Lively Simulation

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End User Development Seminar SS 20
Software Architectures

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Outline

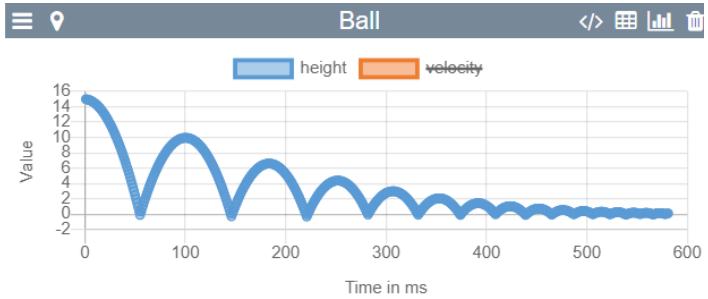
1. Simulations
2. Motivation
3. Project Goal
4. Energy Simulation
5. Demo
6. Improve End User Experience
7. What's Next?

Simulations

Real system 🌍 → Too complex ❔ 😨 → Model 📝 → Simulation ⚙

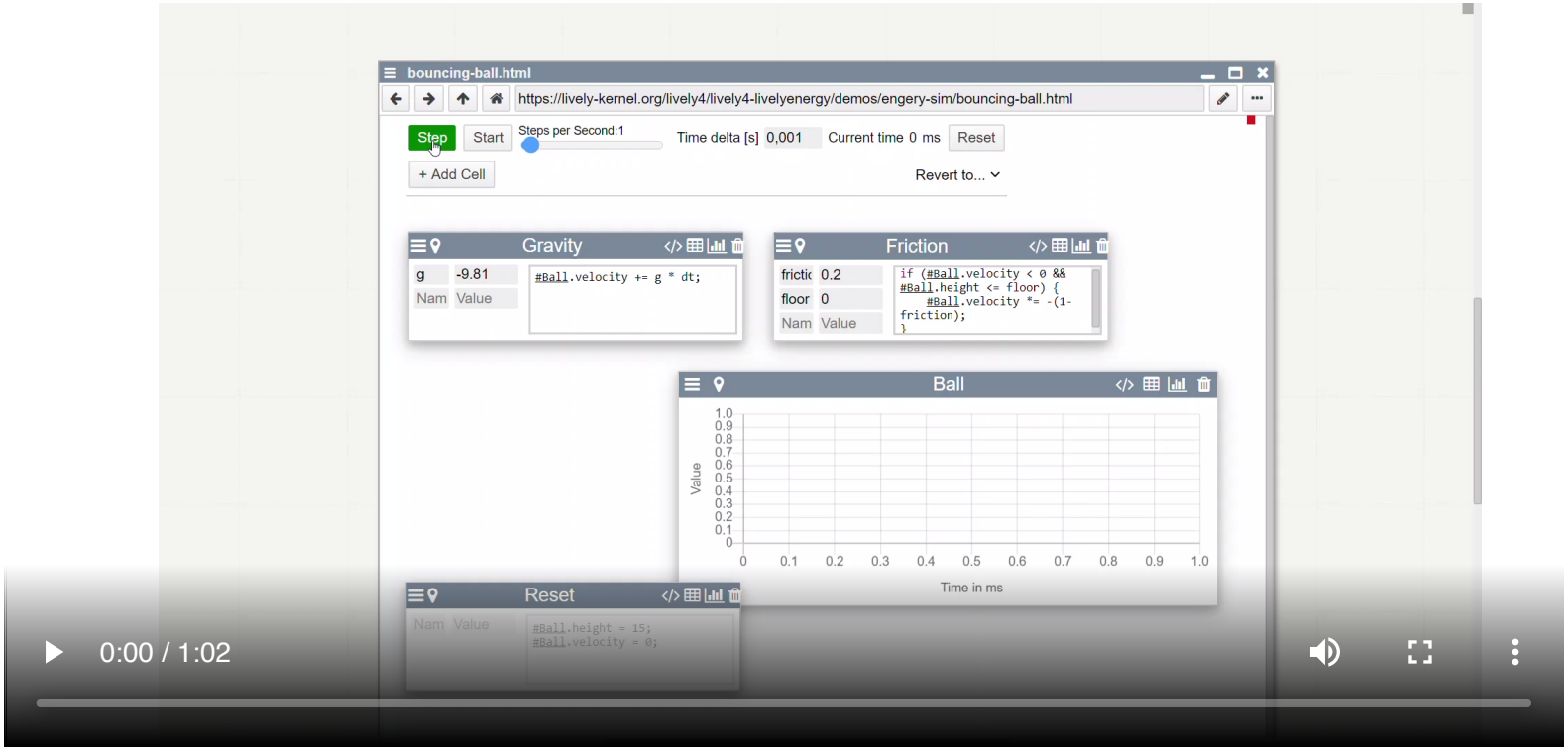
- Experimenting in simulation → finding hypothesis
- Understanding the behavior of systems
- **Dynamic simulations:** time dependent 🕑

  → observe processes and flows

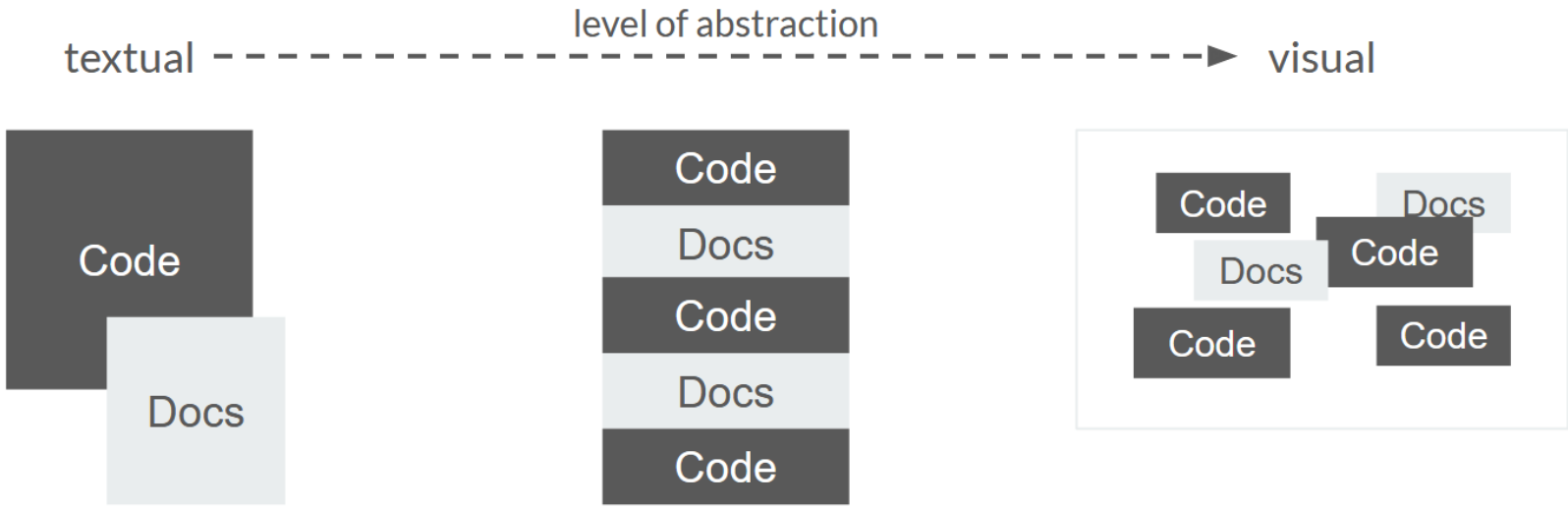


Bouncing Ball Example

Demo Bouncing Ball



Motivation



We want to enable end-users to create simulations in a visually structured way

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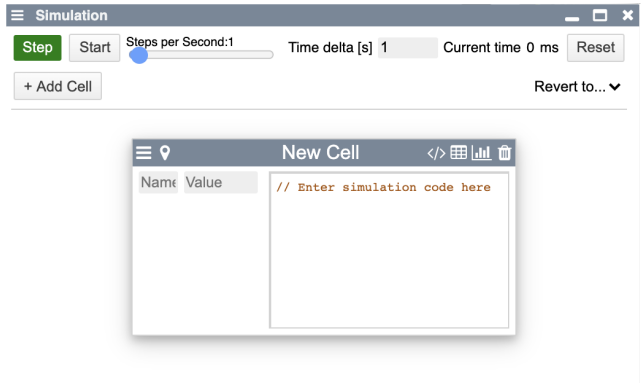
Project Goal

We want to enable end-users to create simulations in a visually structured way

Idea Build a semi-graphical simulation framework

- *Starting point:* PoC* in Lively Webwerkstatt (legacy)
- Allow documentation to be part of simulation
- Provide a way that allows simulation result investigation
- Proper Lively integration
- Port existing *energy simulation* from legacy

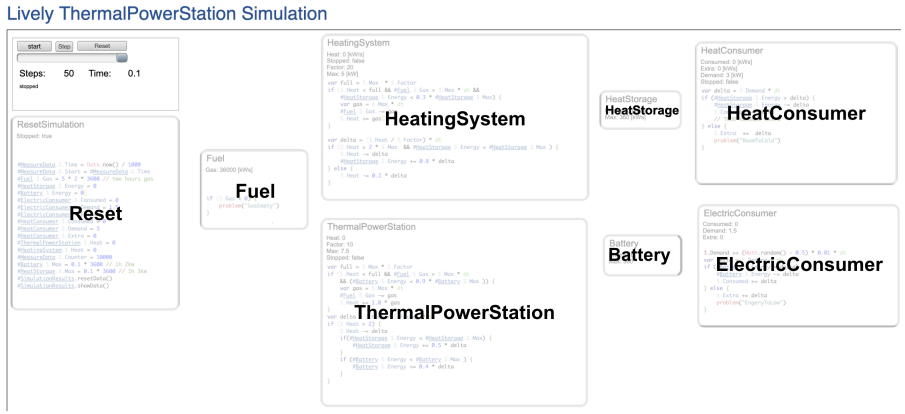


Simulation Framework

*PoC...Proof of concept

Energy Simulation

- Simulate energy flow
- Fuel → transformer → consumer
- Possible hypothesis:
  - Is heat storage big enough?
  - Is a backup system required?



Energy simulation in Lively Webwerkstatt [1]

[1] https://lively-kernel.org/repository/webwerkstatt/demos/EnergySimulationScripted.xhtml

Demo

Energy Simulation Port

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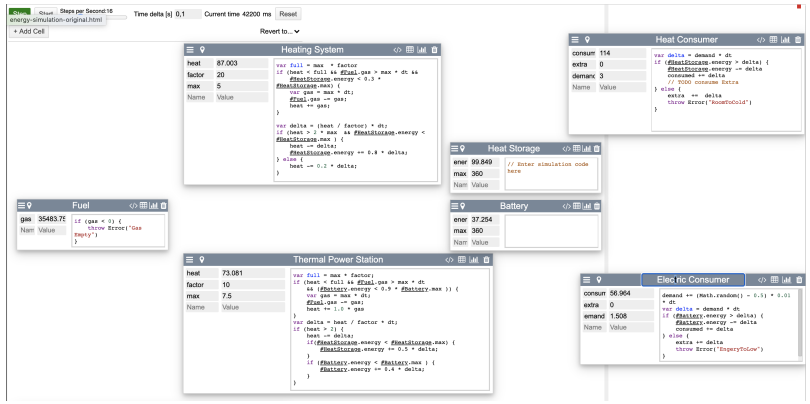
Demo

Let's use our framework for the energy simulation!

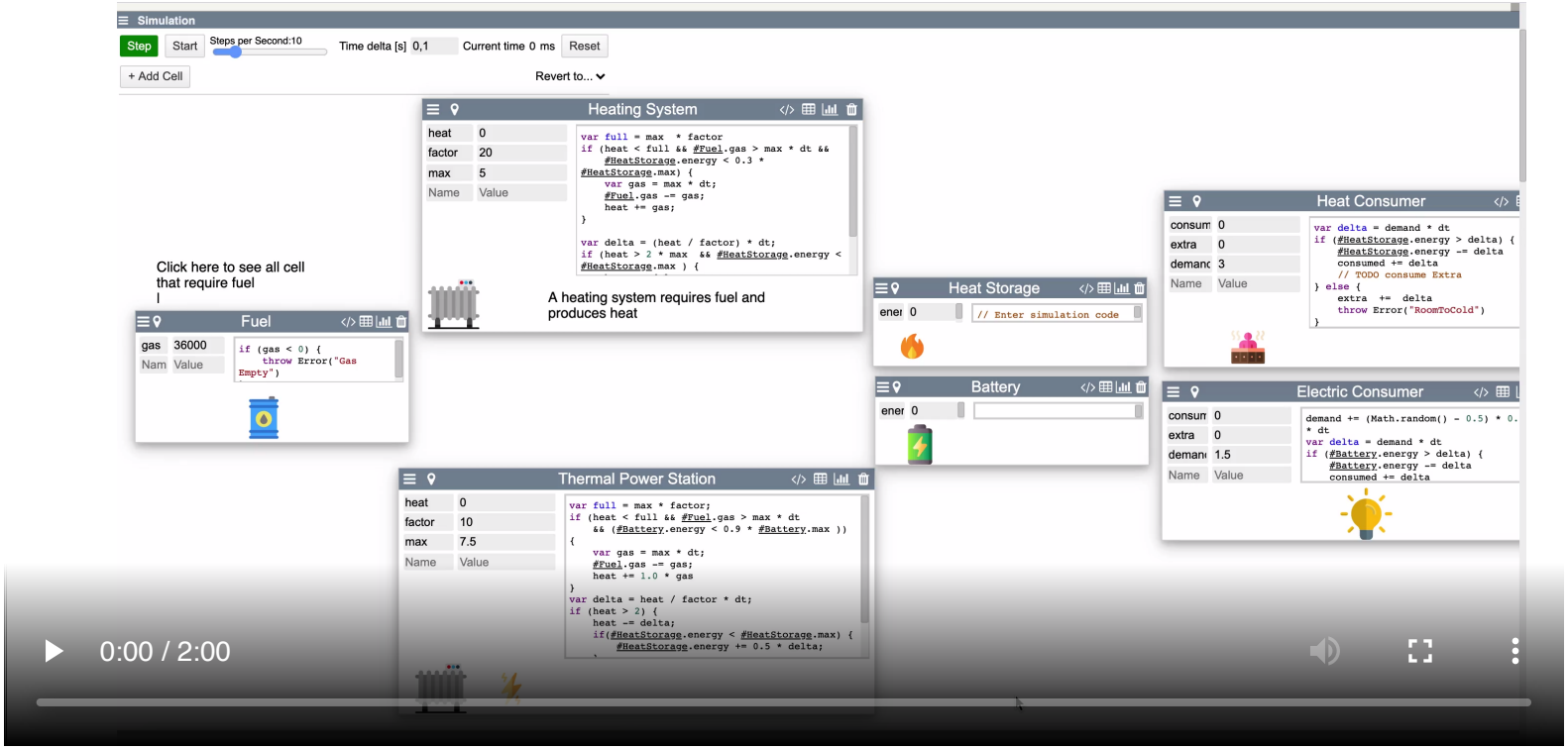
What we want to show:

1. Ported simulation is working
2. How the simulation is being edited
3. Cell locality
4. Cell state visualization



Energy simulation in Lively4

Demo

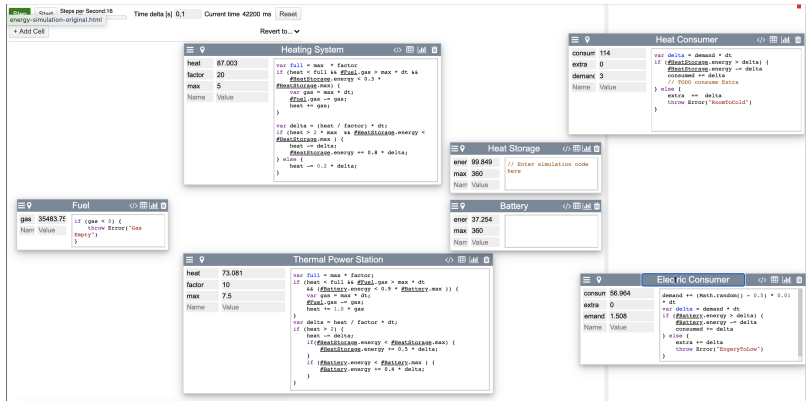

Simulation
Step
Start
Steps per Second:10
Time delta [s] 0,1
Current time 0 ms
Reset
+ Add Cell
Revert to...
Heating System
heat 0
factor 20
max 5
Name Value
var full = max * factor
if (heat < full && #Fuel.gas > max * dt &&
#HeatStorage.energy < 0.3 *
#HeatStorage.max) {
var gas = max * dt;
#Fuel.gas -= gas;
heat += gas;
}
var delta = (heat / factor) * dt;
if (heat > 2 * max && #HeatStorage.energy <
#HeatStorage.max) {
Click here to see all cell
that require fuel
A heating system requires fuel and
produces heat
Fuel
gas 36000
Nam Value
if (gas < 0) {
throw Error("Gas
Empty")
Heat Storage
ener 0
// Enter simulation code
Heat Consumer
consum 0
extra 0
demanc 3
Name Value
var delta = demand * dt
if (#HeatStorage.energy > delta) {
#HeatStorage.energy -= delta
consumed += delta
// TODO consume Extra
} else {
extra += delta
throw Error("RoomToCold")
}
Battery
ener 0
Electric Consumer
consun 0
extra 0
demani 1.5
Name Value
demand += (Math.random() - 0.5) * 0.
* dt
var delta = demand * dt
if (#Battery.energy > delta) {
#Battery.energy -= delta
consumed += delta
Thermal Power Station
heat 0
factor 10
max 7.5
Name Value
var full = max * factor;
if (heat < full && #Fuel.gas > max * dt
&& (#Battery.energy < 0.9 * #Battery.max))
{
var gas = max * dt;
#Fuel.gas -= gas;
heat += 1.0 * gas
}
var delta = heat / factor * dt;
if (heat > 2) {
heat -= delta;
if(#HeatStorage.energy < #HeatStorage.max) {
#HeatStorage.energy += 0.5 * delta;
0:00 / 2:00

Demo

Let's use our framework for the energy simulation!

What we have seen:

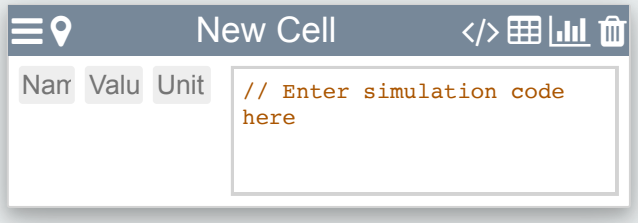
1. Ported simulation works ✅
2. Loading a simulation and adding a cell ✅
3. Independent cells/ global state access ✅
4. Log tables and charts ✅



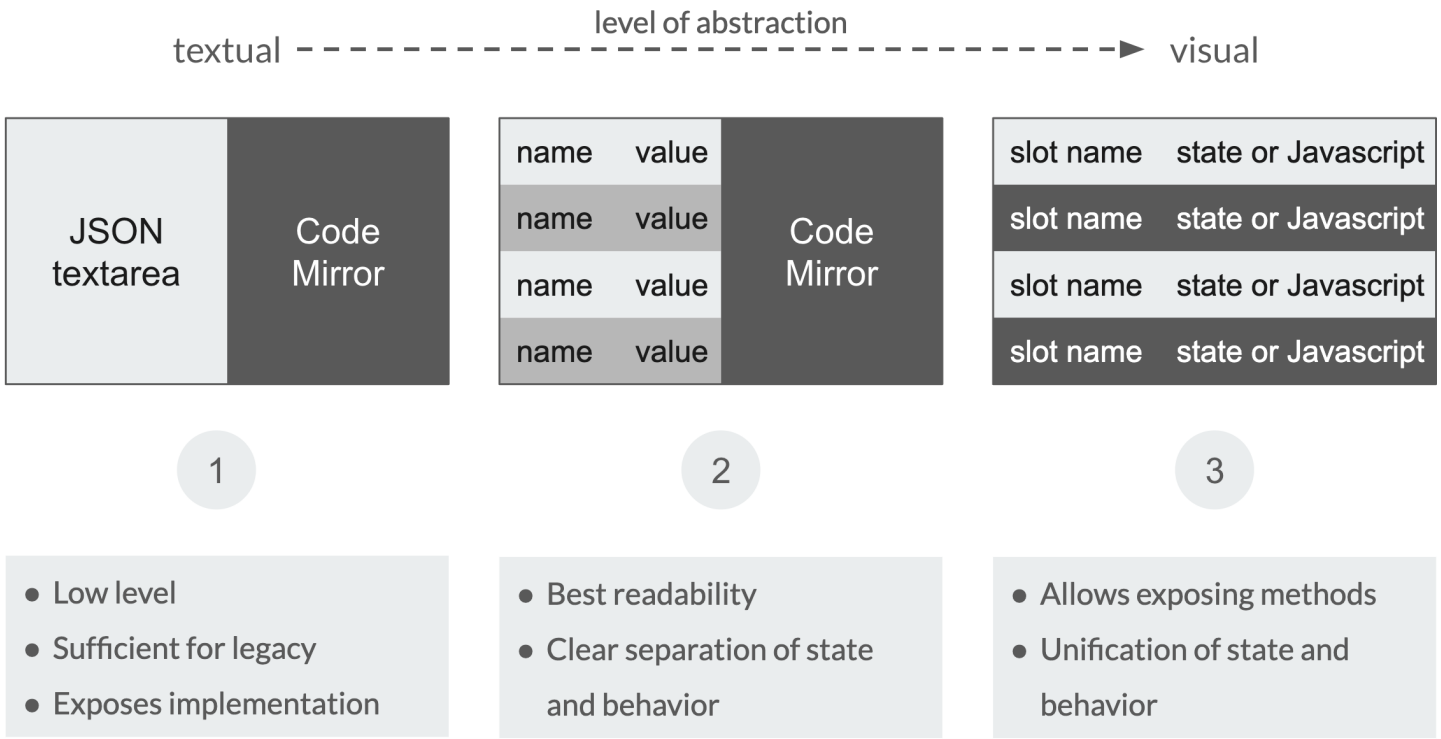
Energy simulation in Lively4

Design Improvements

Improve end user experience



Managing State and Behavior



- Low level
- Sufficient for legacy
- Exposes implementation

- Best readability
- Clear separation of state and behavior

- Allows exposing methods
- Unification of state and behavior

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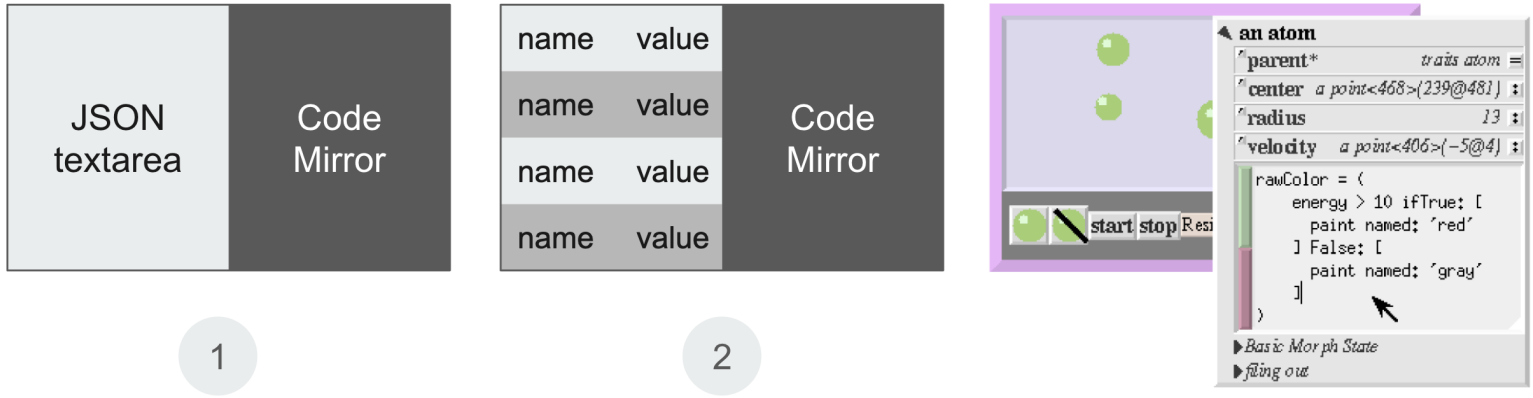
Managing State and Behavior

level of abstraction

textual ----------► visual



1

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- Exposes implementation

2

- Best readability
- Clear separation of state and behavior

- Allows exposing methods
- Unification of state and behavior

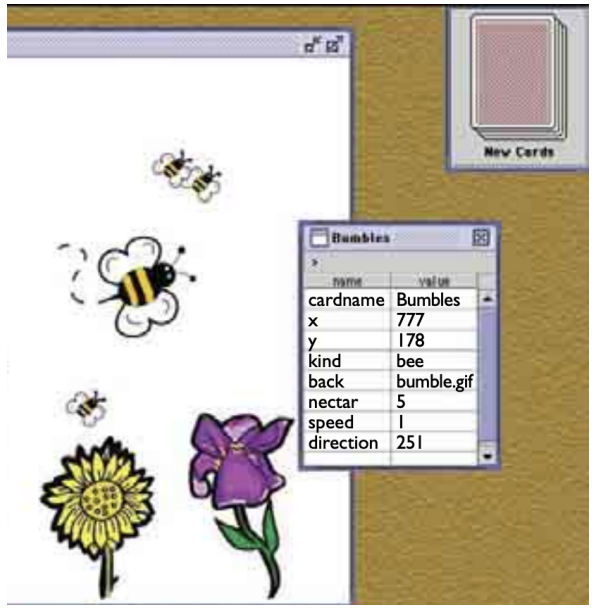
Image based on: Smith, R. B., Maloney, J., & Ungar, D. (1995, October). The Self-4.0 user interface: manifesting a system-wide vision of concreteness, uniformity, and flexibility. In Proceedings of the tenth annual conference on Object-oriented programming systems (pp. 47-60).

Cell Views

- Legacy had one centralized log/ chart
- Each cell represents one simulation unit

> *"An environment that works the way nonprogrammers expect is more inviting and helps users become more confident and productive. [2]*

→ each unit should have it's own state/ behavior, log, chart



each entity has different views [2]

[2] Myers, B. A., Pane, J. F., & Ko, A. (2004). Natural programming languages and environments. Communications of the ACM, 47(9), 47-52.

Cell Views

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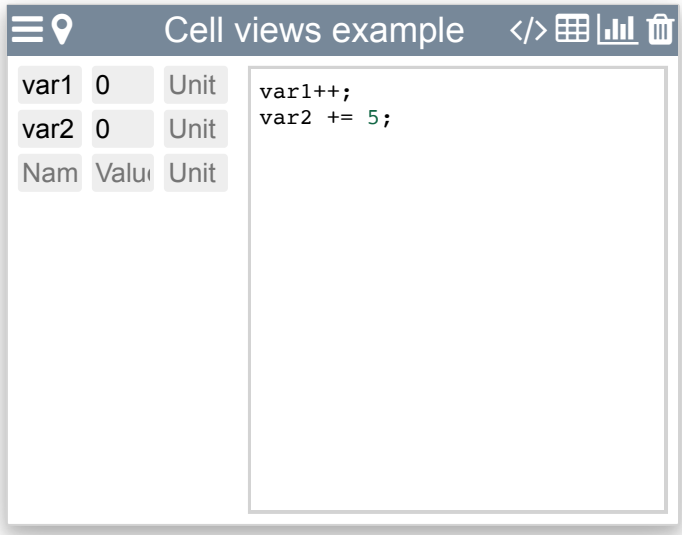
> *An environment that works the way nonprogrammers expect is more inviting and helps users become more confident and productive. [2]*

→ each unit should have it's own state/ behavior, log, chart, **...custom view?!**



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Unit Support for DSL

Goal Allow usage of units in DSL and support automatic conversion

Legacy Add units as comment to state only

Solution Use mathjs [3] to parse the code and work with units

> *[Mathjs] features a flexible expression parser [...] and offers an integrated solution to work with [...] units, and matrices. Powerful and easy to use. [3]*

```
math.evaluate('5.08 cm + 2 inch')     // 10.16 cm
```

[3] https://mathjs.org/

Outlook: Unit Support for DSL

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~~**Solution** Use mathjs [3] to parse the code and work with units~~

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```
math.evaluate('5.08 cm + 2 inch')     // 10.16 cm
```

Mathjs does not fully support Javascript (f.e. loops, if/else)
User would have to learn mathjs to use it

[3] https://mathjs.org/

What's Next?

Learnings 📚

- Lively integration is easier than expected
- Plenty tools & features → keeping overview is hard for newbies
- Stable internet connection required
- Dataflow for nested components is not specified

Next Steps 🏃

- Mirroring of cells

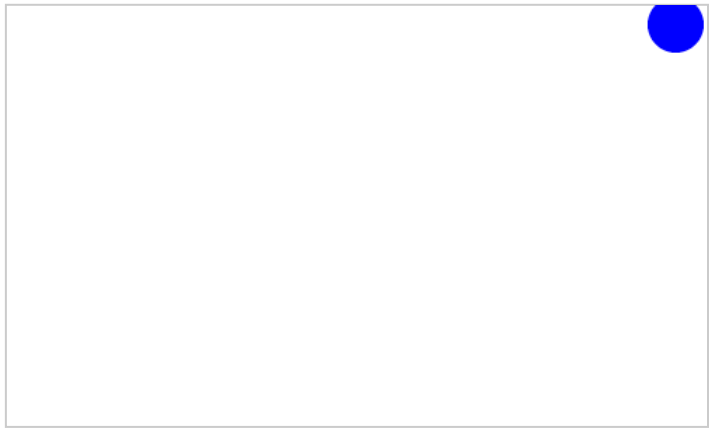
What's Next?

Future Work ➡️

→ *Gas tank simulation* shows functionality for further development

- **Variable number** of entities of a cell
- Creating a **visualization** component

Hits: 5



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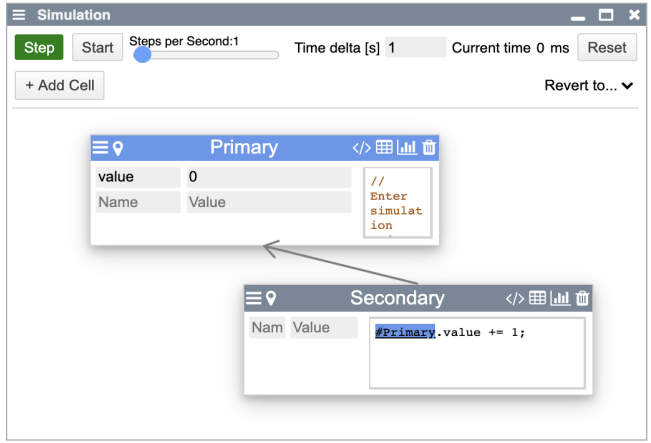

Simulation Framework