# PX 2018: Seminar on Programming Experience

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# Abstract

Active Essays and Explorable Explanations is a form of interactive media that can help understand complex systems for many relevant domains. In particular, the domain of software design is filled with challenging algorithms, patterns, and systems that are hard to understand and master.  In this seminar, the participants will create demos, tools, and applications based on the idea of Explorable Explanations to improve the programming experience when developing such systems. By using our live collaborative development environment, Lively4, they will share, explore, and adapt the created tools and explanations --- even in unanticipated ways.

# What will this Seminar be about?

- Design ideas
  - Algorithms
  - Patterns
- Found in all kinds of software systems
  - Programming languages
  - Frameworks
  - Libraries
  - Applications

# How to present the idea

- Implement the idea in a new environment / language
- Generate visualizations and animations
- Goal: make the idea better understandable

# Examples

- A* vs Dijstra Path Finding Algorithms
- Explorable Explanations

# Implementation Platforms

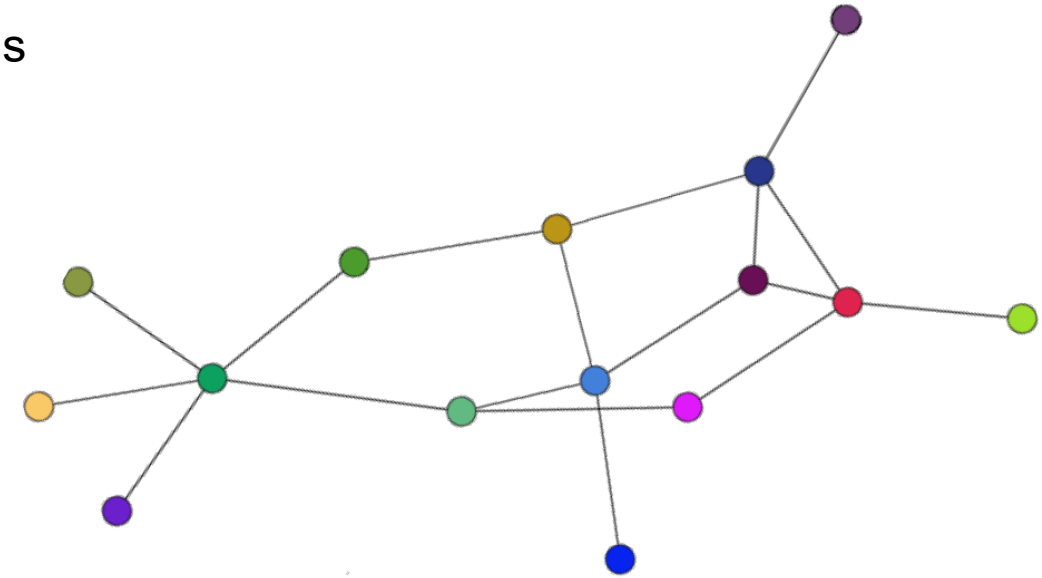
Squeak (Smalltalk)

Lively4: JavaScript, Web components

# Topics

# Topic 01: Graph Drawing

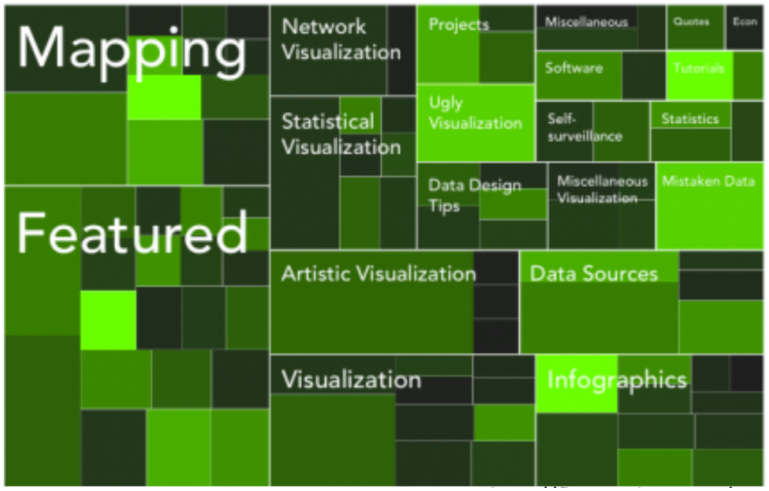
- Domain: Visualization algorithms
- Compare:
  - Simulated Annealing
  - Force Layout



- Literature
  - wikipedia:Graph Drawing
  - Ron Davidson, David Harel (1996). Drawing graphs nicely using simulated annealing
  - Thomas M. J., Fruchterman Edward M. Reingold (1991). Graph drawing by force-directed placement

# Topic 02: Stable Treemaps

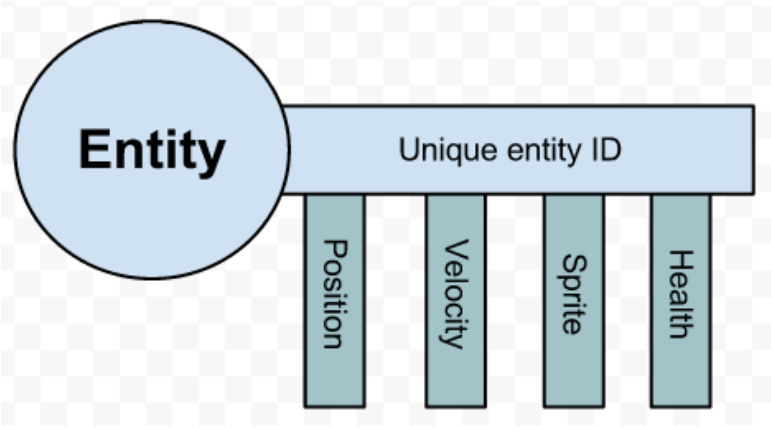
- Domain: Visualization Algorithms
- e.g. Voronoi tree maps




- Literature
  - see Sebastian Hahn @ hpi

# Topic 03: Entity Component System

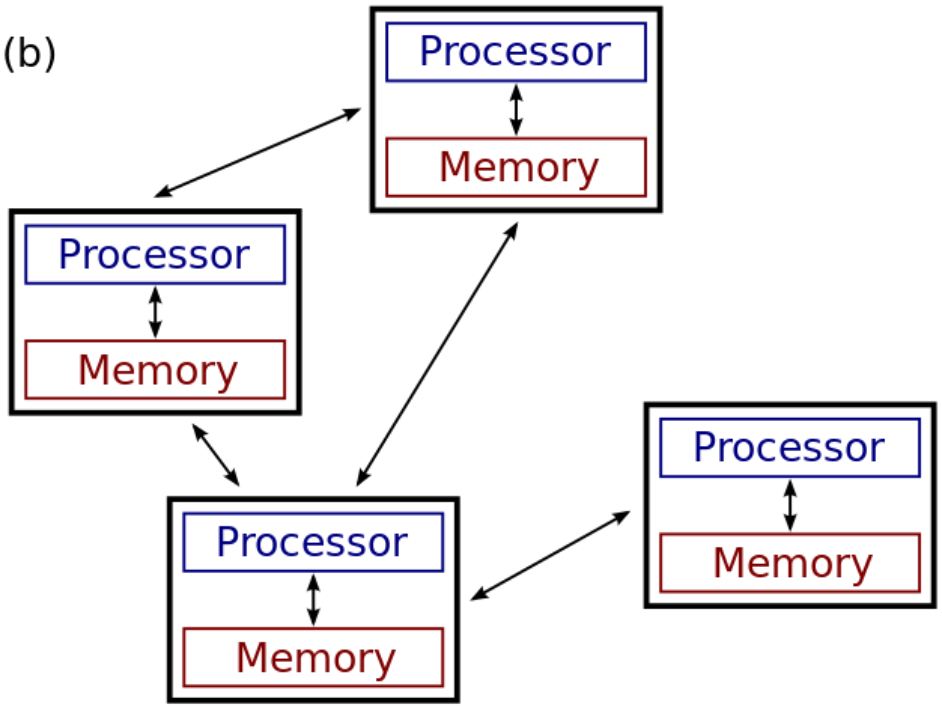
- Domain: Software Engineering
- Links/Resources




- Literature
  - wikipedia:Entity Component System
  - Nick PrÃ¼hs (2014) Component-Based Entity Systems in Spielen
  - Michael House (2012) What is the role of â€œsystemsâ€ in a component-based entity architecture
  - Chris Granger (2012). Anatomy of a Knockout

# Topic 04: Conflict-free replicated data type

- Domain: Software Engineering / Distributed Computing




- Literature
  - wipipedia:Conflict-free replicated data type

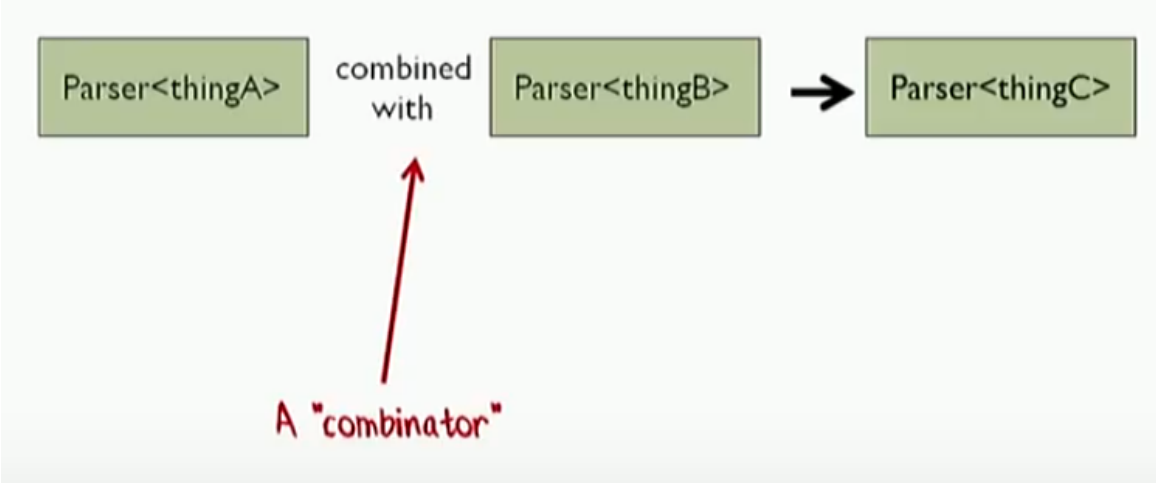
# Topic 05: Regular Expressions

- Domain: Algorithms
- Implementation Strategies
  - Deterministic Finite Automatons (DFAs)
  - Nondeterministic Finite Automatons (NFAs)
  - Backtracking

- Literature
  - wikipedia:Regular Expression

# Topic 06: Parser Combinator

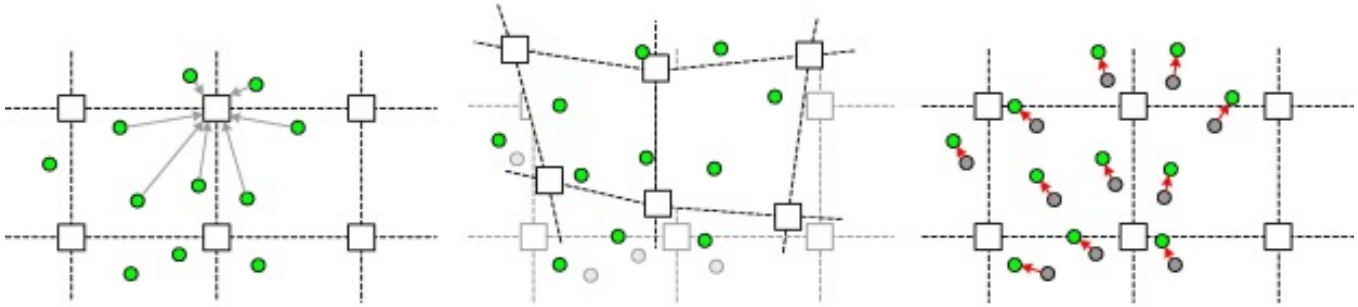
- Domain: Software Engineering




- Literature
  - wikipedia:Parser_combinator

# Topic 07: Material Point Method

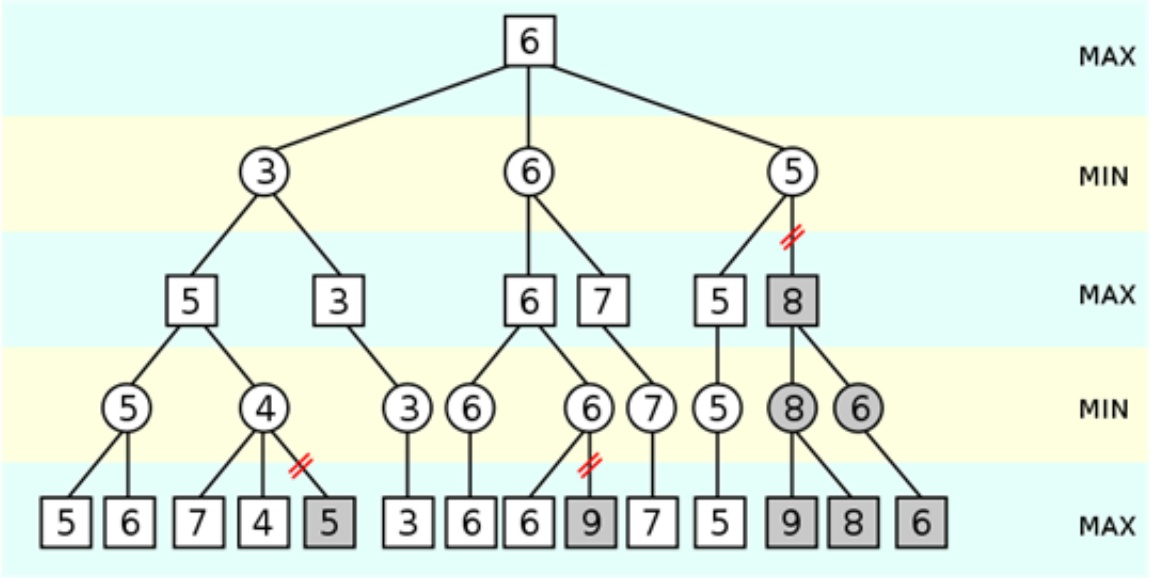
- Domain: Simulation Algorithms
- Example




- Literature
  - wikipedia:Material Point Method

# Topic 08: Alpha-beta Pruning

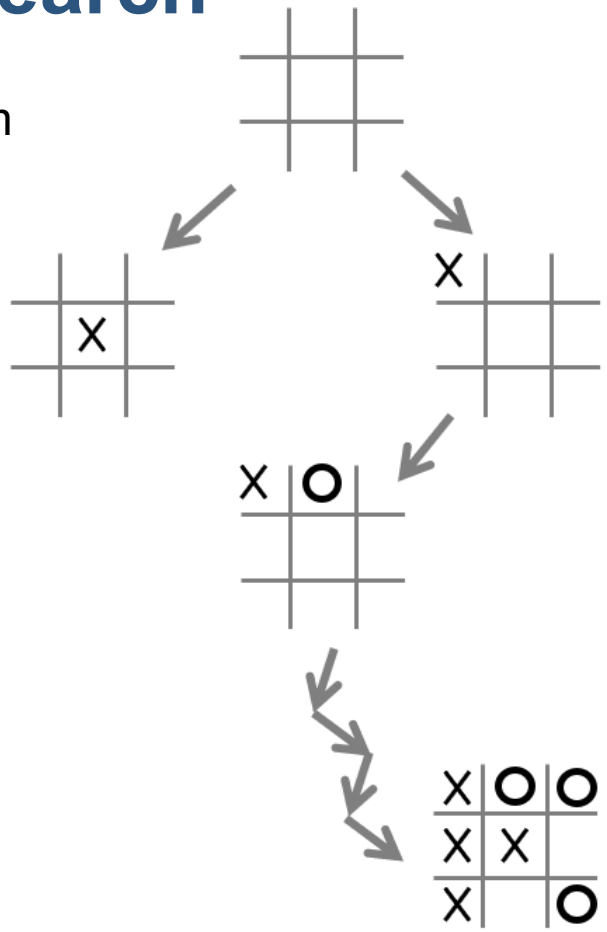
- Domain: Artificial Intelligence / Search Algorithm




- Literature
  - wikipedia:Alpha-beta Pruning
  - Knuth, D. E., and Moore, R. W. (1975). "An Analysis of Alpha-Beta Pruningâ€
  - Chessprogramming Wiki / Alpha-Beta

# Topic 09: Monte Carlo Tree Search

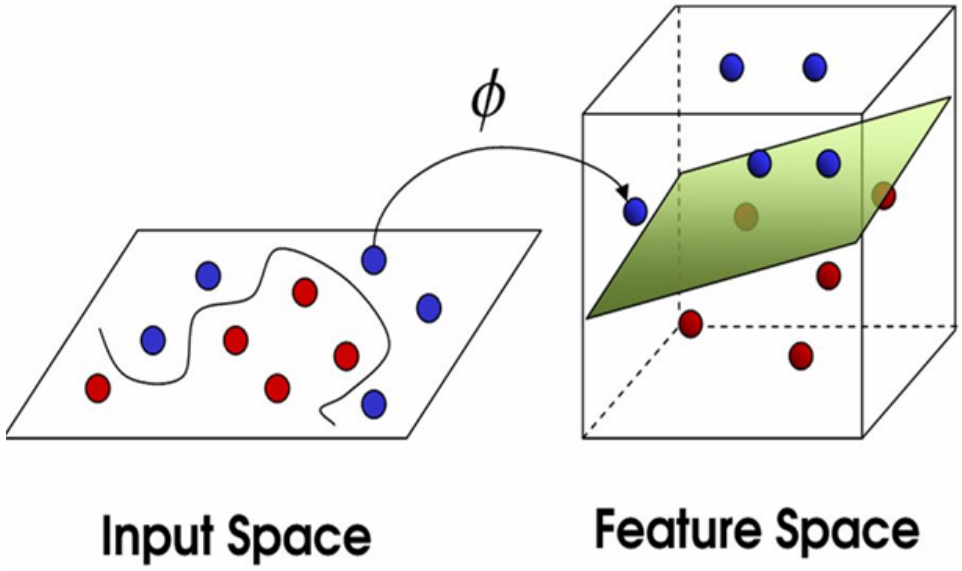
- Domain: Artificial Intelligence / Search Algorithm
- Example Application: Alpha Go KI



- Literature
  - wikipedia:Monte Carlo Tree Search
  - Silver, David, et al. "Mastering the game of Go with deep neural networks and tree search"

# Topic 10: Support Vector Machine

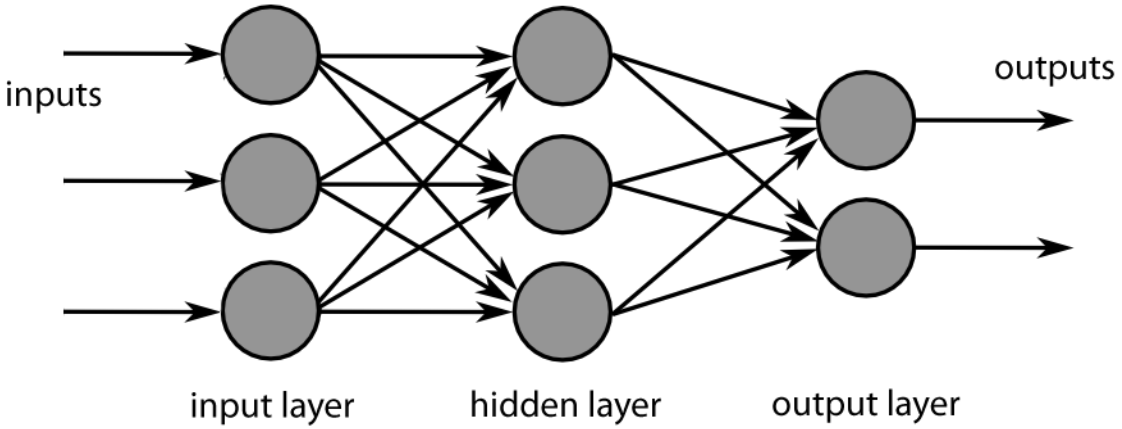
- Domain: Artificial Intelligence




- Literature
  - wikipedia:Support Vector Machine

# Topic 11: Artificial Neural Network

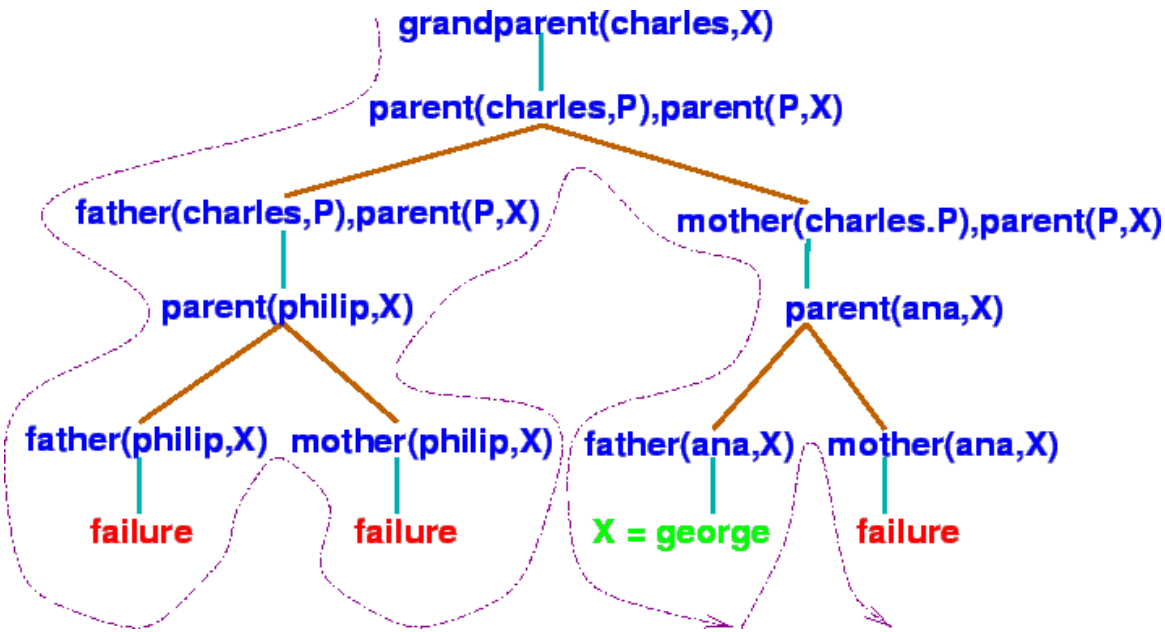
- Domain: Artificial Intelligence




- Literature
  - wikipedia:Deep Learning
  - Michael Nielsen (2017). Neural Networks and Deep Learning

# Topic 12: Prolog / Unification

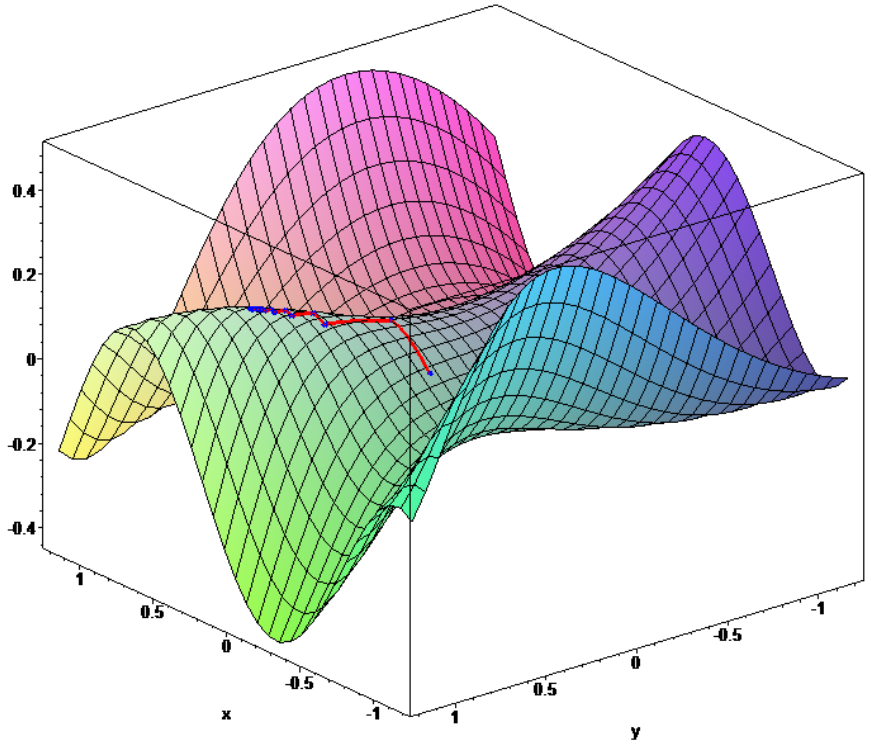
- Domain: Software Engineering / Solving / AI ...




- Literature
  - wikipedia:Unification
  - wikipedia:Prolog

# Topic 13: Constraint Solver

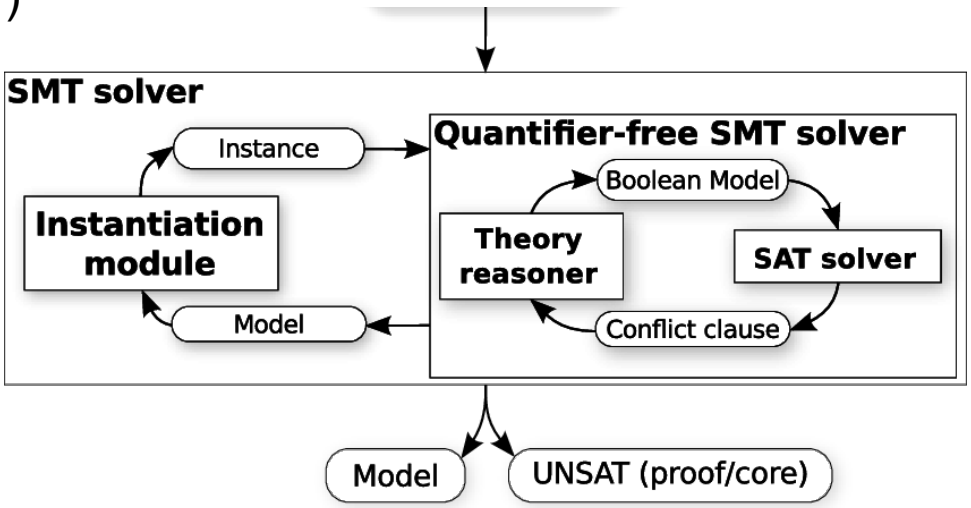
- Domain: Constraints Solving
- Compare
  - Cassowary
  - Gradient Descent
  - Back tracking




- Literature
  - wikipedia:Gradient Descent
  - Greg J. Badros, Alan Borning, and Peter J. Stuckey (2001). The Cassowary Linear Arithmetic Constraint Solving Algorithm

# Topic 14: Z3

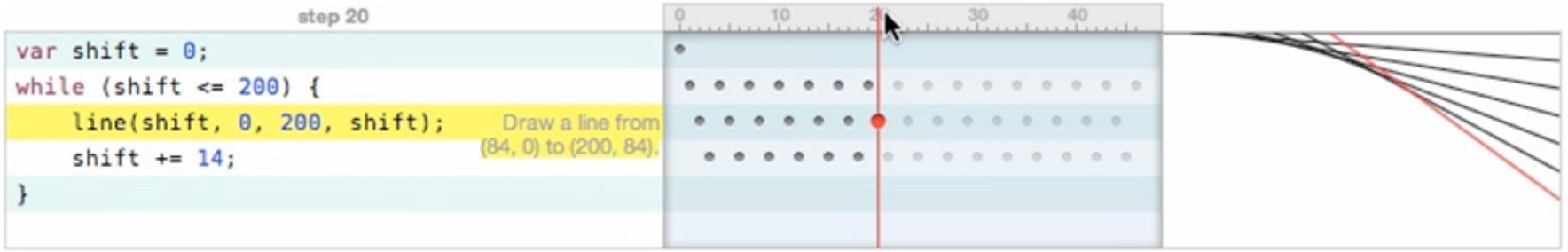
- Domain: Constraints Solving
- Theorem prover
- Satisfiability modulo theories (SMT)




- Literature
  - Leonardo de Moura, Nikolaj BjÃ¸rner (2008). Z3: An efficient SMT solver
  - github:z3

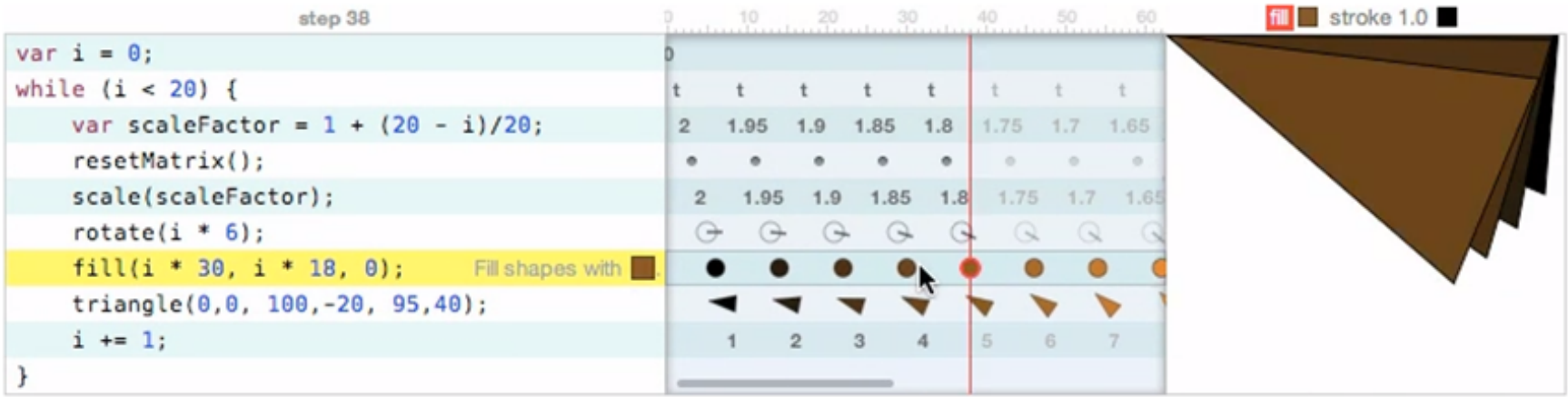
# Topic 15: Learnable Programming
# 1. Follow the flow

- Domain: Programming Experience
- lively4 continous editor prototype



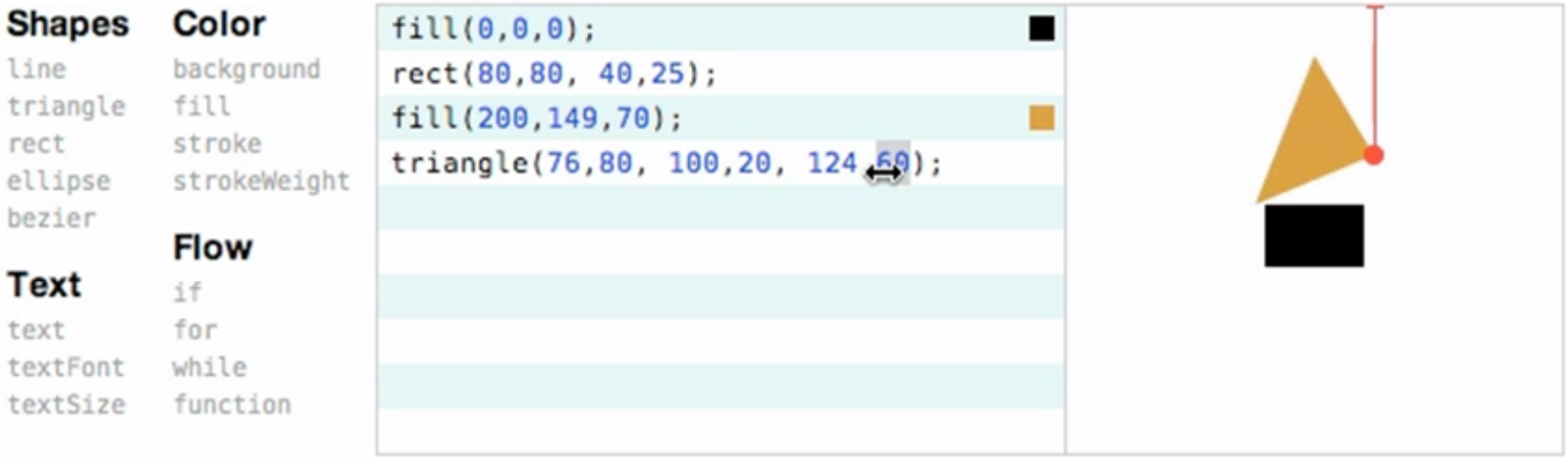

- Literature
  - Bret Victor 2012. Inventing on Principle.
  - Bret Victor 2012. Learnable Programming. http://worrydream.com/

# Topic 16: Learnable Programming
# 2. See the state




- Literature
  - Bret Victor 2012. Inventing on Principle.
  - Bret Victor 2012. Learnable Programming. http://worrydream.com/

# Topic 17: Learnable Programming
# 3. Create by reacting




- Literature
  - Bret Victor 2012. Inventing on Principle.
  - Bret Victor 2012. Learnable Programming. http://worrydream.com/

# Topic 18: Learnable Programming
# 4. Create by abstracting

**Abstract**

var
function

**Flow**

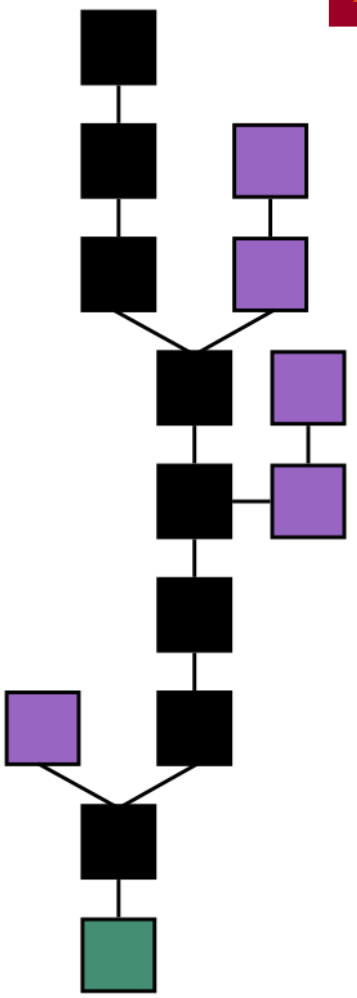
if
for
while

```
function house (x) {
    var y = 80;
    rect(x, y, 40, 20);
    triangle(x, y, 20 + x, -20 + y, 40 + x, y);
}

house(44);
house(101);
house(143);
```

- Literature
  - Bret Victor 2012. Inventing on Principle.
  - Bret Victor 2012. Learnable Programming. http://worrydream.com/

# Topic 19: Blockchain



- Domain: Cryptography Algorithm

- Literature
  - wikipedia:Blockchain

# And ...

Propose your own topic!

# Form of Presentation

- Demo / active content with text (no external slides)
- Squeak: see BookMorph etc
- Lively4: Markdown / HTML

# Content of Presentation

- Present and explain problem and specific solution of the domain problem
- Use interactivity and visualizations that are supported by text
- Present your solution on a meta level: present how you visualized made it interactive

# Early Feedback Presentation

- No weekly meetings, but we want to know if you are on the right track
- Solution, one very short presentation:
  - Understanding the problem / motivation?
  - Handle technical problems with both domain and presentation technogy?
  - Are on the right track?
- Max 10 mins

# Schedule

- Project presentation (April 11th)
- Topic assignment and Tutorial(s) (April 18th)
- Continuous consulations (in C.E)
- Early feedback presentation (10min), May 16th
- Continuous consulations (in C.E)
- Presentations (30min + discussion), 2 projects per session until July 18th

# Organization

- Project-Seminar, 4 SWS, 2 students per group
- Grading
  - 6 ECTS graded credit points
  - Grade based on project and presentation
- Hand-In
  - Presentation, Screencast, Sourcecode
- Enrollment with preferred 3 topic names on or before April 16th
  - Mail to stefan.ramson@hpi.de and jens.lincke@hpi.de with PX2018 in subject
- Presentation dates determined after topics are assigned

HPI