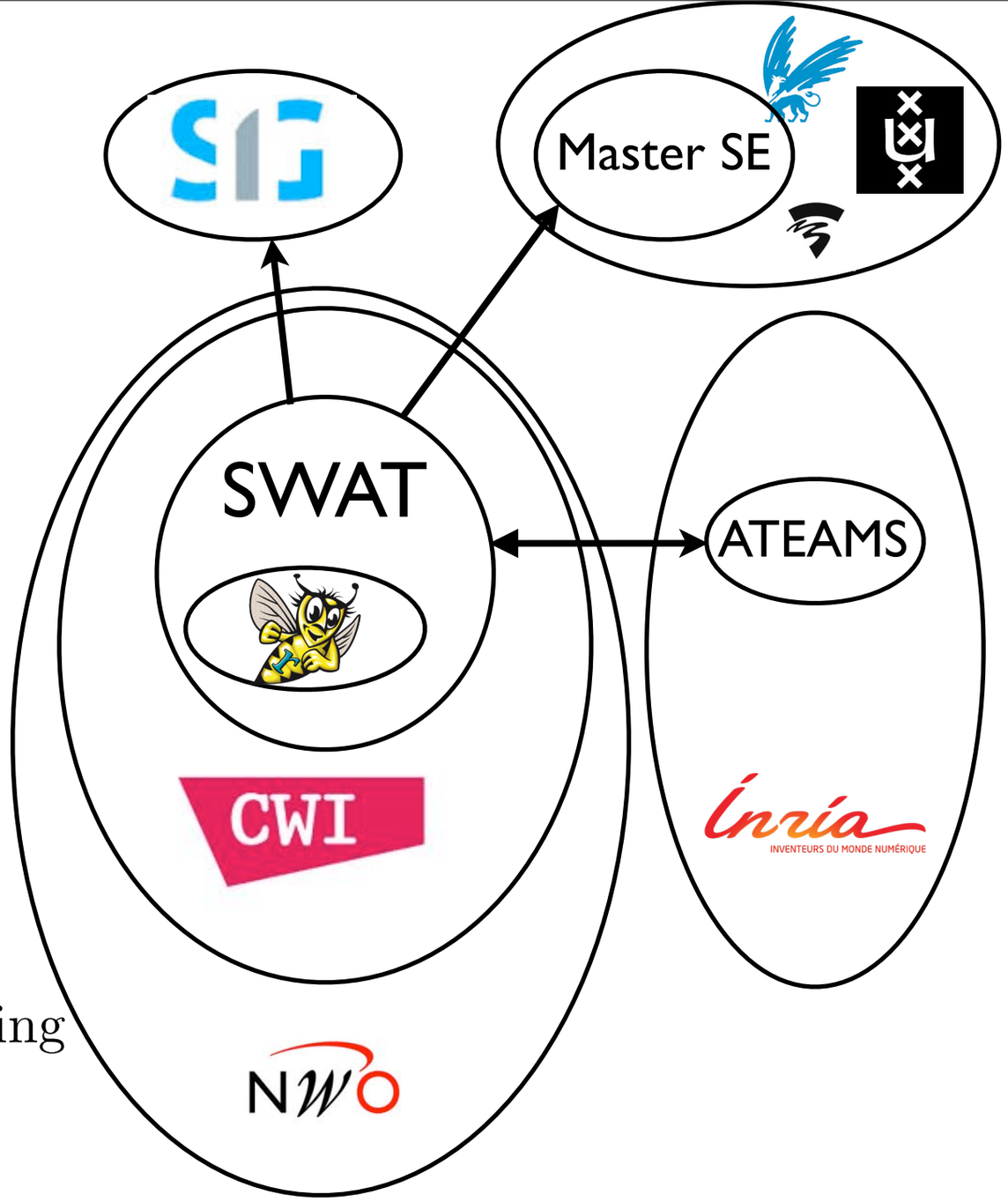
CWI SWAT & Rascal

NWO Special Interest Group Software Engineering
Nov 14th, 2013

Jurgen Vinju



- Centrum Wiskunde & Informatica
- Programming languages and systems
  - Algol
  - Python
  - ASF+SDF, Rascal
  - MonetDB
- Software Improvement Group (spin-off)
  - Software Quality Assessment & Monitoring
  - Reverse Engineering
- CWI SWAT ≡ INRIA ATEAMS
  - all about source code
  - supporting the tasks of programmers
- Master Software Engineering @{Universiteit van Amsterdam, VU, HvA}

Today

- What and why do we research <u>software</u> at CWI?
- How? A glimpse of Rascal.
- Discussions
  - What is “software engineering” to you?
  - Quality for scientific software

SWAT team



















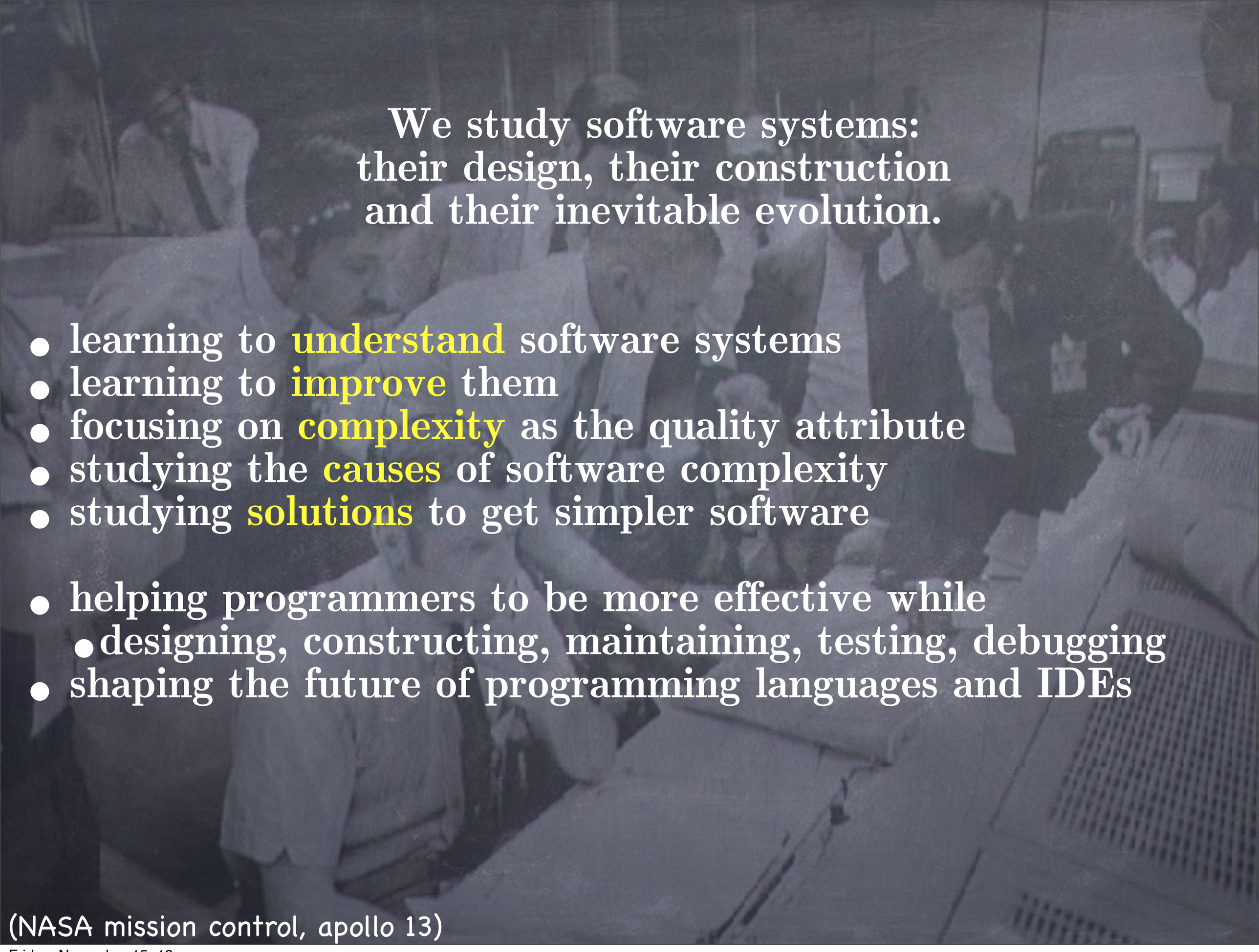



The problem with software is not in constructing it

(given sufficiently experienced architects & engineers)

The problem is in understanding existing software in order to improve it

(and a lot of software exists)



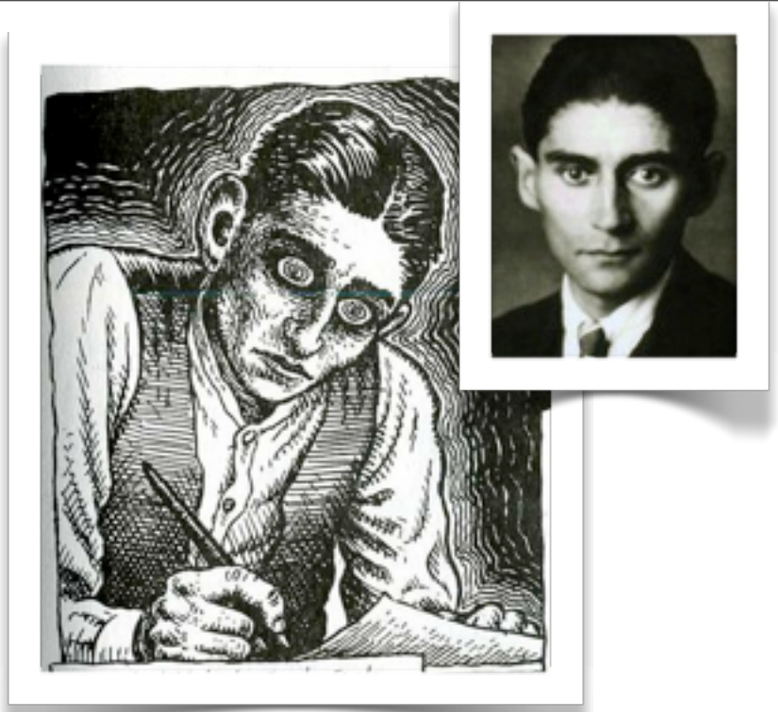
We study software systems:
their design, their construction
and their inevitable evolution.

- learning to understand software systems
- learning to improve them
- focusing on complexity as the quality attribute
- studying the causes of software complexity
- studying solutions to get simpler software

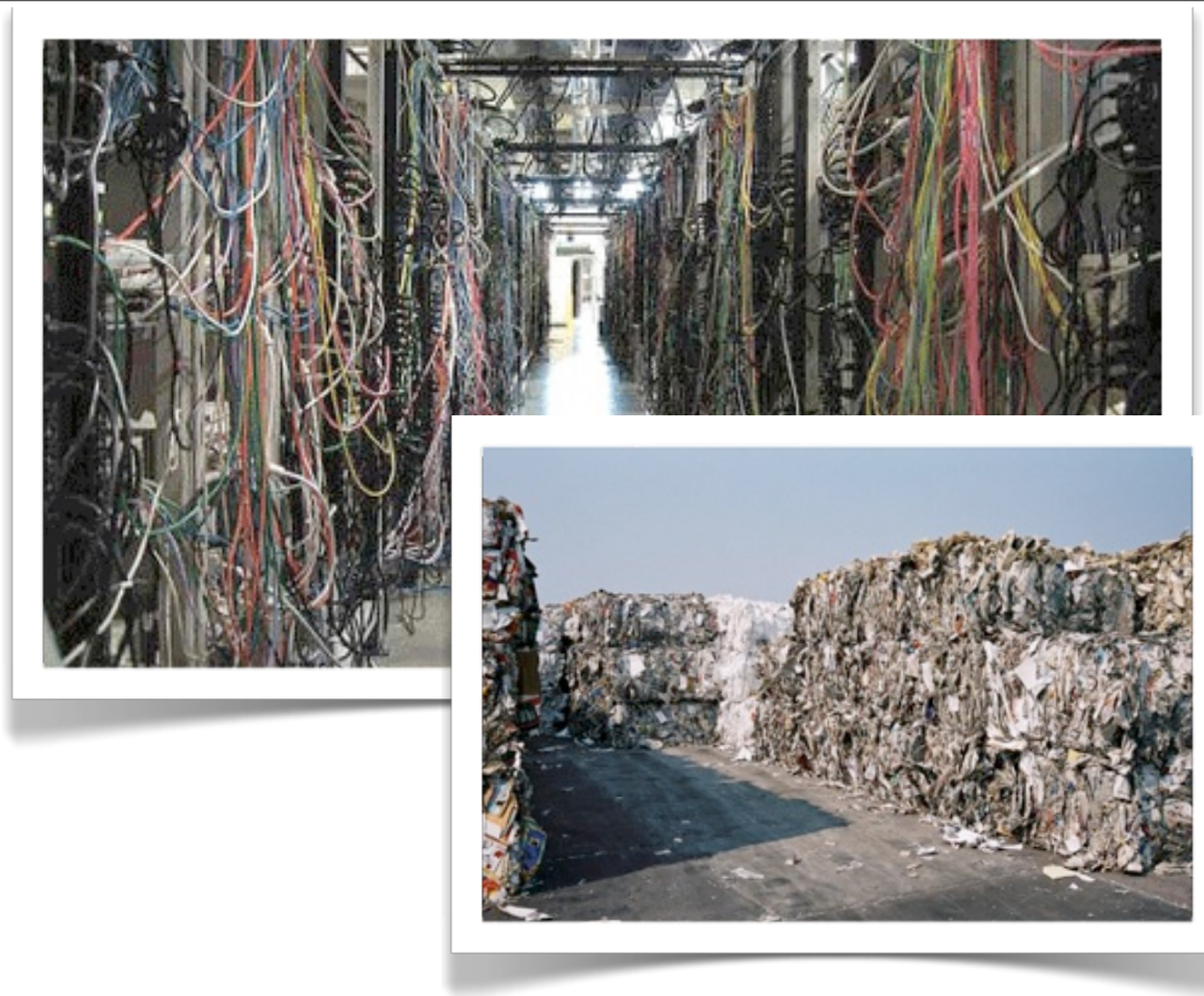
- helping programmers to be more effective while
  - designing, constructing, maintaining, testing, debugging
- shaping the future of programming languages and IDEs

(NASA mission control, apollo 13)

Software is not so difficult to understand, but it is extremely complex



Kafkaesque



Software - large and complex structures of computer instructions, written and read by man, executed by computers.

"marked by a senseless, disorienting, often menacing complexity..." (Infoplease.com)

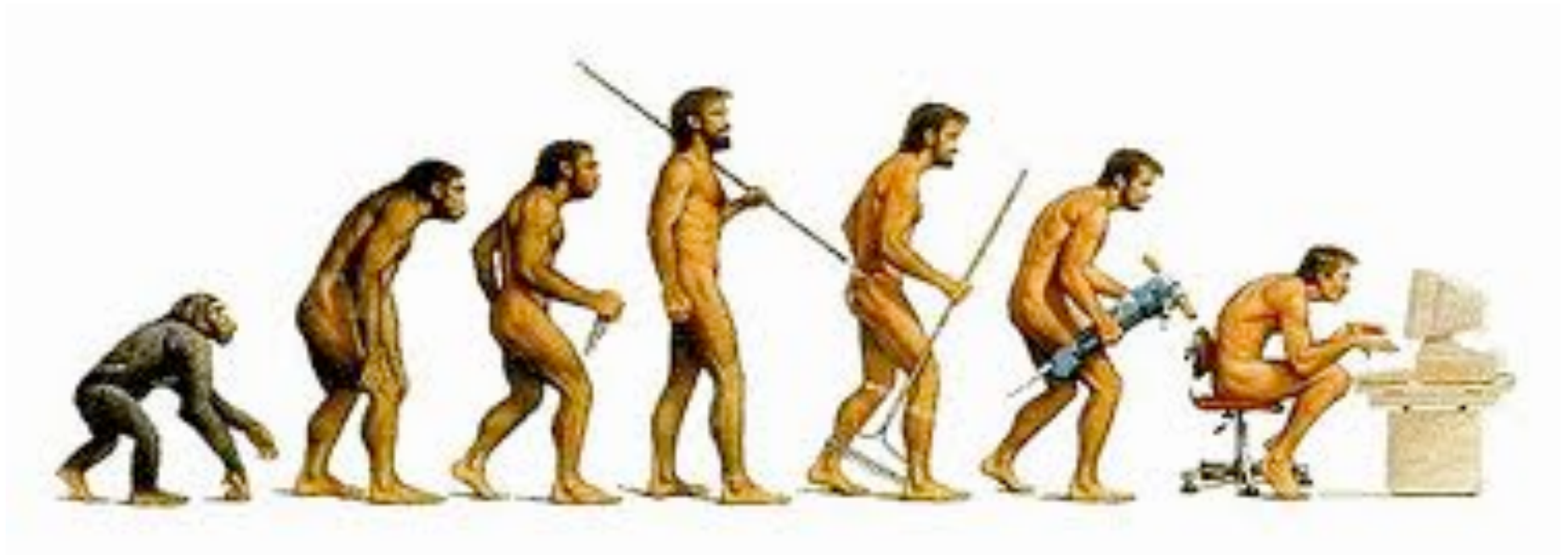
The source code of "ls"

3894 lines

367 ifs

174 cases

Solution...

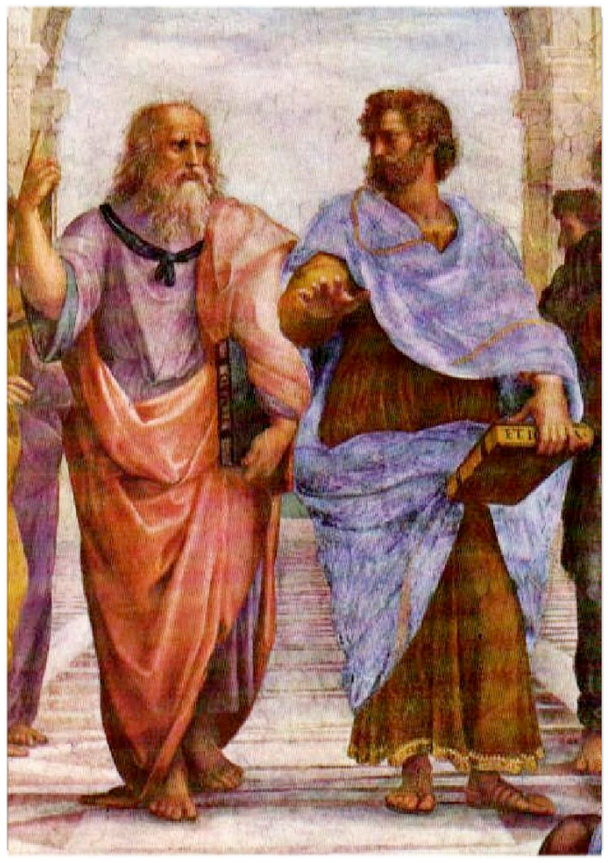


Tools

Transformation & Analysis

- (de)optimization
- GOTO removal
- Bug fixing (Y2K)
- Porting
- Refactoring
- Model-to-code
- Domain specific languages
- Code-to-model

Raphael (1509)

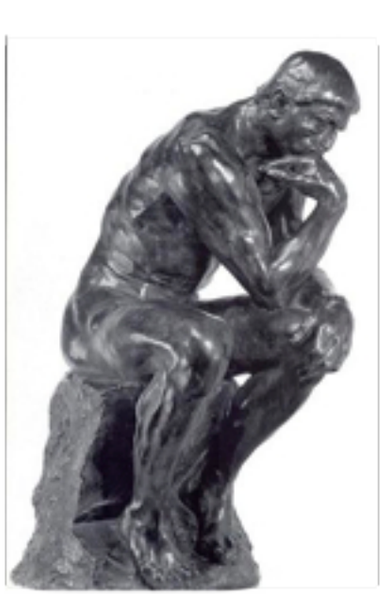


- Quality assessment
- Mining trends
- Dead code detection
- Bug detection
- Model checking
- Impact analysis
- Guided random testing
- Visualization

(etc)

“every week a new tool”

Tools

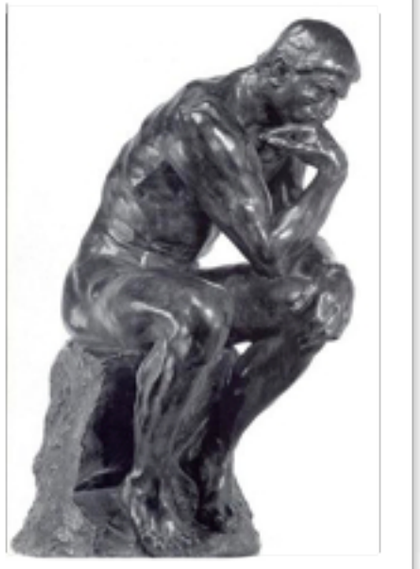


Research

Application

Rascal

Tools

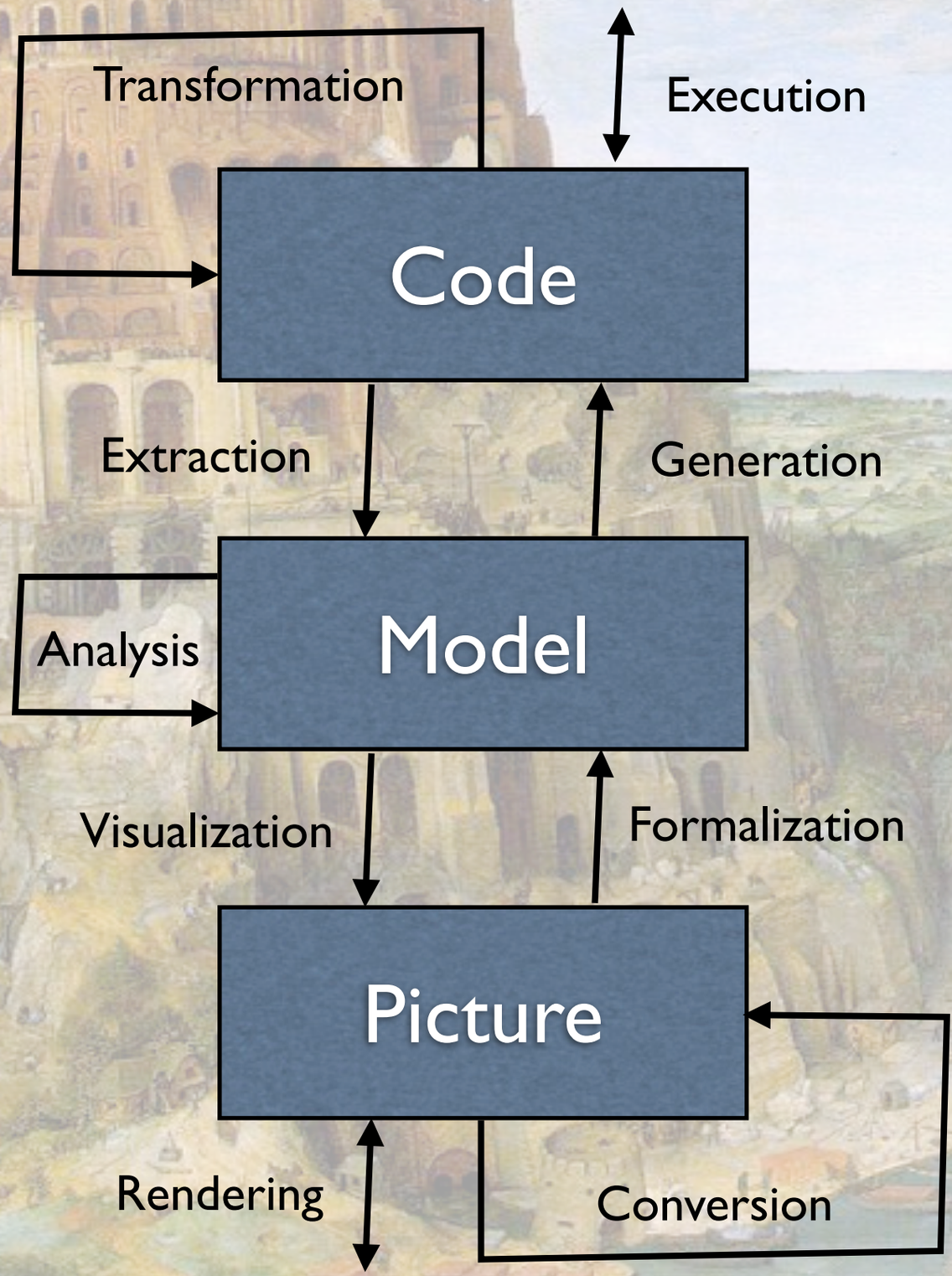


Research

Software

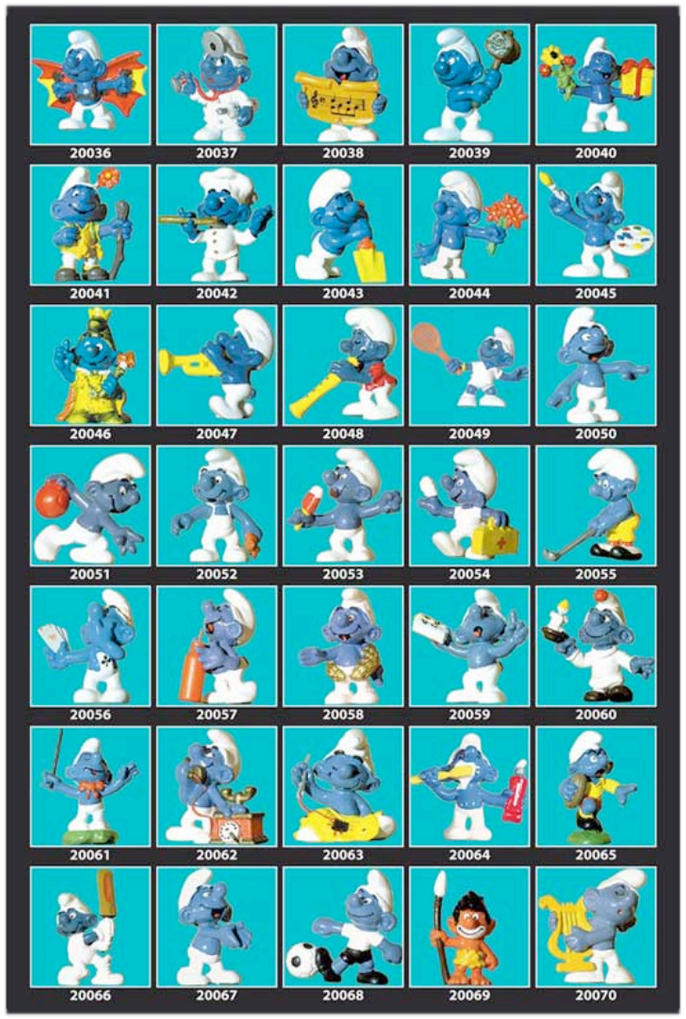

(Brueghel, Tower of Babel)

Rascal is a DSL for meta programming



(Brueghel, Tower of Babel)

The three challenges



Diversity

Multi-disciplinary

Precision vs Efficiency

Example Rascal Tasks

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- Generate code from a new kind of model (DSL)

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- Consolidate data about software systems (bug trackers) with source code analysis results.
- Generate code from a new kind of model (DSL)
- Translate from code to a model to generate test cases

Rascal for Digital Forensics

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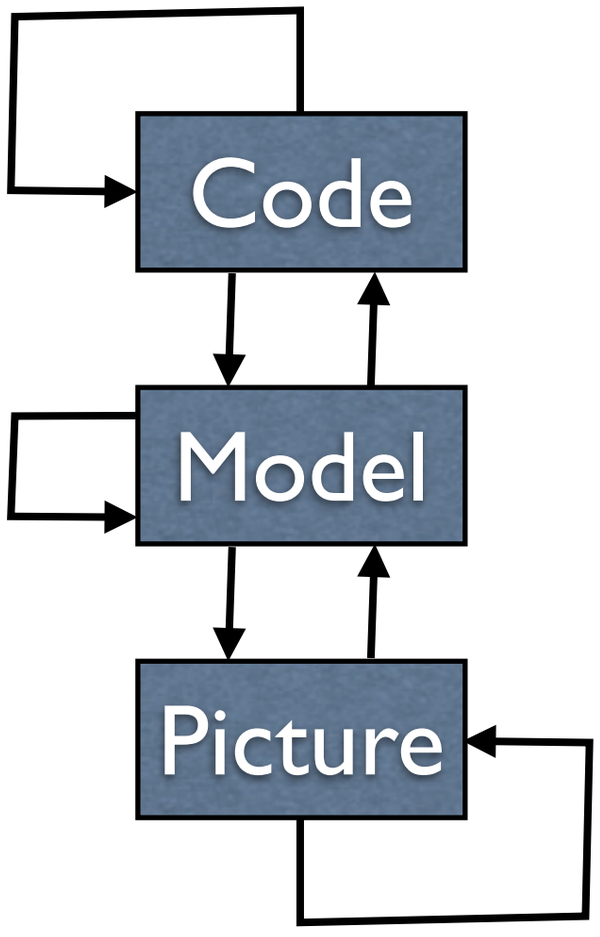
- Problem: variety of file formats [dialects]
- Solution: generate and optimize automatically
- Model: detailed file format description
- Code: plugins for file carver in Java
- Success factors: expert knowledge + rascal implementation

One slide DSL



One slide DSL

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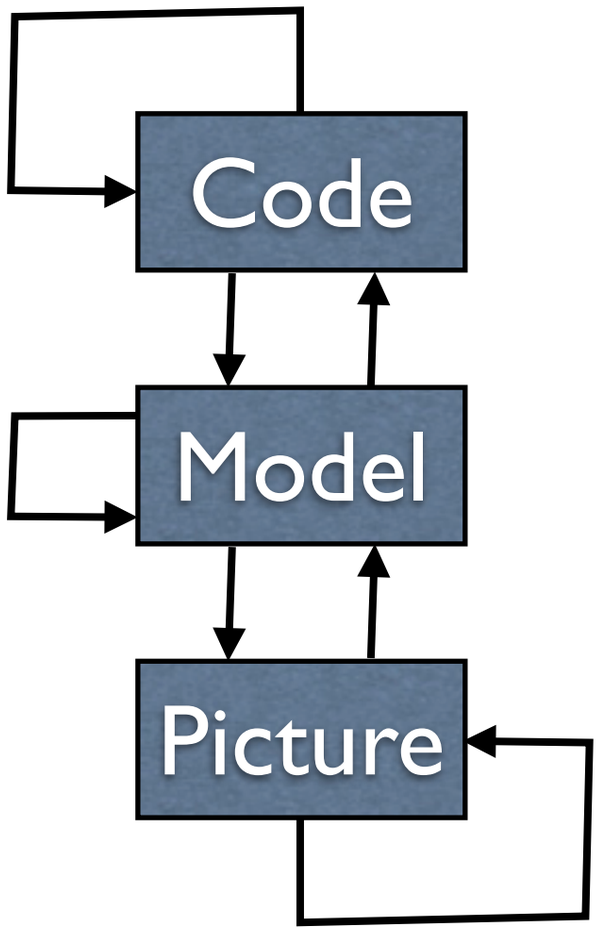

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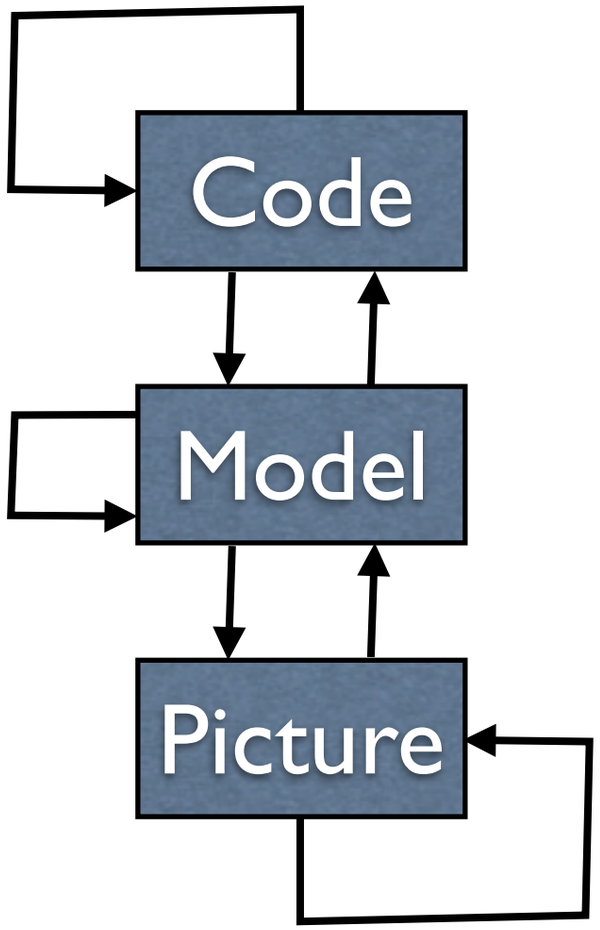

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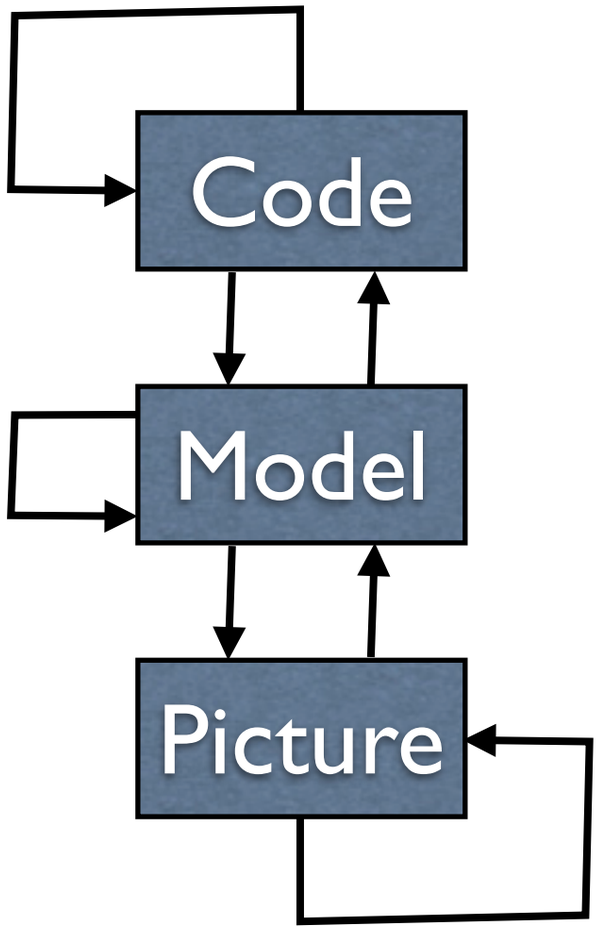

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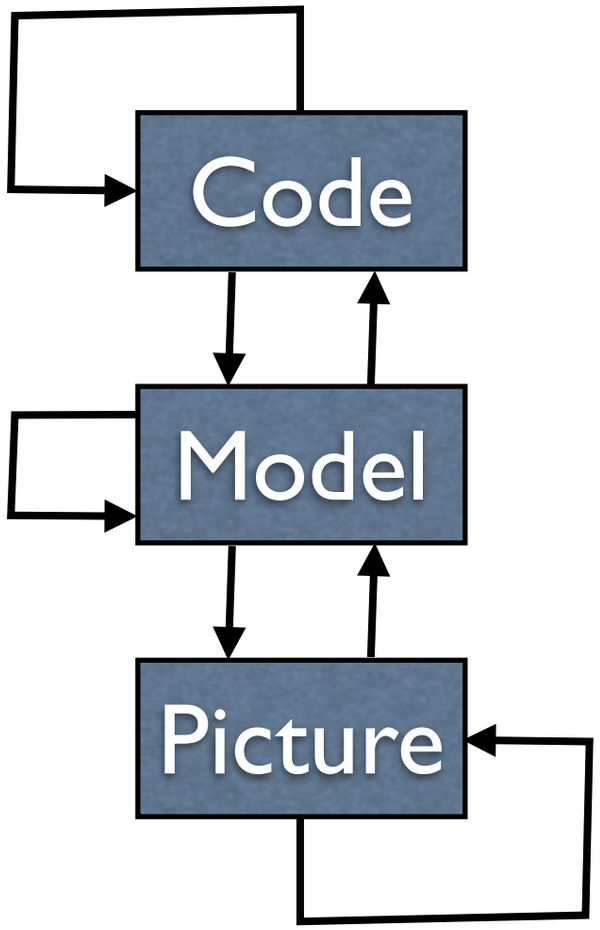
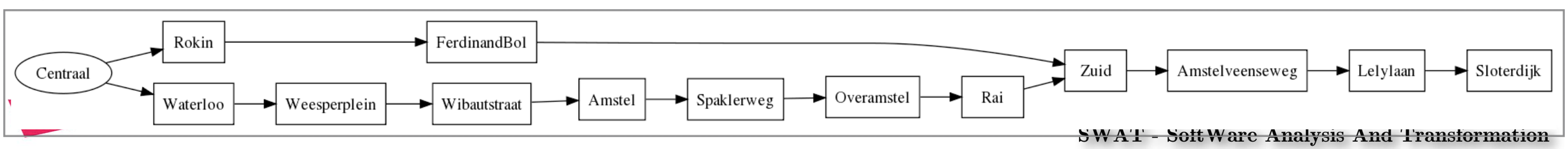
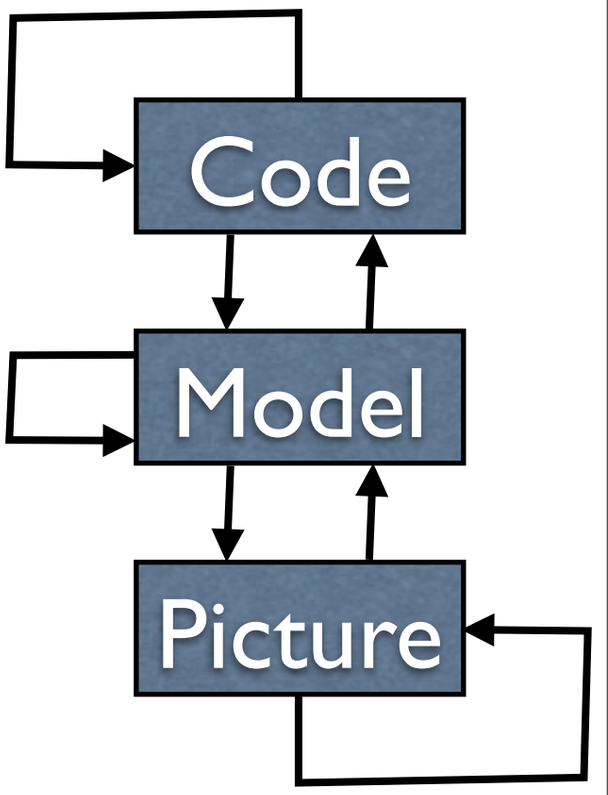
}
```

```
{ <“Centraal”, “Waterloo”>,
  <“Waterloo”,” Weesperplein”>, … }
```

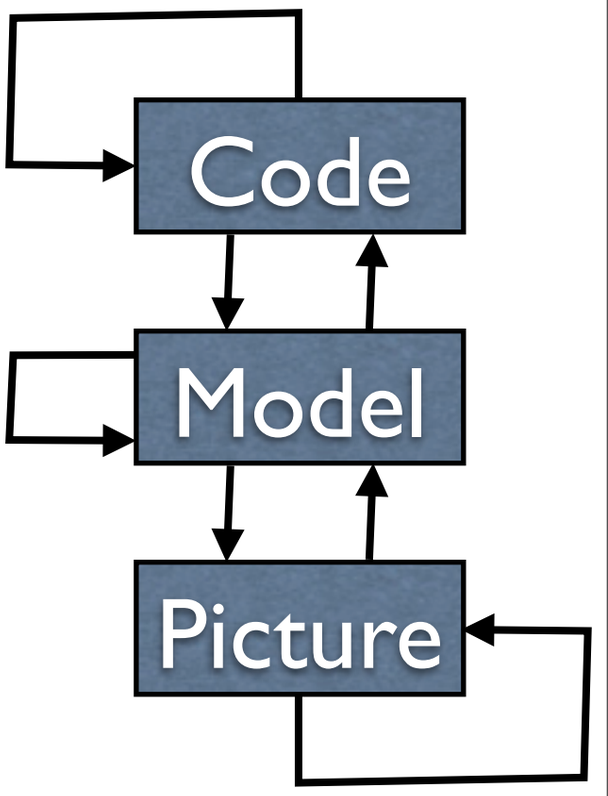
```
digraph Metro {
  node [shape=box]
  Centraal -> Waterloo
  Waterloo -> Weesperplein ...
  Centraal [shape=ellipse]
}
```






Code
Model
Picture

```
module Metro
```



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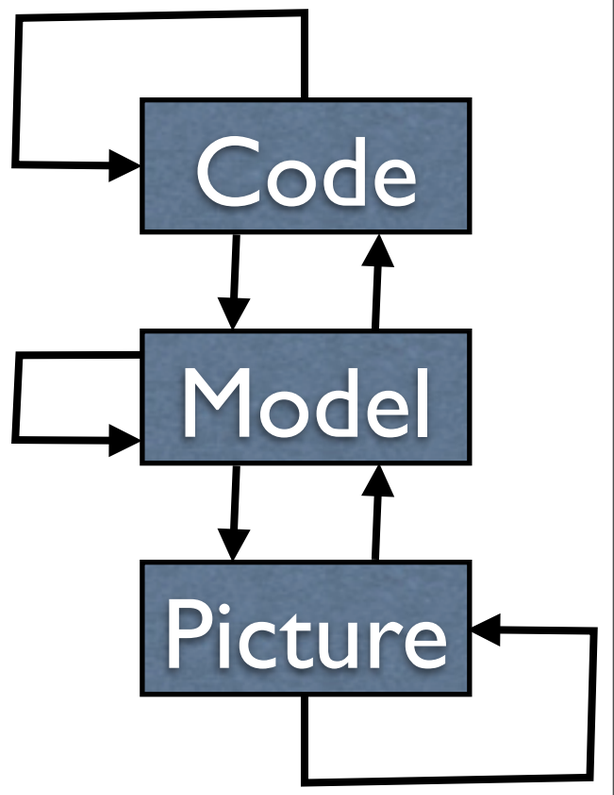

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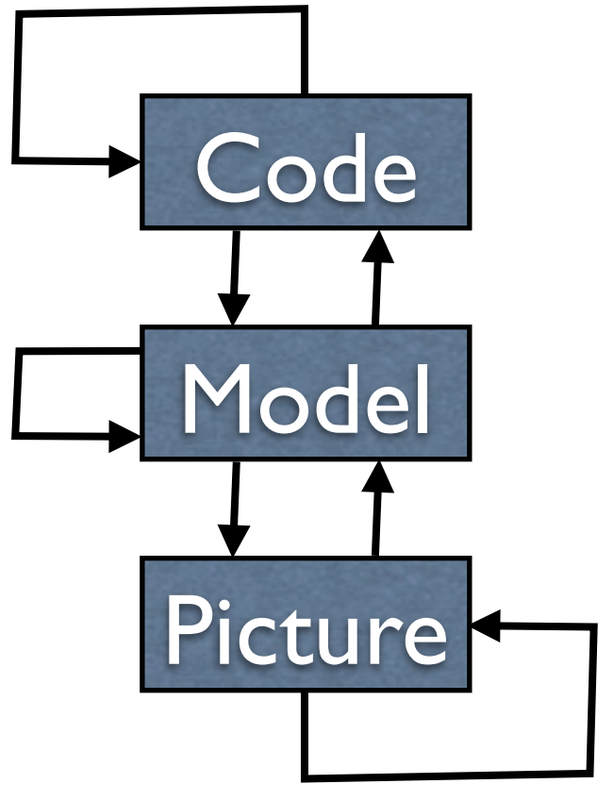

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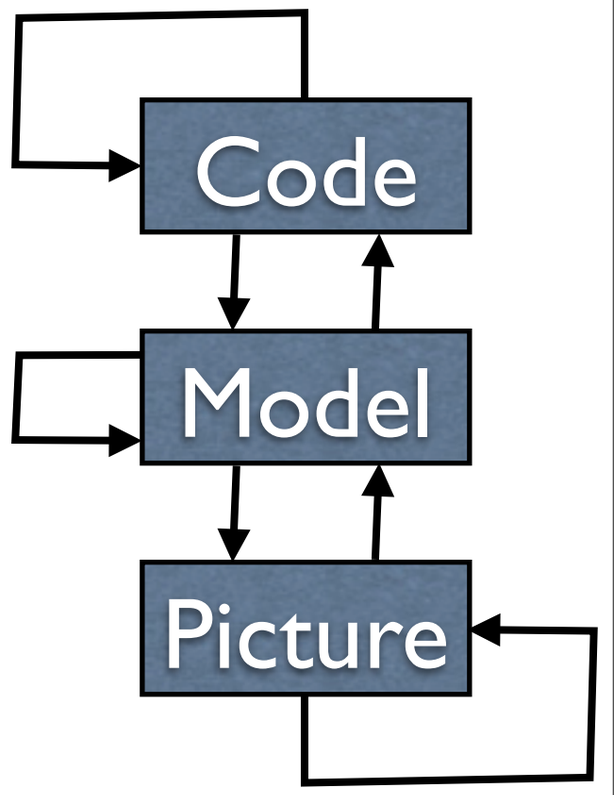

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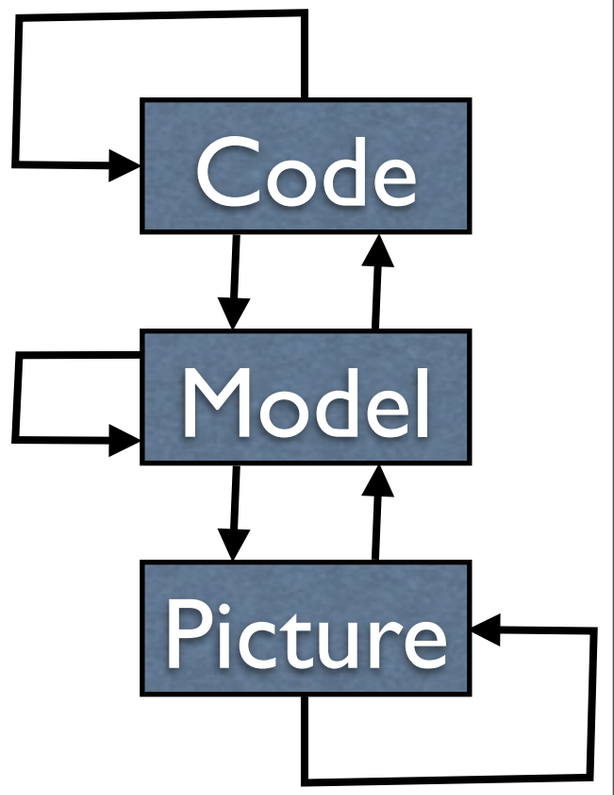

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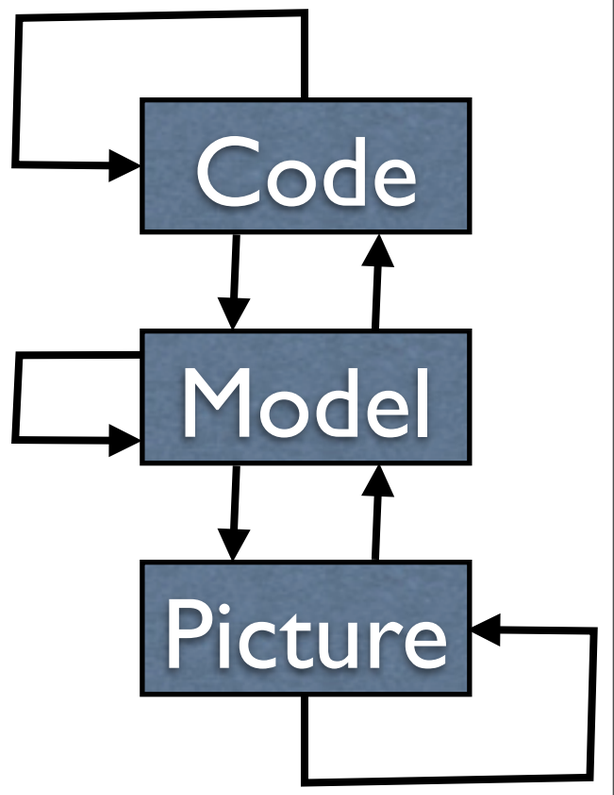

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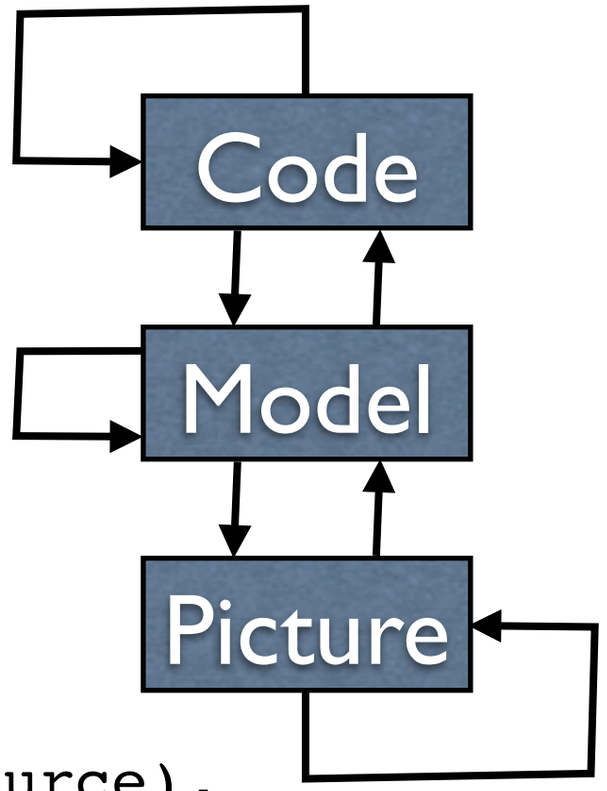

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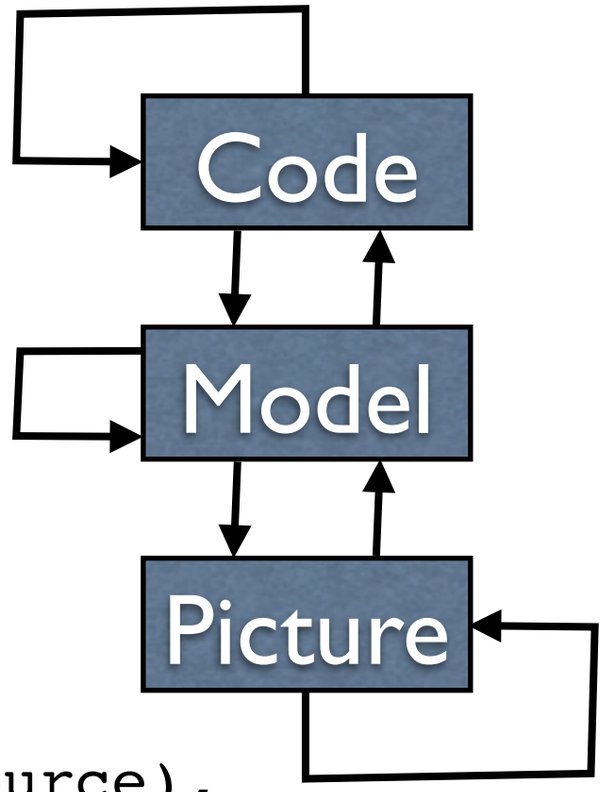

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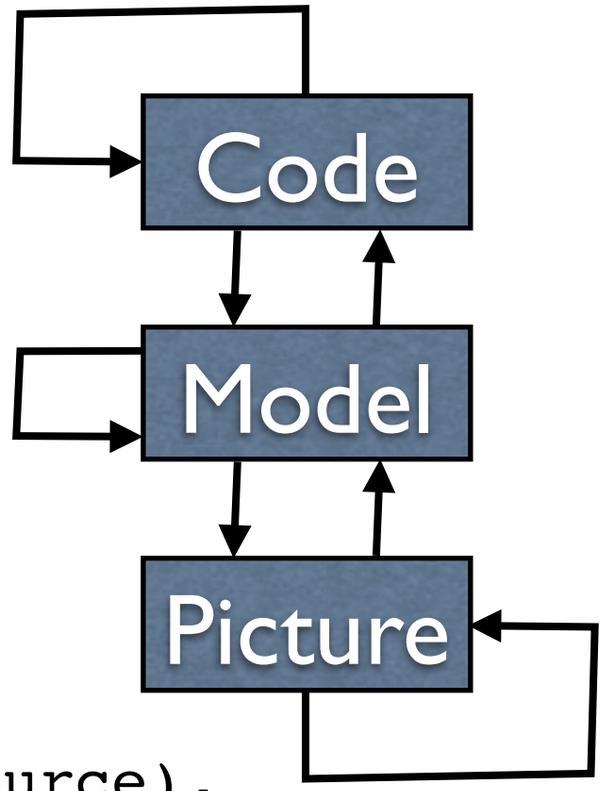

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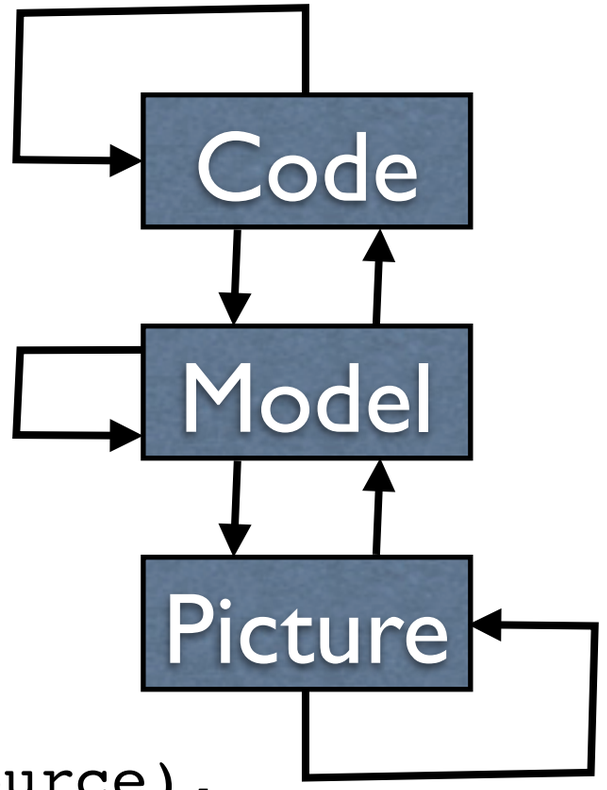

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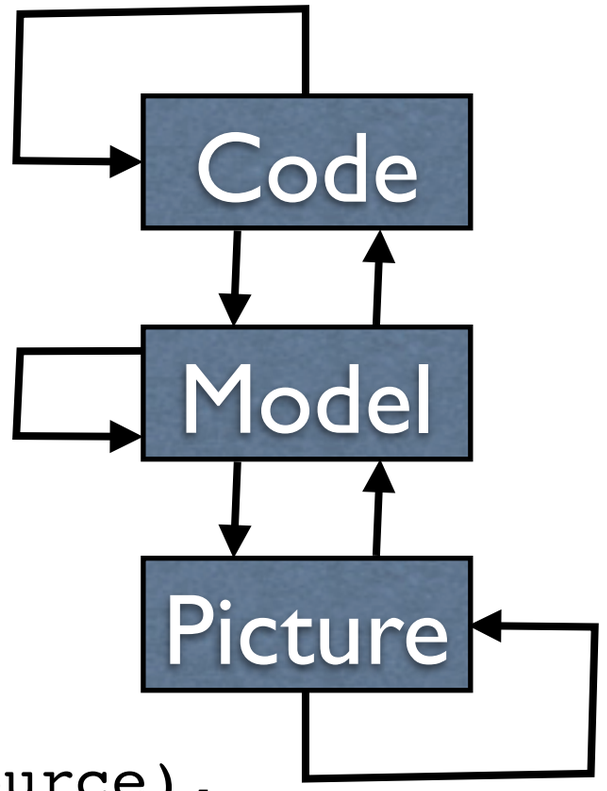

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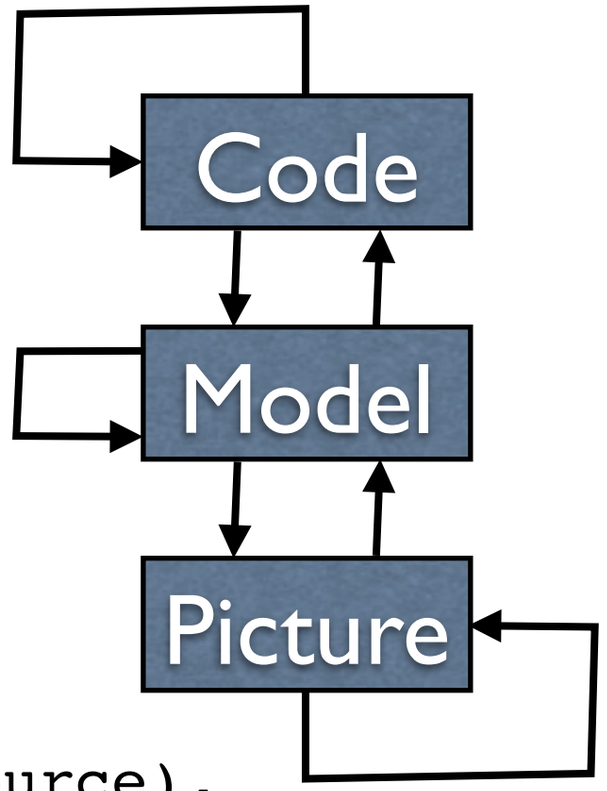

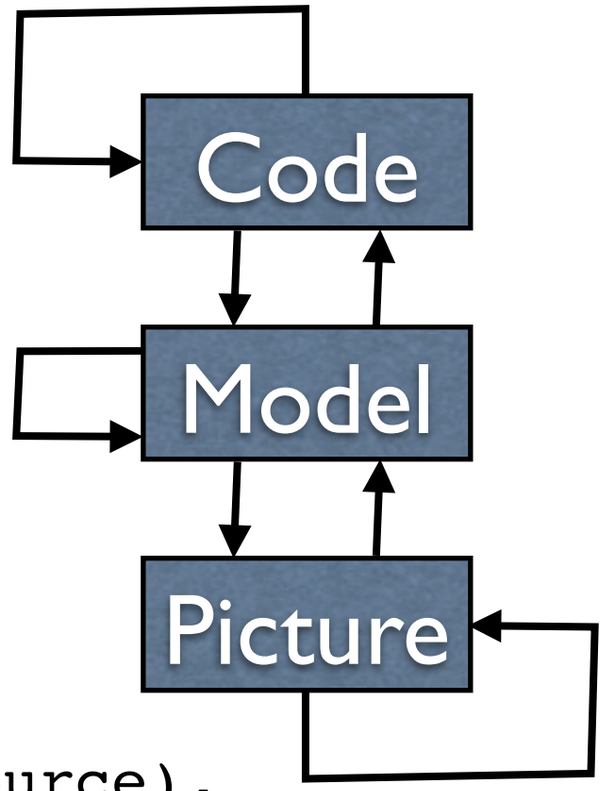


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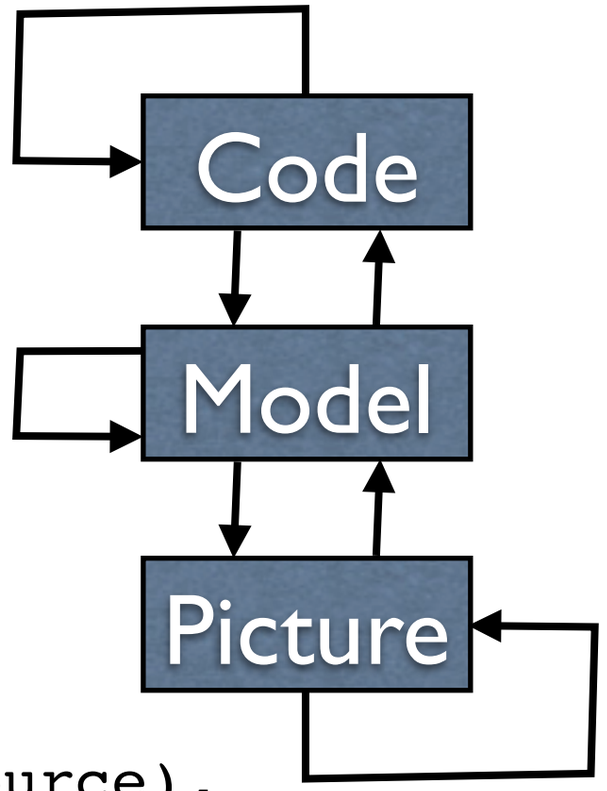

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module Metro
start syntax System = “metro” “{“ Track* tracks “}”;
syntax Track = Id+ stations “;” ;
lexical Id = [A-Za-z][A-Za-z0-9]*;
layout WS = [\ \t\n\r]*;


rel[Id,Id] extractMetroGraph(loc source) =
  {<from, to> | /Track t := parse(#start[System], source),
        (Track) `<Id+ _> <Id from> <Id to> <Id+ _>;` := t};
bool isHub(rel[Id,Id] metro, Id station) = size(metro[Id]) > 1;


void synthesizeDotGraph(loc target, rel[Id from,Id to] metro) {
  writeFile(target,”digraph Metro { node [shape=box]
                  ‘<for (<from, to> <- metro) {>
                  ‘  <from> -\> <to><}>
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                  ‘  <st> [shape=ellipse]<}>
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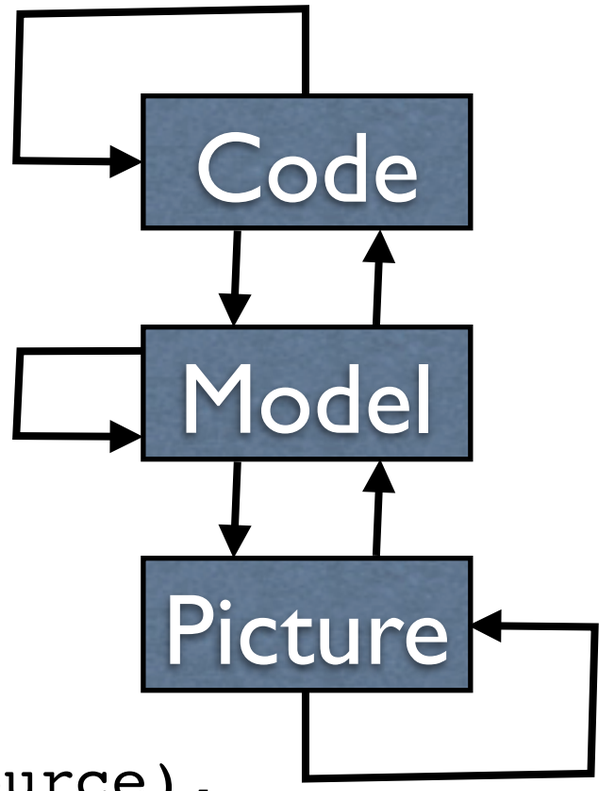

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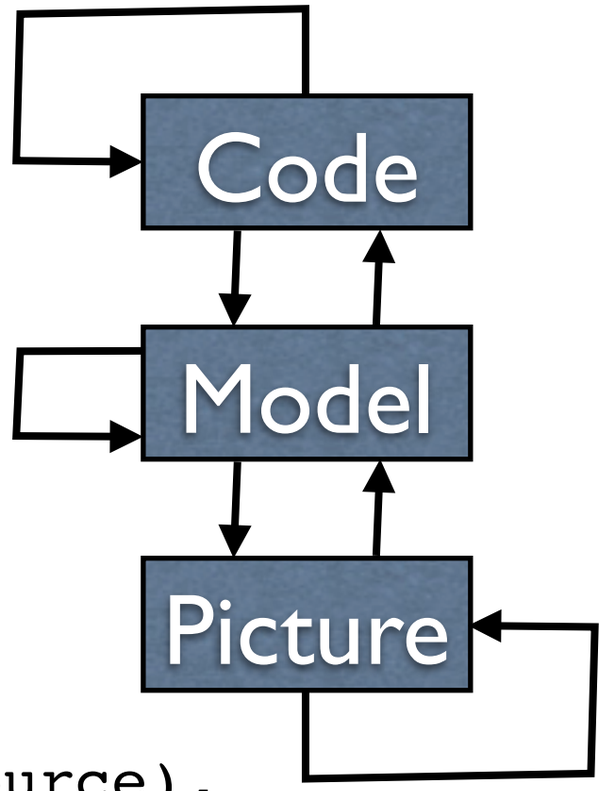

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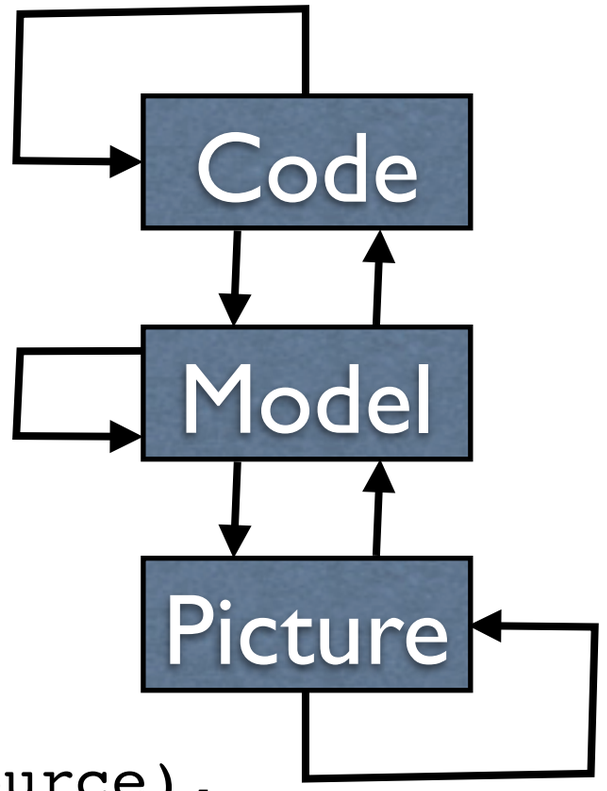
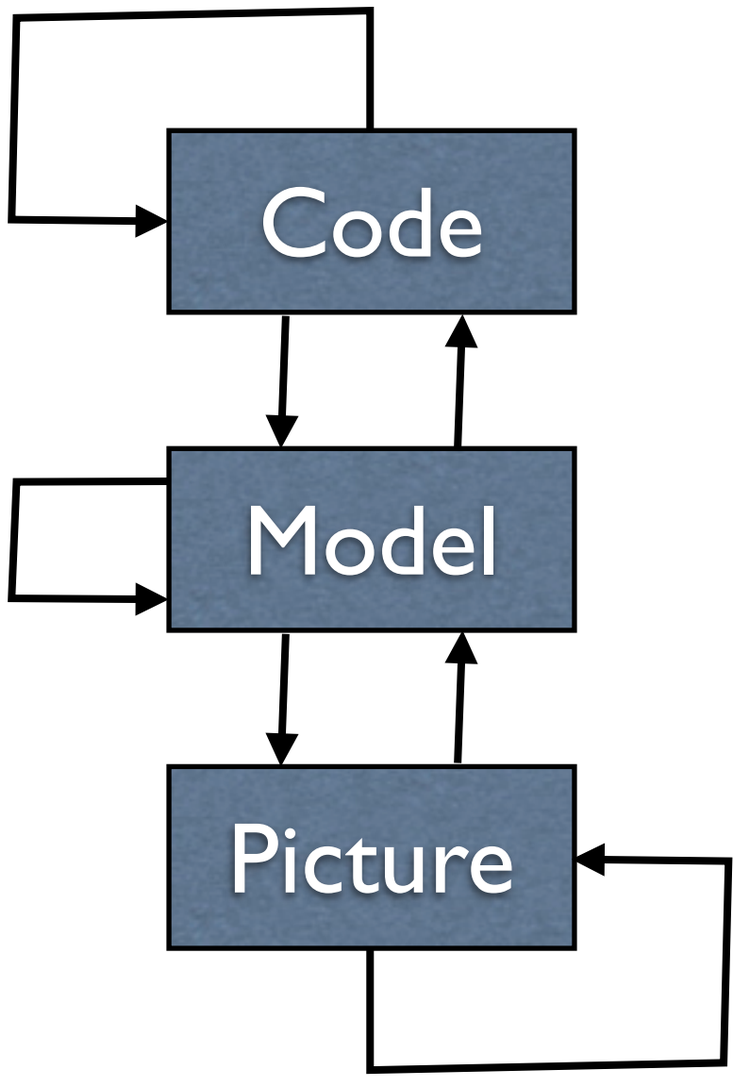
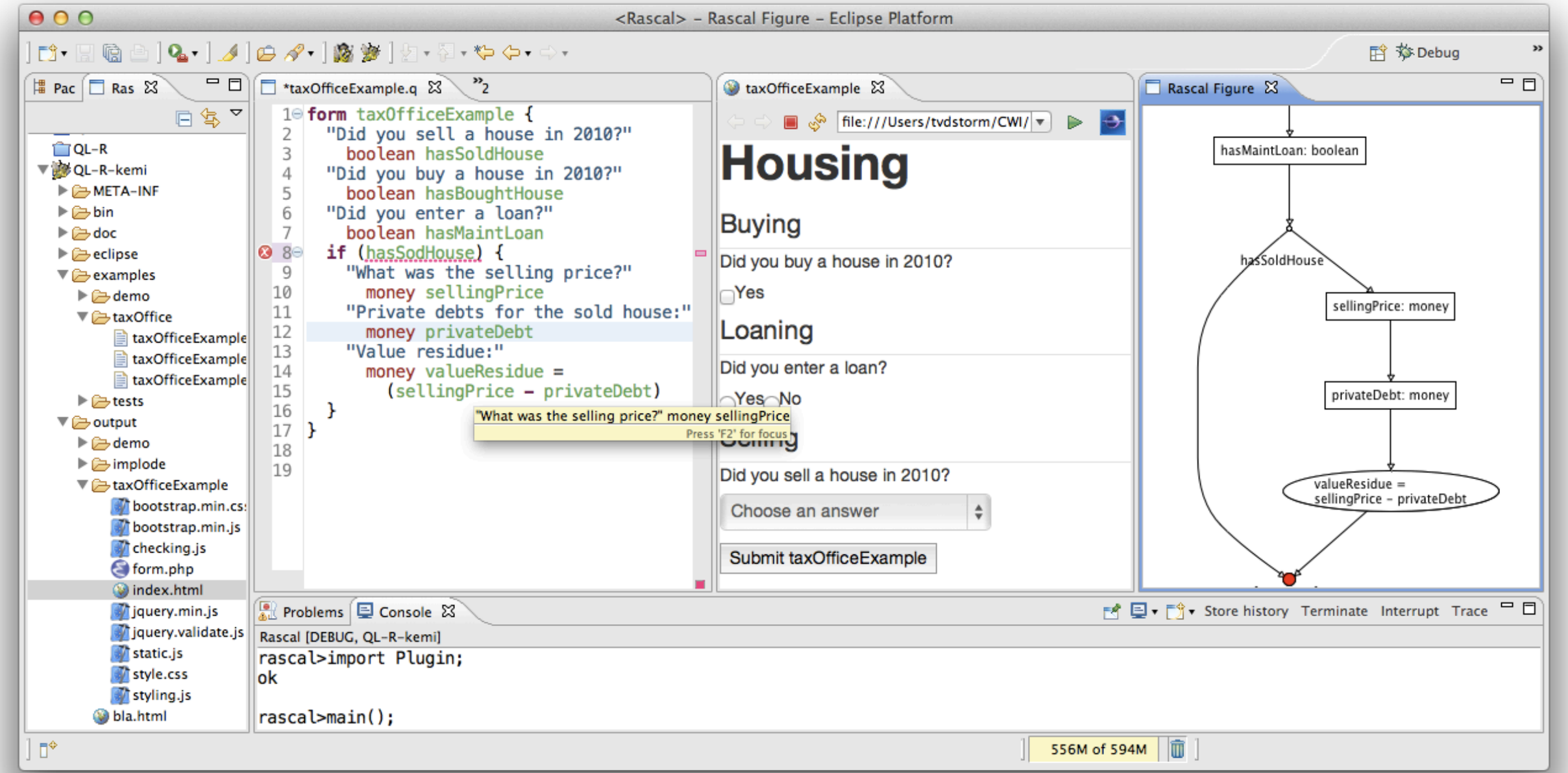


A one-slide DSL

- What is the point?
  - Rapid tool development
  - No boilerplate
  - No glue
  - No magic
  - Done. Next!
- This works for
  - all kinds of meta-programming tools
  - all kinds of languages



IDE “generation”



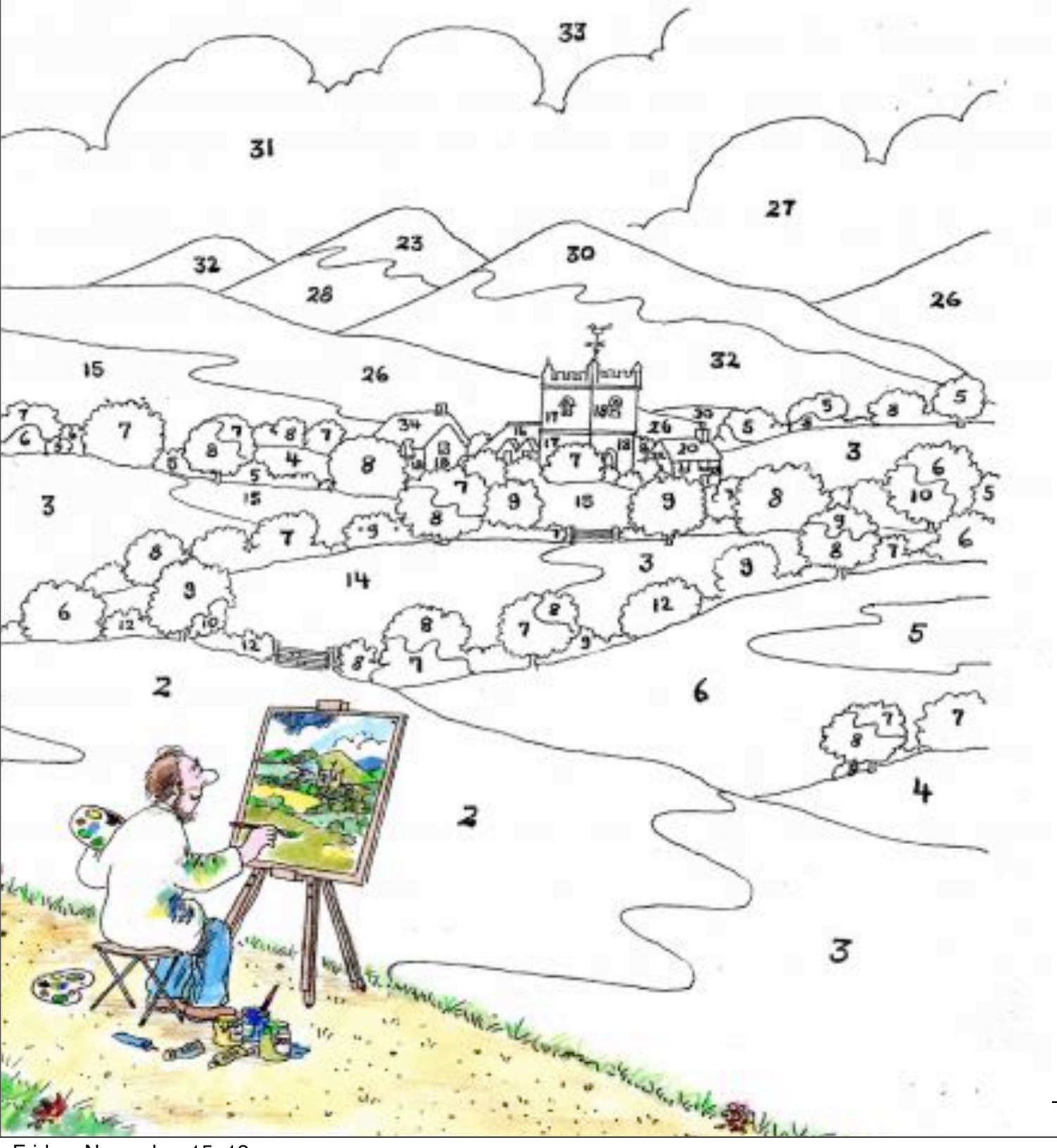
Current applications

- PHP, Lua static analysis of dynamic languages
- Modular/Language parametric refactoring
- Grammar engineering
- Domain specific languages
  - Pacioli - Computational auditing
  - Derric - Digital Forensics
  - QL - Complex Questionaires
  - GPU programming

Rascal

- http://www.rascal-mpl.org
  - open-source on github
  - tools for tools
- documented: http://tutor.rascal-mpl.org
- supported: http://ask.rascal-mpl.org
- “alpha” = under development (language & libraries)
- active: compiler & static checker, adding support for units & dimensions, scripting languages, grammars for legacy languages, libraries for SMT solvers, etc. etc.

D.I.Y.



- That's the goal
- We teach and use it
- Caveat emptor

Discussion(s)

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- What does “software engineering” mean to you?
  - critical or non-critical? has this changed?
  - stakeholders, requirements, deadlines
  - art, science or engineering (or all)

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- What does "software engineering" mean to you?
  - critical or non-critical? has this changed?
  - stakeholders, requirements, deadlines
  - art, science or engineering (or all)
- Quality for scientific software
  - what are important quality aspects?
  - which tools are used?
  - which methods?
  - which problems are hard to solve?
  - what does the future look like?

Take home messages

-  http://www.rascal-mpl.org
  - open-source
  - tools for tools
- CWI SWAT
  - studies real software
  - in software domains: bio, finance, forensics, law, ...
  - builds and evaluates tools
- Master Software Engineering exists

From coding to declaring

```
list[int] even(int max) {
  list[int] result = [];

  for (int i <- [0..max]) {
    if (i % 2 == 0) {
      result += i;
    }
  }
  return result;
}

list[int] even(int max)
  = [ i | i <- [0..max], i % 2 == 0];
```

From coding to declaring

```
list[int] even(int max) {
  list[int] result = [];

  for (int i <- [0..max], i%2 == 0) {
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  }
  return result;
}
```

From coding to declaring

```
list[int] even(int max) {
  result = [];

  for (i <- [0..max], i%2 == 0) {
      result += i;
  }
  return result;
}
```

From coding to declaring

```
list[int] even(int max) {
  r = for (i <- [0..max], i%2 == 0)
        append i;
  return r;
}
```

From coding to declaring

```
list[int] even(int max) {
  return for (i <- [0..max], i%2 == 0)
           append i;
}
```

From coding to declaring

```
list[int] even(int max) {
  return [i | i <- [0..max], i%2 == 0];
}
```

From coding to declaring

```
list[int] even(int max)
  = [i | i <- [0..max], i%2 == 0];
```