JML Model Fields

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Outline

1. JML
2. What are model fields?
3. Translation to JavaDL
   - Axiomatic approach
   - Interpretation as model methods/queries
4. Demo

JML

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- . . . is a specification language tailored to Java.
- . . . serves as an input language for KeY.
- . . . can be used for specifying method contracts and loop invariants.
- . . . allows declaring model methods and model fields.

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//@ public model int a;
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```
/*@ public represents a \such_that 0<=a && a<size();
@*/
```

The `represents` clause

The `represents` clause defines a relation $\mathtt{R}(\mathtt{x}, \tilde{\mathtt{q}})$ between a model field `x` and a vector $\tilde{\mathtt{q}}$, consisting of fields and methods.

```
//@ model t x;
//@ represents x \such_that R(x,q̃);
```

The axiomatic approach – a first attempt

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But:
This is not possible, since there can be a state s, in which $R(x, \tilde{q})$ is equivalent to *false*.

Solution:
The axiom we have to use is:

$$(\exists a : t\ (R(a, \tilde{q}))) \rightarrow R(x, \tilde{q})$$

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- x is the result of the translation of a model field `x` of type t.
- $R(x, \tilde{q})$ is the formula provided by the represents clause.

Then we get the formula:

$$\forall x' : t \, (\{x := x'\}(A(x) \rightarrow \phi(x)))$$

with

$$A(x) := (\exists a : t \, (R(a, \tilde{q}))) \rightarrow R(x, \tilde{q})$$

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Model fields are represented by model method that are free of side effects and have a “suitable” specification.

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Model fields are represented by model method that are free of side effects and have a "suitable" specification.

Let $\phi(x)$ and $R(x,\vec{q})$ be defined as on the previous slides. We get the formula:

$$\phi(m())$$

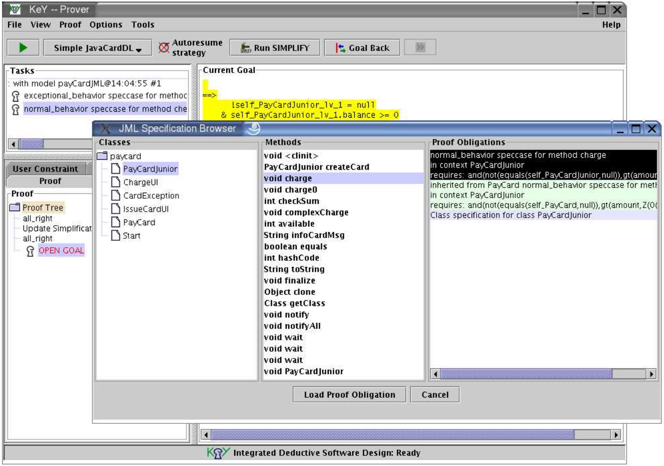
where $m()$ is the model method associated with $R(x,\vec{q})$.

Representing model fields by model methods

The specification of *m*():

```
/*@ public normal_behavior
  @  requires (\exists t x; R(x,q));
  @  assignable \nothing;
  @  ensures R(\result, q);
  @*/
```

Demo


KeY -- Prover
File View Proof Options Tools Help
Simple JavaCardDL
Autoresume strategy
Run SIMPLIFY
Goal Back
Tasks
: with model payCardJML@14:04:55 #1
exceptional_behavior speccase for methoc
normal_behavior speccase for method che
Current Goal
==>
!self_PayCardJunior_lv_1 = null
& self_PayCardJunior_lv_1.balance >= 0
JML Specification Browser
Classes
paycard
PayCardJunior
ChargeUI
CardException
IssueCardUI
PayCard
Start
Methods
void <clinit>
PayCardJunior createCard
void charge
void charge0
int checkSum
void complexCharge
int available
String infoCardMsg
boolean equals
int hashCode
String toString
void finalize
Object clone
Class getClass
void notify
void notifyAll
void wait
void wait
void wait
void PayCardJunior
Proof Obligations
normal_behavior speccase for method charge
in context PayCardJunior
inherited from PayCard normal_behavior speccase for meth
in context PayCardJunior
Class specification for class PayCardJunior
Load Proof Obligation
Cancel
User Constraint
Proof
Proof
Proof Tree
all_right
Update Simplificat
all_right
OPEN GOAL
Integrated Deductive Software Design: Ready

The interface LimitedIntContainer

```
public interface LimitedIntContainer{
    /*@
      @ public model int value;
      @ public model boolean regularState;
      @*/

    /*@ public normal_behavior
      @   ensures regularState ==> \result == value;
      @*/
    int /*@ pure @*/ available();
}
```

The class PayCard

```
public class PayCard implements LimitedIntContainer{

 /*@ public represents value <- balance;
   @ public represents regularState  <-
   @                (unsuccessfulOperations <= 3);
   @*/

  public /*@pure@*/ int available() {
      if (unsuccessfulOperations<=3) return balance;
      return 0;
  }

  ...
}
```