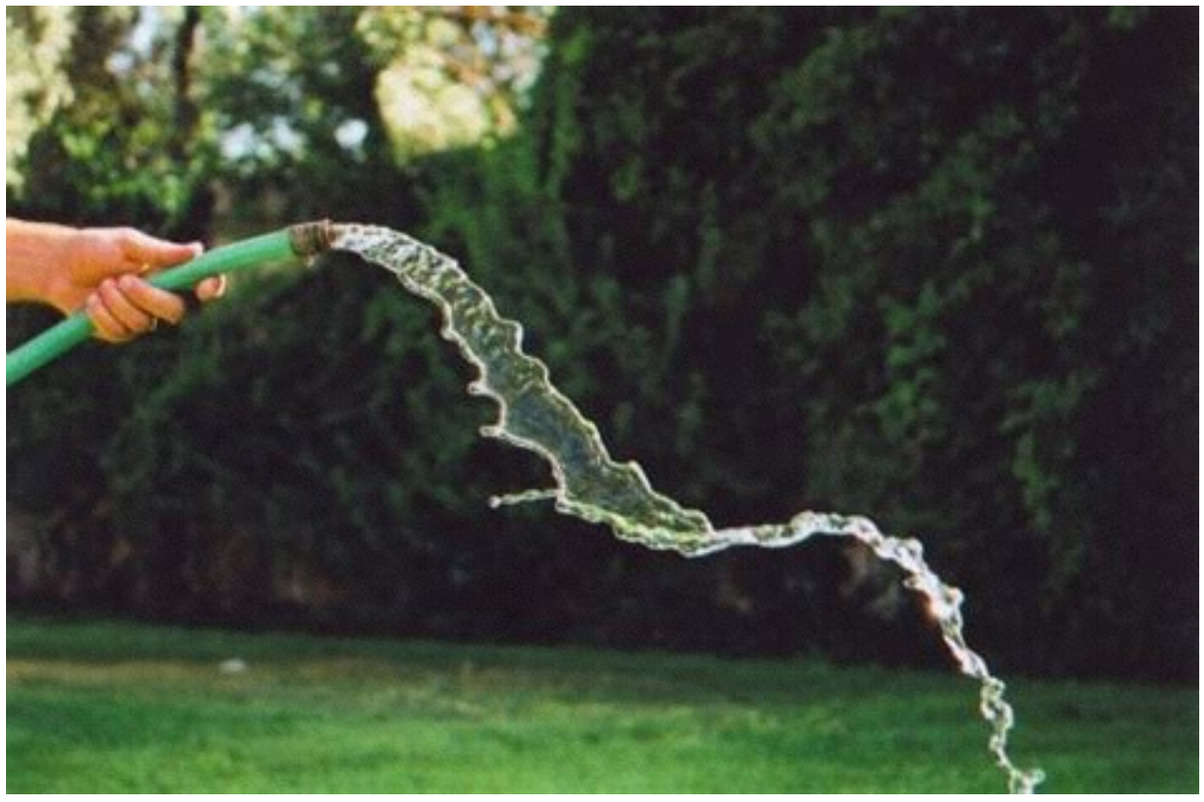
Live Modeling: Why and How?

Tijs van der Storm
storm@cwi.nl / @tvdstorm

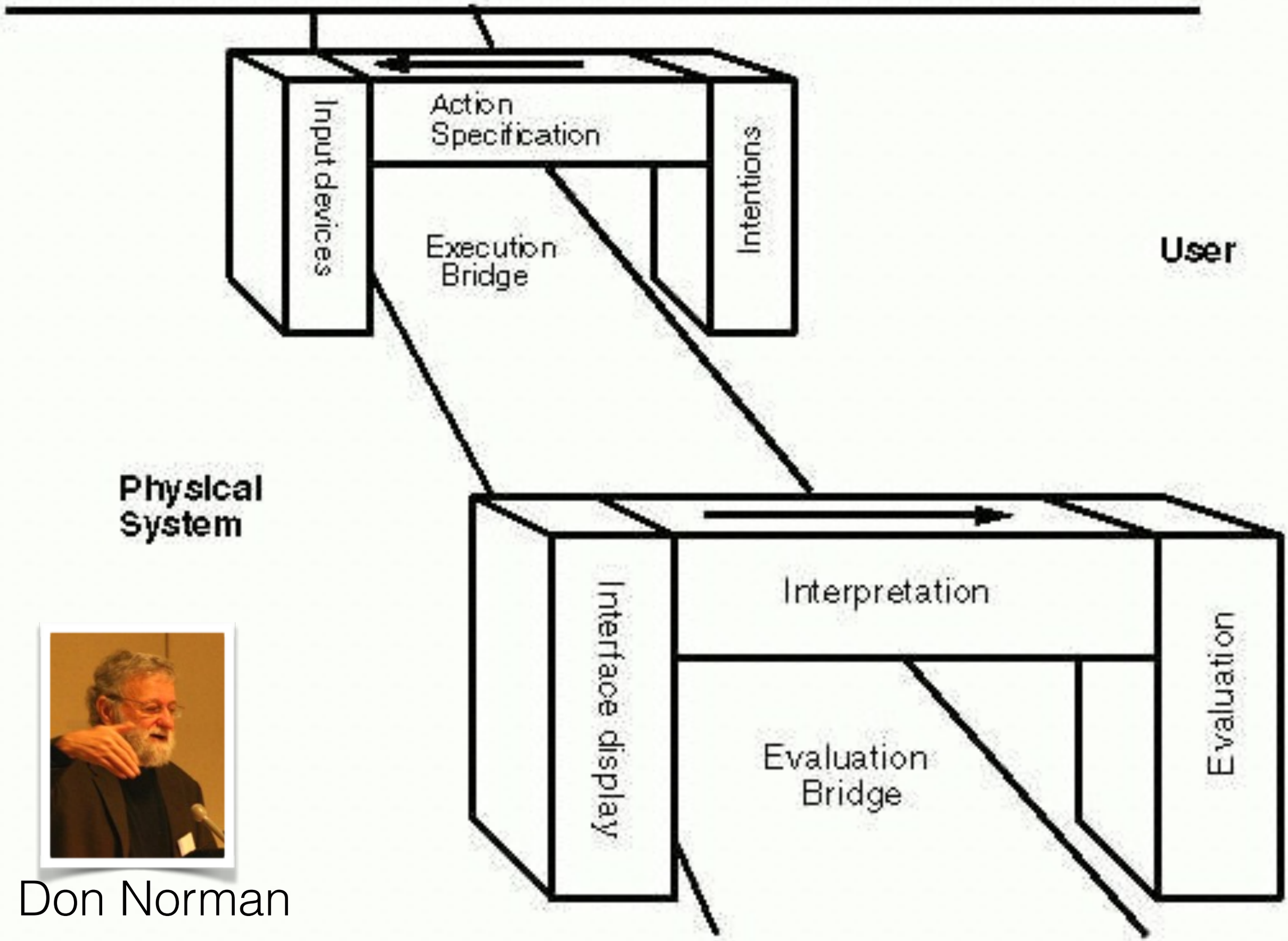
Programming

Aim, shoot, miss, repeat…
Olympic sport…

Live programming

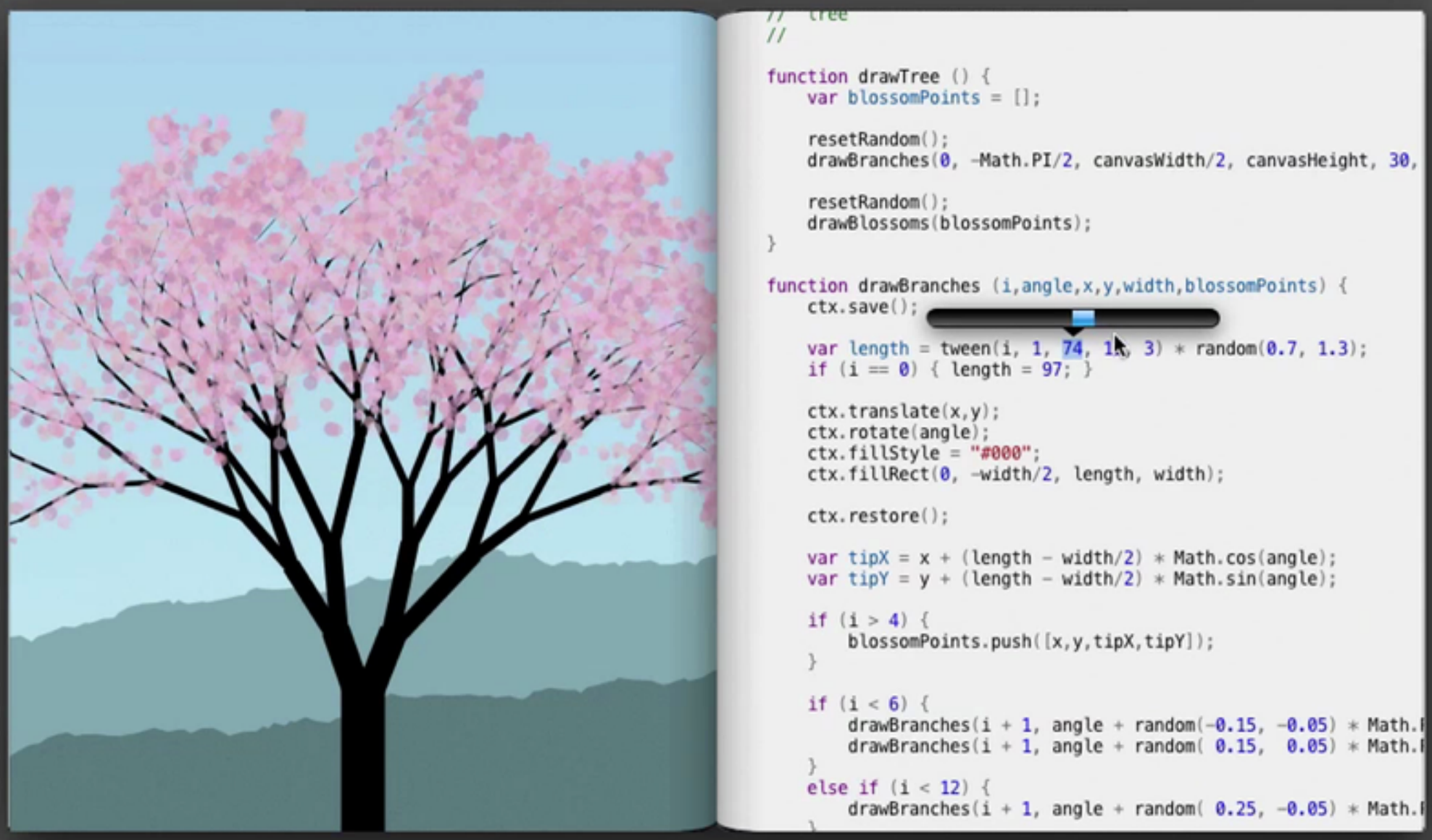


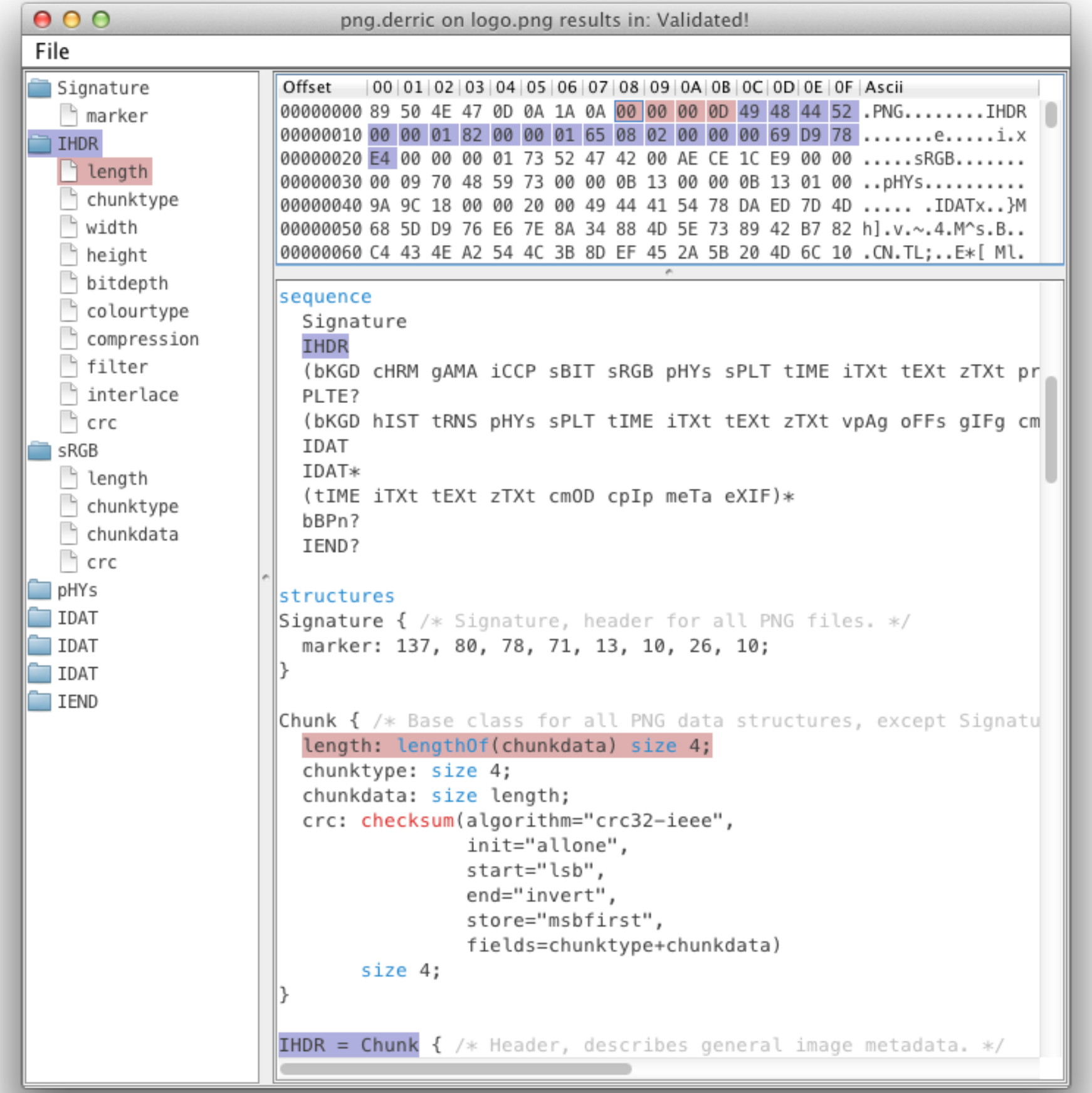
Fluid experience, continuous feedback…
Kid’s play… ;)


Input devices
Action Specification
Intentions
Execution Bridge
User
Physical System
Interface display
Interpretation
Evaluation
Evaluation Bridge

Don Norman

Live programming

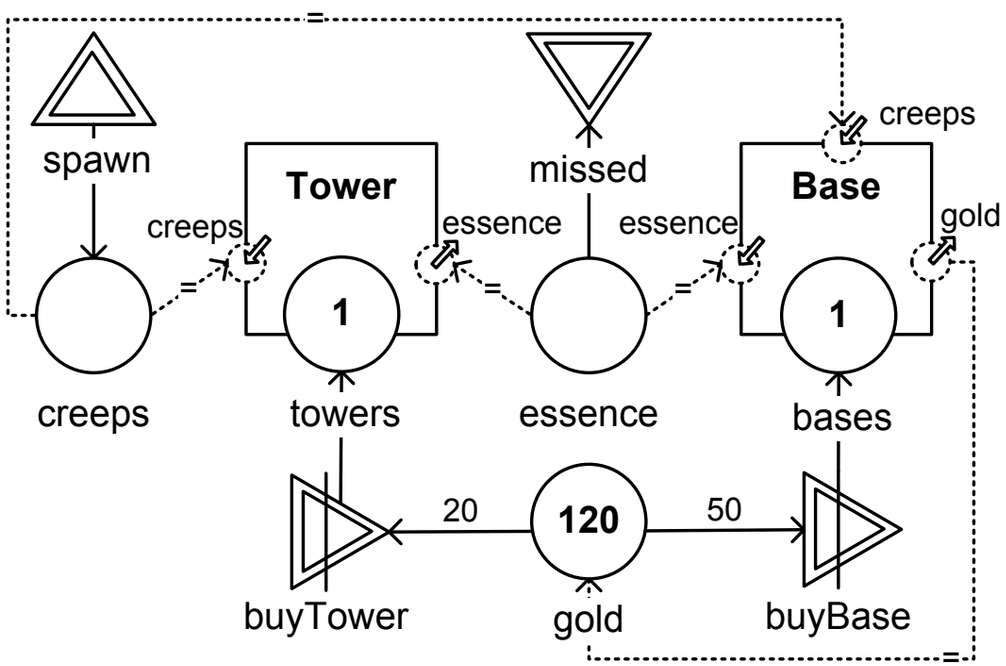




Trinity, an IDE for the Matrix

Live IDE for Derric, a DSL for digital forensics

Micro Machinations



Van Rozen, Dormans, Adapting game mechanics with Micro-Machinations, FDG'14

The Road to Live Programming: Insights From the Practice

Juraj Kubelka
Pleiad @ DCC, University of Chile
Santiago, Chile

Romain Robbes
SwSE @ Free University of Bozen-Bolzano
Bozen-Bolzano, Italy

Alexandre Bergel
Pleiad @ DCC, University of Chile
Santiago, Chile

ABSTRACT

Live Programming environments allow programmers to get feed-

with LIVE 2013 being the most popular workshop at ICSE 2013 [5] (see Section 2 for background on Live Programming).

Exploratory and Live, Programming and Coding

A Literature Study Comparing Perspectives on Liveness

Patrick Rein[a], Stefan Ramson[a], Jens Lincke[a], Robert Hirschfeld[a], and Tobias Pape[a]

a Hasso Plattner Institute, University of Potsdam, Germany

Live Functional Programming with Typed Holes

CYRUS OMAR, University of Chicago
IAN VOYSEY, Carnegie Mellon University
RAVI CHUGH, University of Chicago
MATTHEW A. HAMMER, University of Colorado Boulder

Live DSLs? Live Modeling?

I want my live programming environment!

Form **1040** Department of the Treasury—Internal Revenue Service (99)

U.S. Individual Income Tax Return

2012 OMB No. 1545-0074 IRS Use Only—Do not write or staple in this space.

For the year Jan. 1–Dec. 31, 2012, or other tax year beginning , 2012, ending , 20 — See separate instructions.

Your first name and initial	Last name	**Your social security number**
If a joint return, spouse's first name and initial	Last name	**Spouse's social security number**

Home address (number and street). If you have a P.O. box, see instructions. — Apt. no.

▲ Make sure the SSN(s) above and on line 6c are correct.

City, town or post office, state, and ZIP code. If you have a foreign address, also complete spaces below (see instructions).

Foreign country name | Foreign province/state/county | Foreign postal code

Presidential Election Campaign

Check here if you, or your spouse if filing jointly, want $3 to go to this fund. Checking a box below will not change your tax or refund. ☐ **You** ☐ **Spouse**

Filing Status

Check only one box.

1 ☐ Single
2 ☐ Married filing jointly (even if only one had income)
3 ☐ Married filing separately. Enter spouse's SSN above and full name here. ▶
4 ☐ Head of household (with qualifying person). (See instructions.) If the qualifying person is a child but not your dependent, enter this child's name here. ▶
5 ☐ Qualifying widow(er) with dependent child

Exemptions

6a ☐ **Yourself.** If someone can claim you as a dependent, **do not** check box 6a . . . . .
b ☐ **Spouse** . . . . . .

c **Dependents:** (1) First name Last name	(2) Dependent's social security number	(3) Dependent's relationship to you	(4) ✓ if child under age 17 qualifying for child tax credit (see instructions)
			☐
			☐
			☐
			☐

If more than four dependents, see instructions and check here ▶ ☐

d Total number of exemptions claimed . . . . . .

Boxes checked on 6a and 6b
No. of children on 6c who:
• lived with you
• did not live with you due to divorce or separation (see instructions)
Dependents on 6c not entered above
Add numbers on lines above ▶

Income

Attach Form(s) W-2 here. Also attach Forms W-2G and 1099-R if tax was withheld.

7	Wages, salaries, tips, etc. Attach Form(s) W-2	7	
8a	**Taxable** interest. Attach Schedule B if required	8a	
b	**Tax-exempt** interest. **Do not** include on line 8a . . . **8b**		
9a	Ordinary dividends. Attach Schedule B if required	9a	
b	Qualified dividends **9b**		
10	Taxable refunds, credits, or offsets of state and local income taxes	10	
11	Alimony received	11	
12	Business income or (loss). Attach Schedule C or C-EZ	12	
13	Capital gain or (loss). Attach Schedule D if required. If not required, check here ▶ ☐	13	

```
form Box1HouseOwning {
  "Did you sell a house in 2010?"
     hasSoldHouse: boolean
  "Did you by a house in 2010?"
     hasBoughtHouse: boolean
  "Did you enter a loan?"
     hasMaintLoan: boolean

  if (hasSoldHouse) {
     "What was the selling price?"
        sellingPrice: money
     "Private debts:"
        privateDebt: money
     "Value residue:"
       valueResidue: int (sellingPrice - privateDebt)
  }
}
```

Labeled questions

Conditional control flow

Computed questions

Demo

Box1HouseOwning

```
form Box1HouseOwning {
  "Did you sell a house in 2010?"
     hasSoldHouse: bool
  "Did you by a house in 2010?"
     hasBoughtHouse: bool
  "Did you enter a loan for maintenance?"
     hasMaintLoan: bool

  if (hasSoldHouse) {
    "Private debts for the sold house:"
       privateDebt: int
    "Price the house was sold for:"
       sellingPrice: int
    "Value residue:"
       valueResidue: int (sellingPrice - privateDebt)
  }
}
```

Line	Message

Box1HouseOwning

Did you sell a house in 2010? ☐

Did you by a house in 2010? ☐

Did you enter a loan for maintenance? ☐

Box1HouseOwning

```
form Box1HouseOwning {
  "Did you sell a house in 2010?"
     hasSoldHouse: bool
  "Did you by a house in 2010?"
     hasBoughtHouse: bool
  "Did you enter a loan for maintenance?"
     hasMaintLoan: bool

  if (hasSoldHouse) {
    "Private debts for the sold house:"
       privateDebt: int
    "Price the house was sold for:"
       sellingPrice: int
    "Value residue:"
       valueResidue: int (sellingPrice - privateDebt)
  }
}
```

Line	Message

Box1HouseOwning

Did you sell a house in 2010? ☑

Did you by a house in 2010? ☐

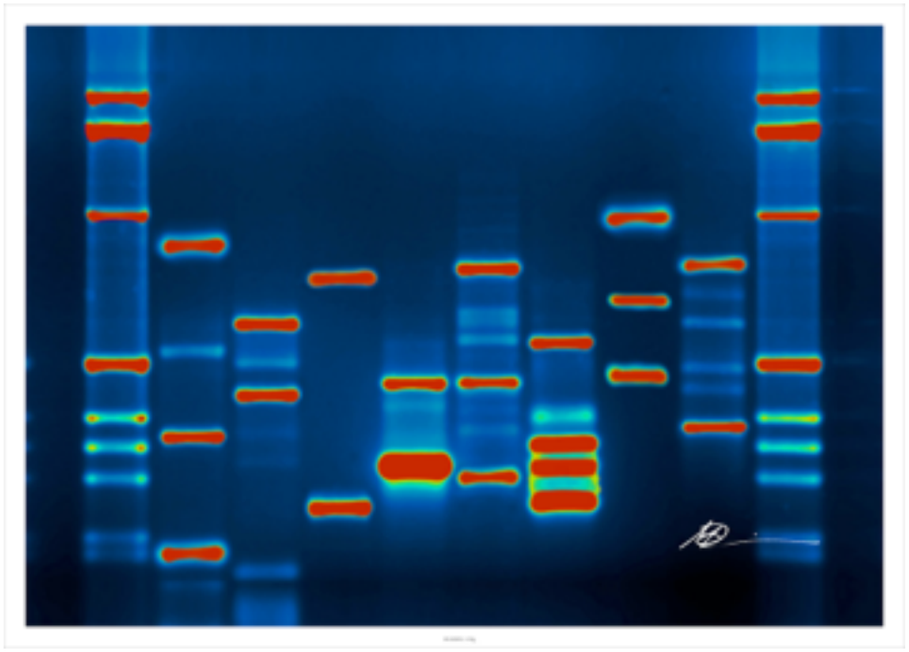
Did you enter a loan for maintenance? ☐

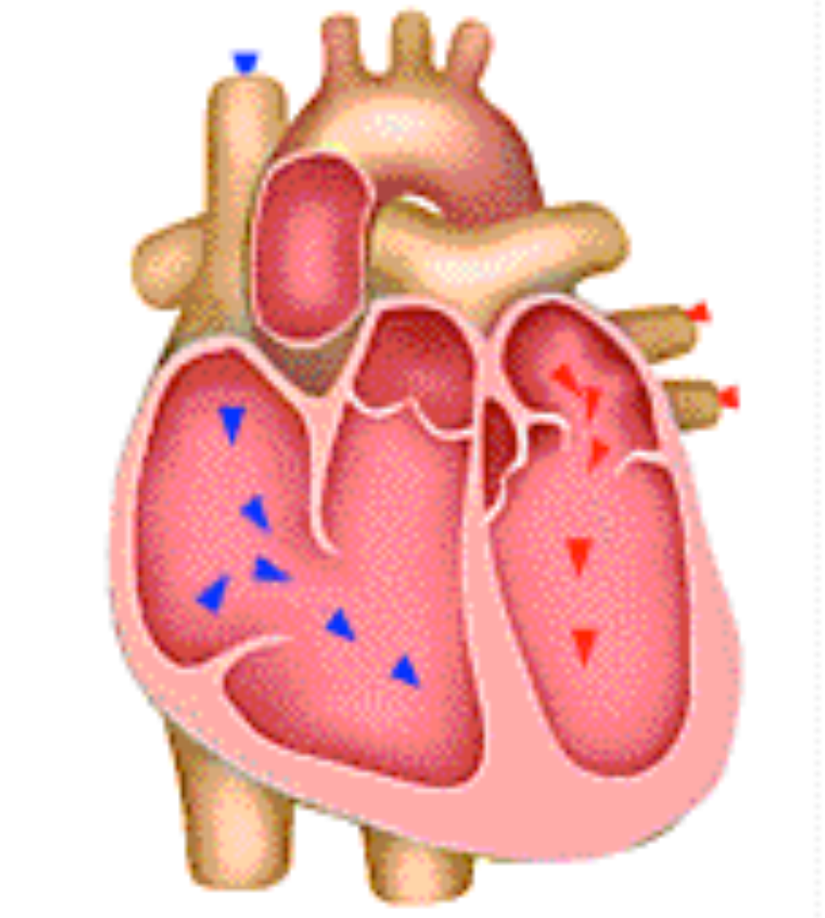
Private debts for the sold house: 200

Price the house was sold for: 100

Value residue: -100

?





The program

The live system

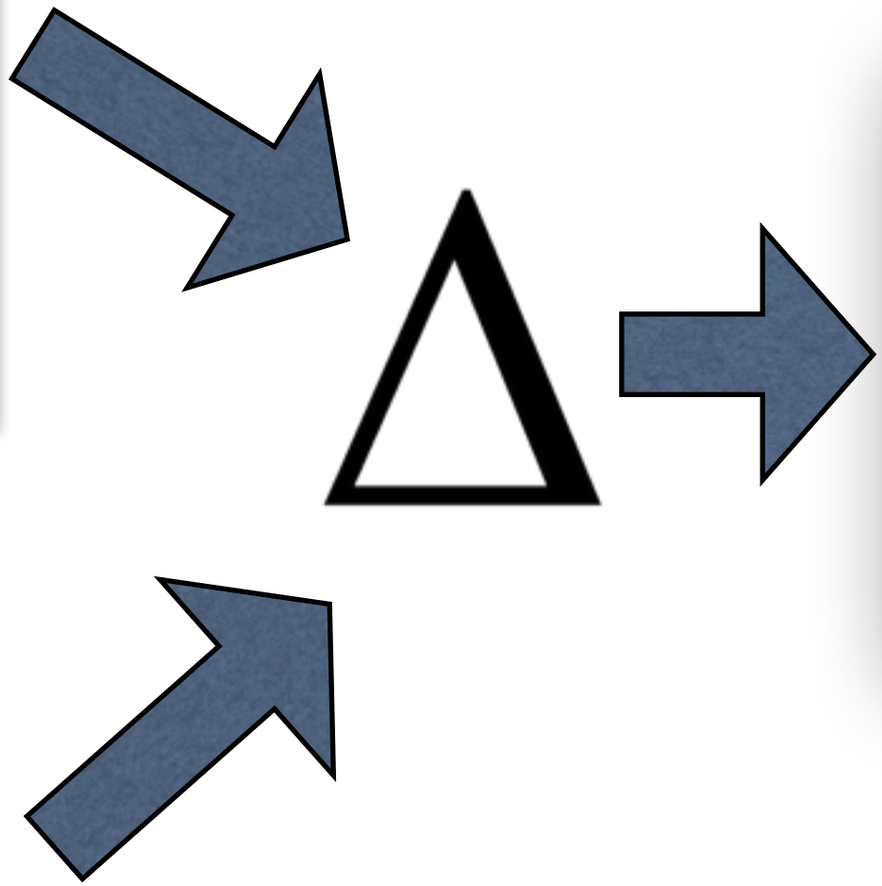
Language workbenches

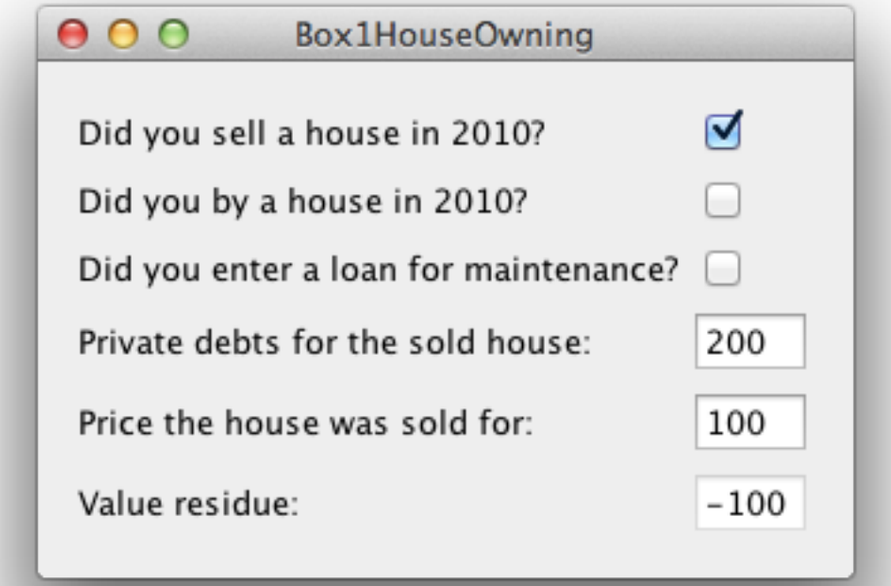
- Generic, reusable tools for language development
- Not only compiler etc, but also IDE services
- Our approach: Rascal
- FP for meta programming
- **How to build language workbench support for Live Modeling?**

http://www.rascal-mpl.org

Goal: generic tools to bridge the gulf of evaluation

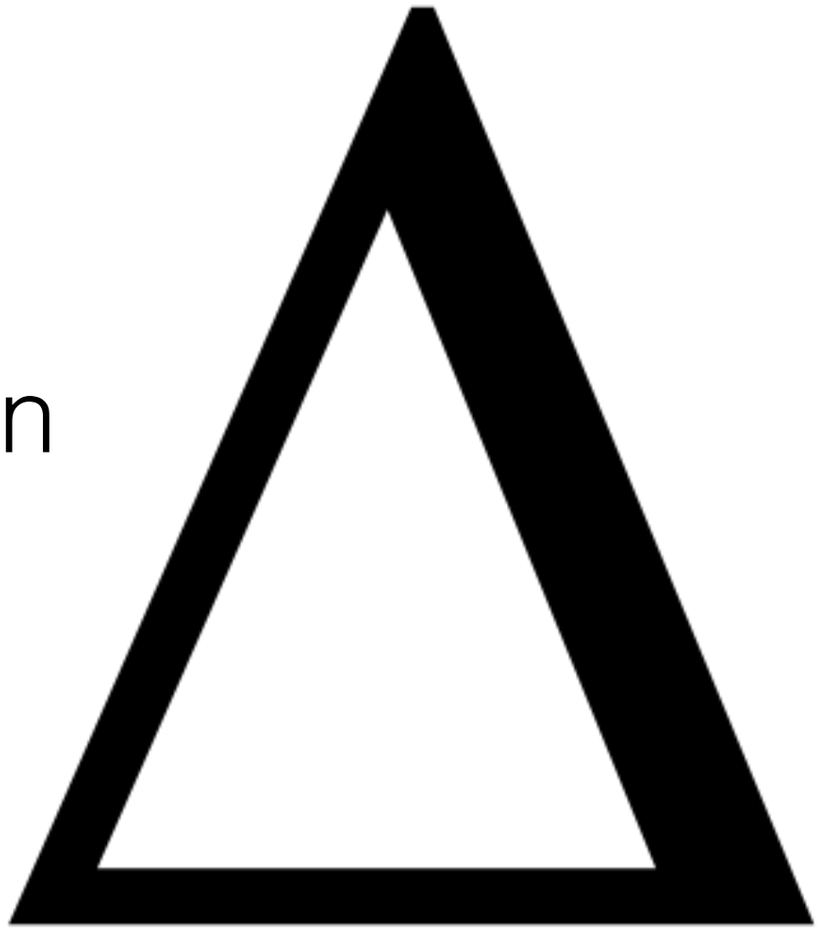
```
form Box1HouseOwning {
  "Did you sell a house in 2010?"
     hasSoldHouse: boolean
  "Did you by a house in 2010?"
     hasBoughtHouse: boolean
  "Did you enter a loan?"
     hasMaintLoan: boolean

  if (hasSoldHouse) {
    "What was the selling price?"
       sellingPrice: money
    "Private debts:"
       privateDebt: money
    "Value residue:"
      valueResidue: int
       (sellingPrice - privateDebt)
  }
}
```





Semantic Deltas

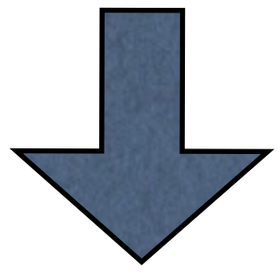
Change label
Change expression
Set value
Rename question



Add question
Remove question
Move question

$$eval : Prog \rightarrow State$$

$$eval' : User_{\delta} \times State \rightarrow State$$



$$eval : (Prog_{\Delta} \cup User_{\delta}) \times State \rightarrow State$$

(cc) stuant63 Flickr

...

Change condition

Set y to 200

Move question

Set x to true

Change label

WATCH WHATEVER WHENEVER.

With Sony's Betamax SL-8600 videorecorder, you can see any TV show you want to see anytime you want to see it.

Because Betamax, which plugs into any TV set and is easy to operate, can videotape a show up to three-hours long (with the L-750 videocassette) while you're doing something else—even while you're out of the house, by setting the electronic timer.

It can also videotape something off one channel while you're watching another channel.

And remember, Sony has more experience in videorecorders than anyone (over 20 years!). In fact, we've sold more videorecorders to broadcasters and industry than any other consumer manufacturer. We even make our own tape.

For years you've watched TV shows at the times you've had to. Now you can watch them at the times you want to.

SONY BETAMAX

THE LEADER IN VIDEO RECORDING

```
3c3
<    "Did you sell a house in 2010?"
---
>    "Hello world?"
5,6d4
<    "Did you by a house in 2010?"
<       hasBoughtHouse: bool
8a7,8
>    "Did you by a house in 2010?"
>       hasBoughtHouse: bool
10c10
<    if (hasSoldHouse) {
```

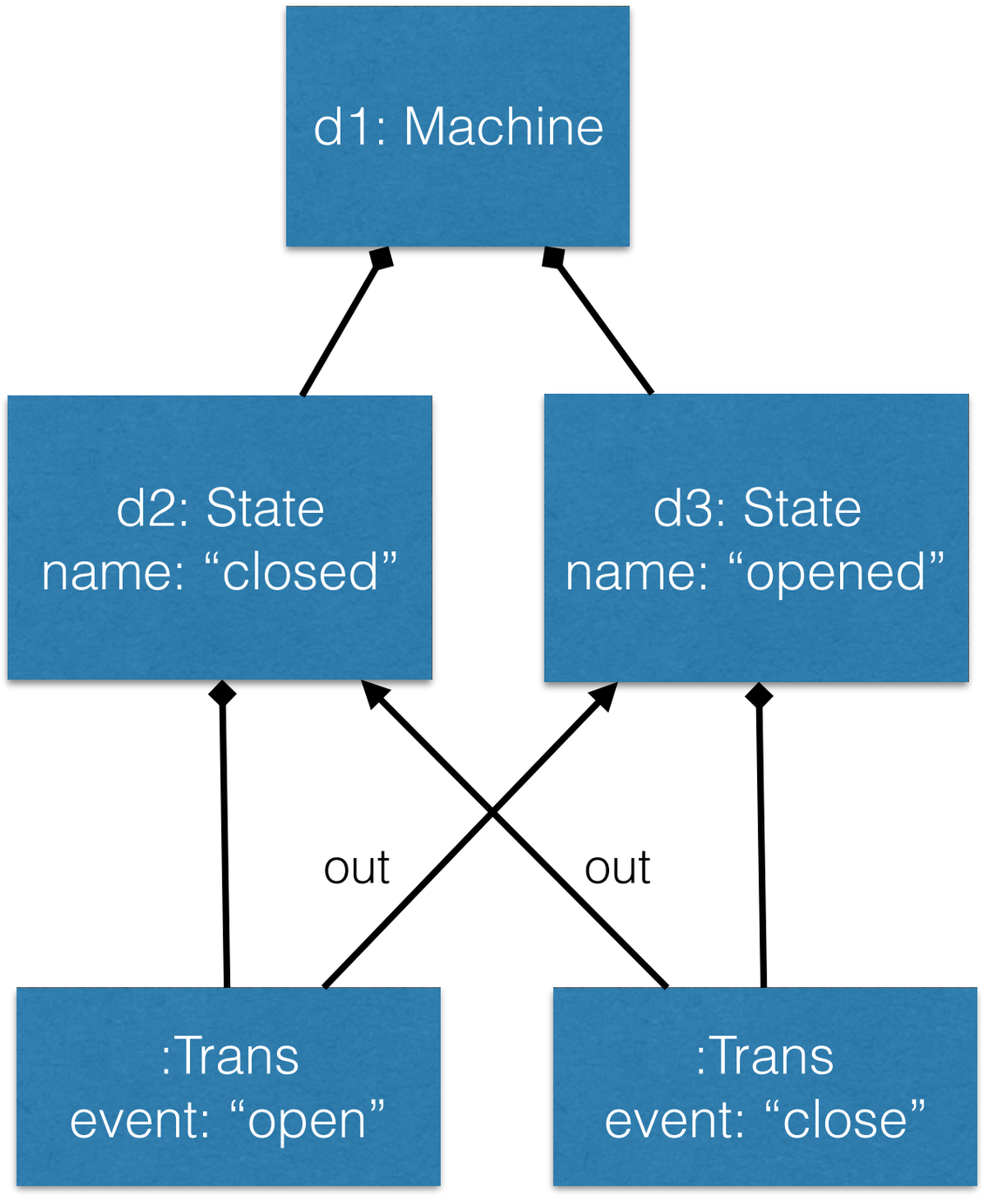
VS

```
hasSoldHouse:
  Change label to “Hello world?”
hasMaintLoan:
  Move from 2 to 1
at 3:
  Change condition to !hasSoldHouse
```

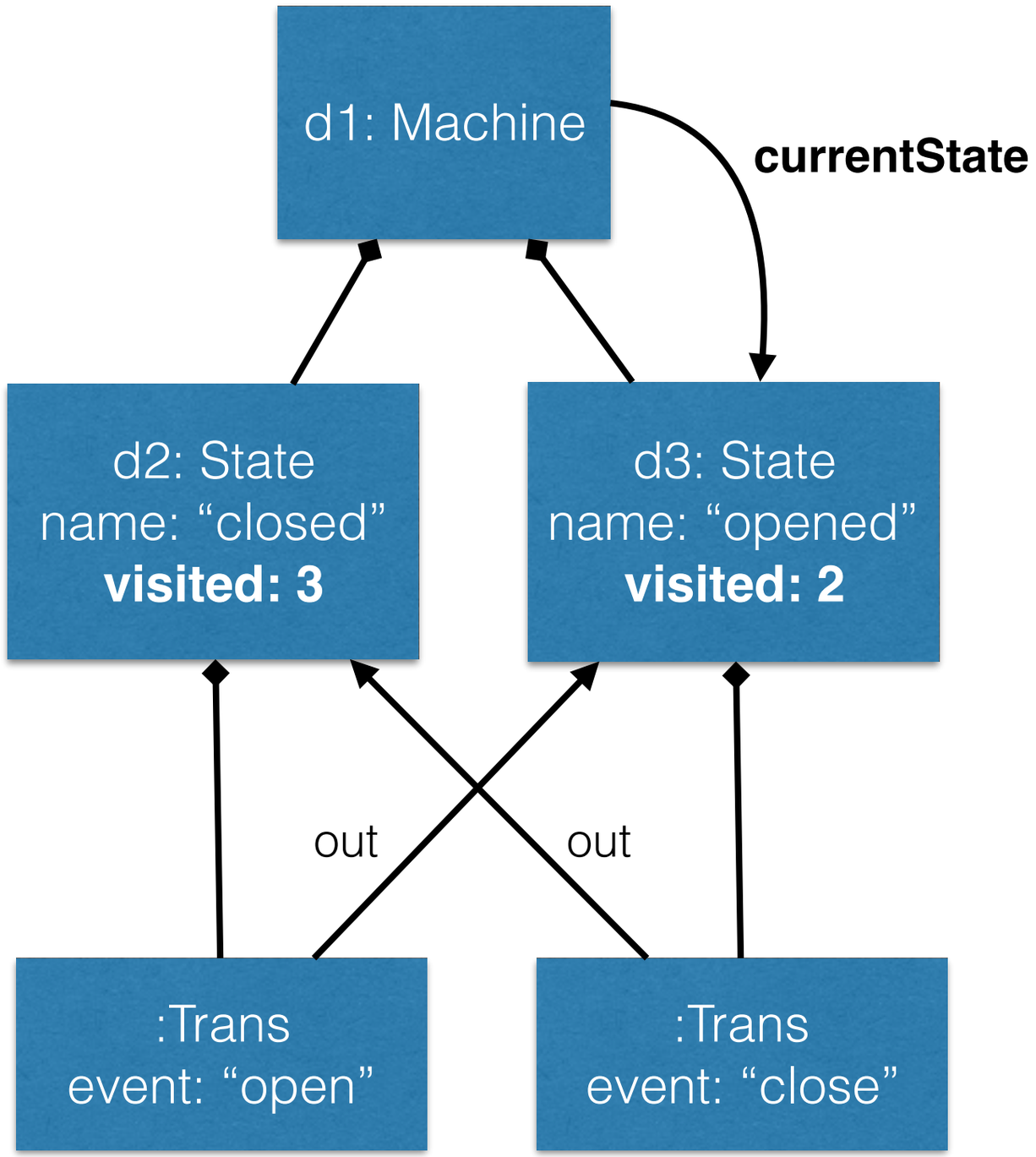
Framework

- “Programs as models”
- Assume this model is executed by an interpreter
- *Diff* the program to obtain semantic deltas
- *Patch* the run-time model during execution
- *Migrate* additional run-time state if needed

```
machine doors d1
  state closed d2
    open => opened u1

  state opened d3
    close => closed u2

end
```



```
machine doors d1
  state closed d2
    open => opened u1

  state opened d3
    close => closed u2

end
```



```
machine doors d1
  state closed d2
    open => opened u1

  state opened d3
    close => closed u2

end
```

```
machine doors d4
  state closed d5
    open => opened u3
    lock => locked u4

  state opened d6
    close => closed u5

  state locked d7
    unlock => closed u6

end
```

diff (

```
machine doors d1
  state closed d2
    open => opened u1

  state opened d3
    close => closed u2

end
```

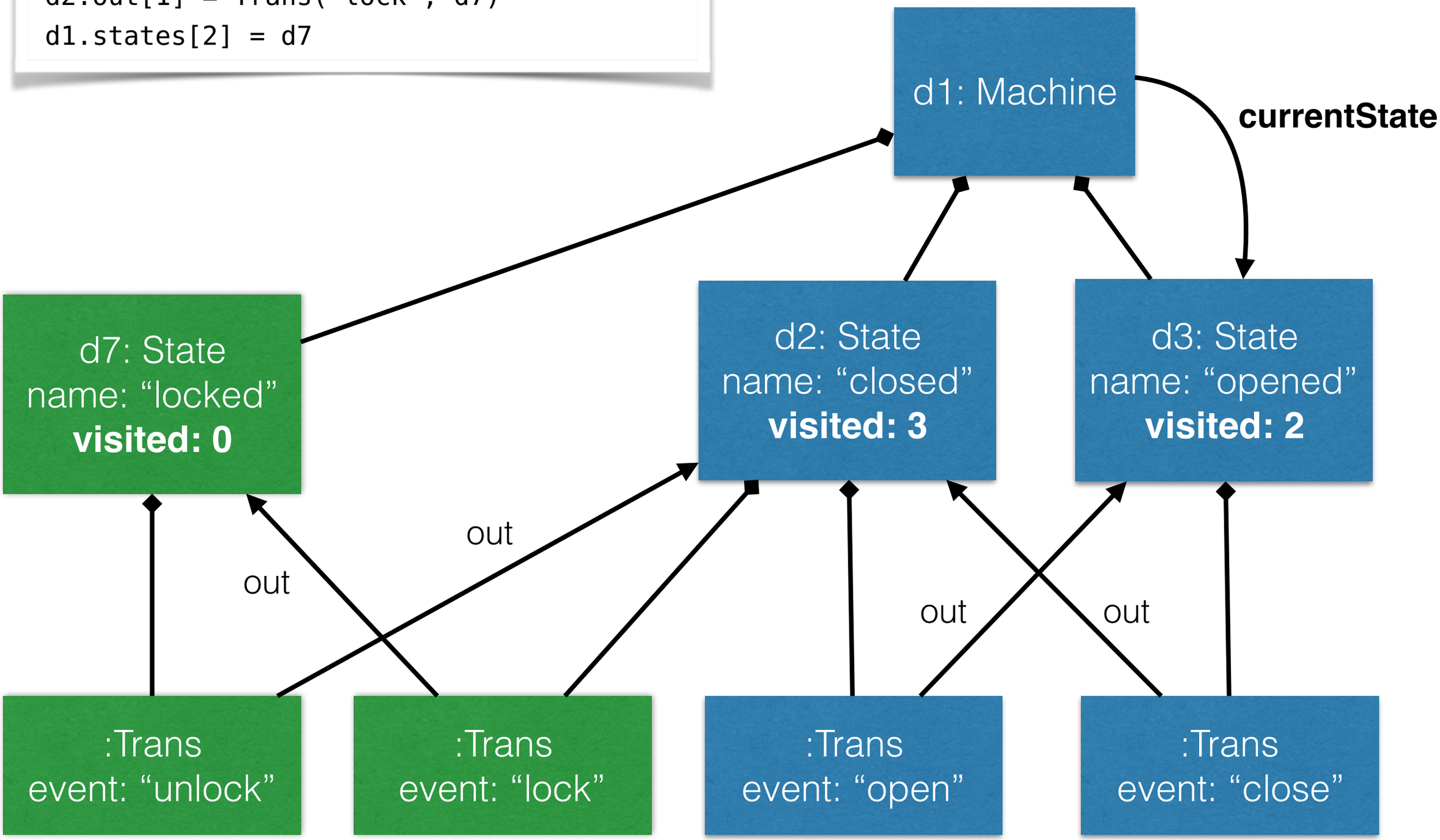
,

```
machine doors d4
  state closed d5
    open => opened u3
    lock => locked u4

  state opened d6
    close => closed u5

  state locked d7
    unlock => closed u6

end
```

) =

```
create State d7
d7 = State("locked",[Trans("unlock",d2)])
d2.out[1] = Trans("lock", d7)
d1.states[2] = d7
```

```
create State d7
d7 = State("locked",[Trans("unlock",d2)])
d2.out[1] = Trans("lock", d7)
d1.states[2] = d7
```



Live Modeling

- Live programming in the context of domain-specific modeling languages
- Why? Shortened feedback loop during modeling
- How? Semantic interpretation of program changes
- Next up:
  - Jouke: declarative techniques for state migration
  - Riemer: model evolution and run-time patching