TheServerSide JAVA SYMPOSIUM

Software Visualization and Model Generation

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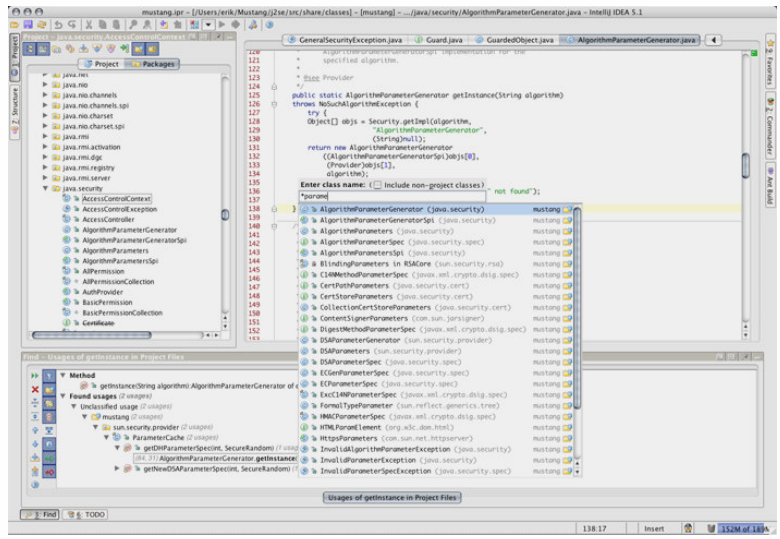
Where are the most defects?



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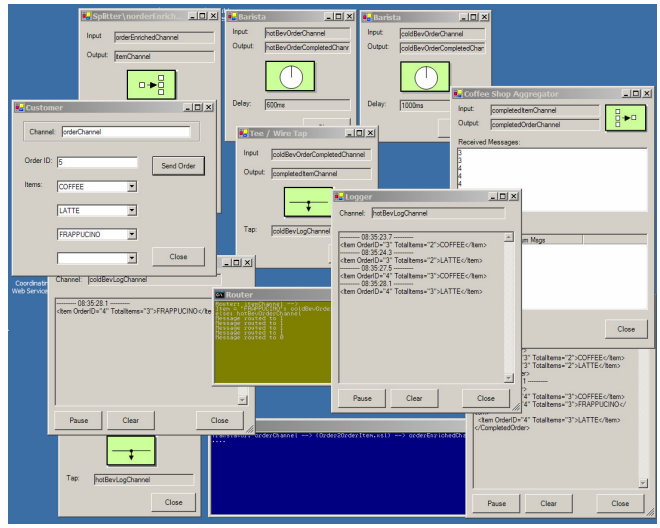
Which way do the messages flow?



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A picture says more than 1000 words

- **The amount of information in current systems is beyond what we can handle (understand?)**
- **Often we are only interested in a specific angle**
  - **Relationship between classes – not the entire source**
  - **Number of messages flowing – not the message content**
- **We're good at a spotting patterns in images…**

Being able to control large-scale systems is an illusion.
But we can observe what is happening…

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Where do we get the picture from?

- **Models created upfront convey a vision but usually don't reflect reality**
- **Generating a complete model for large systems is nearly impossible**
- **Systems evolve locally, often uncontrolled**
  - **Particularly true for loosely coupled, dynamic systems (SOA)**
- **The best picture very much depends on the question you are trying to answer**
  - **We need tools that make it easy to create ad-hoc models**

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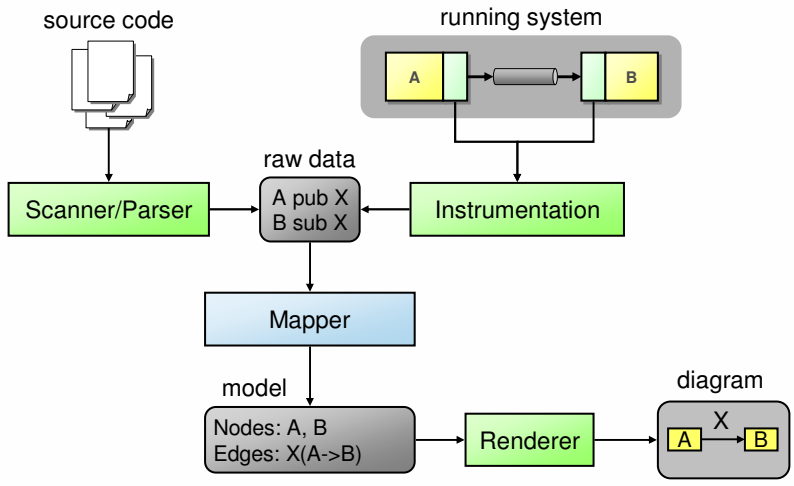
Visualizing Software



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Five Steps

1. **Select Meta-model**
2. **Inspection / Instrumentation**
3. **Mapping to Model**
4. **Visualization / Output**
5. **Validation / Analysis**

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1. Select Meta-model

- **"A model that describes a model"**
  - **The elements a model can be composed of**
  - **How to combine these elements**
- **Example: meta-model for a class diagram**
  - **A class is a box with name, methods, fields,…**
  - **Available connectors: association, inheritance, aggregation…**
  - **Rules: no circles in inheritance etc.**
- **Sounds more scientific than it really is**
- **Usually pick from a few popular candidates**

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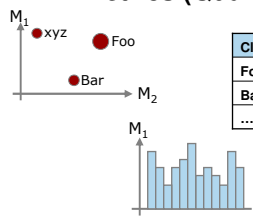
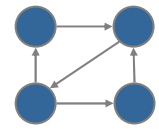
Common Metamodels

Metrics (Quantitative)

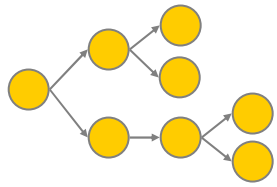


Class	M1	M2	M3
Foo	3.4	3.8	6.5
Bar	5.0	0.0	10.0
...	...	...	...

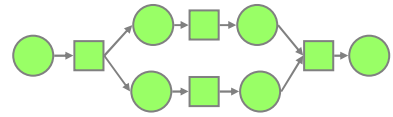
Directed Graph



Tree



Process Model (e.g. Petri Net)



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2. Inspection / Instrumentation

Static Analysis	Dynamic Analysis
Inspect System Design	Inspect Running System
Source code	Profiling
Configuration repository	Listen to messages
Scan / Parse into intermediate format	Log files
	Network sniffer
	Compiler decorator

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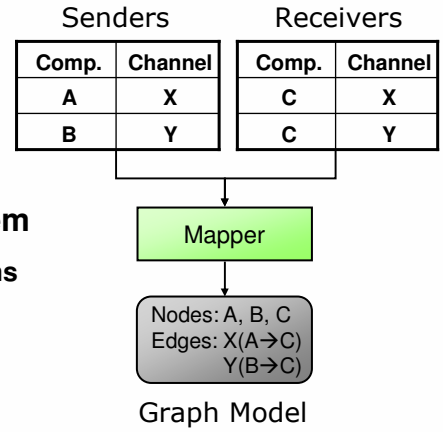
3. Mapping to Model

- **Map the gathered data onto the meta-model**



- **Example: Messaging System**
  - **Capture send / receive actions**
  - **Map onto directed graph**

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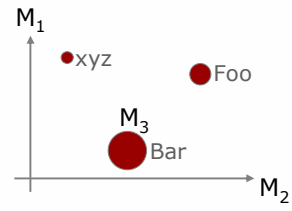
4. Visualization / Output

- **Example: GraphViz Dot**
  - **Automated graph layout tool**
  - **Takes textual input, produces many graphics formats**
  - **Developed by AT&T, Common Public License**

- **Example: Codecrawler**
  - **Object-Oriented reverse engineering**
  - **Polymetric views of metrics**
  - **Hotspots, complexity, inheritance, data storage, etc.**
  - **All views are interactive**



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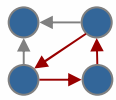
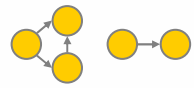
5. Validation / Analysis

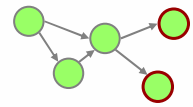
- **A model is useful for more than pretty pictures**
- **Can apply rules against the model**
- **Example: Directed Graph**



Identify circles



Identify islands
(in domain models)



Identify leaf nodes
(in dependency graphs)

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Example: Object Dependencies

- **Static analysis: Spring bean configuration**
- **SpringViz, a small XSLT sheet, maps bean configuration to input for GraphViz Dot**
- **Mapping and format hard-coded in style sheet**
- **Really simple but really useful**

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Example: Component Dependencies

- Dynamic Analysis: JAR references
- Decorate compiler with custom Ant task to get dependencies on a JAR level
- Map to a Directed Graph
- Render with GraphViz Dot as clickable SVG
- Navigate through model

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Example: Code Crawler, System Complexity

- Static analysis: Source code analysis
- Code Crawler imports XMI and calculates metrics
  - NOA, NOM, WLOC
- Renders polymetric System Complexity view
  - Width, height, color used for metrics
  - Position used for tree layout of inheritance
- Goal of this view is to classify inheritance hierarchies
  - Subsystems
  - Large stand-alone classes
- Can use other views to understand inner workings of specific hierarchies

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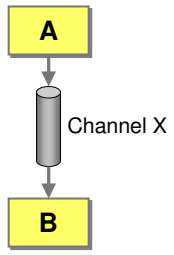
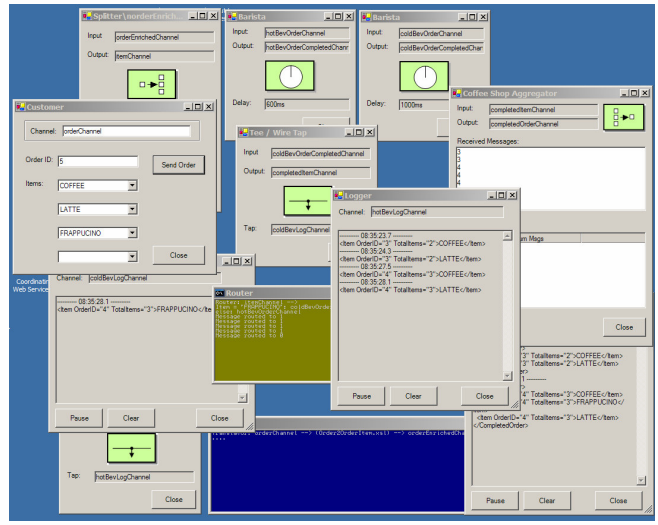
Example: Asynchronous Messaging

Processes communicate by sending messages across channels





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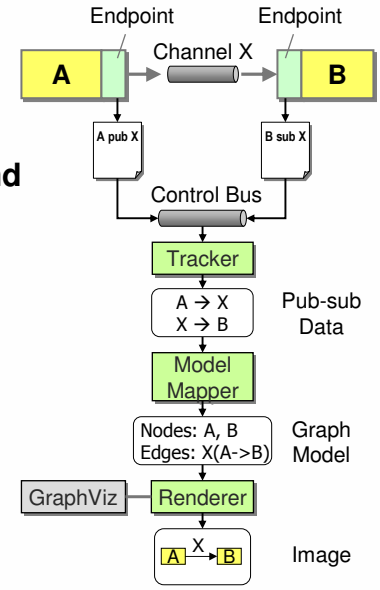
Visualization

- **Dynamic Analysis: Instrument Message Sender and Receiver**
- **Collect publication and subscription data centrally**
- **Map to a Directed Graph model**
- **Render with GraphViz Dot**
- **Re-render as model changes**



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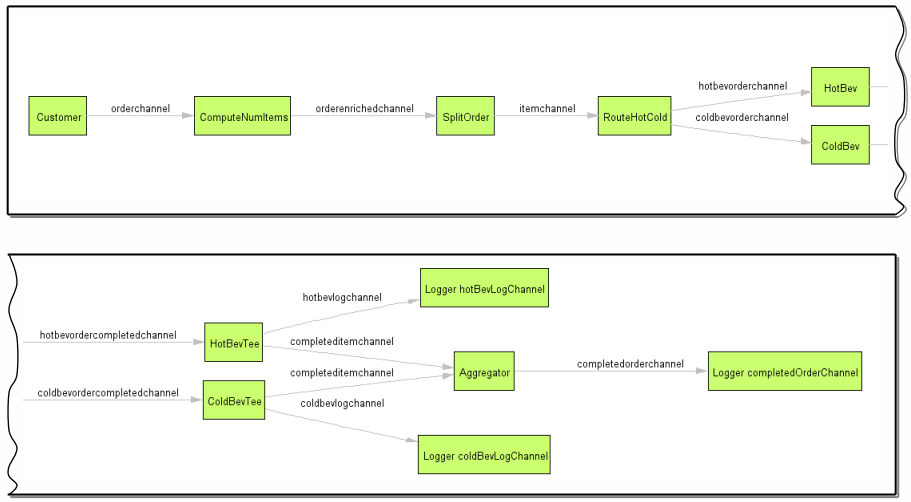
Message Flow Graph



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Example: Process Mining

- **A system performs a series of activities for each case (process instance)**
- **Goal: create a process model from running system**
- **Approach: Analyze activity logs and create process model**
- **Meta-model: Petri Net**
- **Variety of algorithms, e.g. α-Algorithm (Wil v.d. Aalst)**

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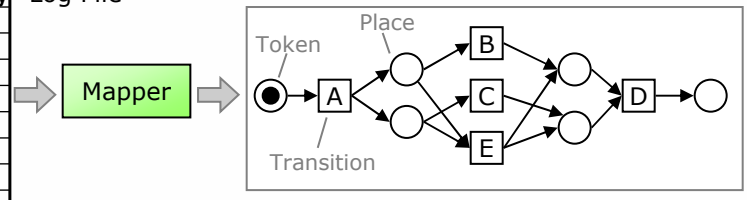
Process Mining Example

Case	Activity
1	A
2	A
3	A
3	B
1	B
1	C
2	C
4	A
2	B
2	D
5	A
4	C
1	D
3	C
3	D
4	B
5	E
5	D
4	D

Log File



Process Model

Process-Aware information Systems, Dumas et al.

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What's Next?

- **Applies to many levels**
  - **Single module source code**
  - **Multiple modules**
  - **Whole systems**
- **Diagrams hard to scale to huge systems**
  - **Interactive zoom / drill-down**
  - **Annotation-aided visualization**
- **As systems become larger and more dynamic tools like this become a necessity**

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Resources

- **Tools**
  - http://www.graphviz.org **(Dot)**
  - http://www.samoht.com/wiki/wiki.pl?SpringViz
  - http://www.eaipatterns.com **(Messaging visualization)**
- **Wil v.d. Aalst: Process Aware Information Systems, Wiley, 2005**
  - www.processmining.org **(Process Mining Tool)**
- **Michele Lanza's work (CodeCrawler)**
  - http://www.inf.unisi.ch/faculty/lanza

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Questions ?