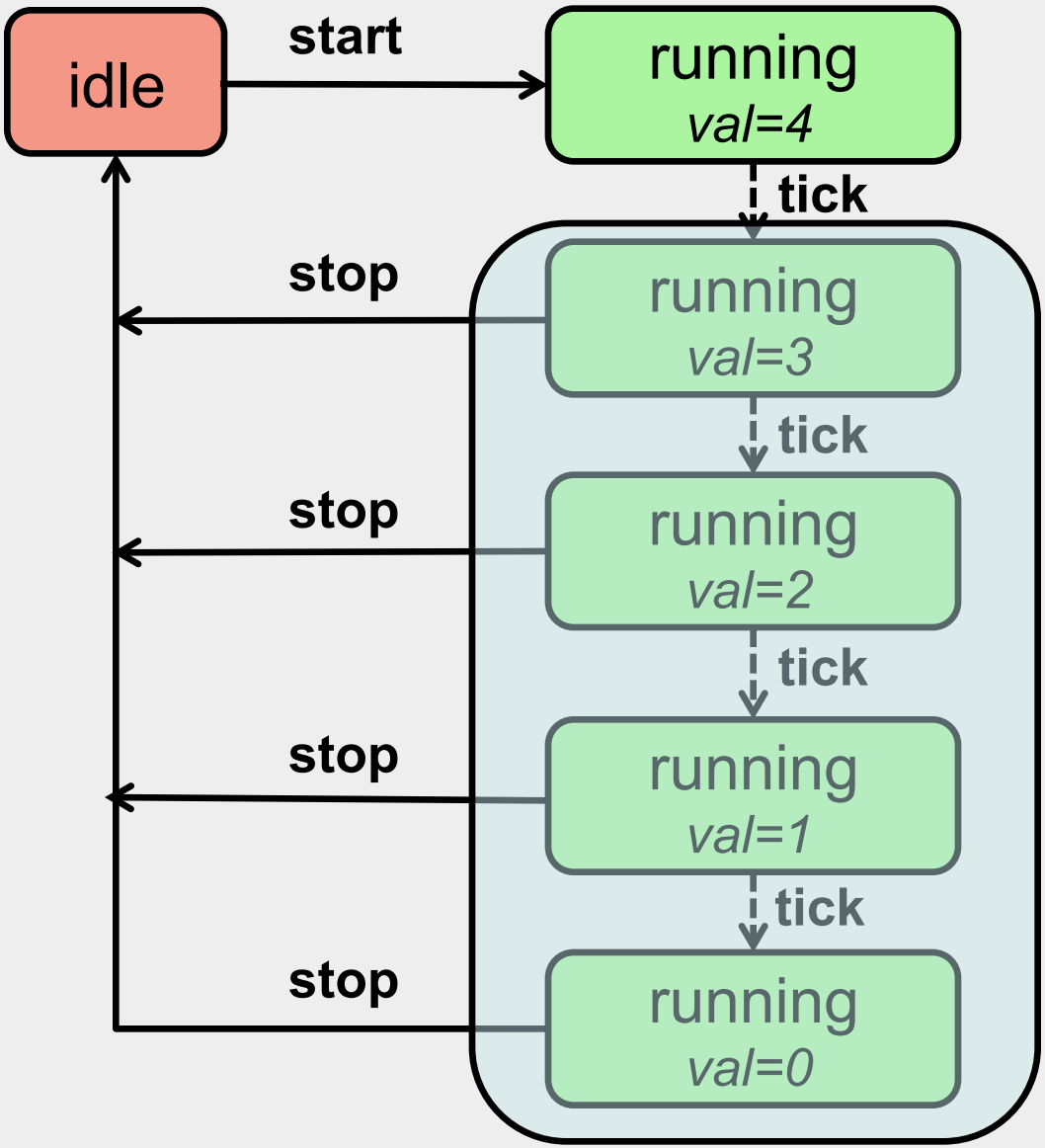
     public static class Behaviour extends State {
        private static final int MAX = 4;

        public class Idle extends State {
             public void start() ...
        }

        public class Running extends State {
             int val = 0;
             public void stop() ...
             public void tick() ...
        } ...
```



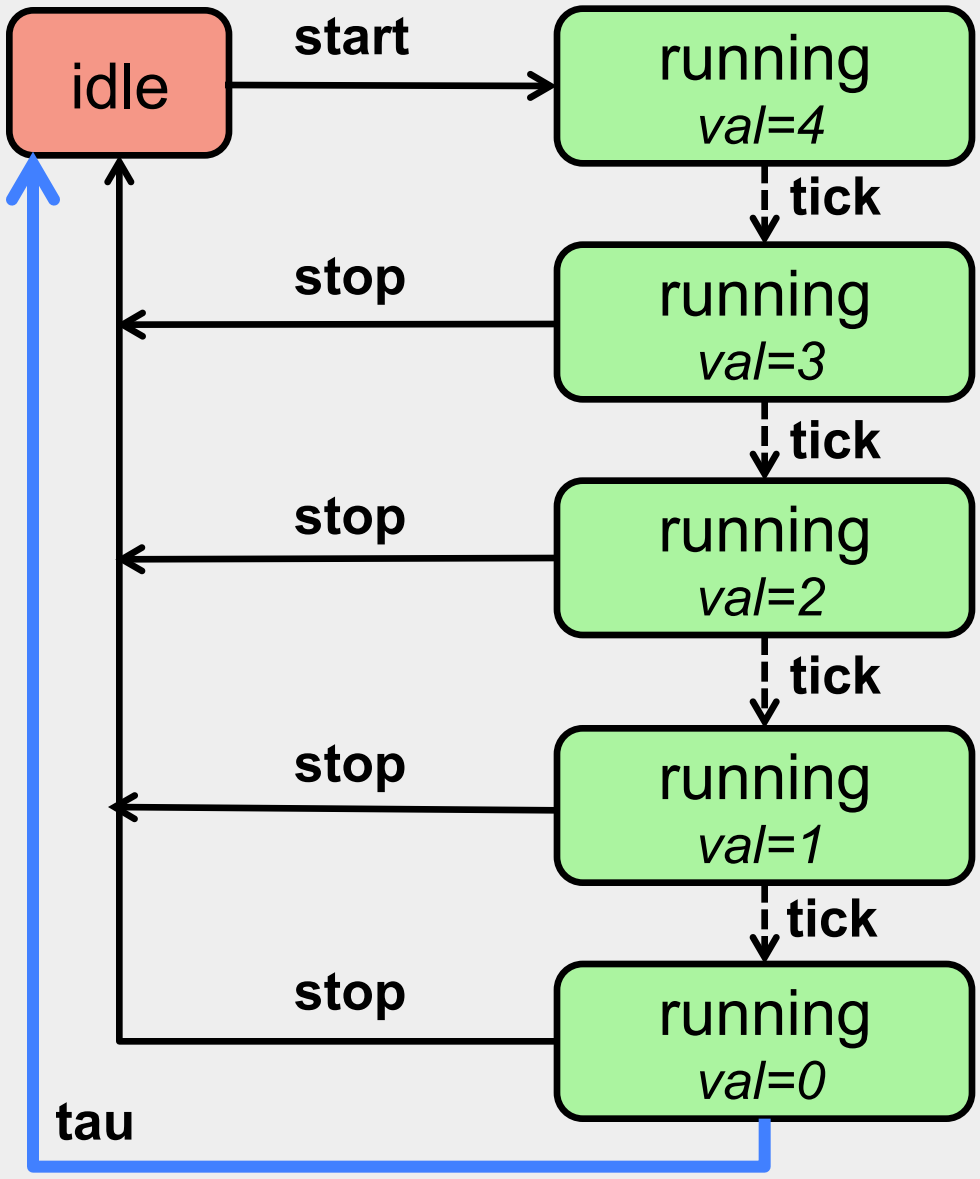
HMI analyses: behavioral abstraction



abstraction M_U allows full control of system M_M if at any time, when using the system according to M_U :

1. the set of available commands is exactly the same for the two models
2. abstraction allows at least all the observations that can be produced by the system

HMI analyses during generation



FC determinism

```
System model is not full
control deterministic :

CEX:[start, tick, tick,
tick, tick]
```

Mode confusion

Modes are self-loop transitions treated like commands. If CEX ends in mode action, then it represents mode confusion.

where would we be without abstraction?

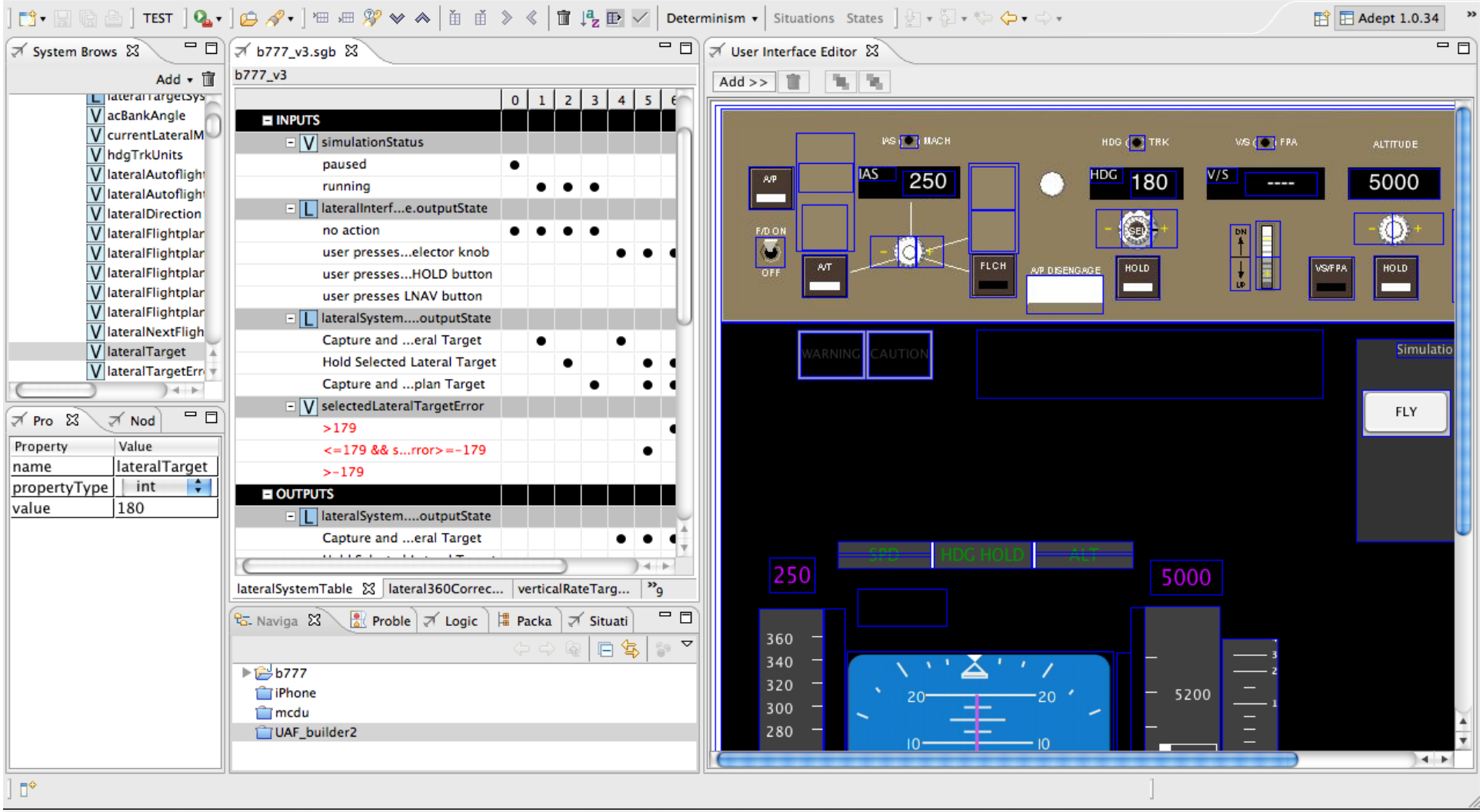
- **@FilterField**

- ```
  public static class ValAbs1 extends AbstractionAdapter {
        public int getAbstractValue (int v) {
              if (v > 0) {
                    return 0;
              } else if (v == 0) {
                    return 1;
              }
              return -1;
        }

        public String getName (int v) {
              int i = getAbstractValue (v);
              return i == 0 ? "(>0)" : "(=0)";
        }
  }
  ```
  ```

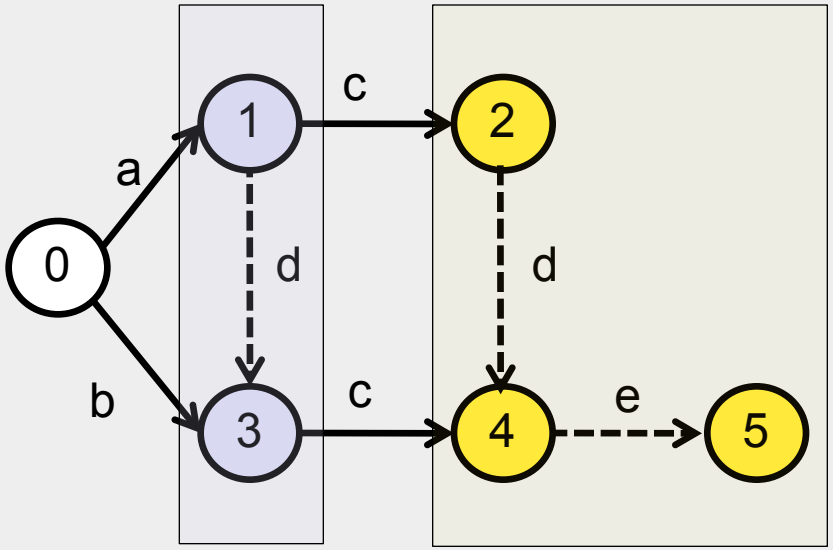
conclusions & extensions

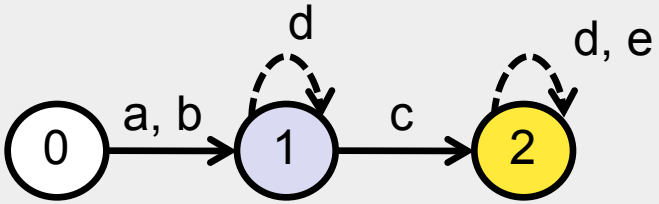
more input sources / analyses / scalability, more users…



system vs mental models

- system model describes complete behavior of a system
- mental model describes user's view of the system





- user does not need to distinguish states with the same color
- the focus of this work is to generate mental models automatically

full control mental model

- what is a good mental model?
  - it should be as compact as possible
  - the user should have enough information to control the system
- mental model M_U allows full control of a system M_M if at any time, when using the system according to the mental model:
  - the set of available commands is exactly the same for the two models
  - the mental model allows at least all the observations that can be produced by the system