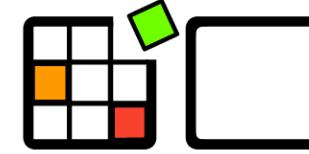


# Modeling and Reverse Engineering Product Lines

Product ▾	First name	Age	Country	Title	Breton
	Find	Filter	Filter	Filter	Yes <input type="checkbox"/> No <input type="checkbox"/>
Acher	Mathieu	30	France	Associate Professor	no
Allier	Simon	28	France	Postdoc	no
Barais	Olivier	34	France	Professor	no
Baudry	Benoit	38	France	Scientist	yes
Becan	Guillaume	24	France	PhD student	yes
Behjati	Razieh	?	Iran	Postdoc	no
Blouin	Arnaud	32	France	Associate Professor	no
Combemale	Benoit	34	France	Scientist	no
Davril	Jean-Marc	?	Belgium	PhD student	no
Degueule	Thomas	24	France	PhD student	no (Poitou)
Filho	Bosco	28	Brazil	Postdoc	no
Galindo	Jose	28	Spain	Postdoc	no
Gotlieb	Arnaud	?	France	Scientist	no
Heymans	Patrick	?	Belgium	Professor	no
Jezequel	Jean-Marc	50	France	Professor	yes
Sana	Ben Nasr	24	Tunisia	PhD student	no
Sannier	Nicolas	33	France	Postdoc	no



OpenCompare

FAMILIAR



The background image shows a vast parking lot packed with thousands of new vehicles, primarily sedans and SUVs, arranged in long, horizontal rows. In the foreground, there are several white delivery trucks and smaller vans parked in a grid pattern. The scene is set outdoors under a clear sky, with a body of water visible in the distance.

# Product Lines

# (Software) Product Lines



01011011  
110111110  
001101110  
1100011101  
1000011111  
101001110  
100001010  
101001011  
000001110  
11010101  
110111010  
011000100  
01010101  
110101010  
1010101010

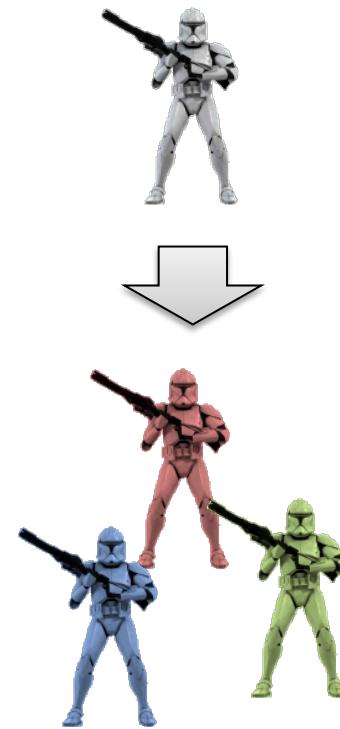


# The three ways to build a (software) product

Independently



„Clone & Own“



„Shared“ (reusable) Assets



(credits: Thorsten Berger's slide)

# The three ways to build a (software) product

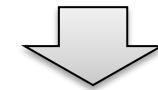
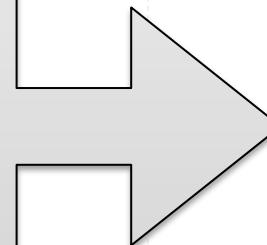
Independently

„Clone & Own“

„Shared“ (reusable) Assets

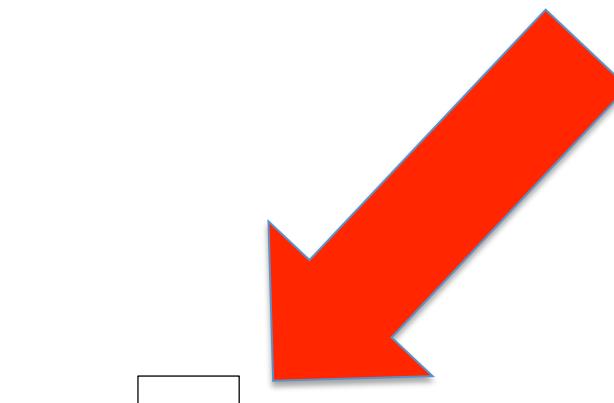
## Software Product Lines

- Product Configuration
- Variability Modeling
- Components
- Domain-specific Languages
- Generators
- Preprocessors
- Design Patterns
- ...

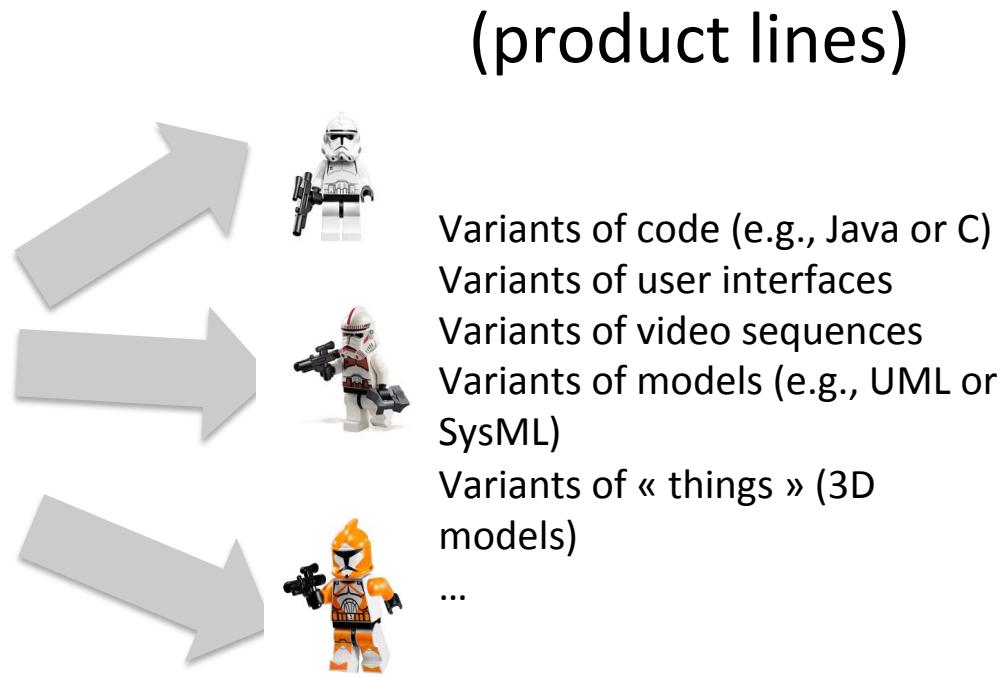


(credits: Thorsten Berger's slide)

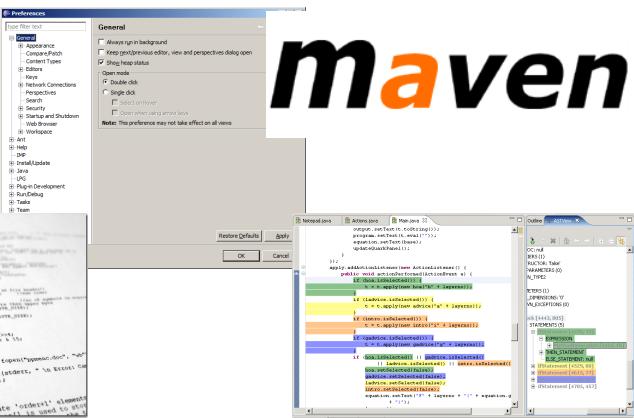
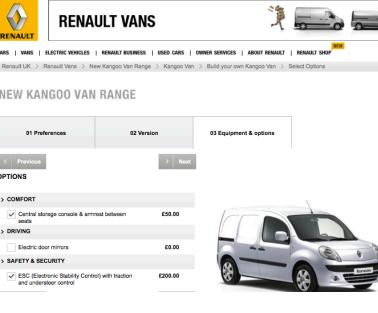
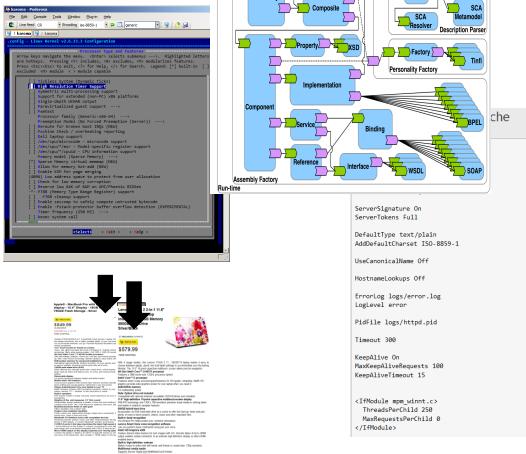
# Modeling and Reverse Engineering Variability



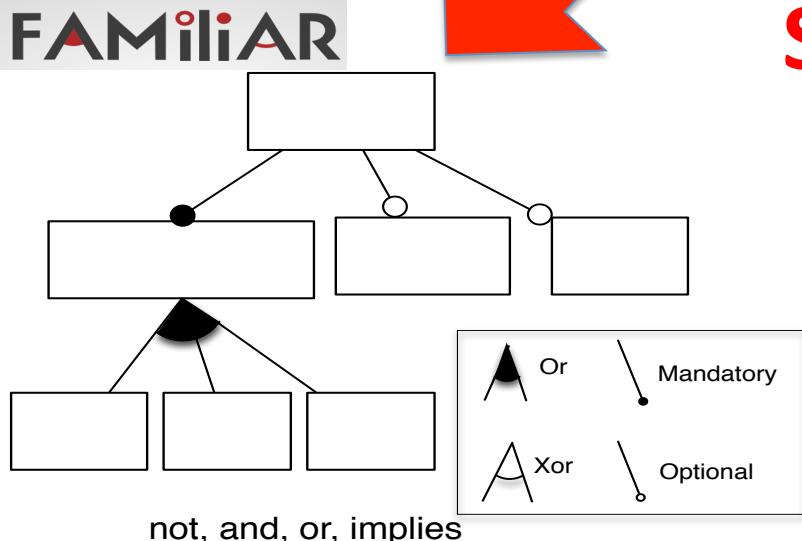
Feature models  
or Product Matrices



- Variants of code (e.g., Java or C)
- Variants of user interfaces
- Variants of video sequences
- Variants of models (e.g., UML or SysML)
- Variants of « things » (3D models)



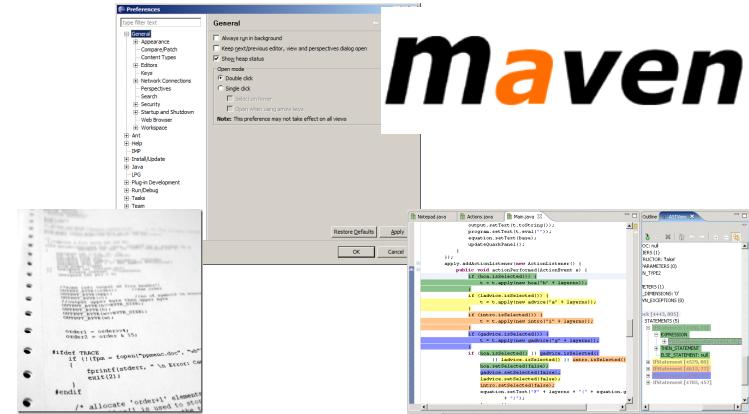
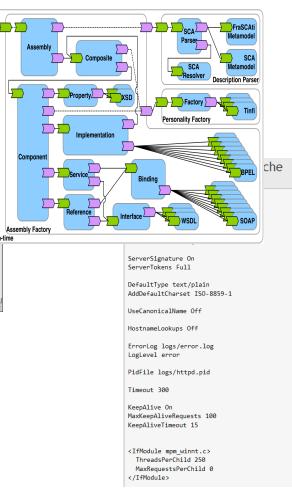
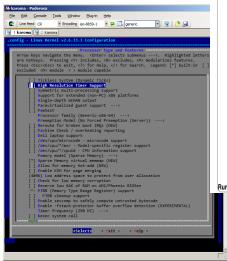
# Mining/Extracting Encoding/Formalizing Synthesising



# Variability Models (feature models)

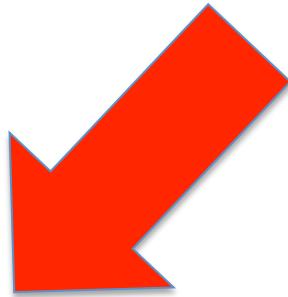


- Variants of code (e.g., Java or C)
- Variants of user interfaces
- Variants of video sequences
- Variants of models (e.g., UML or SysML)
- Variants of « things » (3D models)



# maven

# Mining/Extracting Encoding/Formalizing Synthesising

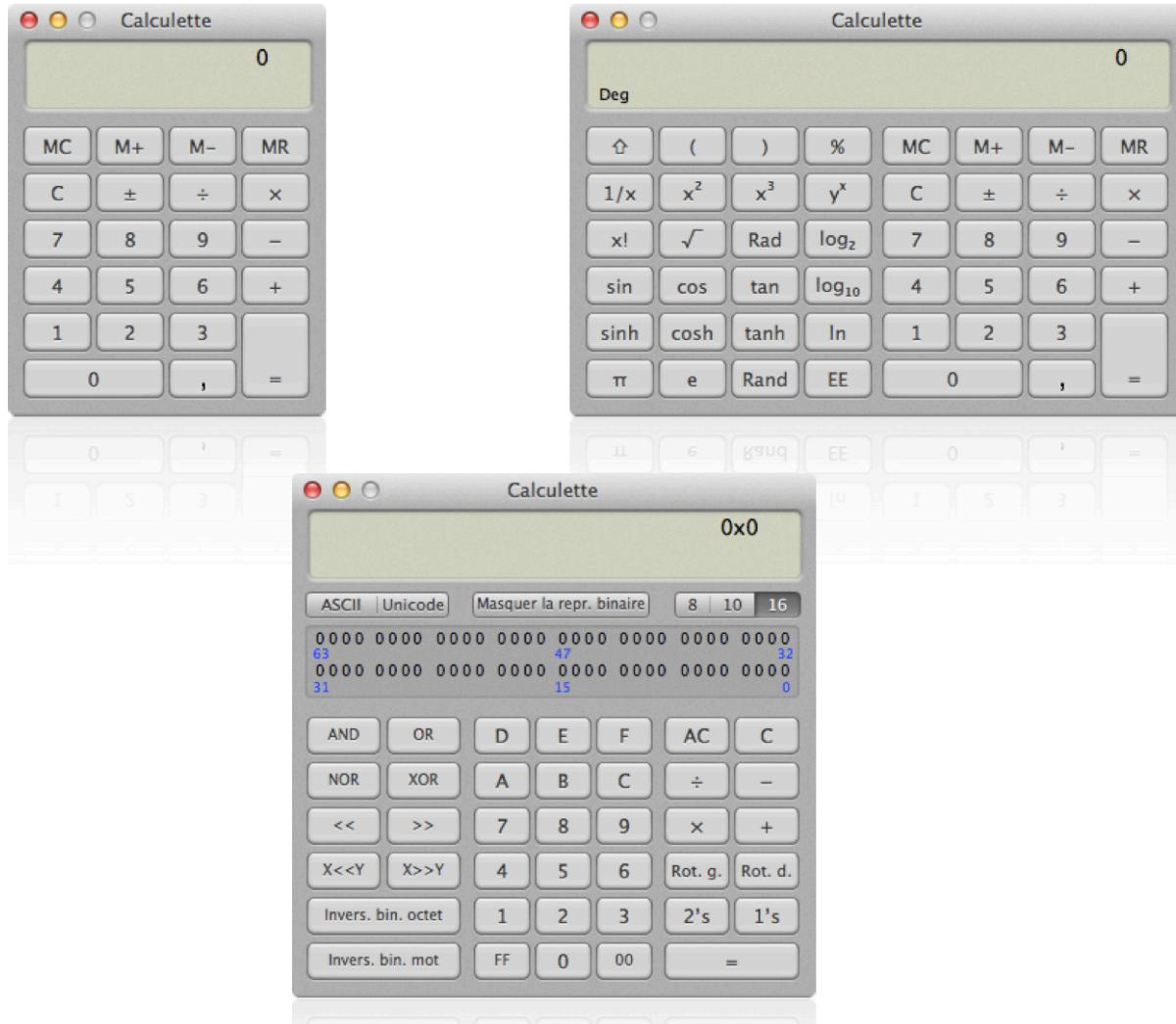


OpenCompare

Product	License	Price	Language Support	Language	WYSIWIG
W1	Commercial	10	Yes	Java	Yes
W2	NoLimit	20	No		Yes
W3	NoLimit	10	No		Yes
W4	GPL	0	Yes	Python	Yes
W5	GPL	0	Yes	Perl	Yes
W6	GPL	10	Yes	Perl	Yes
W7	GPL	0	Yes	PHP	No
W8	GPL	10	Yes	PHP	Yes

# Variability and Software Product Lines

Perhaps, you ignore the names of something omnipresent in numerous contexts



« A set of programs is considered to constitute a **family**, whenever it is worthwhile to study programs from the set by **first studying the common properties** of the set and then determining the **special properties** of the individual family members »



aka Variability

David L. Parnas — “On the design and development of program families” in Transactions on Software Engineering, SE-2(1):1–9, 1976

# Variability

“the ability of a system to be efficiently extended, changed, customized or configured for use in a particular context”

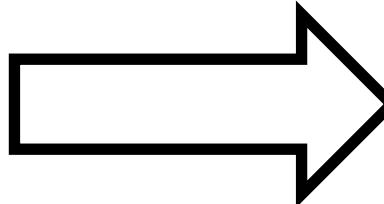
*Mikael Svahnberg, Jilles van Gurp, and Jan Bosch (2005)*







# Software-intensive systems



come in many variants



# RENAULT VANS



CARS | VANS | ELECTRIC VEHICLES | RENAULT BUSINESS | USED CARS | OWNER SERVICES | ABOUT RENAULT | RENAULT SHOP NEW

Renault UK > Renault Vans > New Kangoo Van Range > Kangoo Van > Build your own Kangoo Van > Select Options

## NEW KANGOO VAN RANGE

01 Preferences

02 Version

03 Equipment & options

< Previous

Next >

### OPTIONS

#### > COMFORT

- |   |        |
|---|--------|
| <input checked="" type="checkbox"/> Central storage console & armrest between seats | £50.00 |
|---|--------|

#### > DRIVING

- |  |       |
|--|-------|
| <input type="checkbox"/> Electric door mirrors | £0.00 |
|--|-------|

#### > SAFETY & SECURITY

- |   |         |
|---|---------|
| <input checked="" type="checkbox"/> ESC (Electronic Stability Control) with traction and understeer control | £200.00 |
|---|---------|



“Reverse Engineering Web Configurators” Ebrahim Khalil Abbasi, Mathieu Acher, Patrick Heymans, and Anthony Cleve. In 17th European Conference on Software Maintenance and Reengineering (CSMR'14)

# LE PLIAGE PERSONNALISÉ

MODÈLES

COULEUR  
RECTO

COULEUR  
VERSO

BOUCLERIE

RESET



LE PLIAGE CUIR

LE PLIAGE TOILE



## VOTRE PERSONNALISATION

Porte-monnaie Toile : 9 x 7 x 5 cm  
Couleur recto : Garance  
Couleur verso : Malabar  
Bouclerie : Bronze

35,00 € AJOUTER AU PANIER

Infos Partager J'aime

<a href="#">Developer Tools</a>
<a href="#">Development</a>
<a href="#">Drivers</a>
<a href="#">DTP/Prepress</a>
<a href="#">Educational</a>
<a href="#">Finance</a>
<a href="#">Font Tools</a>
<a href="#">Games</a>
<a href="#">Graphics</a>
<a href="#">HTML Tools</a>
<a href="#">Internet Utilities</a>
<a href="#">iPhone Applications</a>
<a href="#">iPod Tools</a>
<a href="#">Math/Scientific</a>
<a href="#">Multimedia</a>
<a href="#">Network/Admin</a>
<a href="#">Screensavers</a>
<a href="#">Security</a>
<a href="#">Spotlight Plugins &amp; Utilities</a>
<a href="#">System Utilities</a>
<a href="#">Utilities</a>
<a href="#">Video</a>
<a href="#">Word Processing</a>
 <a href="#">GLOBAL PAGES &gt;&gt;</a>
<a href="#">NEWS ARCHIVE &gt;&gt;</a>
<a href="#">DFTPEDIA REVIEWS &gt;&gt;</a>
<a href="#">MEET THE EDITORS &gt;&gt;</a>

## Power Matte 2.0.1.3 update



Adobe After Effects plugin that can extract any object in an Image  
[\[read more >\]](#)

**Size:** 13.20 MB  
**Platform:** Mac OS X 10.5 or later  
**License:** Trial  
**Rating:** Good (3.0/5)  
**Downloads:** 1,504  
**Updated:** June 20th, 08:21 UTC

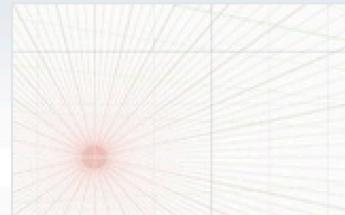


## Gridus 1.1 update



Helps you generate perspective grids  
[\[read more >\]](#)

**Size:** 102 KB  
**Platform:** Mac OS X 10.8 or later  
**License:** Commercialware  
**Rating:** NOT RATED  
**Downloads:** 21  
**Updated:** June 20th, 07:56 UTC



## Picture Frame 2.2 update



Quickly generate multi-frame photos using your Mac  
[\[read more >\]](#)

**Size:** 716 KB  
**Platform:** Mac OS X 10.6.6 or later  
**License:** Commercialware  
**Rating:** Excellent (5.0/5)  
**Downloads:** 297  
**Updated:** June 20th, 07:53 UTC

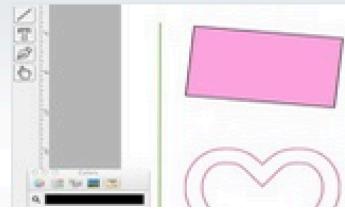


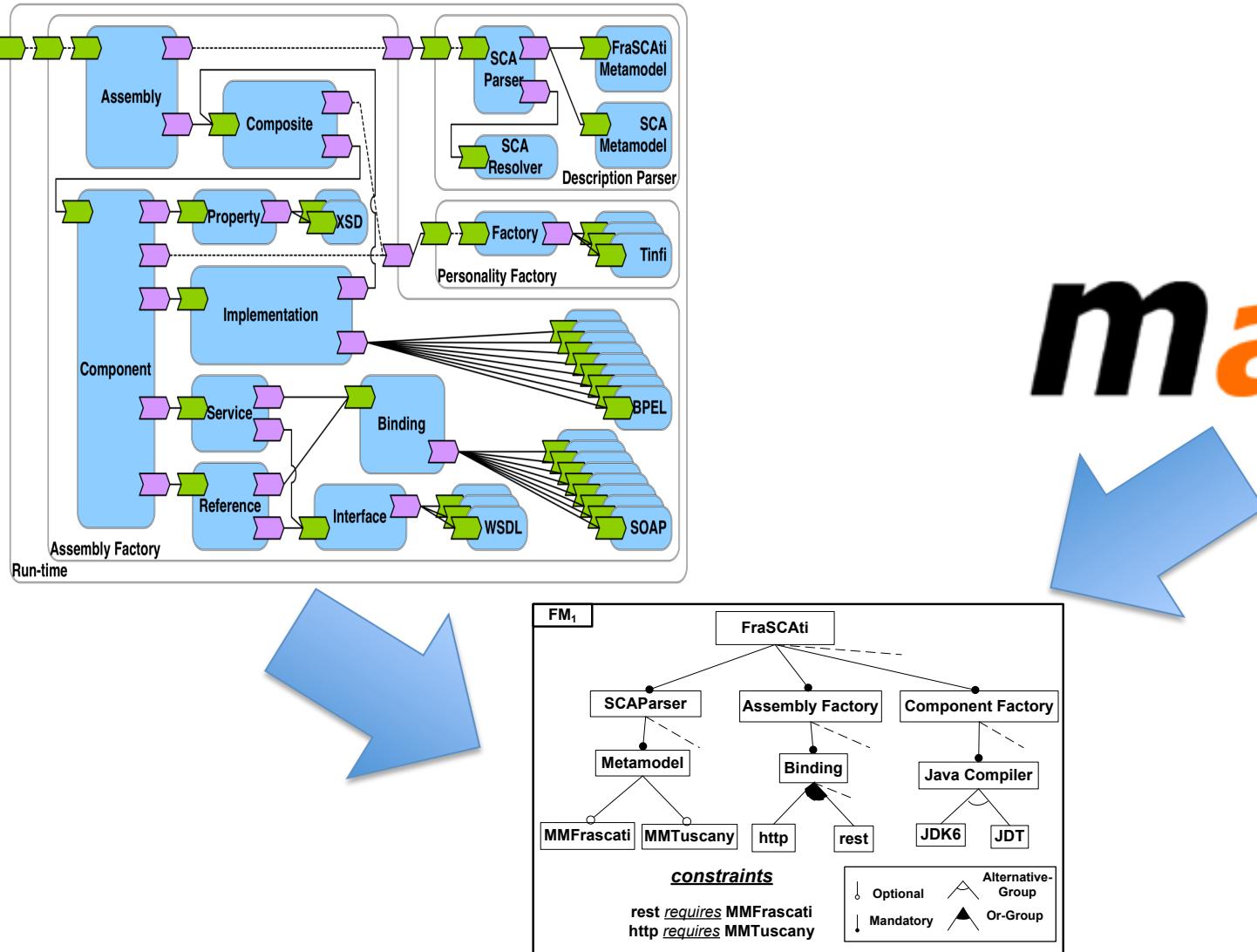
## FashionLab Studio 1.1 update



Makes it easy to design your own T-shirt using a Mac  
[\[read more >\]](#)

**Size:** 3.10 MB  
**Platform:** Mac OS X 10.6.6 or later  
**License:** Commercialware  
**Rating:** NOT RATED  
**Downloads:** 3  
**Updated:** June 20th, 07:49 UTC



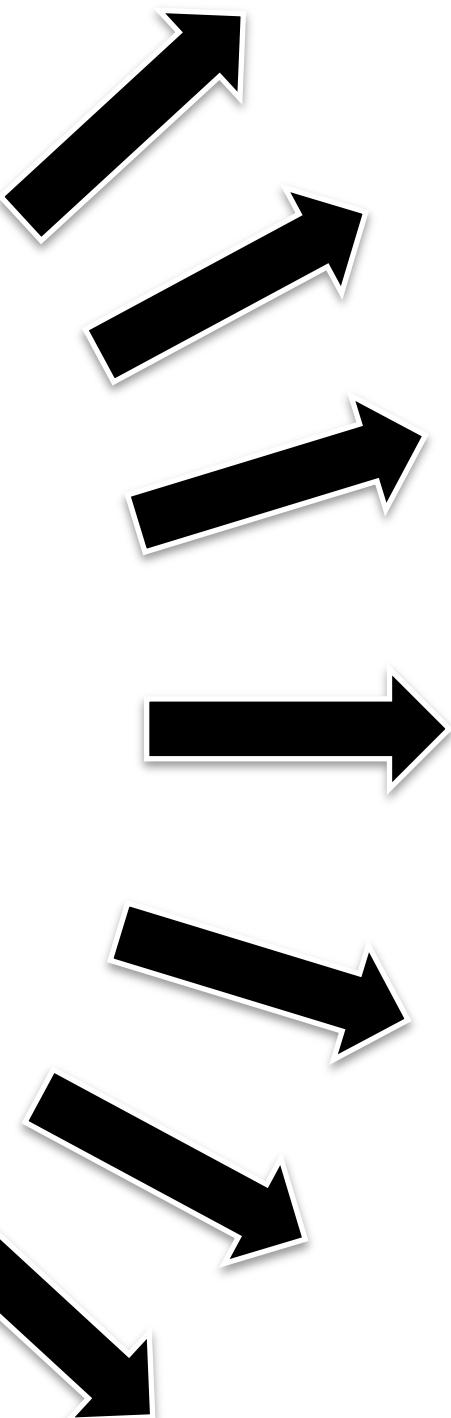


# maven

## Variability Model

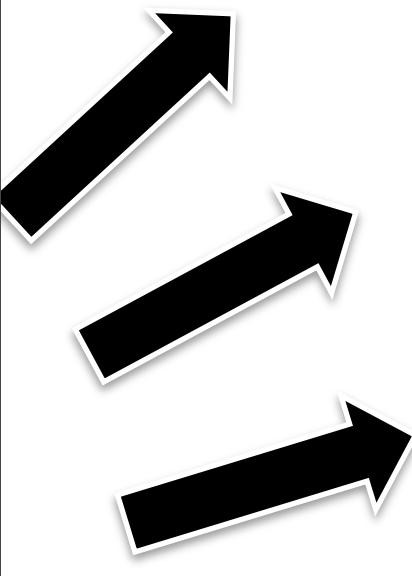
« Extraction and Evolution of Architectural Variability Models in Plugin-based Systems »  
 Mathieu Acher, Anthony Cleve, Philippe Collet, Philippe Merle, Laurence Duchien, Philippe Lahire ECSA/SoSyM'14

# Printer Firmware



```
1 karmad 2 karmas Encoding: iso-8859-1 generic .config - Linux Kernel v2.6.33.3 Configuration Processor type and features Arrow keys navigate the menu. <Enter> selects submenus -->. Highlighted letters are hotkeys. Pressing <> includes, <> excludes, <M> modularizes features. Press <Esc><Esc> to exit, <?> for Help, </> for Search. Legend: [*] built-in [ ] excluded [<> module] < > module capable [ ] Tickless System (Dynamic Ticks) [*] High Resolution Timer Support [ ] SYSPOLLING timer interrupt support [ ] Support for extended (non-PC) x86 platforms [ ] Single-depth ICHAN output [ ] Paravirtualized guest support ... [ ] Memtest [ ] Processor family (Generic-x86-64) --- [ ] Preemption Model (No Forced Preemption (Server)) --- [ ] Renote for broken boot IRQs (NEW) [ ] Machine Check / overheating reporting [ ] Dell laptop support [ ] /dev/cpu/microcode - microcode support [ ] /dev/cpu/*msr - Model-specific register support [ ] /dev/cpu/*cpuid - CPU information support [ ] Sparse Memory virtual memmap (NEW) [ ] Allow for memory hot-add (NEW) [ ] Enable KSM for page merging [4096] low address space to protect from user allocation [ ] Check for low memory corruption [ ] Reserve low 64M of RAM on AMI/Phoenix BIOSen [ ] MTRR (Memory Type Range Register) support [ ] MTRR cleanup support [ ] Enable seccomp to safely compute untrusted bytecode [ ] Enable -fstack-protector buffer overflow detection (EXPERIMENTAL) [ ] Timer frequency (250 Hz) --- [ ] kexec system call v(<) <Select> < Exit > < Help >
```

# Linux Kernel



Brand	Model name	Sensor size	Effective megapixels	Lens mount	Viewfinder type	Viewfinder coverage (% of the frame)	Metering zones	Focus points	Lowest ISO	Highest ISO	DxOMark sensor score	DxO ISO performance <sup>[1]</sup>	
Canon	1D X	Full frame	18.1	EF	Pentaprism	100	252	61	50	204800	82	2786	
Canon	1Ds Mark III	Full frame	21.1				63	45	50	3200	80	1663	
Canon	1D Mark IV	APS-H	16.1				63	45	50	102400	74	1320	
Canon	5D Mark III	Full frame	22.3				63	61	50	102400	81	2293	
Canon	5D Mark II	Full frame	21.1				35	9	50	25600	79	1815	
Canon	6D	Full frame	20.2				63	11	100	102400	82	2340	
Canon	7D	APS-C	18.0				63	19	100	12800	66	854	
Canon	70D	APS-C	20.2				63	19	100	25600	68	926	
Canon	60D	APS-C	18.0				63	9	100	12800	66	813	
Canon	50D	APS-C	15.1		EF, EF-S	Pentaprism	95	35	9	100	12800	63	696
Canon	40D	APS-C	10.1		EF, EF-S	Pentaprism	95	35	9	100	3200	64	703
Canon	30D	APS-C	8.2		EF, EF-S	Pentaprism	95	35	9	100	3200	59	736
Canon	20D	APS-C	8.2		EF, EF-S	Pentaprism	95	35	9	100	3200	62	721



Guillaume Bécan, Nicolas Sannier, Mathieu Acher, Olivier Barais, Arnaud Blouin, and Benoit Baudry.  
 Automating the Formalization of Product Comparison Matrices (2014). In 29th IEEE/ACM International Conference on Automated Software Engineering (ASE'14)



```
macher-wifi:getting-started macher1$ yo jhipster
```

I'm all done. Running `npm install & bower install` for you to install the required dependencies.

```
JHIPSTER GENERATOR
  JHipster
  JHipster
  JHipster
  JHipster
```

Welcome to the JHipster Generator v2.17.0

```
? (1/15) What is the base name of your application? jhipster
? (2/15) What is your default Java package name? com.mycompany.myapp
? (3/15) Do you want to use Java 8? Yes (use Java 8)
? (4/15) Which *type* of authentication would you like to use? (Use arrow keys)
> HTTP Session Authentication (stateful, default Spring Security mechanism)
  OAuth2 Authentication (stateless, with an OAuth2 server implementation)
  Token-based authentication (stateless, with a token)
```

[generator-jhipster / app / templates / src / main / java / package / config / \\_DatabaseConfiguration.java](#) **jdubois** 2 days ago Use Spring Boot's configuration meta-data9 contributors 

184 lines (165 sloc) | 9.69 KB

[Raw](#) [Blame](#) [History](#)   

```
1 package <%=packageName%>.config;
2 <% if (databaseType == 'sql') { %>
3 import <%=packageName%>.config.liquibase.AsyncSpringLiquibase;
4 import com.codahale.metrics.MetricRegistry;
5 import com.fasterxml.jackson.datatype.hibernate4.Hibernate4Module;
6 import com.zaxxer.hikari.HikariConfig;
7 import com.zaxxer.hikari.HikariDataSource;
8 import liquibase.integration.spring.SpringLiquibase;<% } %><% if (databaseType == 'mongodb' && authenticationType == 'oauth2') { %>
9 import <%=packageName%>.config.oauth2.OAuth2AuthenticationReadConverter;<% } %><% if (databaseType == 'mongodb') { %>
10 import com.mongodb.Mongo;
11 import org.mongeez.Mongeez;<% } %>
12 import org.slf4j.Logger;
13 import org.slf4j.LoggerFactory;<% if (databaseType == 'sql') { %><% if (hibernateCache == 'hazelcast') { %>
14 import org.springframework.cache.CacheManager;<% } %>
15 import org.springframework.beans.factory.annotation.Autowired;
16 import org.springframework.boot.autoconfigure.condition.ConditionalOnExpression;<% } %><% if (databaseType == 'mongodb') { %>
17 import org.springframework.boot.autoconfigure.mongo.MongoAutoConfiguration;
18 import org.springframework.boot.autoconfigure.mongo.MongoProperties;<% } %><% if (databaseType == 'sql') { %>
19 import org.springframework.boot.autoconfigure.jdbc.DataSourceProperties;
20 import org.springframework.boot.autoconfigure.liquibase.LiquibaseProperties;
21 import org.springframework.context.ApplicationContextException;<% } %>
22 import org.springframework.context.annotation.Bean;
23 import org.springframework.context.annotation.Configuration;
24 import org.springframework.context.annotation.Profile;<% if (databaseType == 'mongodb') { %>
25 import org.springframework.context.annotation.Import;<% } %><% if (databaseType == 'sql') { %>
26 import org.springframework.core.env.Environment;<% } %><% if (databaseType == 'mongodb' && authenticationType == 'oauth2') { %>
27 import org.springframework.core.convert.converter.Converter;<% } %><% if (databaseType == 'mongodb') { %>
28 import org.springframework.core.io.ClassPathResource;<% } %><% if (searchEngine == 'elasticsearch') { %>
29 import org.springframework.data.elasticsearch.repository.config.EnableElasticsearchRepositories;<% } %><% if (databaseType == 'mon
30 import org.springframework.data.mongodb.config.AbstractMongoConfiguration;
31 import org.springframework.data.mongodb.config.EnableMongoAuditing;<% } %><% if (databaseType == 'mongodb' && authenticationType =
32 import org.springframework.data.mongodb.core.convert.CustomConversions;<% } %><% if (databaseType == 'mongodb') { %>
33 import org.springframework.data.mongodb.core.mapping.event.ValidatingMongoEventListener;
34 import org.springframework.data.mongodb.repository.config.EnableMongoRepositories;
35 import org.springframework.validation.beanvalidation.LocalValidatorFactoryBean;<% } %><% if (databaseType == 'sql') { %>
```

# Variability

```

class Graph {
    Vector nv = new Vector(); Vector ev = new Vector();
    Edge add(Node n, Node m) {
        Edge e = new Edge(n, m);
        nv.add(n); nv.add(m); ev.add(e);
        e.weight = new Weight();
        return e;
    }
    Edge add(Node n, Node m, Weight w) {
        Edge e = new Edge(n, m);
        nv.add(n); nv.add(m); ev.add(e);
        e.weight = w; return e;
    }
    void print() {
        for(int i = 0; i < ev.size(); i++) {
            ((Edge)ev.get(i)).print();
        }
    }
}

```

```

class Node {
    int id = 0;
    Color color = new Color();
    void print() {
        Color.setDisplayColor(color);
        System.out.print(id);
    }
}

```

```

class Edge {
    Node a, b;
    Color color = new Color();
    Weight weight = new Weight();
    Edge(Node _a, Node _b) { a = _a; b = _b; }
    void print() {
        Color.setDisplayColor(color);
        a.print(); b.print();
        weight.print();
    }
}

```

```

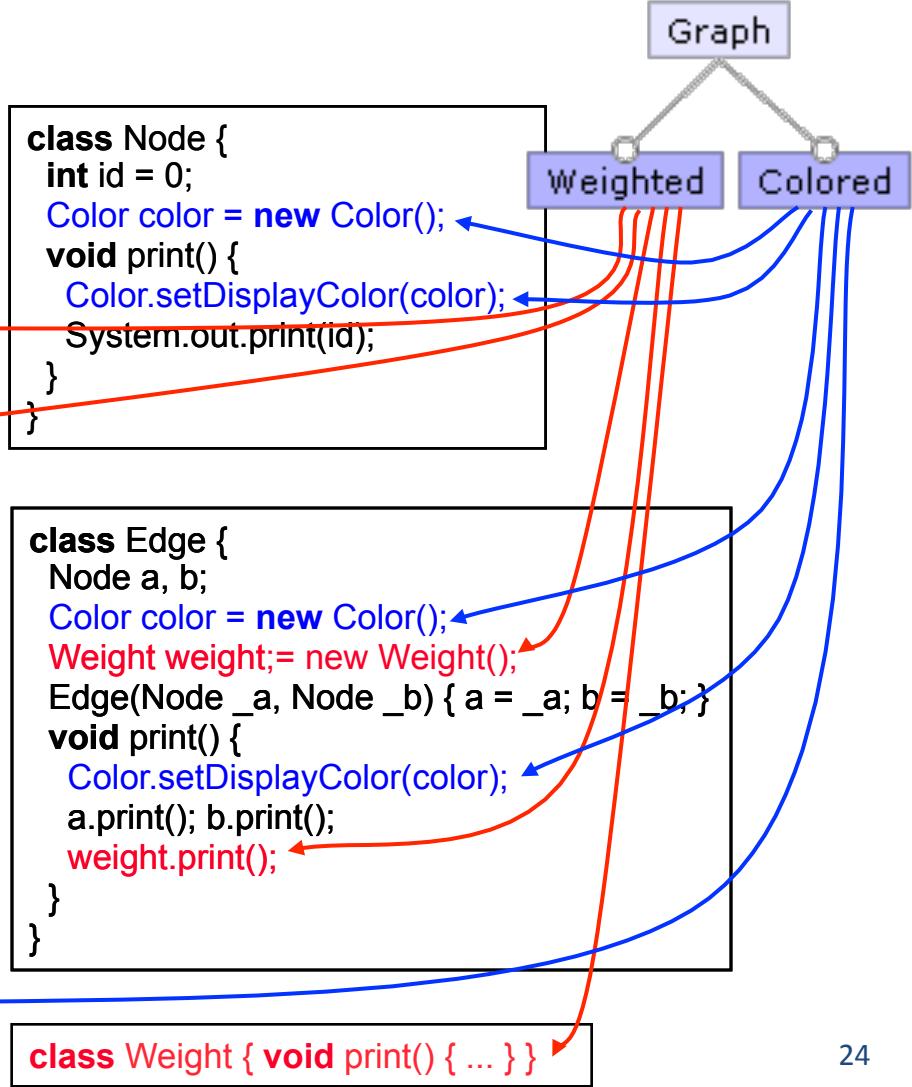
class Color {
    static void setDisplayColor(Color c) { ... }
}

```

```

class Weight { void print() { ... } }

```



# Mining Features from the Object-Oriented Source Code of Software Variants by Combining Lexical and Structural Similarity

R. AL-msie'deen, A.-D. Seriai, M. Huchard

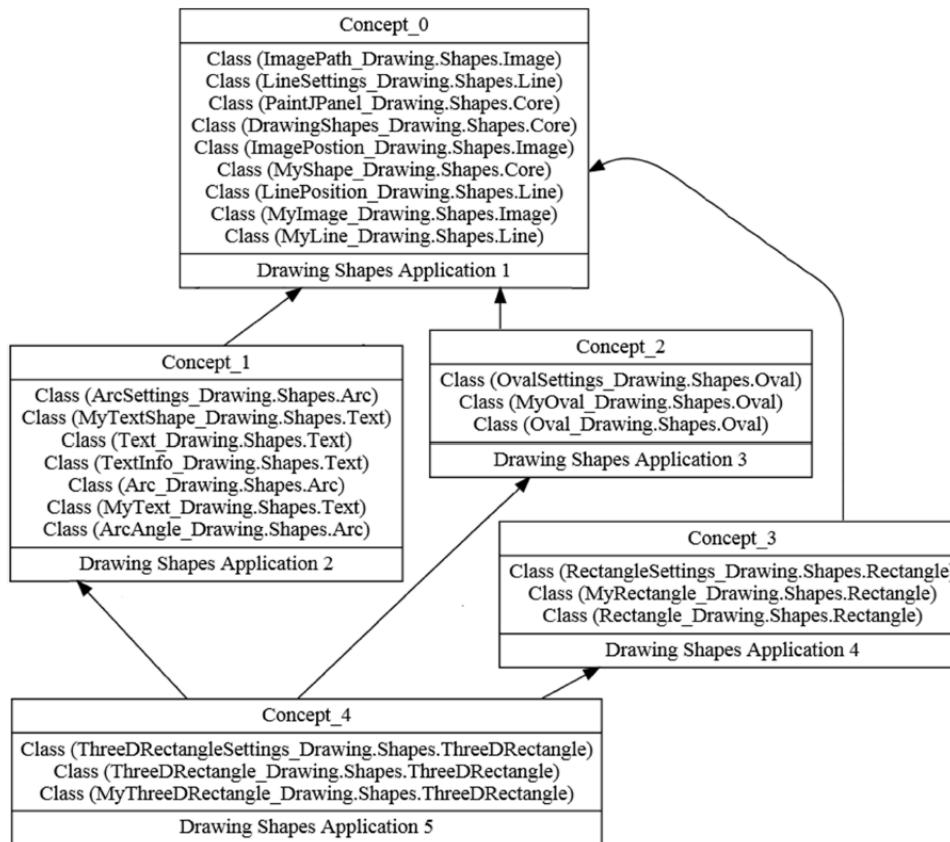
LIRMM / CNRS & Montpellier 2 University, Montpellier, France

Al-msiedee, Abdelhak.Seriai, huchard@lirmm.fr

C. Urtado and S. Vauttier

LGI2P / Ecole des Mines d'Alès, Nîmes, France

Christelle.Urtado, Sylvain.Vauttier@mines-ales.fr



	Class (ArcSettings_Drawing.Shapes.Arc)	Class (Arc_Drawing.Shapes.Arc)	Class (ArcAngle_Drawing.Shapes.Arc)	Class (MyTextShape_Drawing.Shapes.Text)	Class (Text_Drawing.Shapes.Text)	Class (TextInfo_Drawing.Shapes.Text)	Class (MyText_Drawing.Shapes.Text)
Class (ArcSettings_Drawing.Shapes.Arc)	×	×	×				
Class (Arc_Drawing.Shapes.Arc)	×	×	×				
Class (ArcAngle_Drawing.Shapes.Arc)	×	×	×				
Class (MyTextShape_Drawing.Shapes.Text)				×	×	×	×
Class (Text_Drawing.Shapes.Text)				×	×	×	×
Class (TextInfo_Drawing.Shapes.Text)				×	×	×	×
Class (MyText_Drawing.Shapes.Text)				×	×	×	×



(a) Variant #1 of video sequence



(b) Variant #2 of video sequence



(c) Variant #3 of video sequence



(d) Variant #4 of video sequence

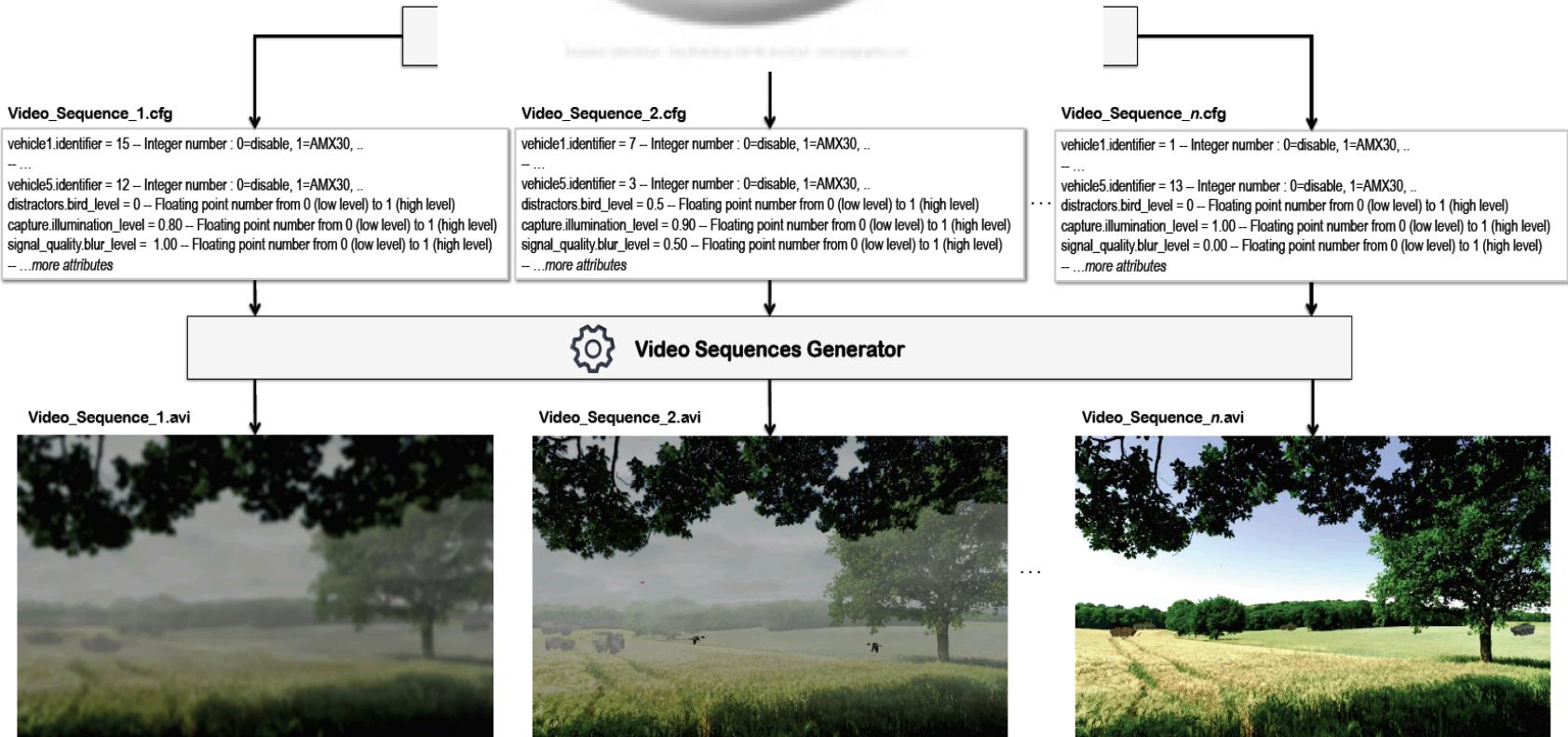


(e) Variant #5 of video sequence



(f) Variant #6 of video sequence

Figure 1: Six variants of video sequences synthesized with ViViD



```
/* [Customize body] */

//Set the outside length of your pencil box.
length=190;//[70:400]
//Set the outside depth of your pencil box.
depth=70;//[50:400]
//Set the total height of your pencil box. The top of the box is set at 15mm.
//Extra height is added to the body section.
height=40;//[40:150]
```

1

```
//Choose divider orientation. Long is for the X direction.
long = 1;//[0,1,2]
//Short is for the Y direction.
short = 2;//[0,1,2,3]
//When you have 2 long dividers,
// picking yes here will put short dividers in the center section.
center = 0;//[1:Yes,0>No]
```

Lid inside settings    Lid inside content    Lid outside

Customize body

Design key

Customize ruler

Printer platform se

**Length** Set the outside length of your pencil box. 190

**Depth** Set the outside depth of your pencil box. 70

**Height** Set the total height of your pencil box. The top of the box is set at 15mm. Extra height is added to the body section. 40

**Long** Choose divider orientation. Long is for the X direction.

**Short** Short is for the Y direction.

**Center** When you have 2 long dividers, picking yes here will put short dividers in the center section.

### Customizable Battery Case

by water, published Mar 5, 2013



Thing Info

Instructions

Thing Files

20  
Comments

8  
Made

473  
Collections

366  
Remixes

#### Description

A customizable battery case to hold batteries while traveling. Configurable for the number of batteries and type (as long as they're cylindrical). This is a updated version of the customizable battery carrier ([thingiverse.com/thing:51376](#)), re-designed to work without magnets as requested by GregFisk25.

20865

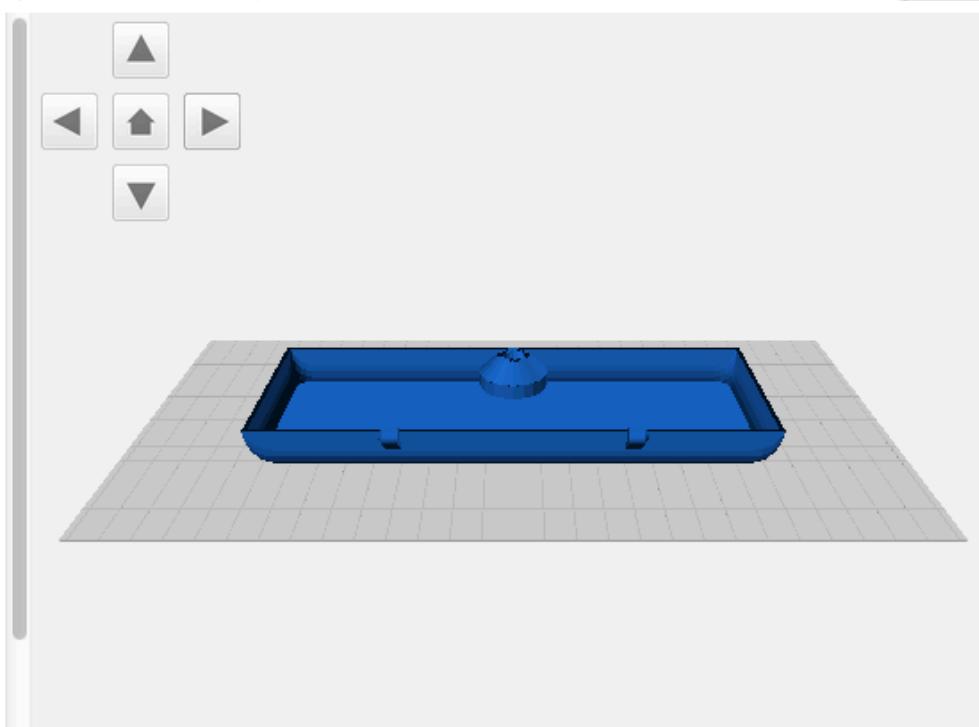
2444

Found in Containers

Report Thing as Inappropriate

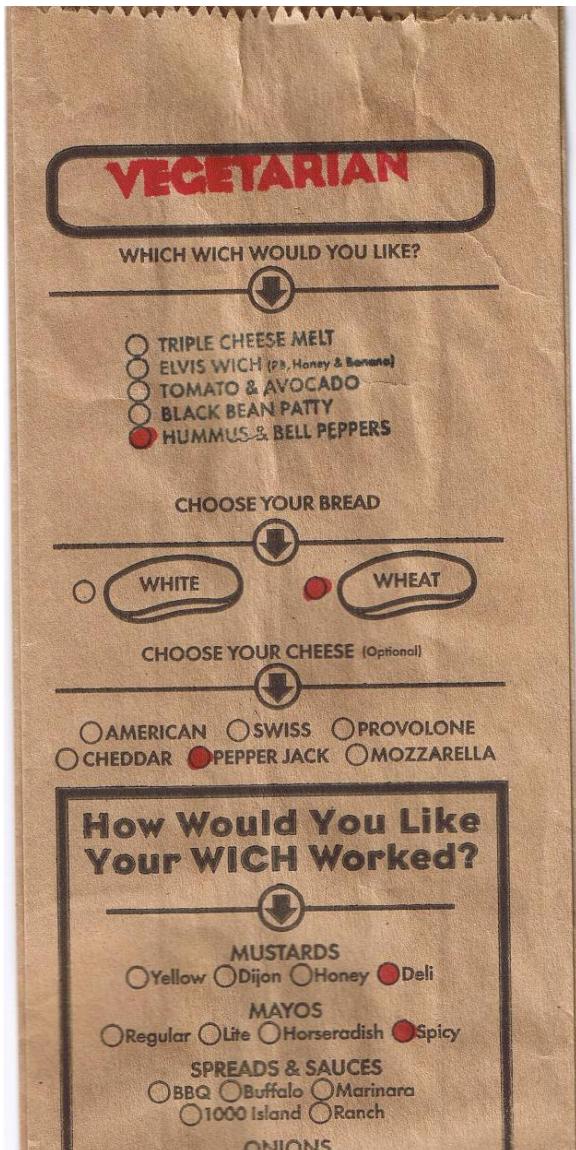
Makes

view more >



(credits: Christian Kaestner's slide)

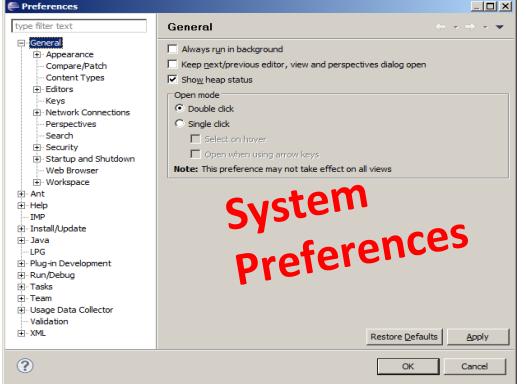
# Food? Product lines!



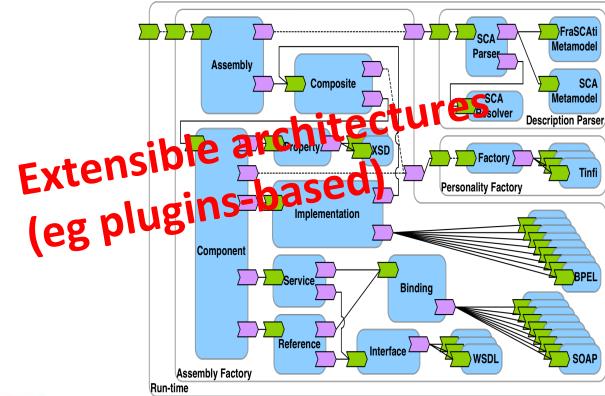


NEW KANGOO VAN RANGE

Configurators



System  
Preferences



Extensible architectures  
(eg plugins-based)



Comparison of \*

# Product Lines and Variability



[httpd.conf](http://httpd.conf) -- win32 Apache  
Building a Web Server, for Windows

```
Listen 80
ServerRoot "/www/Apache2"
DocumentRoot "/www/webroot"

ServerName localhost:80
ServerAdmin admin@localhost

ServerSignature On
ServerTokens Full

DenyType text/plain
AddDefaultCharset ISO-8859-1

UseSendfile Off

HostnameLookups Off

ErrorLog logs/error.log
LogLevel error

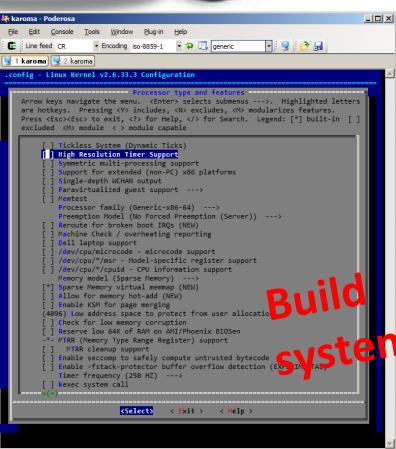
PidFile logs/httpd.pid

Timeout 300

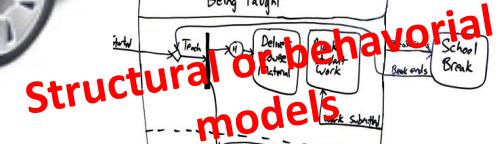
KeepAlive On
MaxKeepAliveRequests 100
KeepAliveTimeout 15

<IfModule mpm_winnt.c>
  ThreadsPerChild 250
  MaxRequestsPerChild 0
</IfModule>
```

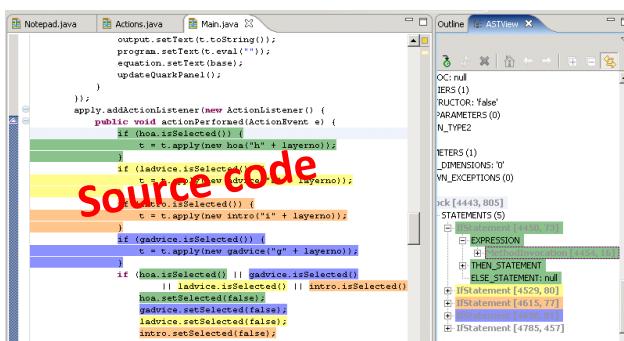
Configuration  
files



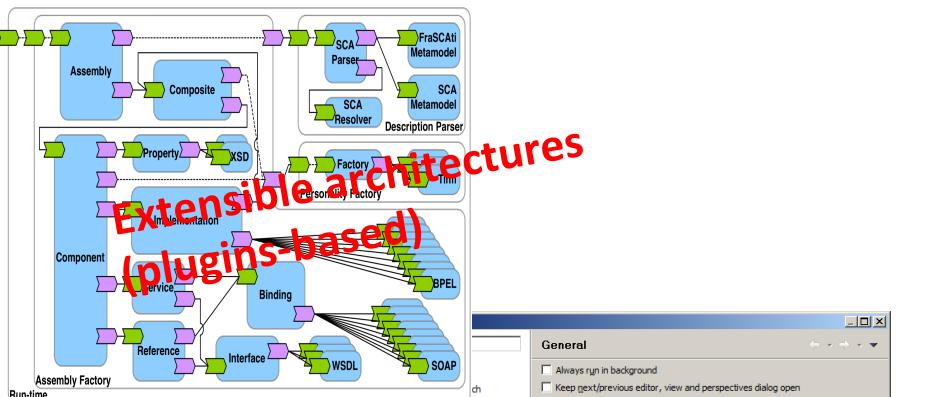
Build  
systems



Structural or behavioral  
models



Source code



<http://httpd.conf -- win32 App Building a Web Server, for Windows>

```

Listen 80
ServerRoot "/www/Apache2"
DocumentRoot "/www/webroot"

ServerName localhost:80
ServerAdmin admin@localhost

ServerSignature On
ServerTokens Full

DefaultType text/plain
AddDefaultCharset ISO-8859-1
UseCanonicalName Off
HostnameLookups Off

ErrorLog logs/error.log
LogLevel error

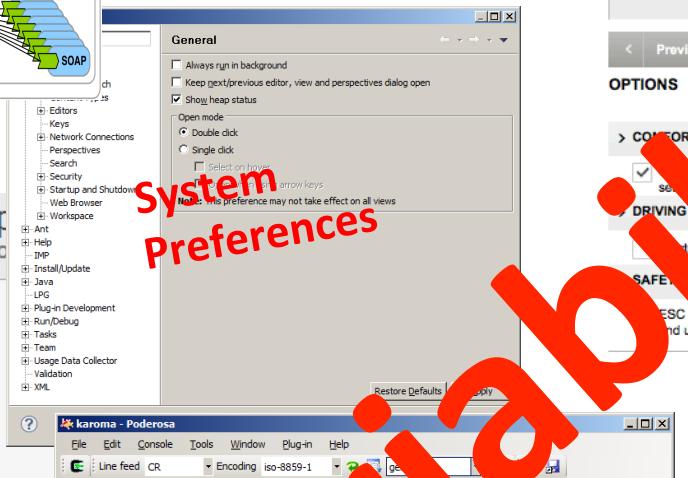
PidFile logs/httpd.pid

Timeout 300

KeepAlive On
MaxKeepAliveRequests 100
KeepAliveTimeout 15

<IfModule mpm_winnt.c>
  ThreadsPerChild 250
  MaxRequestsPerChild 0
</IfModule>
```

System Preferences



```

karoma - Poderosa
File Edit Console Tools Window Plugin Help
[ ] Line feed CR Encoding iso-8859-1
[ ] karoma

.config - Linux Kernel v2.6.33.3 Config
Processor type and features
Arrow keys navigate the menu system; submenus >>>. Highlighted letters are hotkeys. Pressing <Shift><Up> or <Shift><Down> modulates features. Press <Esc><F2> to exit <F2> to search. Legend: [*] built-in [ ] excluded [ ] module [ ] module

[ ] tick System (Dynamic Tick Support)
[ ] High Resolution Timer Support
[ ] Symmetric multi-processing support
[ ] Supports extended memory (x86 platforms)
[ ] Single channel WCHAN output
[ ] Multi-threaded guest support >>>

[*] tick Generic (x86-64) --->
[ ] Preemptible (No Forced Preemption (Server)) --->
[ ] Renroute: broken boot IRQs (NEW)
[ ] Machine Check / overheating reporting
[ ] Dell laptop support
[ ] /dev/cpu/microcode - microcode support
[ ] /dev/cpu/*msr - Model-specific register support
[ ] /dev/cpu/*cpuid - CPU information support
Memory model (Sparse Memory) --->
[ ] sparse Memory virtual memmap (NEW)
[ ] allow for memory hot-add (NEW)
[ ] Intel KSM for page merging (4096 Low address space to protect from user location)
[ ] check for low memory for KSM
[ ] Reserve memory for KSM on NVMe/Phoenix BIOSen
[*] TMR (Time Management Register) support
[ ] Enable seccomp to safely compute untrusted bytecode
[ ] Enable -fstack-protector buffer overflow detection (EXPERIMENTAL)
[ ] Timer frequency (250 Hz) --->
[ ] exec system call

<Select> <Exit> <Help>
```

Build systems



NEW KANGOO VAN RANGE



Compare Adobe Creative Suite 4 editions	
Design Premium	US\$1,799
Design Standard	US\$1,399
Web Premium	US\$1,699
Web Standard	US\$999
Production Premium	US\$1,699
Production Standard	US\$799
Master Collection	US\$2,499

Comparison of Product

```

Notepad.java Actions.java Main.java
output.setText(t.toString());
program.setText(t.eval(""));
equation.setText("a");
updateQuarkPanel();
}
apply.addActionListener(new ActionListener() {
  public void actionPerformed(ActionEvent e) {
    if (hoa.isSelected()) {
      t = t.apply("a" + layerno);
    }
    if (ladvice.isSelected()) {
      t = t.apply(new advice("a" + layerno));
    }
    if (intro.isSelected()) {
      t = t.apply(new intro("a" + layerno));
    }
    if (gadvice.isSelected()) {
      t = t.apply(new gadvice("a" + layerno));
    }
    if (hoa.isSelected() || gadvice.isSelected() ||
        ladvice.isSelected() || intro.isSelected()) {
      hoa.setSelected(false);
      gadvice.setSelected(false);
      ladvice.setSelected(false);
      intro.setSelected(false);
      equation.setText("F" + layerno + "(" + equation.get
      + ")");
    }
  }
});
```

source code

# Quizz Time

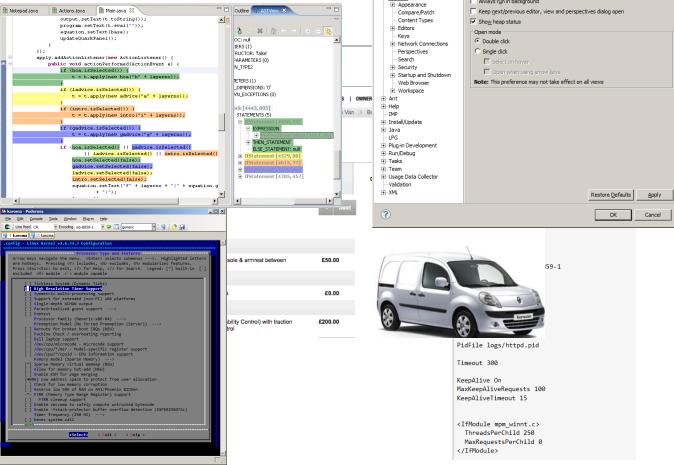
Give three examples of software product lines (also called configurable systems or variability-intensive systems)

# Software is eating the world (any company will be a software company)

If you have the super-power to  
“**vary**” (e.g., for delivering customized  
solutions to customers; or for  
engineering customized solutions for  
addressing your specific problems)

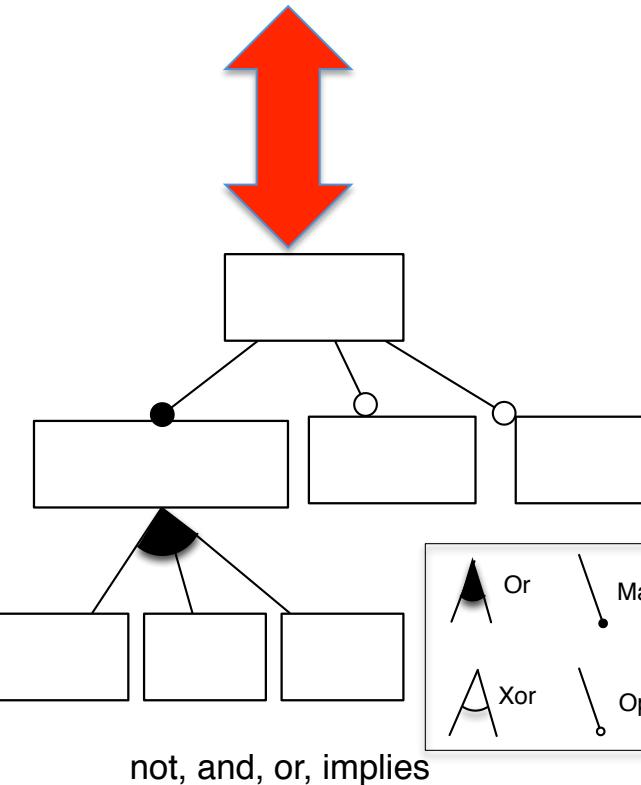
Then you will rule the world





Variants of code (e.g., Java ou C)  
 Variants of user interfaces  
 Variants of video sequences  
 Variants of models (e.g., UML or SysML)  
 Variants of « things » (3D models)

...



# Variability Models

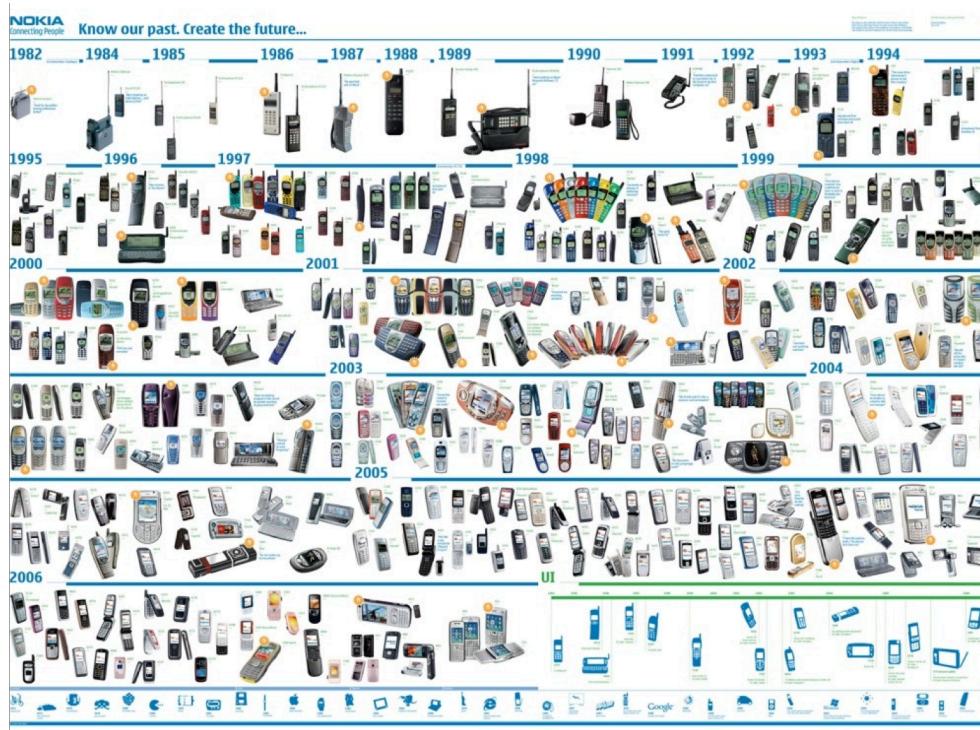
(feature models)

# Variability: two definitions

- “the **ability** of a software system or artifact to be efficiently extended, changed, customized or configured for use in a particular context” (Svahnberg et al. 2005)
  - software/**customization** perspective
- “an assumption about how members of a family may **differ** from each other” (Weiss and Lai 1999)
  - more related to the notions of **domain** and **commonality**

# Variability in time vs in space

- **Variability in Time (releases)**
  - the existence of different **versions** of an artifact that are valid at different times
- **Variability in Space (variants)**
  - the existence of an artifact in different **shapes** at the same time



# Benefits

Improve product reliability

Improve usability

Improve consistency across products...



# Benefits

Reduce production costs



Reduce certification costs



Shorten time-to-market



# Hall of Fame

[splc.net/fame.html](http://splc.net/fame.html)



**BOSCH**

Invented for life



**PHILIPS**



**NOKIA**  
Connecting People

**CelsiusTech**

**ERICSSON**



**Lucent Technologies**  
Bell Labs Innovations





# Printer Firmware

- Production cost reduced by 75%
- Development time reduced by 33%
- Reported defects reduced by 96%



A large, intricate 3D white maze is set against a light gray background. The maze consists of many interconnected paths and dead ends, creating a complex network of levels and corners. It occupies the entire frame, from the top left to the bottom right.

**Variability = Complexity**

(credits: Christian Kaestner's slide)

# 33 features

optional, independent



a unique variant for every  
person on this planet

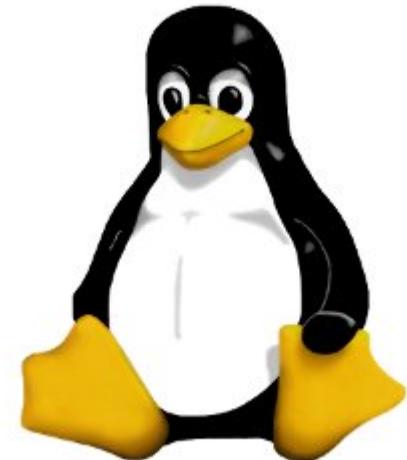
320<sup>optional, independent</sup>  
features

more variants than estimated  
atoms in the universe



2000 features

10000  
features



# Software product line and Variability engineering

Basic techniques

# What is new?

**Family vs single systems**

**Focus on reuse**

**Domain engineering**

**Factoring out commonality**

**Managing variability**

« variability »

Is it really new?

# Intentional Code Cloning

~ Copy & Paste

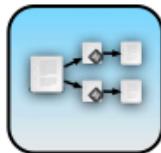
# Code Cloning (example, Linux driver)

cyberstorm.c

```
....  
static void dma_dump_state(struct NCR_ESP *esp)  
{  
    ESPLOG("esp%d: dma -- cond_reg<%02x>\n",  
           esp->esp_id, ((struct cyber_dma_registers *)  
                           (esp->dregs))->cond_reg);  
    ESPLOG("intreq:<%04x>, intena:<%04x>\n",  
           custom.intreq, custom.intenar));  
}  
  
static void dma_init_read(struct NCR_ESP *esp, __u32 addr, int  
length)  
{  
    struct cyber_dma_registers *dregs =  
        (struct cyber_dma_registers *) esp->dregs;  
  
    cache_clear(addr, length);  
  
    addr &= ~(1);  
    dregs->dma_addr0 = (addr >> 24) & 0xff;  
    dregs->dma_addr1 = (addr >> 16) & 0xff;  
    dregs->dma_addr2 = (addr >> 8) & 0xff;  
    dregs->dma_addr3 = (addr      ) & 0xff;  
    ctrl_data &= ~(CYBER_DMA_WRITE);  
}.....
```

cyberstormll.c

```
....  
static void dma_dump_state(struct NCR_ESP *esp)  
{  
    ESPLOG("esp%d: dma -- cond_reg<%02x>\n",  
           esp->esp_id, ((struct cyberll_dma_registers *)  
                           (esp->dregs))->cond_reg);  
    ESPLOG("intreq:<%04x>, intena:<%04x>\n",  
           custom.intreq, custom.intenar));  
}  
  
static void dma_init_read(struct NCR_ESP *esp, __u32 addr, int  
length)  
{  
    struct cyberll_dma_registers *dregs =  
        (struct cyberll_dma_registers *) esp->dregs;  
  
    cache_clear(addr, length);  
  
    addr &= ~(1);  
    dregs->dma_addr0 = (addr >> 24) & 0xff;  
    dregs->dma_addr1 = (addr >> 16) & 0xff;  
    dregs->dma_addr2 = (addr >> 8) & 0xff;  
    dregs->dma_addr3 = (addr      ) & 0xff;  
}  
.....
```

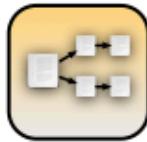


# Replicate & Specialize

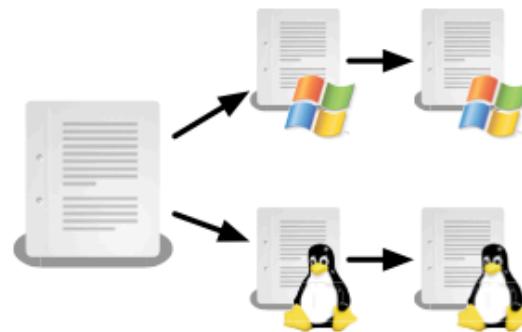


## **Clone to reuse and adapt existing solutions**

- + Less effort needed
- Long-term cost outweighs short-term benefit
- ~ Cost of refactoring rises over time



# Platform Variations



**Clone existing code and fix  
low level platform interaction**

- + Avoid complexity of virtualization layer
- Hard to propagate bug fixes
- ~ Ensure consistent behavior of all clones

# Parameter

```
Administrator: C:\Windows\system32\cmd.exe
C:\Users\kaestner.INFORMATIK.000>dir /?
Displays a list of files and subdirectories in a directory.

DIR [drive:][path][filename] [/A[[:l]attributes] [/B] [/C] [/D] [/L] [/N]
  [/O[[:l]sortorder]] [/P] [/Q] [/R] [/S] [/T[[:l]timefield]] [/W] [/X] [/4]

[drive:][path][filename]
      Specifies drive, directory, and/or files to list.

/A          Displays files with specified attributes.
attributes   D  Directories                  R  Read-only files
              H  Hidden files                A  Files ready for archiving
              S  System files                I  Not content indexed files
              L  Reparse Points             -  Prefix meaning not
/B          Uses bare format (no heading information or summary).
/C          Display the thousand separator in file sizes. This is the
            default. Use /-C to disable display of separator.
/D          Same as wide but files are list sorted by column.
/L          Uses lowercase.
/N          New long list format where filenames are on the far right.
/O          List by files in sorted order.
sortorder    N  By name (alphabetic)        S  By size (smallest first)
              E  By extension (alphabetic)  D  By date/time (oldest first)
              G  Group directories first   -  Prefix to reverse order
/P          Pauses after each screenful of information.
```

# Parameter -i in grep

```
1 int match_icase;
2
3 int main (int argc, char **argv)
4 {
5     [...]
6     while ((opt = get_nondigit_option (argc, argv, &default_color))
7         switch (opt)
8         {
9             [...]
10            case 'i':
11                match_icase = 1;
12                break;
13            }
14        }
15
16
17 static const char *
18 print_line_middle (const char *beg, const char *lim,
19                     const char *line_color, const char *match_color)
20 {
21     [...]
22     if (match_icase)
23     {
24         ibeg = buf = (char *) xmalloc(i);
25         while (--i >= 0)
26             buf[i] = tolower(beg[i]);
27     }
}
```

# Global configuration

```
class Config {  
    public static boolean isLogging = false;  
    public static boolean isWindows = false;  
    public static boolean isLinux = true;  
}  
class Main {  
    public void foo() {  
        if (isLogging)  
            log(„running foo()“);  
        if (isWindows)  
            callWindowsMethod();  
        else if (isLinux)  
            callLinuxMethod();  
        else  
            throw RuntimeException();  
    }  
}
```

# Configuration

## httpd.conf -- win32 Apache Building a Web Server, for Windows

```
Listen 80
ServerRoot "/www/Apache2"
DocumentRoot "/www/webroot"
```

```
ServerName localhost:80
ServerAdmin admin@localhost
```

```
ServerSignature On
ServerTokens Full
```

```
DefaultType text/plain
AddDefaultCharset ISO-8859-1
```

```
UseCanonicalName Off
```

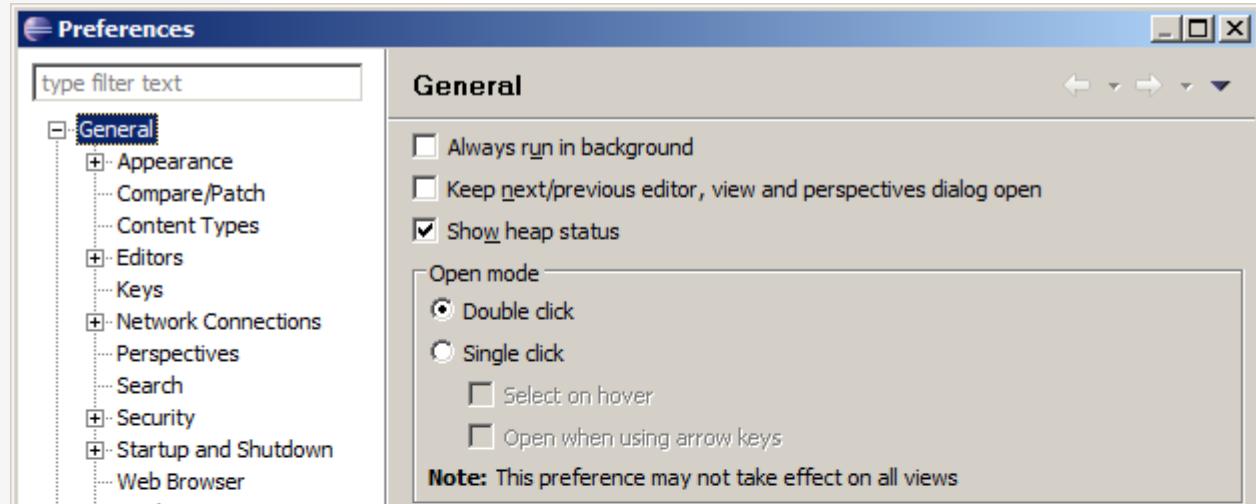
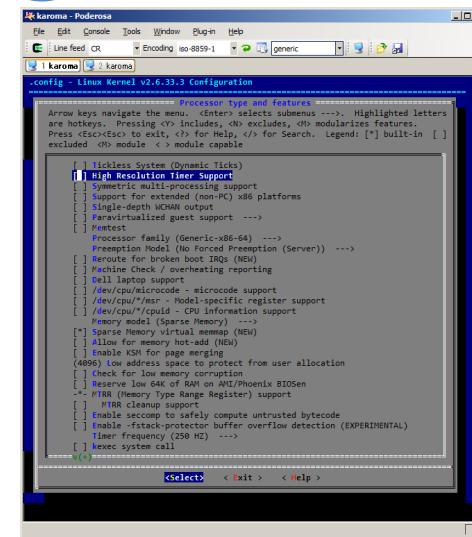
```
HostnameLookups Off
```

```
ErrorLog logs/error.log
LogLevel error
```

```
PidFile logs/httpd.pid
```

```
Timeout 300
```

```
KeepAlive On
MaxKeepAliveRequests 100
```



# Conditional compilation

## #ifdef (Berkeley DB)

```
static int __rep_queue_filedone(dbenv, rep, rfp)
    DB_ENV *dbenv;
    REP *rep;
    __rep_fileinfo_args *rfp; {
#ifndef HAVE_QUEUE
    COMPQUIET(rep, NULL);
    COMPQUIET(rfp, NULL);
    return (__db_no_queue_am(dbenv));
#else
    db_pgno_t first, last;
    u_int32_t flags;
    int empty, ret, t_ret;
#endif
#ifdef DIAGNOSTIC
    DB_MSGBUF mb;
#endif
    // over 100 lines of additional code
}
#endif
```

# Inheritance (OOP)

Base Class encapsulate commonalities

Derive classes specialize peculiarities

# Generic Programming

## C++ template

```
template <typename T>
T max(T x, T y)
{
    return x < y ? y : x;
}
```

## Generics in Java

```
public interface List<E> {
    void add(E x);
    Iterator<E> iterator();
}
public interface Iterator<E> {
    E next();
    boolean hasNext();
}
```

# Design Patterns

Template Method

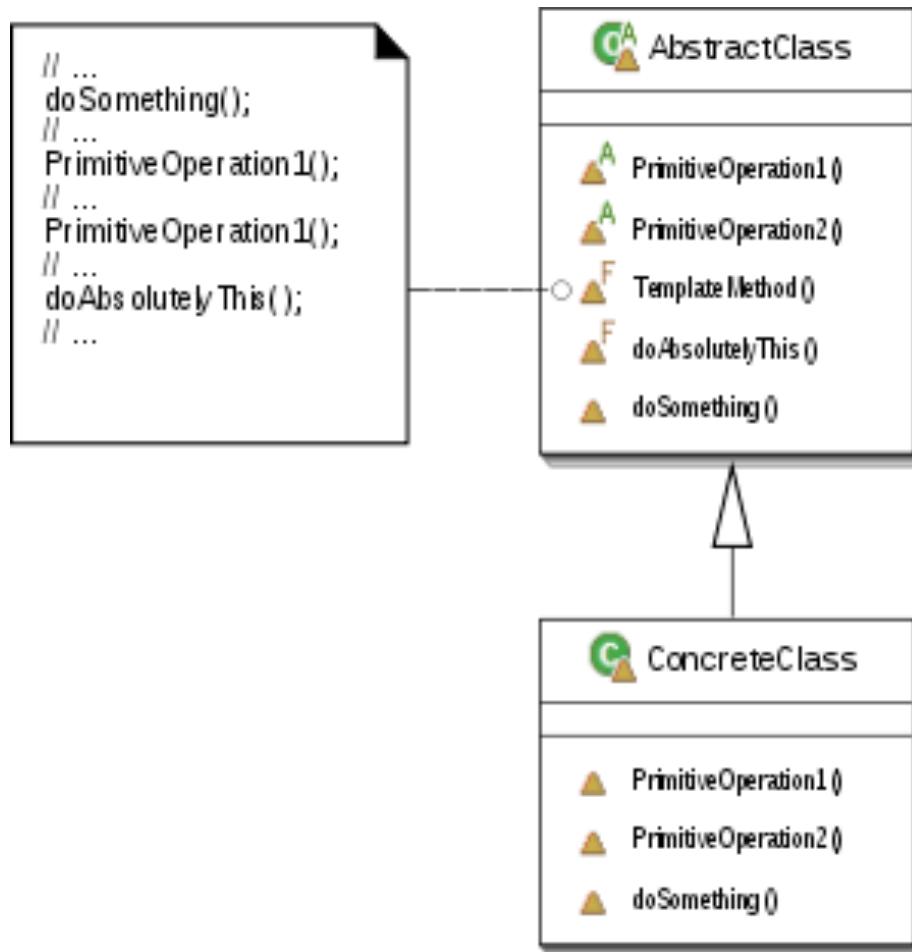
Factory

Strategy

Decorator

....

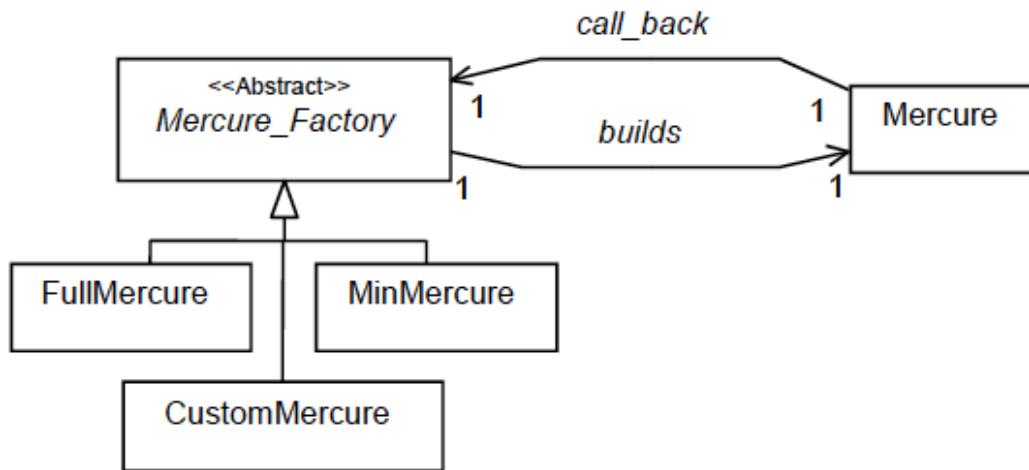
# Template Method



# The decision model

## ■ The Abstract Factory Design Pattern – [Gamma et al 95]

Mercure_Factory
new_gui() : GUI
new_language() : Language
new_network_manager() : Manager
new_netdriver() : Net Driver
new_engine() : Engine



CustomMercure
<<GUI1>> <<GUI2>> new_gui() : GUI
<<<Language2-1>> new_language() : Language
<<Manager1>> new_network_manager() : Manager
<<NetDriver1>> <<NetDriver2>> new_netdriver() : Net Driver
<<Engine1>> new_engine() : Engine

# API Framework

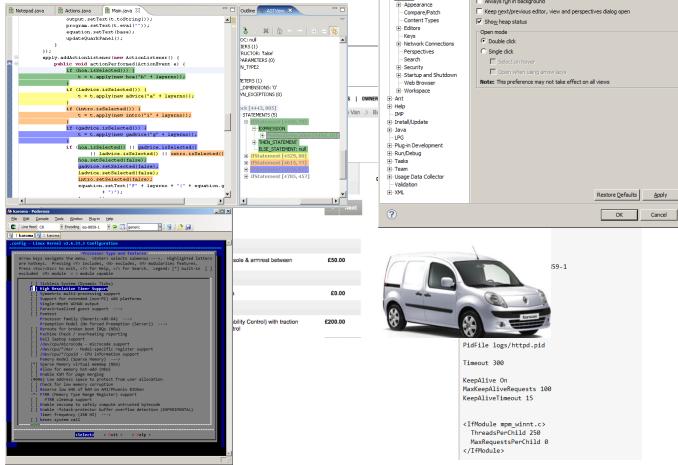
# Plugin-based systems

# (Active) Annotations

can have parameters

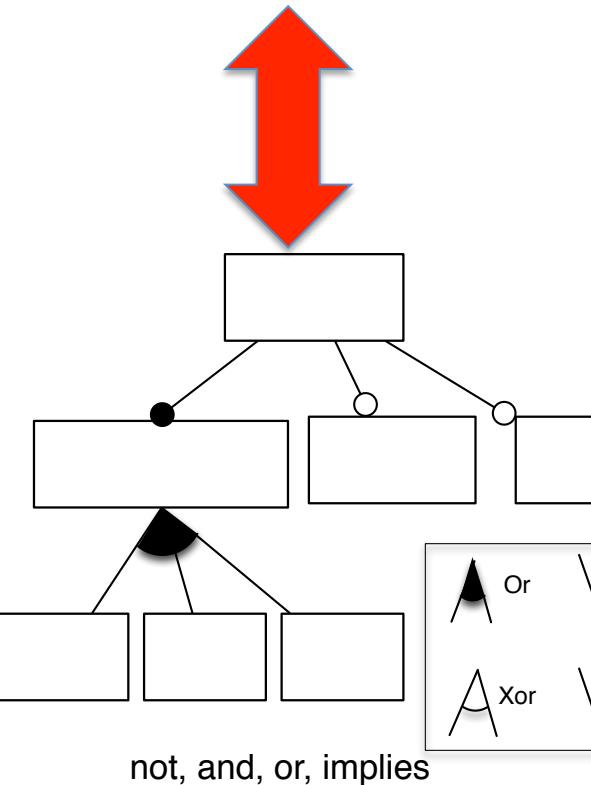
# Metamodeling and Domain-Specific Languages

# Variability (general approach)

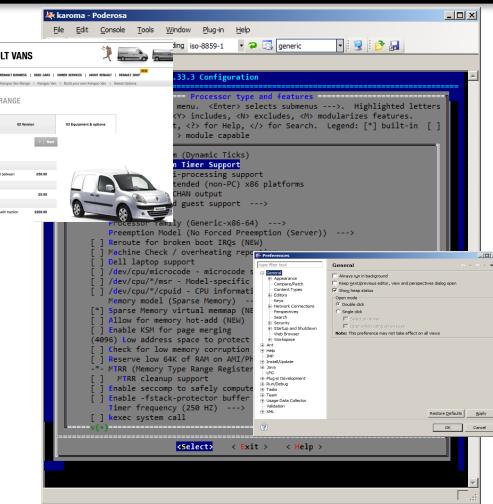


Variants of code (e.g., Java ou C)  
 Variants of user interfaces  
 Variants of video sequences  
 Variants of models (e.g., UML or SysML)

...

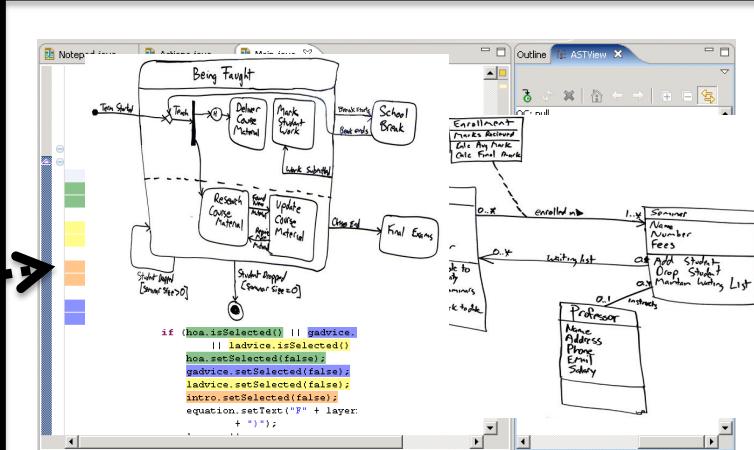


# Variability Models (feature models)

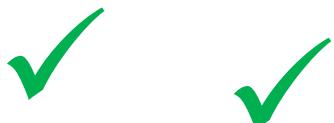


## Variability Model

mapping



Base Artefacts (e.g.,  
models)

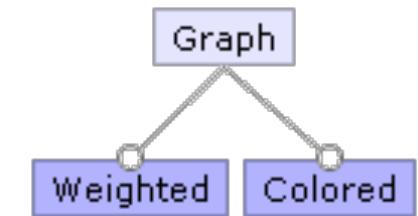


Configuration



Software Generator  
(derivation engine)





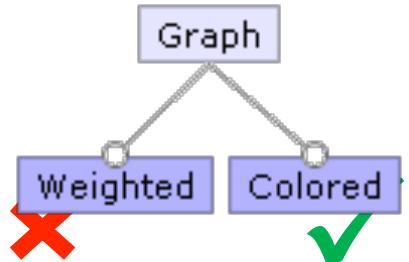
## Variability Model

mapping

```

class Graph {
    Vector nv = new Vector(); Vector ev = new Vector();
    Edge add(Node n, Node m) {
        Edge e = new Edge(n, m);
        nv.add(n); nv.add(m); ev.add(e);
        /*if[WEIGHT]*/
        e.weight = new Weight();
        /*end[WEIGHT]*/
        return e;
    }
    /*if[WEIGHT]*/
    Edge add(Node n, Node m, Weight w) {
        Edge e = new Edge(n, m);
        nv.add(n); nv.add(m); ev.add(e);
        e.weight = w; return e;
    }
    /*end[WEIGHT]*/
    void print() {
        for(int i = 0; i < ev.size(); i++) {
            ((Edge)ev.get(i)).print();
        }
    }
}
  
```

## Base Artefacts



```

class Graph {
    Vector nv = new Vector(); Vector ev = new Vector();
    Edge add(Node n, Node m) {
        Edge e = new Edge(n, m);
        nv.add(n); nv.add(m); ev.add(e);
        return e;
    }
    void print() {
        for(int i = 0; i < ev.size(); i++) {
            ((Edge)ev.get(i)).print();
        }
    }
}
  
```

## Software Generator (derivation engine)

# Mapping: an example

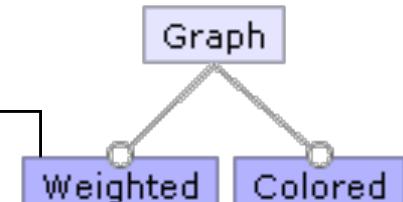
```
class Graph {  
    Vector nv = new Vector(); Vector ev = new Vector();  
    Edge add(Node n, Node m) {  
        Edge e = new Edge(n, m);  
        nv.add(n); nv.add(m); ev.add(e);  
        e.weight = new Weight();  
        return e;  
    }  
    Edge add(Node n, Node m, Weight w)  
    Edge e = new Edge(n, m);  
    nv.add(n); nv.add(m); ev.add(e);  
    e.weight = w; return e;  
}  
void print() {  
    for(int i = 0; i < ev.size(); i++) {  
        ((Edge)ev.get(i)).print();  
    }  
}
```

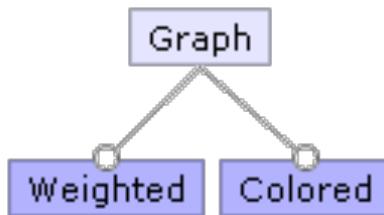
```
class Node {  
    int id = 0;  
    Color color = new Color();  
    void print() {  
        Color.setDisplayColor(color);  
        System.out.print(id);  
    }  
}
```

```
class Edge {  
    Node a, b;  
    Color color = new Color();  
    Weight weight = new Weight();  
    Edge(Node _a, Node _b) { a = _a; b = _b; }  
    void print() {  
        Color.setDisplayColor(color);  
        a.print(); b.print();  
        weight.print();  
    }  
}
```

```
class Color {  
    static void setDisplayColor(Color c) { ... }  
}
```

```
class Weight { void print() { ... } }
```





```

class Graph {
    Vector nv = new Vector(); Vector ev = new Vector();
    Edge add(Node n, Node m) {
        Edge e = new Edge(n, m);
        nv.add(n); nv.add(m); ev.add(e);
        /*if[WEIGHT]*/
        e.weight = new Weight();
        /*end[WEIGHT]*/
        return e;
    }
    /*if[WEIGHT]*/
    Edge add(Node n, Node m, Weight w)
        Edge e = new Edge(n, m);
        nv.add(n); nv.add(m); ev.add(e);
        e.weight = w; return e;
    }
    /*end[WEIGHT]*/
    void print() {
        for(int i = 0; i < ev.size(); i++) {
            ((Edge)ev.get(i)).print();
        }
    }
}

/*if[WEIGHT]*/
class Weight { void print() { ... } }
/*end[WEIGHT]*/

```

```

class Edge {
    Node a, b;
    /*if[COLOR]*/
    Color color = new Color();
    /*end[COLOR]*/
    /*if[WEIGHT]*/
    Weight weight;
    /*end[WEIGHT]*/
    Edge(Node _a, Node _b) { a = _a; b = _b; }
    void print() {
        /*if[COLOR]*/
        Color.setDisplayColor(color);
        /*end[COLOR]*/
        a.print(); b.print();
        /*if[WEIGHT]*/
        weight.print();
        /*end[WEIGHT]*/
    }
}

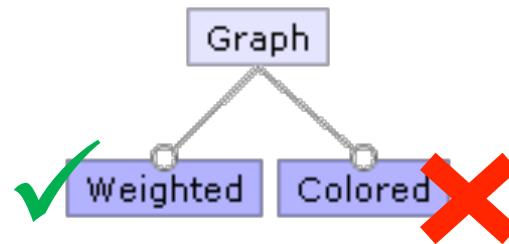
/*if[COLOR]*/
class Color {
    static void setDisplayColor(Color c) { ... }
}
/*end[COLOR]*/

```

```

class Node {
    int id = 0;
    /*if[COLOR]*/
}

```



```

class Graph {
    Vector nv = new Vector(); Vector ev = new Vector();
    Edge add(Node n, Node m) {
        Edge e = new Edge(n, m);
        nv.add(n); nv.add(m); ev.add(e);
        e.weight = new Weight();
        return e;
    }
    Edge add(Node n, Node m, Weight w)
        Edge e = new Edge(n, m);
        nv.add(n); nv.add(m); ev.add(e);
        e.weight = w; return e;
    }
    void print() {
        for(int i = 0; i < ev.size(); i++) {
            ((Edge)ev.get(i)).print();
        }
    }
}
    
```

```

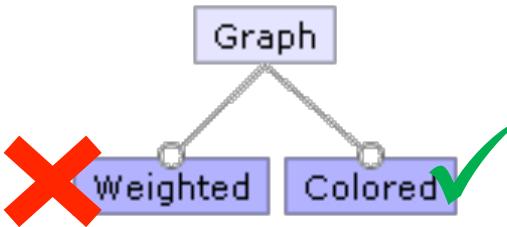
class Edge {
    Node a, b;
    Weight weight;
    Edge(Node _a, Node _b) { a = _a; b = _b; }
    void print() {
        a.print(); b.print();
        weight.print();
    }
}
    
```

```

class Node {
    int id = 0;
    void print() {
        System.out.print(id);
    }
}
    
```

```

class Weight { void print() { ... } }
    
```



```

class Graph {
    Vector nv = new Vector(); Vector ev = new Vector();
    Edge add(Node n, Node m) {
        Edge e = new Edge(n, m);
        nv.add(n); nv.add(m); ev.add(e);
    return e;
    }
    void print() {
        for(int i = 0; i < ev.size(); i++) {
            ((Edge)ev.get(i)).print();
        }
    }
}

```

```

class Edge {
    Node a, b;
    Color color = new Color();
    Edge(Node _a, Node _b) { a = _a; b = _b; }
    void print() {
        Color.setDisplayColor(color);
        a.print(); b.print();
    }
}

```

```

class Color {
    static void setDisplayColor(Color c) { ... }
}

```

```

class Node {
    int id = 0;
    Color color = new Color();
    void print() {
        Color.setDisplayColor(color);
        System.out.print(id);
    }
}

```

macher-wifi:getting-started macher1\$ yo jhipster

I'm all done. Running `npm install & bower install` for you to install the required dependencies.

# JHIPSTER STACKER FOR JAVA EDIENS

Welcome to the JHipster Generator v2.17.0

? (1/15) What is the base name of your application? **jhipster**  
? (2/15) What is your default Java package name? **com.mycompany.myapp**  
? (3/15) Do you want to use Java 8? **Yes (use Java 8)**  
? (4/15) Which \*type\* of authentication would you like to use? (Use arrow keys)  
-> **HTTP Session Authentication (stateful, default Spring Security mechanism)**  
OAuth2 Authentication (stateless, with an OAuth2 server implementation)  
Token-based authentication (stateless, with a token)

## Variability Model



mapping

Branch: master

generator-jhipster / app / templates / src / main / java / package / config / \_DatabaseConfiguration.java

l d b

```
1 package com.mycompany.myapp.config;
2 
3 import com.codahale.metrics.MetricRegistry;
4 import com.fasterxml.jackson.databind.ObjectMapper;
5 import com.zaxxer.hikari.HikariConfig;
6 import com.zaxxer.hikari.HikariDataSource;
7 import org.hibernate.SessionFactory;
8 import org.hibernate.boot.autoconfigure.SpringLiquibase;
9 import org.springframework.boot.autoconfigure.security.oauth2.OAuth2AuthenticationConverter;
10 import org.springframework.boot.autoconfigure.web.EmbeddedServletContainerCustomizer;
11 import org.springframework.boot.autoconfigure.web.ServerProperties;
12 import org.springframework.boot.context.embedded.AnnotationConfigServletWebServerApplicationContext;
13 import org.springframework.boot.context.embedded.EmbeddedServletContainerCustomizer;
14 import org.springframework.boot.context.embedded.EmbeddedServletContainerCustomizer;
15 import org.springframework.boot.context.embedded.EmbeddedServletContainerCustomizer;
16 import org.springframework.boot.context.embedded.EmbeddedServletContainerCustomizer;
17 import org.springframework.boot.context.embedded.EmbeddedServletContainerCustomizer;
18 import org.springframework.boot.context.embedded.EmbeddedServletContainerCustomizer;
19 import org.springframework.boot.context.embedded.EmbeddedServletContainerCustomizer;
20 import org.springframework.boot.context.embedded.EmbeddedServletContainerCustomizer;
21 import org.springframework.boot.context.embedded.EmbeddedServletContainerCustomizer;
22 import org.springframework.boot.context.embedded.EmbeddedServletContainerCustomizer;
23 import org.springframework.boot.context.embedded.EmbeddedServletContainerCustomizer;
24 import org.springframework.boot.context.embedded.EmbeddedServletContainerCustomizer;
25 import org.springframework.boot.context.embedded.EmbeddedServletContainerCustomizer;
26 import org.springframework.boot.context.embedded.EmbeddedServletContainerCustomizer;
27 import org.springframework.boot.context.embedded.EmbeddedServletContainerCustomizer;
28 import org.springframework.core.io.ClassPathResource;
29 import org.springframework.data.elasticsearch.repository.config.EnableElasticsearchRepositories;
30 import org.springframework.data.mongodb.config.AbstractMongoConfiguration;
31 import org.springframework.data.mongodb.config.EnableMongoAuditing;
32 import org.springframework.data.mongodb.core.mapping.event.ValidatingMongoEventListener;
33 import org.springframework.data.mongodb.repository.config.EnableMongoRepositories;
34 import org.springframework.validation.beanvalidation.LocalValidatorFactoryBean;
35 import org.springframework.validation.beanvalidation.LocalValidatorFactoryBean;
```

## Base Artefacts

## Software Generator (derivation engine)

[generator-jhipster / app / templates / src / main / java / package / config / \\_DatabaseConfiguration.java](#) **jdubois** 2 days ago Use Spring Boot's configuration meta-data9 contributors 

184 lines (165 sloc) | 9.69 KB

[Raw](#) [Blame](#) [History](#)   

```
1 package <%=packageName%>.config;
2 <% if (databaseType == 'sql') { %>
3 import <%=packageName%>.config.liquibase.AsyncSpringLiquibase;
4 import com.codahale.metrics.MetricRegistry;
5 import com.fasterxml.jackson.datatype.hibernate4.Hibernate4Module;
6 import com.zaxxer.hikari.HikariConfig;
7 import com.zaxxer.hikari.HikariDataSource;
8 import liquibase.integration.spring.SpringLiquibase;<% } %><% if (databaseType == 'mongodb' && authenticationType == 'oauth2') { %>
9 import <%=packageName%>.config.oauth2.OAuth2AuthenticationReadConverter;<% } %><% if (databaseType == 'mongodb') { %>
10 import com.mongodb.Mongo;
11 import org.mongeez.Mongeez;<% } %>
12 import org.slf4j.Logger;
13 import org.slf4j.LoggerFactory;<% if (databaseType == 'sql') { %><% if (hibernateCache == 'hazelcast') { %>
14 import org.springframework.cache.CacheManager;<% } %>
15 import org.springframework.beans.factory.annotation.Autowired;
16 import org.springframework.boot.autoconfigure.condition.ConditionalOnExpression;<% } %><% if (databaseType == 'mongodb') { %>
17 import org.springframework.boot.autoconfigure.mongo.MongoAutoConfiguration;
18 import org.springframework.boot.autoconfigure.mongo.MongoProperties;<% } %><% if (databaseType == 'sql') { %>
19 import org.springframework.boot.autoconfigure.jdbc.DataSourceProperties;
20 import org.springframework.boot.autoconfigure.liquibase.LiquibaseProperties;
21 import org.springframework.context.ApplicationContextException;<% } %>
22 import org.springframework.context.annotation.Bean;
23 import org.springframework.context.annotation.Configuration;
24 import org.springframework.context.annotation.Profile;<% if (databaseType == 'mongodb') { %>
25 import org.springframework.context.annotation.Import;<% } %><% if (databaseType == 'sql') { %>
26 import org.springframework.core.env.Environment;<% } %><% if (databaseType == 'mongodb' && authenticationType == 'oauth2') { %>
27 import org.springframework.core.convert.converter.Converter;<% } %><% if (databaseType == 'mongodb') { %>
28 import org.springframework.core.io.ClassPathResource;<% } %><% if (searchEngine == 'elasticsearch') { %>
29 import org.springframework.data.elasticsearch.repository.config.EnableElasticsearchRepositories;<% } %><% if (databaseType == 'mon
30 import org.springframework.data.mongodb.config.AbstractMongoConfiguration;
31 import org.springframework.data.mongodb.config.EnableMongoAuditing;<% } %><% if (databaseType == 'mongodb' && authenticationType =
32 import org.springframework.data.mongodb.core.convert.CustomConversions;<% } %><% if (databaseType == 'mongodb') { %>
33 import org.springframework.data.mongodb.core.mapping.event.ValidatingMongoEventListener;
34 import org.springframework.data.mongodb.repository.config.EnableMongoRepositories;
35 import org.springframework.validation.beanvalidation.LocalValidatorFactoryBean;<% } %><% if (databaseType == 'sql') { %>
```

# Variability in the Video Domain (first example)



# What are the differences?

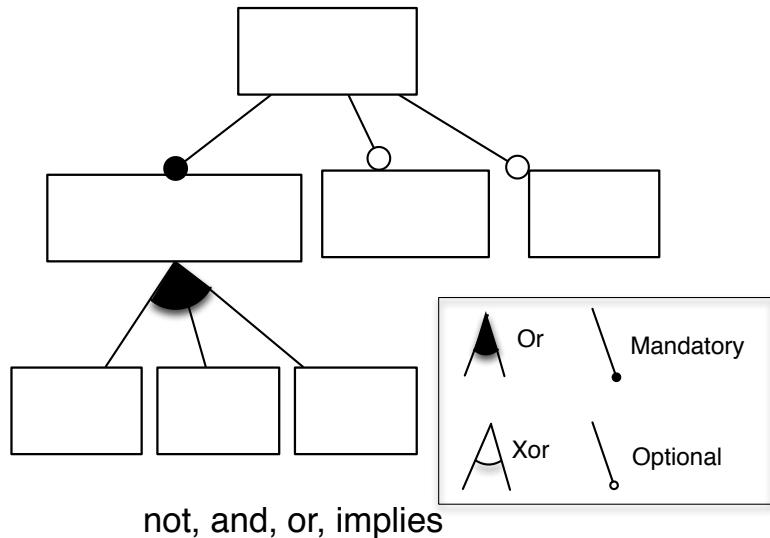




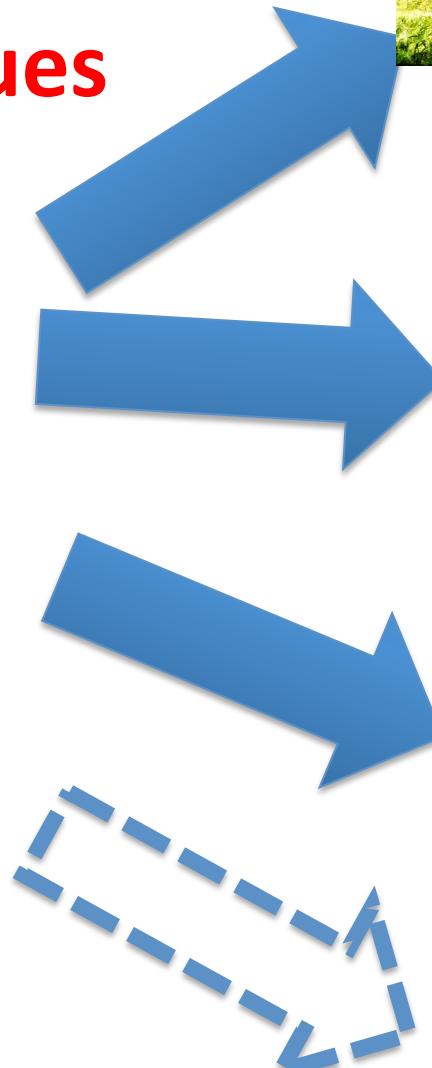
**aka what is the variability of a video?**



# We synthesize video sequence variants with variability techniques



## Variability Models (feature models)



# Why?

**Industrial needs:  
consumer and provider of  
video algorithms have severe**

**difficulties to **test** their  
algorithms on different kinds  
of inputs.**

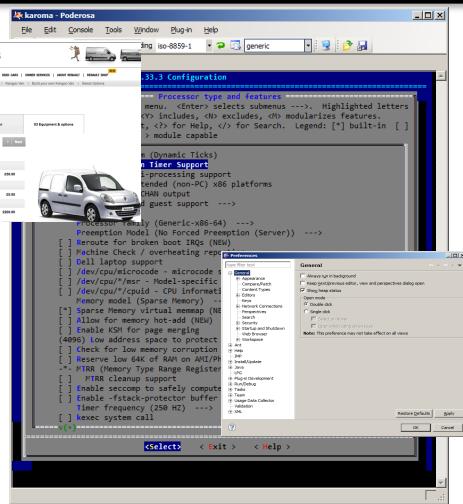


# Why?

**Problem: collecting videos is a key economic problem.**

**Solution: hundreds of video sequences with different characteristics.**





## Feature Model

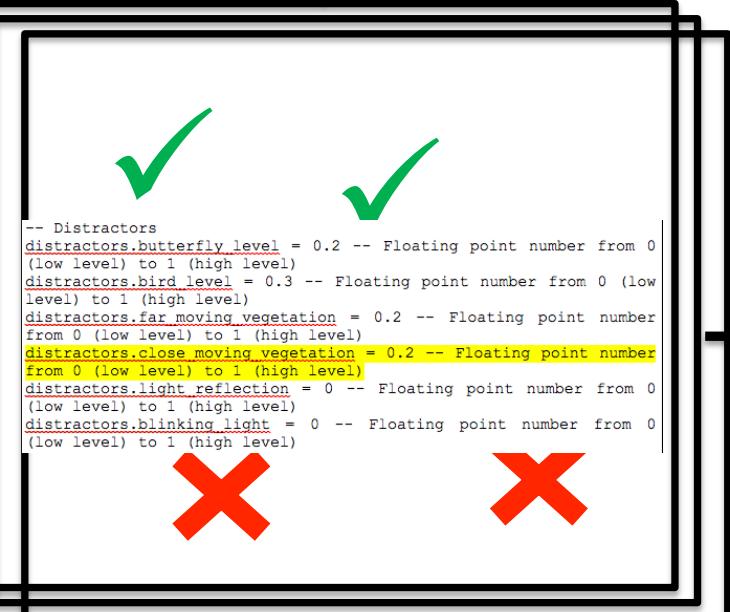
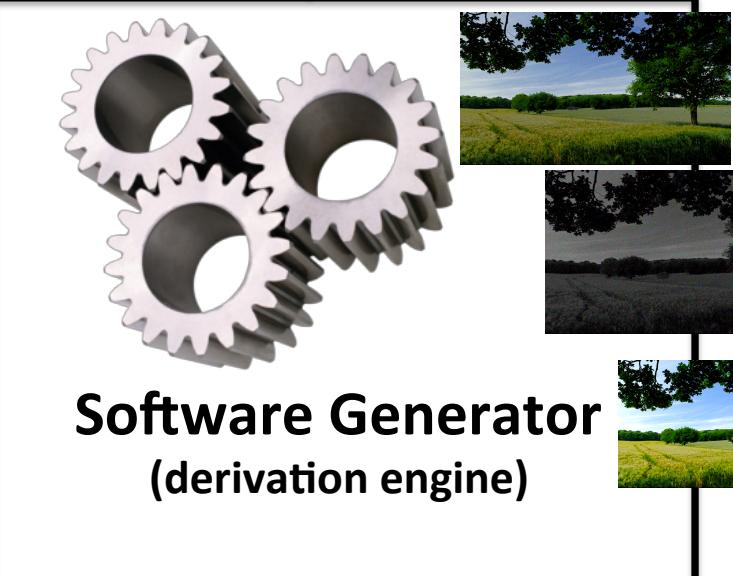
mapping

```

print("->Step9")
if(CFG.distractors.close_moving_vegetation~=0) then
    windvect5, precwindvect5, newwindvect5 =
    generate_wind_vector_field2(workwidth, workheight, 256, 1, 1, 35, picnum,
    precwindvect5, newwindvect5)
    windvectmul =
    windvect5:mul(24*CFG.distractors.close_moving_vegetation)
    globalvect = compose_vect(masque_feuilles_sombres, windvectmul, globalvect)
    hfvx, hfvy =
    windvect5:mul(6*CFG.distractors.close_moving_vegetation):to_matrix()
    hfvx = MATRIX.multerm(hfvx, invdepthmat)
    hfvy = MATRIX.multerm(hfvy, invdepthmat)
    lfvect = windvect2:resize_bilinear(windvect2.Width, windvect2.Height/16)
    lfvect = lfvect:resize_bilinear(windvect2.Width, windvect2.Height)
    lfvx, lfvy = lfvect:mul(
12*CFG.distractors.close_moving_vegetation):to_matrix()
    lfvx = MATRIX.multerm(lfvx, depthmat)
    lfvy = MATRIX.multerm(lfyv, depthmat*0.1)
    windvectcomp = VECT2D.new_from_matrices(MATRIX.addterm(lfvx, hfvx),
    MATRIX.addterm(lfvx, hfvy))
    globalvect = compose_vect(masque_ble, windvectcomp, globalvect)
    globalvect = compose_vect(masque_orge, windvectcomp, globalvect)
    globalvect = compose_vect(masque_ble_fond, windvectcomp, globalvect)
end

print("->Step10")

```



## Old Approach



Developers

*modify  
 $N$  times*

$N$  Configuration Files



Video Sequences Generator

*generates*

$N$  Video  
Sequences



## VM Approach

Developers and  
Domain Experts



*generates*



VM interpreter, and  
configuration files  
customizer

*model  
1 time*

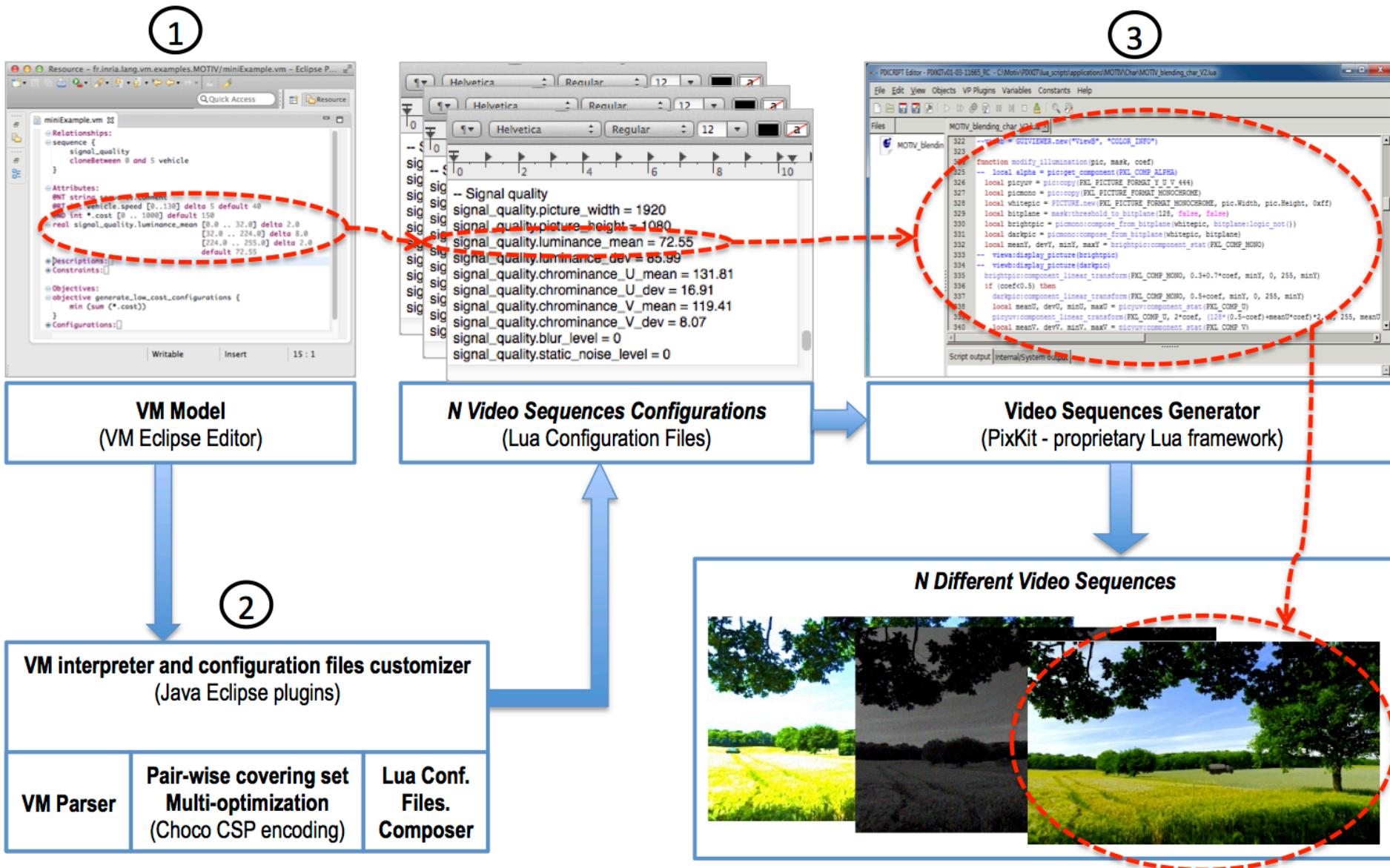


VM model

Artifact(s)



Processing  
tool(s)



# (configuration file)

```
-- Distractors
distractors.butterfly_level = 0.2 -- Floating point number from 0
(low level) to 1 (high level)
distractors.bird_level = 0.3 -- Floating point number from 0 (low
level) to 1 (high level)
distractors.far_moving_vegetation = 0.2 -- Floating point number
from 0 (low level) to 1 (high level)
distractors.close_moving_vegetation = 0.2 -- Floating point number
from 0 (low level) to 1 (high level)
distractors.light_reflection = 0 -- Floating point number from 0
(low level) to 1 (high level)
distractors.blinking_light = 0 -- Floating point number from 0
(low level) to 1 (high level)
```

---

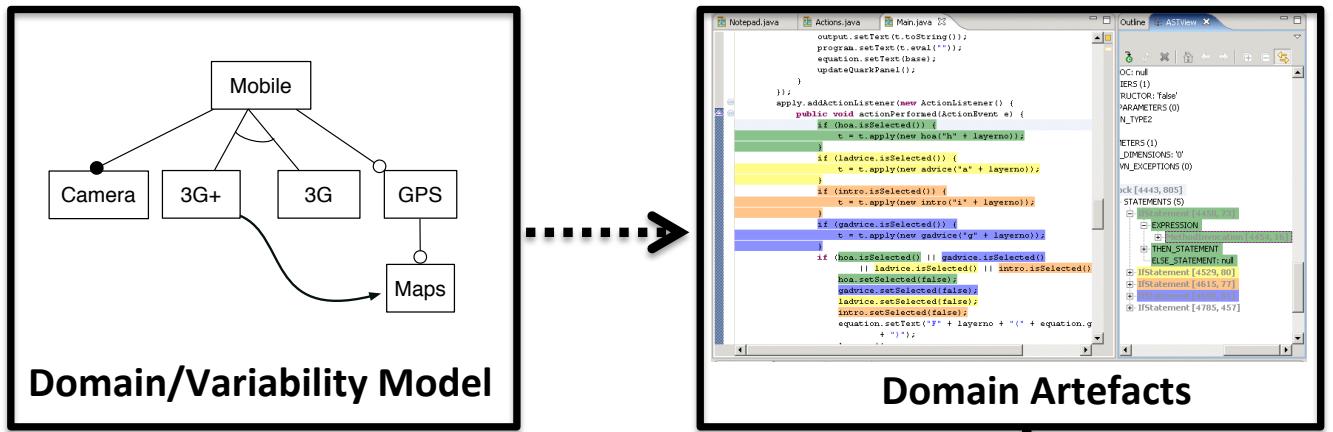
```
print(">Step9")
if (CFG.distractors.close_moving_vegetation~=0) then
    windvect5, precwindvect5, newwindvect5 =
generate_wind_vector_field2(workwidth, workheight, 256, 1, 1, 35, picnum,
precwindvect5, newwindvect5)
    windvectmul =
windvect5:mul(24*CFG.distractors.close_moving_vegetation)
    globalvect = compose_vect(masque_feuilles_sombres, windvectmul, globalvect
hfvx, hfvy =
windvect0:mul(6*CFG.distractors.close_moving_vegetation):to_matrix()
    hfvx = MATRIX.multerm(hfvx, invdepthmat)
    hfvy = MATRIX.multerm(hfvy, invdepthmat)
    lfvect = windvect2:resize_bilinear(windvect2.Width, windvect2.Height/16)
    lfvect = lfvect:resize_bilinear(windvect2.Width, windvect2.Height)
    lfvx, lfvy = lfvect:mul(
12*CFG.distractors.close_moving_vegetation):to_matrix()
    lfvx = MATRIX.multerm(lfvx, depthmat)
    lfvy = MATRIX.multerm(lfvy, depthmat*0.1)
    windvectcomp = VECT2D.new_from_matrices(MATRIX.addterm(lfvx, hfvx),
MATRIX.addterm(lfvy, hfvy))
    globalvect = compose_vect(masque_ble, windvectcomp, globalvect)
    globalvect = compose_vect(masque_orge, windvectcomp, globalvect)
    globalvect = compose_vect(masque_ble_fond, windvectcomp, globalvect)
end
print(">Step10")
```

---

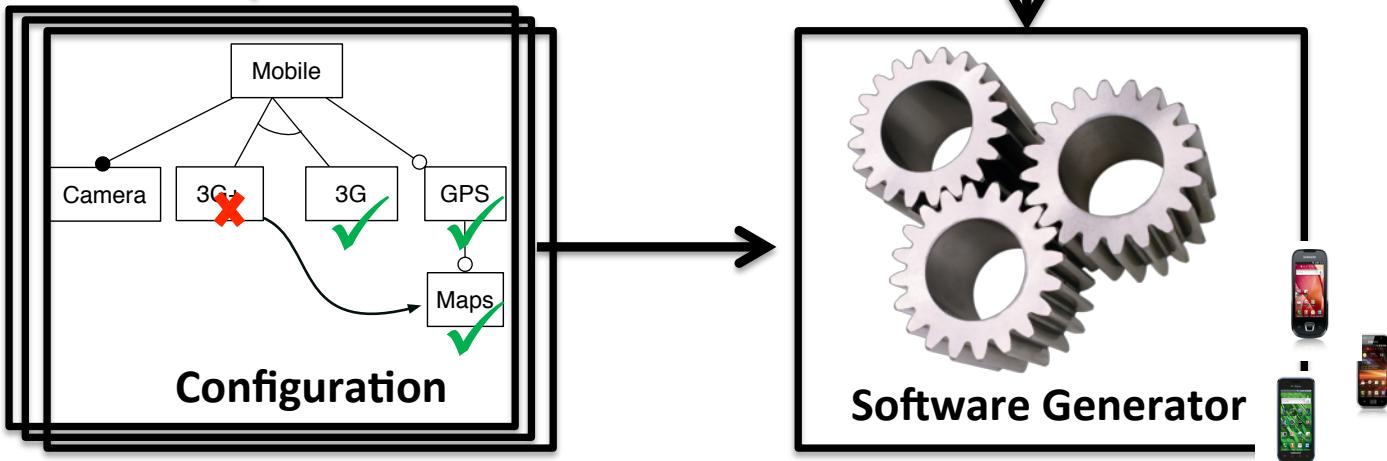
(Lua code)

# Modeling Variability

# Domain Engineering

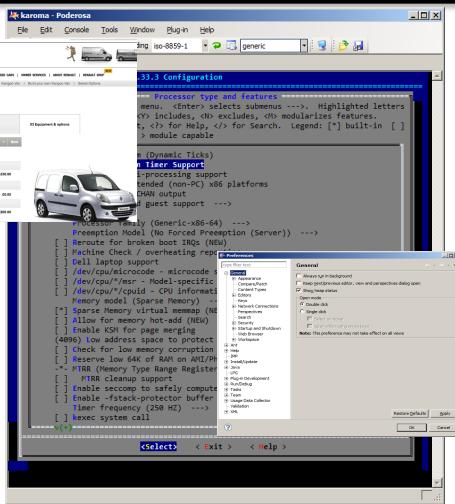


# Application Engineering



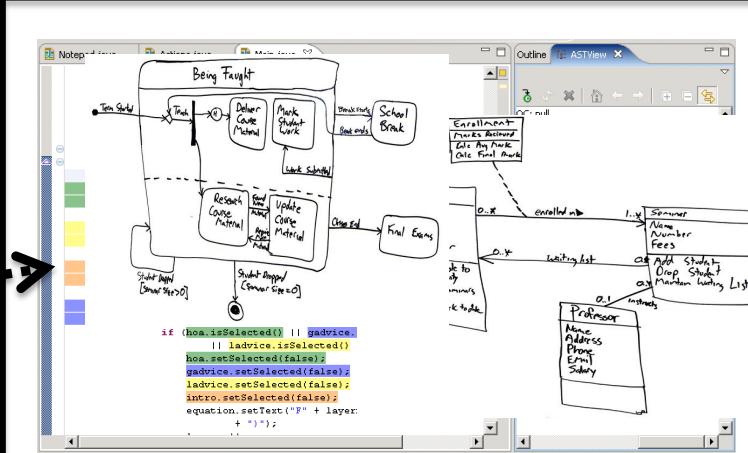
« the investments required to develop the reusable artifacts during **domain engineering**, are outweighed by the benefits of deriving the individual products during **application engineering** »

Jan Bosch et al. (2004)



Feature Model

## Variability Realization Model (VRM)



Base Artefacts (e.g.,  
models)

✓ ✓  
Configuration  
(resolution model)



Software Generator  
(derivation engine)



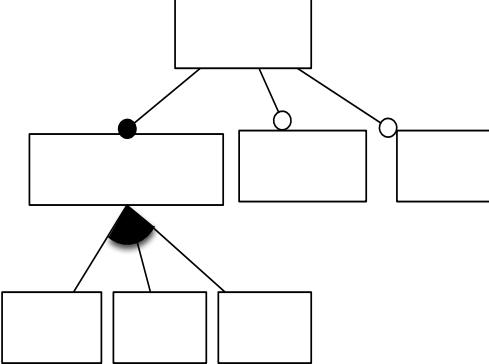
A photograph of an old, rusted green pickup truck. The truck is heavily damaged, with its front end crushed and the driver's side door missing. It is situated in a field of tall, dry grass and weeds, with a dense thicket of bushes in the background.

Unused flexibility



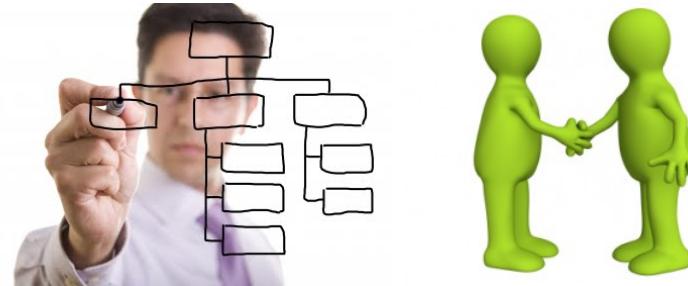
Illegal variant

# Feature Model



not, and, or, implies

## Communicative



## Analytic

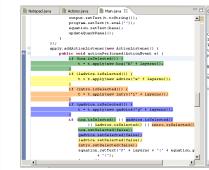


## Generative



# Feature Models

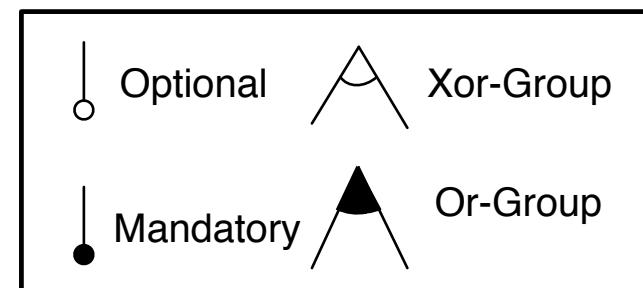
(defacto standard for modeling variability)

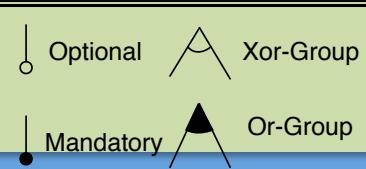
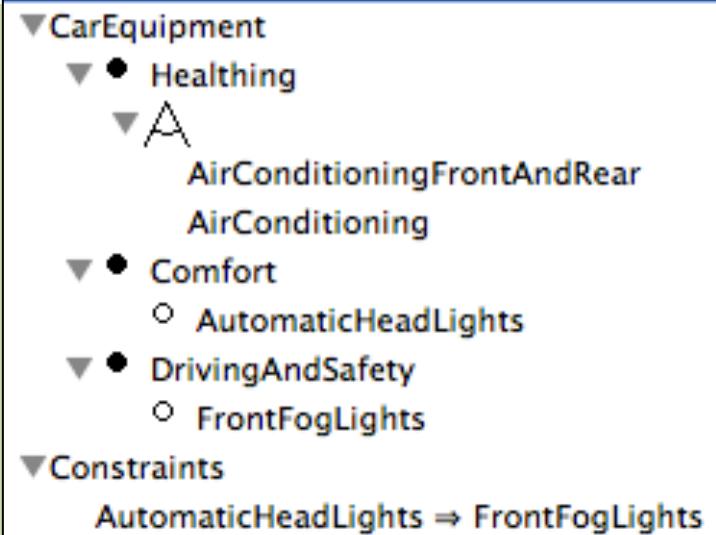
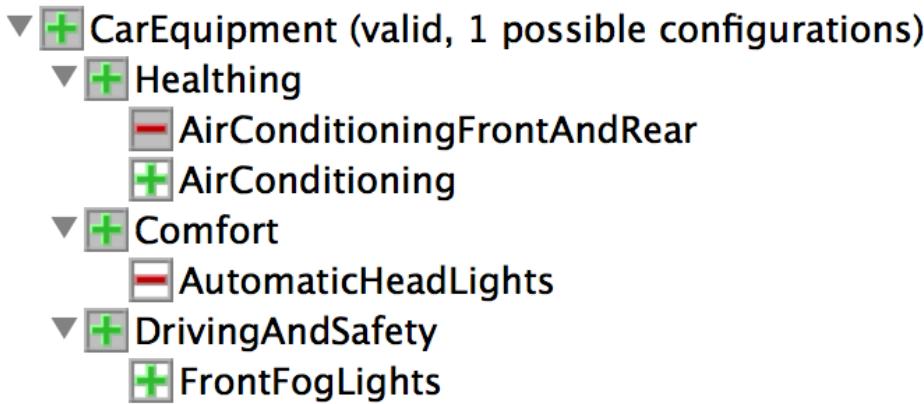


**Hierarchy:** rooted tree

**Variability:**

- mandatory,
- optional,
- Groups: exclusive or inclusive features
- Cross-tree constraints





# Hierarchy + Variability

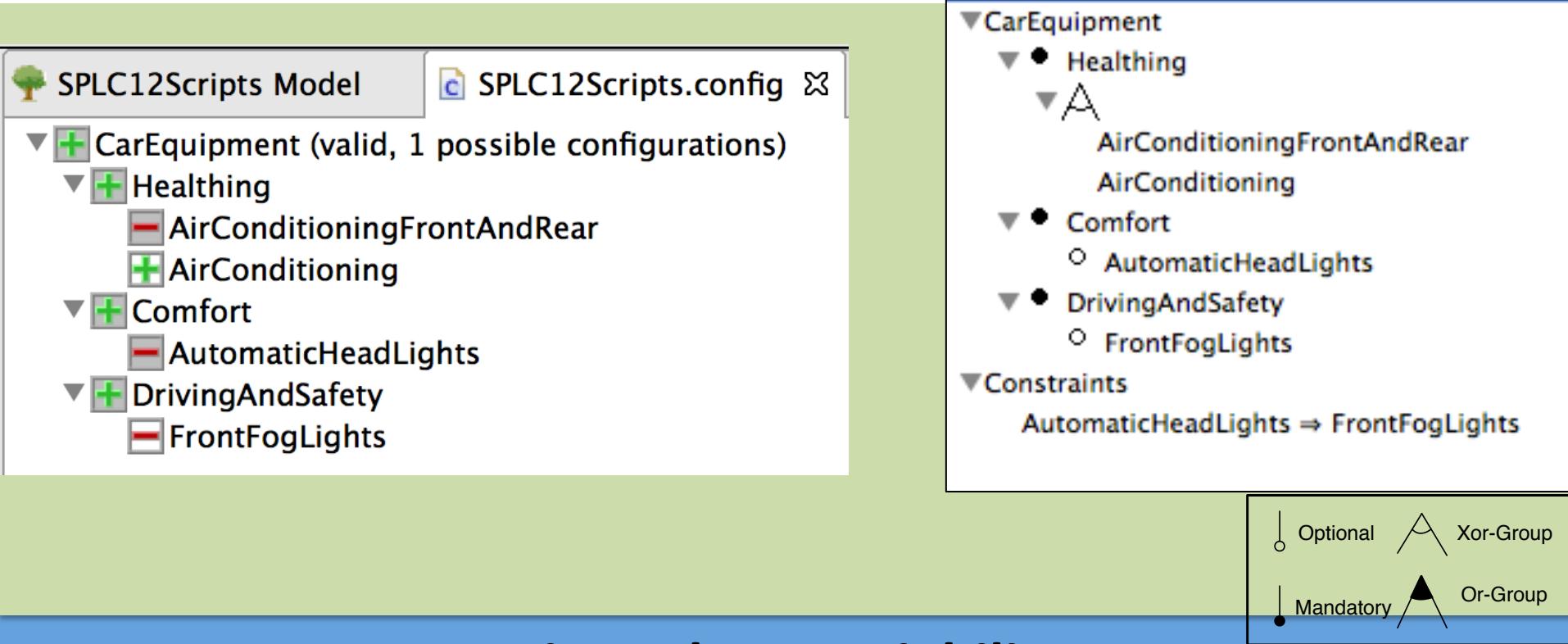
=

## set of valid configurations

**configuration = set of features selected**

{CarEquipment, Comfort, DrivingAndSafety, Healthing, AirConditioning, FrontFogLights}





## Hierarchy + Variability

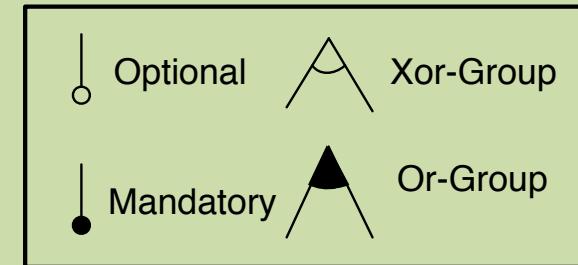
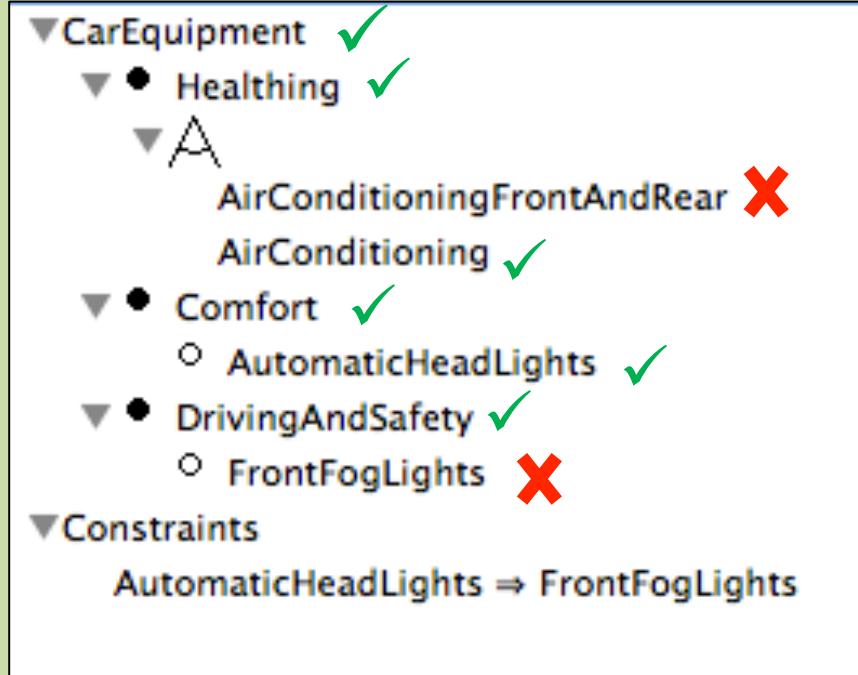
=

## set of valid configurations

**configuration = set of features selected**

{CarEquipment, Comfort, DrivingAndSafety, Healthing, AirConditioning}





## Hierarchy + Variability

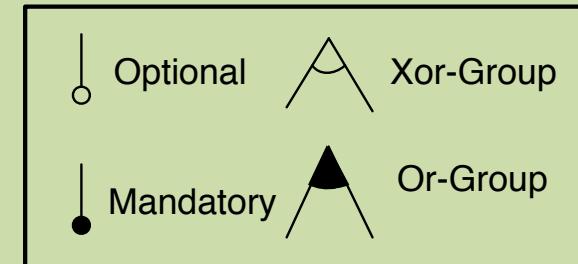
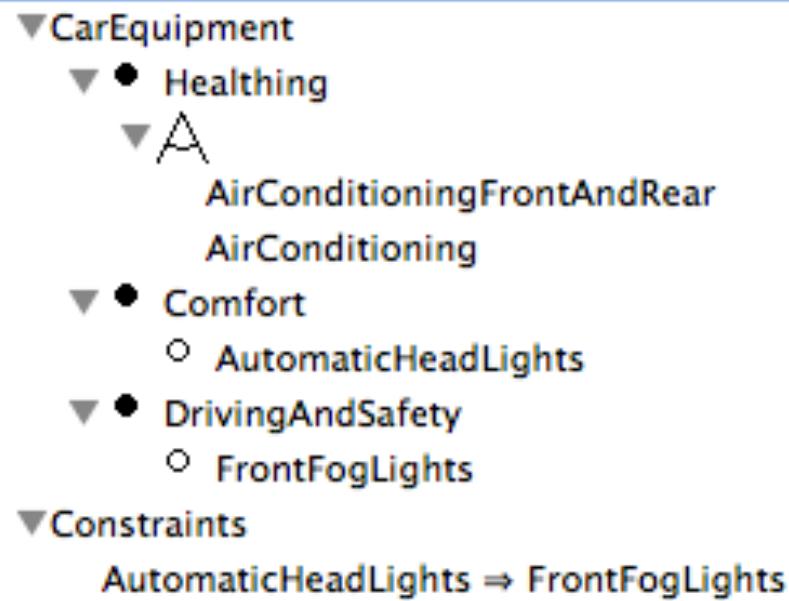
=

## set of valid configurations

configuration = set of features selected

{CarEquipment, Comfort, DrivingAndSafety, Healthing, AirConditioning, AutomaticHeadLights}





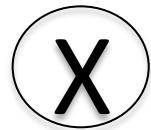
## Hierarchy + Variability

=

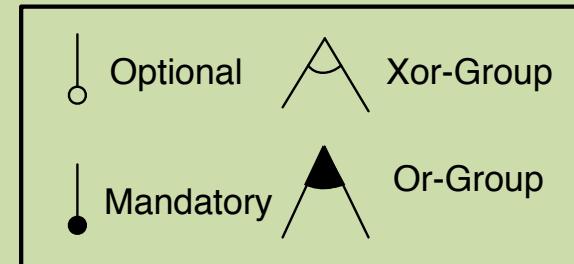
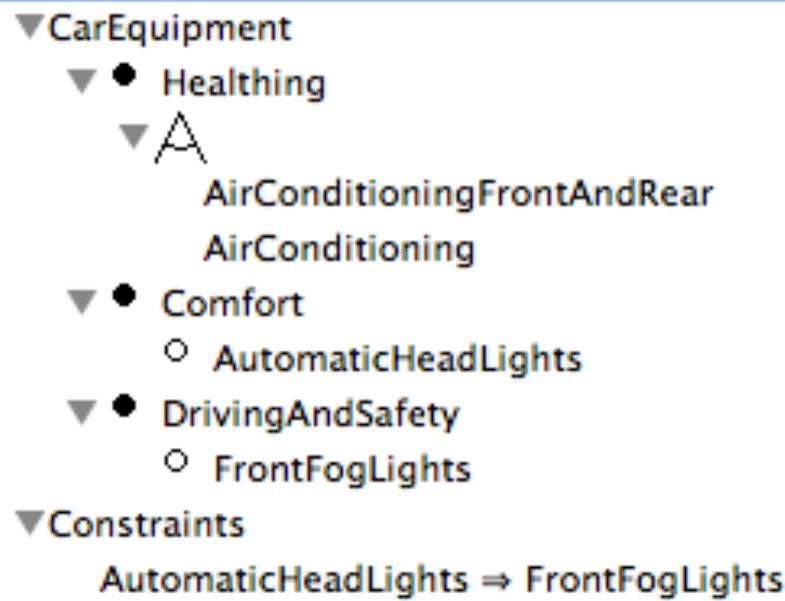
## set of valid configurations



{CarEquipment, Comfort,  
DrivingAndSafety,  
Healthing}



- {AirConditioning, FrontFogLights}
- {AutomaticHeadLights, AirConditioning, FrontFogLights}
- {AutomaticHeadLights, FrontFogLights, AirConditioningFrontAndRear}
- {AirConditioningFrontAndRear}
- {AirConditioning}
- {AirConditioningFrontAndRear, FrontFogLights}



## Hierarchy + Variability

=

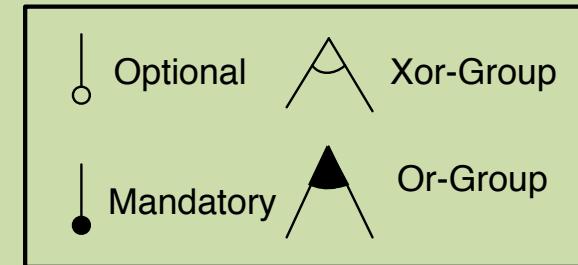
## set of valid configurations

Configuration set (from a basic feature model of car)

	CarEquipment	Comfort	DrivingAndSafety	Healting	AirConditioning	FrontFogLights	AutomaticHeadLights	AirConditioningFrontAndRear
Car2	yes	yes	yes	yes	yes	yes	yes	no
Car6	yes	yes	yes	yes	no	yes	no	yes
Car1	yes	yes	yes	yes	yes	yes	no	no
Car4	yes	yes	yes	yes	no	no	no	yes
Car5	yes	yes	yes	yes	yes	no	no	no
Car3	yes	yes	yes	yes	no	yes	yes	yes



ar}



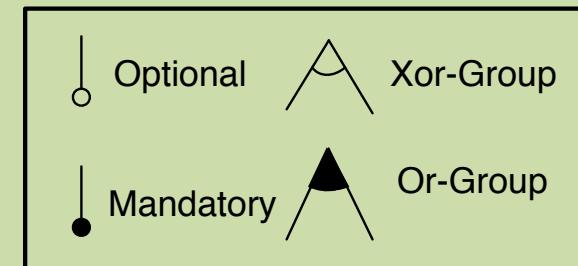
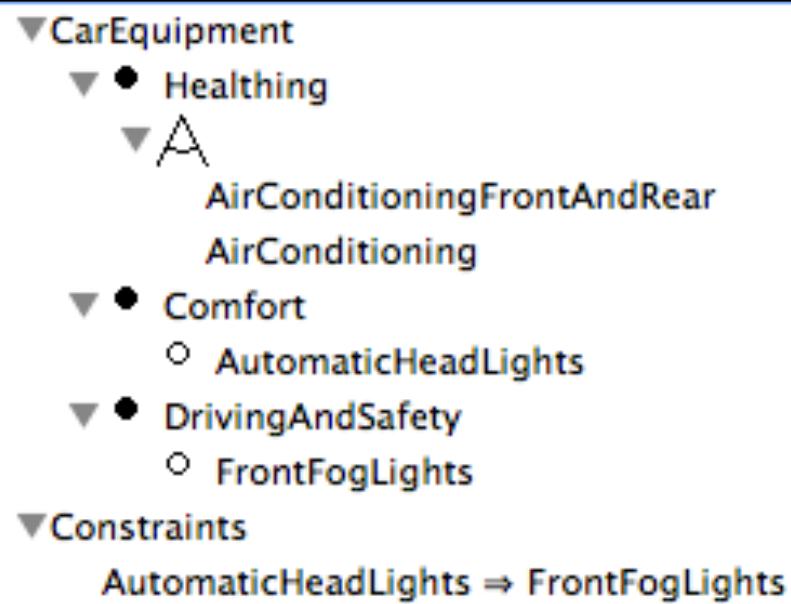
# Hierarchy + Variability

=

# set of valid configurations



Product ▲ ▼	CarEquipment ▼	Comfort ▼	DrivingAndSafety ▼	Healthing ▼	AirConditioning ▼	FrontFogLights ▼	AutomaticHeadLights ▼	AirConditioningFrontAndRear ▼
	Find	Yes <input type="checkbox"/> No <input type="checkbox"/>						
Car1	yes	yes	yes	yes	yes	yes	no	no
Car2	yes	yes	yes	yes	yes	yes	yes	no
Car3	yes	yes	yes	yes	no	yes	yes	yes
Car4	yes	yes	yes	yes	no	no	no	yes
Car5	yes	yes	yes	yes	yes	no	no	no
Car6	yes	yes	yes	yes	no	yes	no	yes



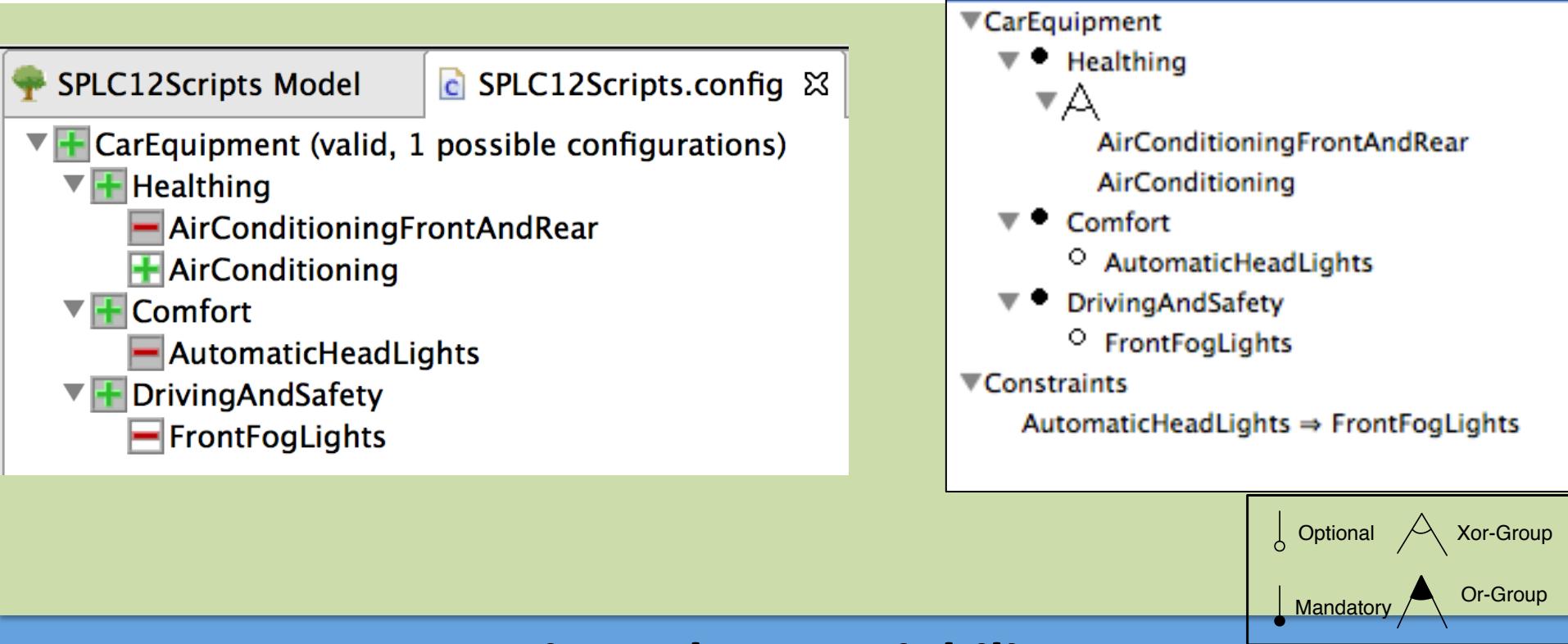
## Hierarchy + Variability

=

## set of valid configurations



Product ▾	Find												
		AirConditioning	FrontFogLights	AutomaticHeadLights	AirConditioningFrontAndRear								
		Yes <input type="checkbox"/>	No <input type="checkbox"/>										
Car1				yes	yes	no				no			
Car2				yes	yes	yes				no			
Car3				no	yes	yes				yes			
Car4				no	no	no				yes			
Car5				yes	no	no				no			
Car6				no	yes	no				yes			



## Hierarchy + Variability

=

## set of valid configurations

**configuration = set of features selected**

{CarEquipment, Comfort, DrivingAndSafety, Healthing, AirConditioning}

Product ▾	▼	▼	▼	▼	▼	AirConditioning	▼	FrontFogLights	▼	AutomaticHeadLights	▼	AirConditioningFrontAndRear	▼
Find						Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>		Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>		Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>		Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>	
Car5						yes		no		no		no	

# FAMILIAR

(FeAture Model script Language for manipulation and Automatic Reasoning)

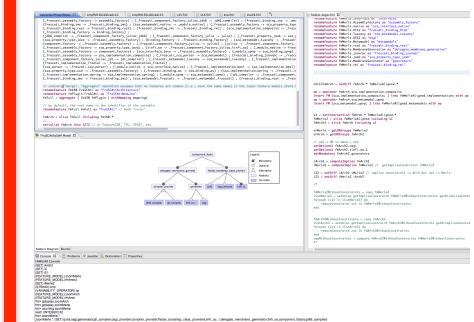
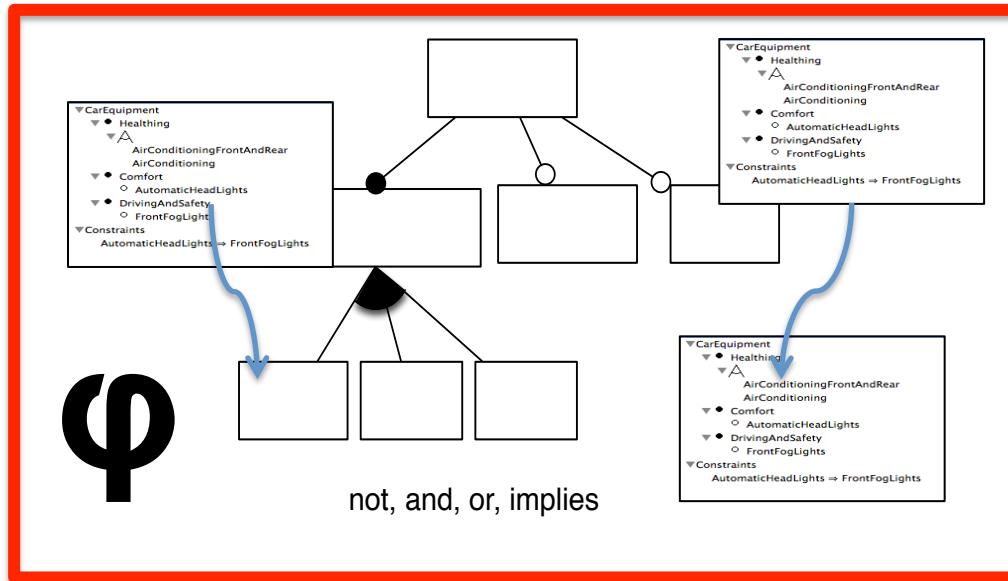
<http://familiar-project.github.com/>



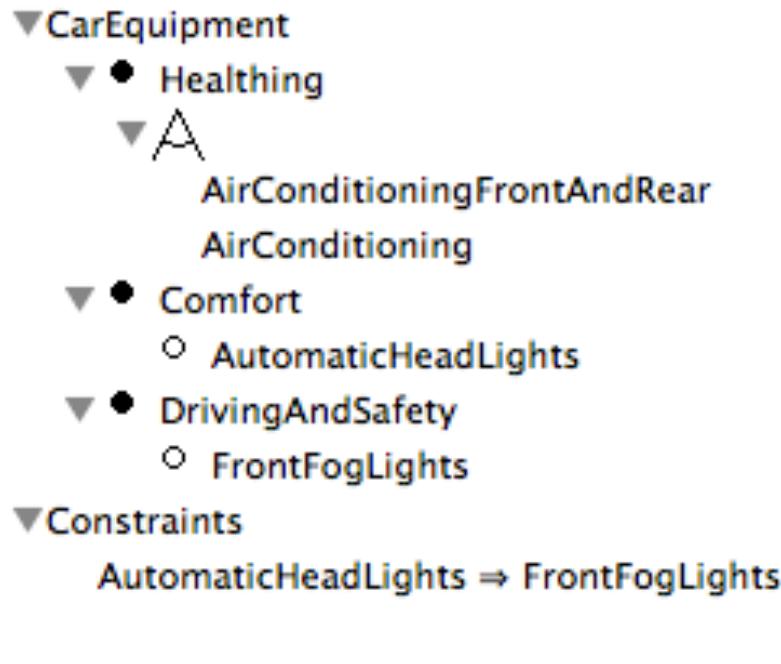
S.P.L.O.T.  
Software Product Lines Online Tools



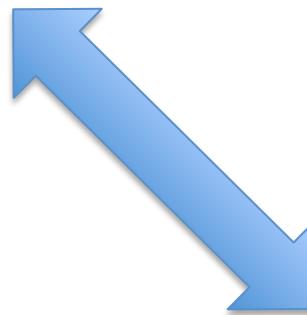
TVL  
DIMACS



importing, exporting, composing, decomposing, editing, configuring,  
reverse engineering, computing "diffs", refactoring, testing,  
and reasoning about (multiple) variability models



(Boolean)  
Feature Models

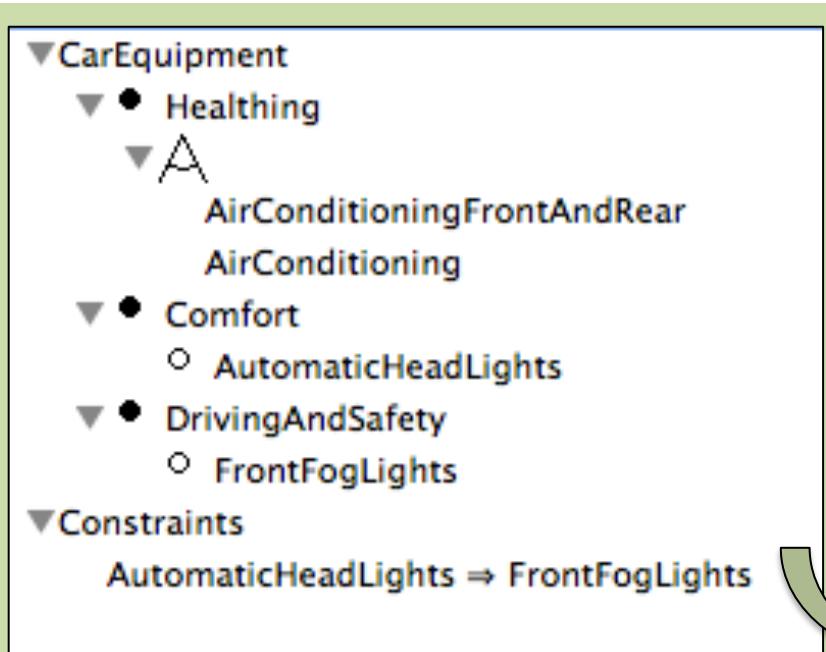
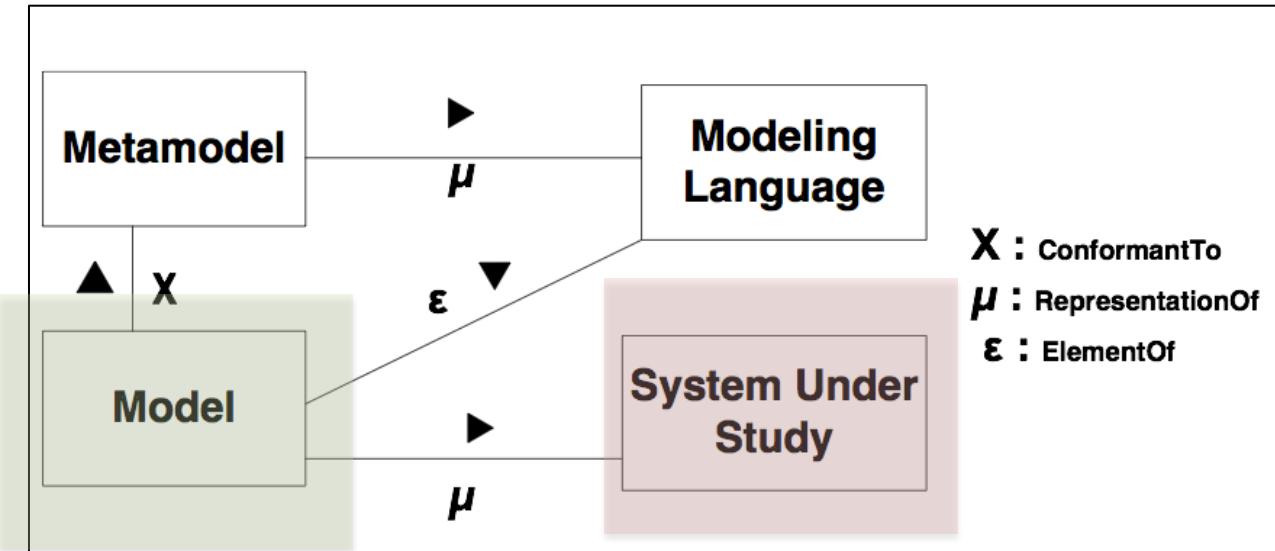


(Boolean)  
Formula  $\varphi$

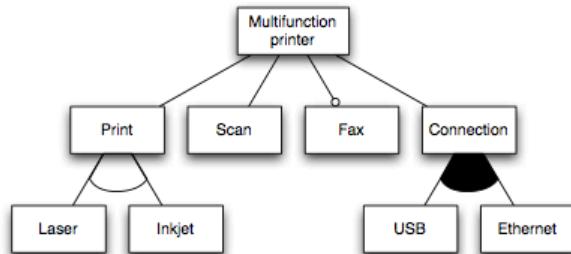
Product ▾	CarEquipment	Comfort	DrivingAndSafety	Healthing	AirConditioning	FrontFogLights	AutomaticHeadLights	AirConditioningFrontAndRear
Find	Yes <input type="checkbox"/> No <input type="checkbox"/>							
Car1	yes	yes	yes	yes	yes	yes	no	no
Car2	yes	no						
Car3	yes	yes	yes	yes	no	yes	yes	yes
Car4	yes	yes	yes	yes	no	no	no	yes
Car5	yes	yes	yes	yes	yes	no	no	no
Car6	yes	yes	yes	yes	no	yes	no	yes

(Boolean)  
Product Comparison Matrix

# Feature Models



# Typical implementations



Font: Arial Bold - Free Photoshop PSD file download - www.freepik.com



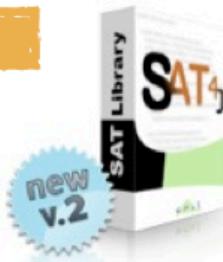
result



logics



solvers



Z3

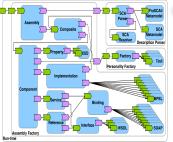
Practice (see  
lab instructions)

# Reverse Engineering Variability

# Reverse Engineering

Compose/Decompose  
Configure  
Analyse  
Generate

Component Models



Dependencies Files



Source Code



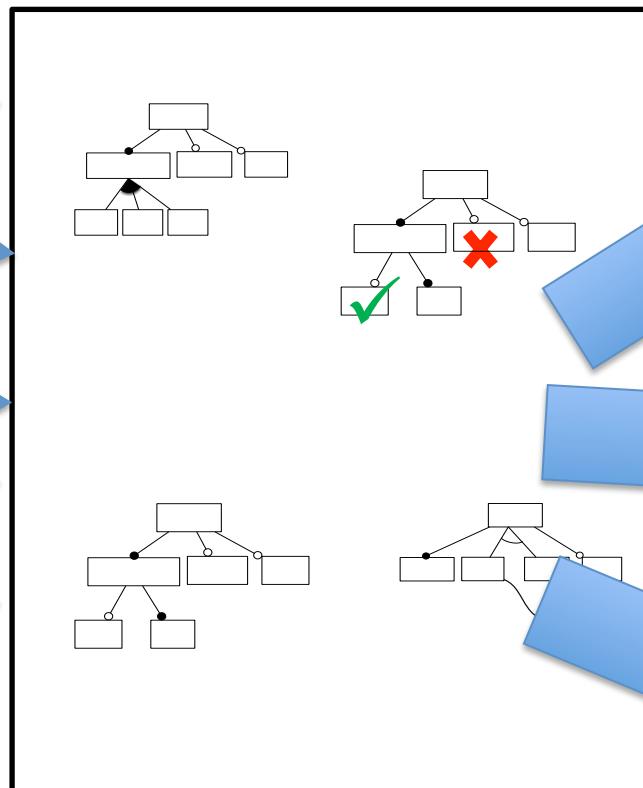
Product descriptions



Regulatory Requirements



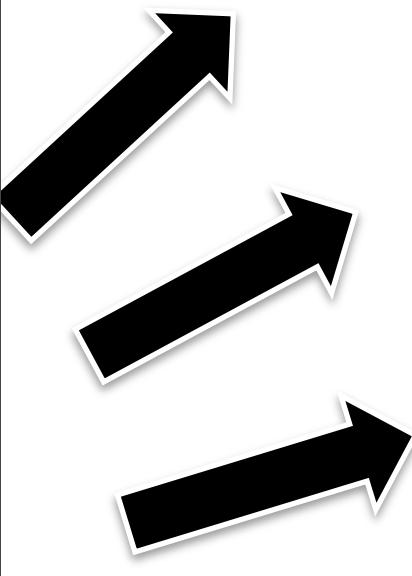
Web Configurators



FAMiliAR

```
1 karmad 2 karmas Encoding: iso-8859-1 generic .config - Linux Kernel v2.6.33.3 Configuration Processor type and features Arrow keys navigate the menu. <Enter> selects submenus -->. Highlighted letters are hotkeys. Pressing <> includes, <> excludes, <M> modularizes features. Press <Esc><Esc> to exit, <?> for Help, </> for Search. Legend: [*] built-in [ ] excluded [<> module] < > module capable [ ] Tickless System (Dynamic Ticks) [*] High Resolution Timer Support [ ] Support for extended (non-PC) x86 platforms [ ] Single-depth ICHAN output [ ] Paravirtualized guest support ... [ ] Memtest [ ] Processor family (Generic-x86-64) --- [ ] Preemption Model (No Forced Preemption (Server)) --- [ ] Renote for broken boot IRQs (NEW) [ ] Machine Check / overheating reporting [ ] Dell laptop support [ ] /dev/cpu/microcode - microcode support [ ] /dev/cpu/*msr - Model-specific register support [ ] /dev/cpu/*cpuid - CPU information support [ ] Sparse Memory virtual memmap (NEW) [ ] Allow for memory hot-add (NEW) [ ] Enable KSM for page merging (4096) low address space to protect from user allocation [ ] Check for low memory corruption [ ] Reserve low 64M of RAM on AMI/Phoenix BIOSen [ ] MTRR (Memory Type Range Register) support [ ] MTRR cleanup support [ ] Enable seccomp to safely compute untrusted bytecode [ ] Enable -fstack-protector buffer overflow detection (EXPERIMENTAL) [ ] Timer frequency (250 Hz) --- [ ] kexec system call v(<) <Select> < Exit > < Help >
```

# Linux Kernel



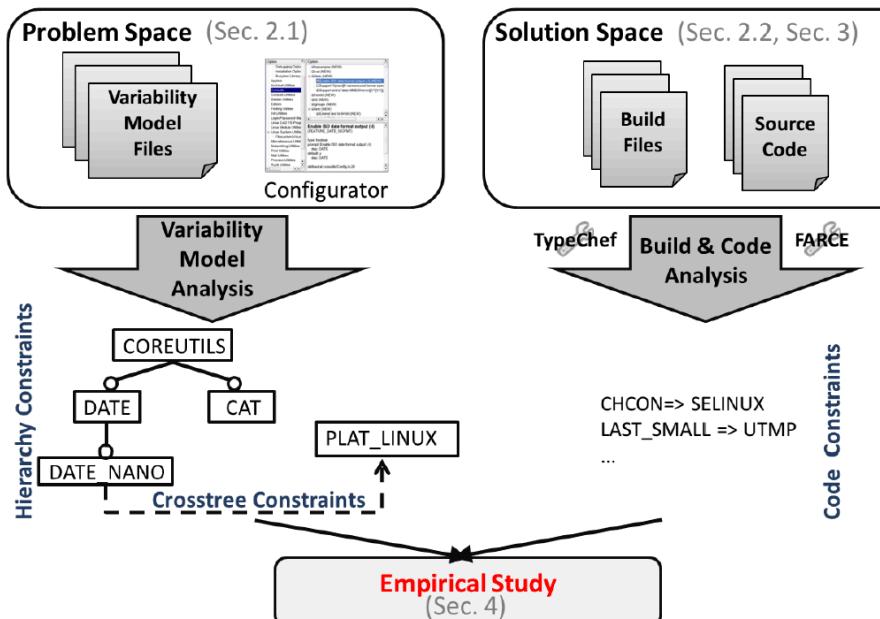
# Mining Configuration Constraints: Static Analyses and Empirical Results

Sarah Nadi  
University of Waterloo,  
Canada

Thorsten Berger  
IT University of  
Copenhagen, Denmark

Christian Kästner  
Carnegie Mellon  
University, USA

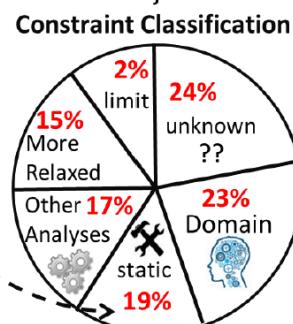
Krzysztof Czarnecki  
University of Waterloo,  
Canada



Obj. 1  
**Accuracy & Scalability**  
Spec. 1: **93%** accurate  
Spec. 2: **77%** accurate

Obj. 2  
**Recoverability**

**19 %**



```

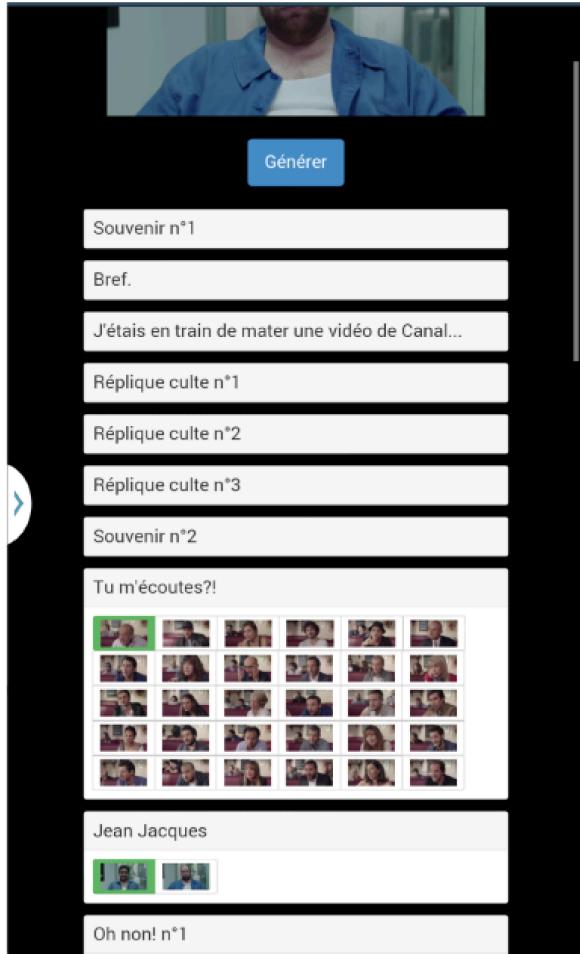
1 #ifndef Y
2 void foo() { ... }
3 #endif
4
5 #ifdef X
6 void bar() { foo(); }
7 #endif

```

```

1 #if defined(Z)&&defined(X)
2 ...
3 #ifdef W
4 ...
5 #endif
6 ...
7 #endif

```



```
"sq": ["dwlcjv", "1y60t3z", "1lyfhk", "wqzv0y",
"1xxivi2", "1oxnvtu", "lolbe9", "wvo06o",
"1u6y5t2", "1eqb8bw", "1j9aij7", "nr7jom",
"1jmvi1y", "1qgn9dh", "1bv7rka", "19ykyyw",
"5znrg7", "116hv1k"]
```

← → C bref30cdn.wildmoka.com/vidv2/116hv1k\_med.txt

```
#EXTINF:06.40,
http://bref30cdn.wildmoka.com/vidv2/116hv1k_med0.ts
#EXTINF:03.96,
http://bref30cdn.wildmoka.com/vidv2/116hv1k_med1.ts
#EXTINF:04.52,
http://bref30cdn.wildmoka.com/vidv2/116hv1k_med2.ts
#EXTINF:03.08,
http://bref30cdn.wildmoka.com/vidv2/116hv1k_med3.ts
```

.DS\_Store  
blank.ts  
jg0meq\_med0.ts  
vp1  
vp2  
vp3  
vp4  
vp5  
vp6  
vp7  
vp8  
vp9  
vp10  
vp11  
vp12  
vp13  
vp14  
vp15  
vp16  
vp17  
vp18

1u6y5t2\_med0.ts  
1u6y5t2\_med1.ts  
1u6y5t2\_med2.ts  
1u6y5t2\_med3.ts  
p8ocev\_med0.ts  
p8ocev\_med1.ts  
p8ocev\_med2.ts

Figure 2: Re-engineering of the novel configurator (excerpt): users can now select a specific video for the 18 variation points identified during the reverse engineering of the original generator



# RENAULT VANS



CARS | VANS | ELECTRIC VEHICLES | RENAULT BUSINESS | USED CARS | OWNER SERVICES | ABOUT RENAULT | RENAULT SHOP **NEW**

Renault UK > Renault Vans > New Kangoo Van Range > Kangoo Van > Build your own Kangoo Van > Select Options

## NEW KANGOO VAN RANGE

01 Preferences

02 Version

03 Equipment & options

< Previous

Next >

### OPTIONS

#### > COMFORT

- |   |        |
|---|--------|
| <input checked="" type="checkbox"/> Central storage console & armrest between seats | £50.00 |
|---|--------|

#### > DRIVING

- |  |       |
|--|-------|
| <input type="checkbox"/> Electric door mirrors | £0.00 |
|--|-------|

#### > SAFETY & SECURITY

- |   |         |
|---|---------|
| <input checked="" type="checkbox"/> ESC (Electronic Stability Control) with traction and understeer control | £200.00 |
|---|---------|



“Reverse Engineering Web Configurators” Ebrahim Khalil Abbasi, Mathieu Acher, Patrick Heymans, and Anthony Cleve. In 17th European Conference on Software Maintenance and Reengineering (CSMR'14)

# Mining Features from the Object-Oriented Source Code of Software Variants by Combining Lexical and Structural Similarity

R. AL-msie'deen, A.-D. Seriai, M. Huchard

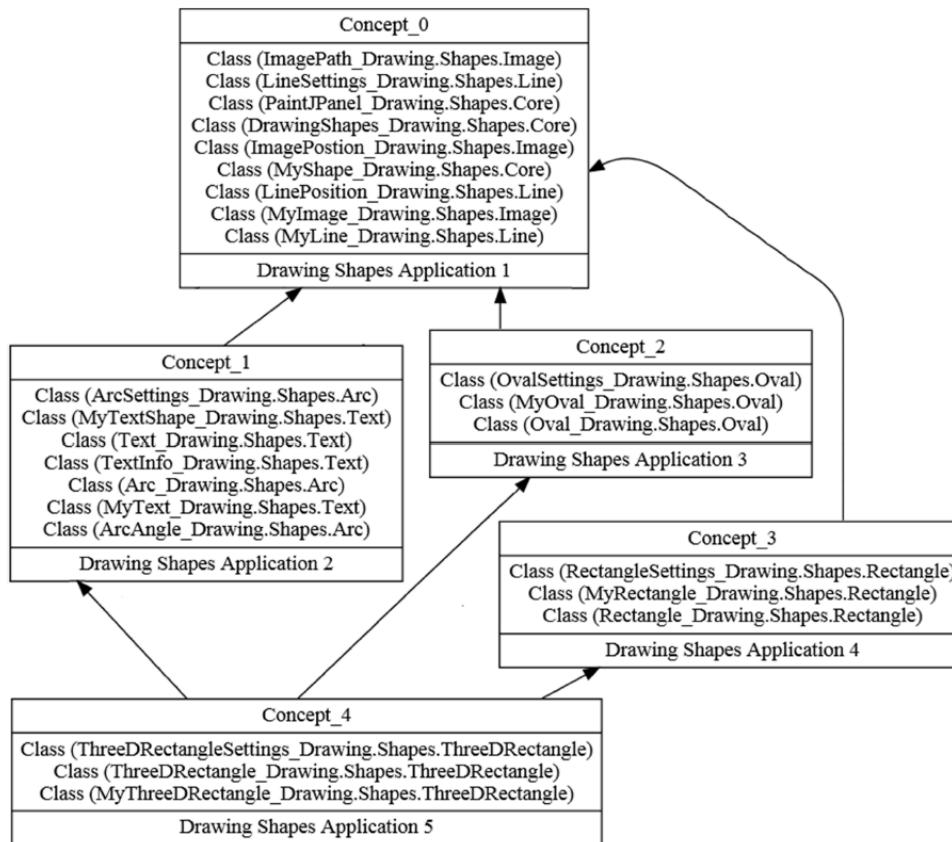
LIRMM / CNRS & Montpellier 2 University, Montpellier, France

Al-msiedee, Abdelhak.Seriai, huchard@lirmm.fr

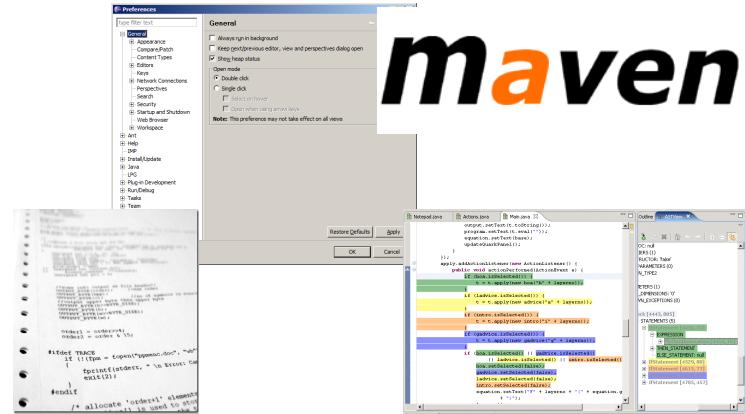
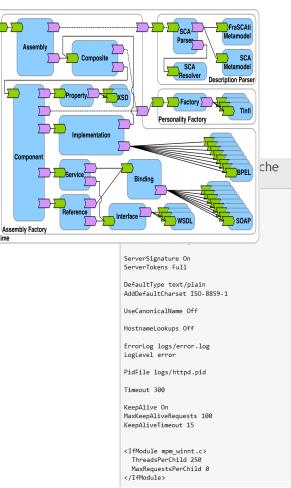
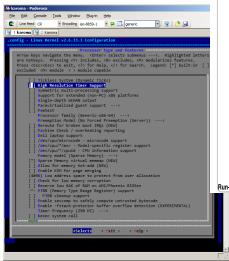
C. Urtado and S. Vauttier

LGI2P / Ecole des Mines d'Alès, Nîmes, France

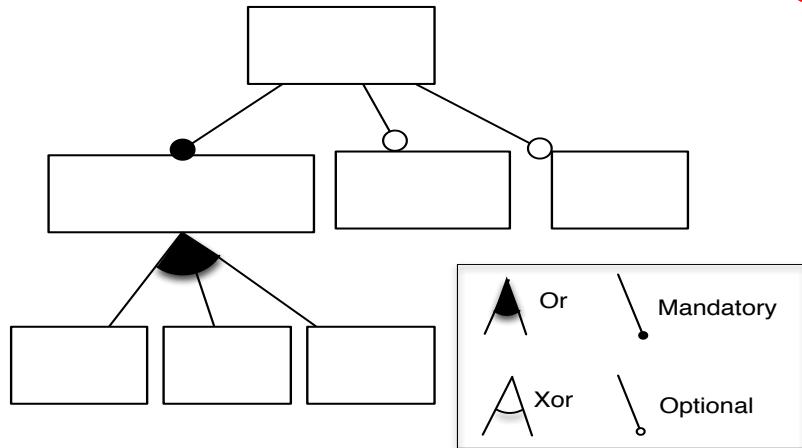
Christelle.Urtado, Sylvain.Vauttier@mines-ales.fr



	Class (ArcSettings_Drawing.Shapes.Arc)	Class (Arc_Drawing.Shapes.Arc)	Class (ArcAngle_Drawing.Shapes.Arc)	Class (MyTextShape_Drawing.Shapes.Text)	Class (Text_Drawing.Shapes.Text)	Class (TextInfo_Drawing.Shapes.Text)	Class (MyText_Drawing.Shapes.Text)
Class (ArcSettings_Drawing.Shapes.Arc)	×	×	×				
Class (Arc_Drawing.Shapes.Arc)	×	×	×				
Class (ArcAngle_Drawing.Shapes.Arc)	×	×	×				
Class (MyTextShape_Drawing.Shapes.Text)				×	×	×	×
Class (Text_Drawing.Shapes.Text)				×	×	×	×
Class (TextInfo_Drawing.Shapes.Text)				×	×	×	×
Class (MyText_Drawing.Shapes.Text)				×	×	×	×

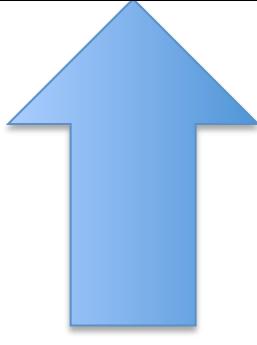
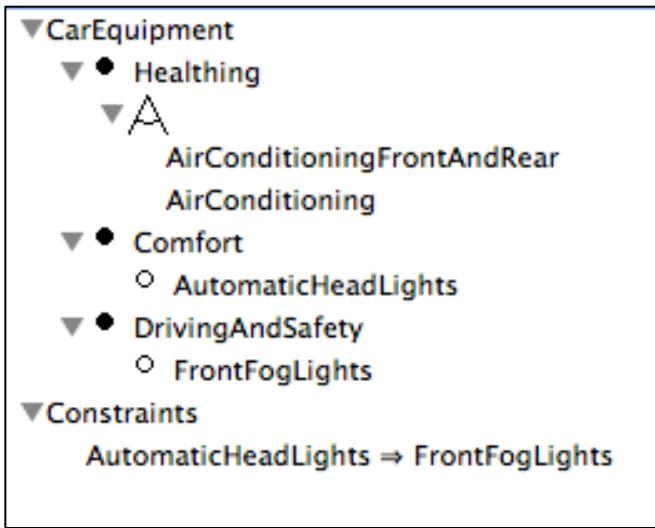


# Mining/Extracting Extracting/ Encoding/Formalizing Synthesising



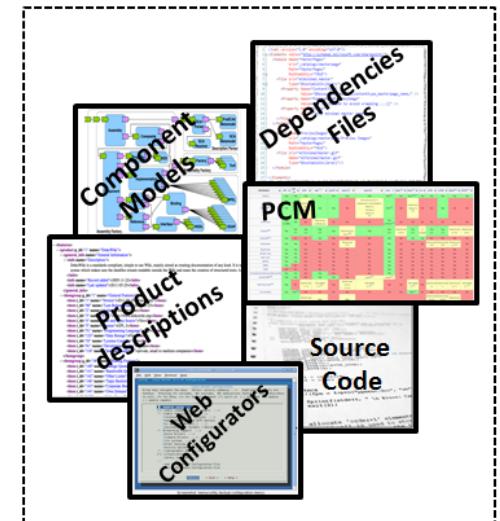
**Variability Models** (feature models)

**FAMILIAR**



$\varphi$

Product	CarEquipment	Comfort	DrivingAndSafety	Healthing	AirConditioning
Find	Yes <input type="checkbox"/> No <input type="checkbox"/>				
Car1	yes	yes	yes	yes	yes
Car2	yes	yes	yes	yes	yes
Car3	yes	yes	yes	yes	no
Car4	yes	yes	yes	yes	no
Car5	yes	yes	yes	yes	yes
Car6	yes	yes	yes	yes	no

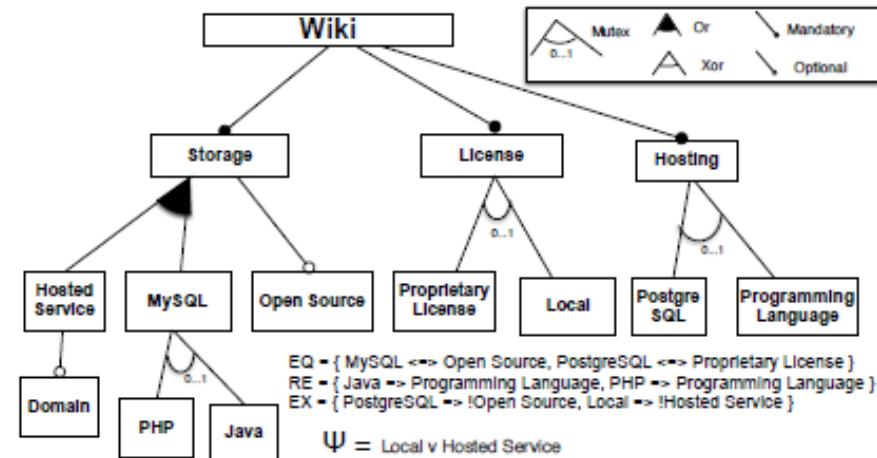
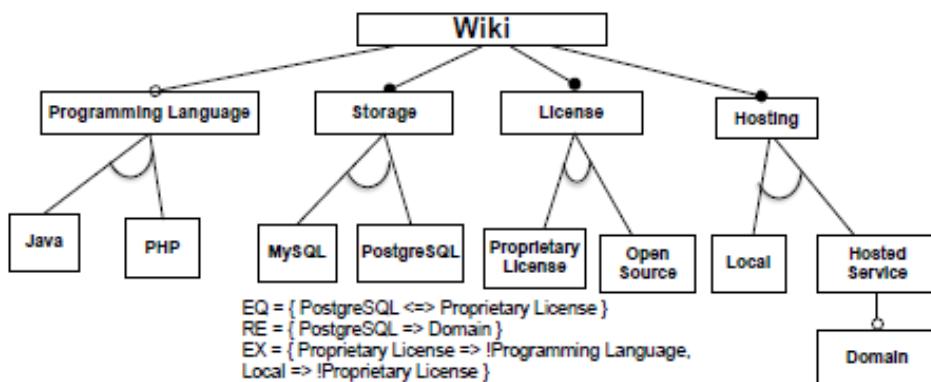
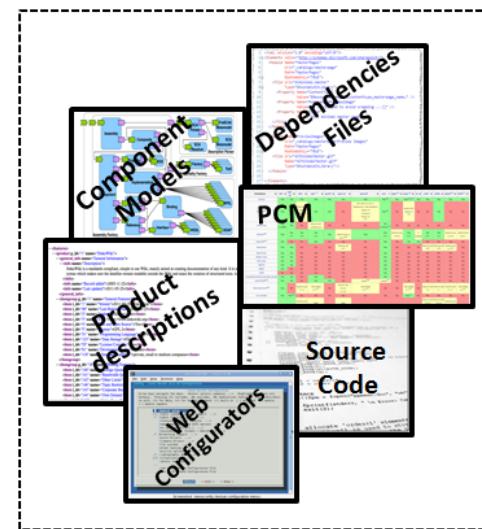


# For a given configuration set,

## many (maximal) feature diagrams

### with different ontological semantics

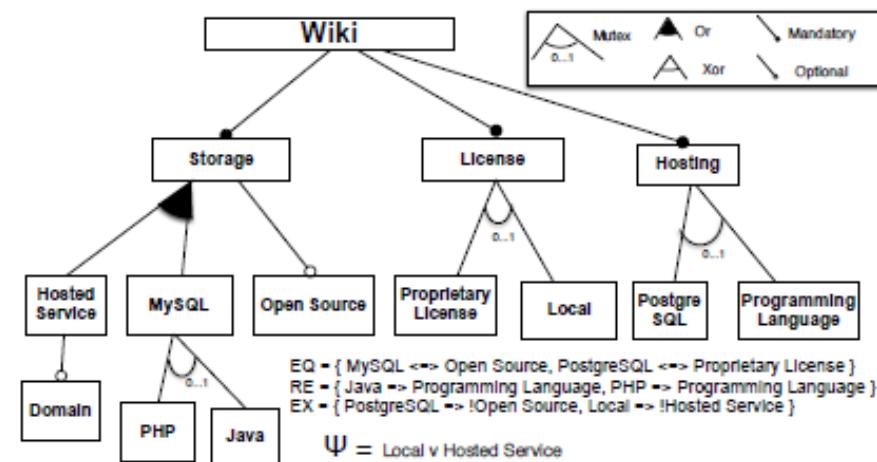
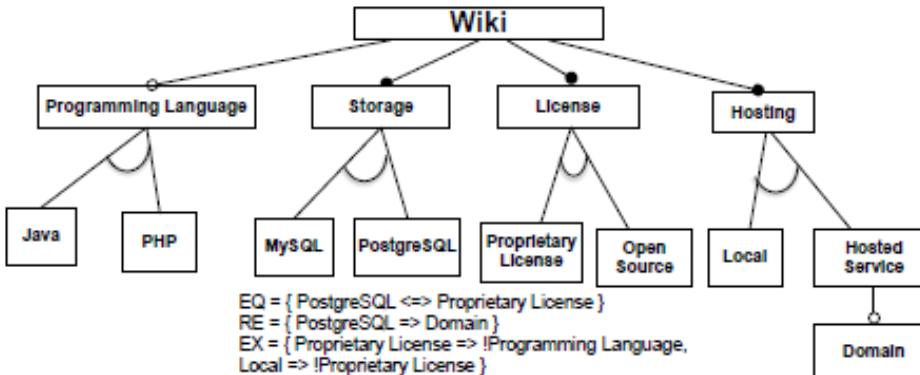
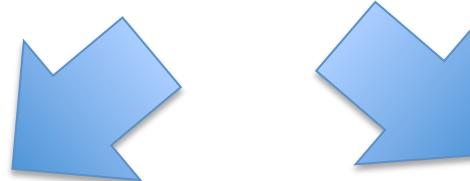
[She et al. ICSE'11, Andersen et al. SPLC'12, Acher et al. VaMoS'13]



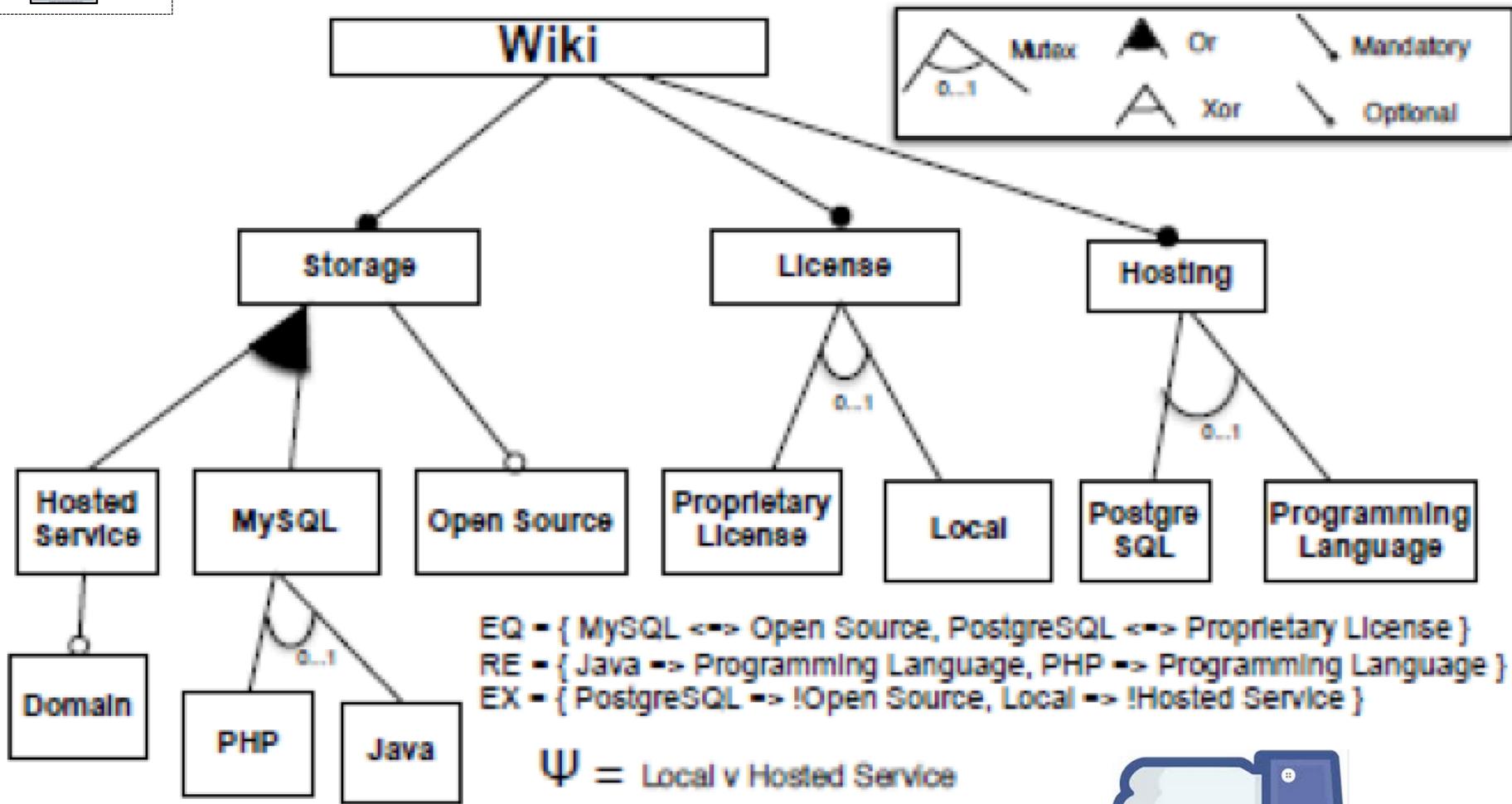
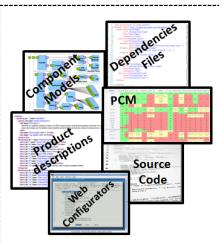
# For a given configuration set, many (maximal) feature diagrams with different ontological semantics [She et al. ICSE'11, Andersen et al. SPLC'12, Acher et al. VaMoS'13]

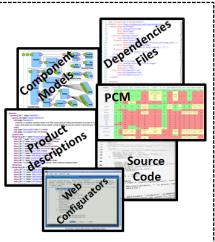
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
PostgreSQL	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗
MySQL	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓
License	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Domain	✓	✗	✗	✗	✗	✓	✗	✓	✓	✗
Proprietary License	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗
Local	✗	✗	✓	✗	✓	✗	✗	✗	✗	✓
Programming Language	✗	✓	✗	✗	✓	✓	✓	✓	✗	✓
Java	✗	✓	✗	✗	✗	✓	✗	✗	✗	✓
Storage	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PHP	✗	✗	✗	✗	✓	✗	✓	✓	✗	✗
Open Source	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓
Wiki	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hosting	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hosted Service	✓	✓	✗	✓	✗	✓	✓	✓	✓	✗

(a) Product comparison matrix (✓ feature is in the product ; ✗ feature is not in the product)



# Importance of ontological semantics (1)





# Importance of ontological semantics (2)

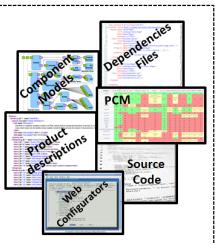
Wiki Wizard

## Choose your Wiki

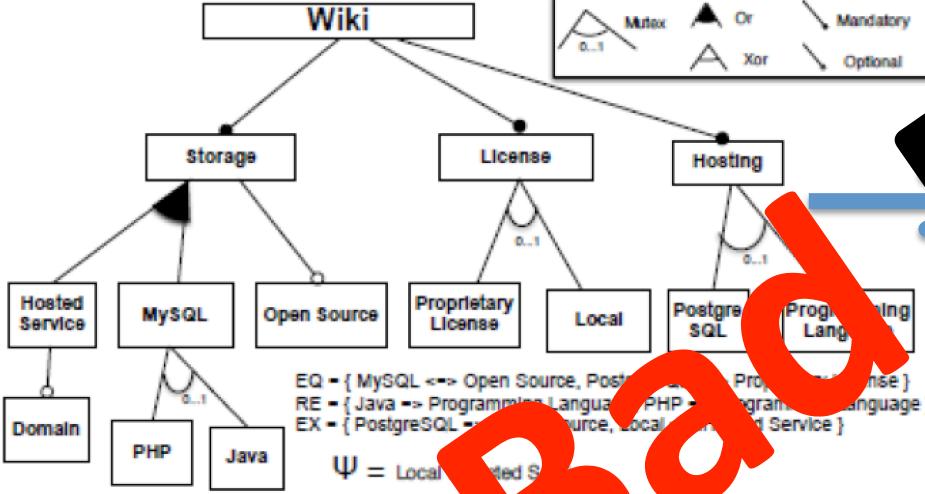
Storage	License	Hosting
<p>Do you want to choose Open Source as your storage system?</p> <p><input checked="" type="radio"/> Yes, I want.</p> <p><input type="radio"/> No.</p>	<p>Select your License:</p> <p><input type="radio"/> Proprietary License</p> <p><input checked="" type="radio"/> Local</p> <p><input type="radio"/> None</p>	<p>What would you like to choose?</p> <p><input type="radio"/> PostgreSQL</p> <p><input checked="" type="radio"/> Programming Language</p> <p><input type="radio"/> None.</p>
<p>Should your hosted service provide a Domain ?</p> <p><input checked="" type="radio"/> Yes.</p> <p><input type="radio"/> No.</p>		
<p>Choose your MySQL database:</p> <p><input checked="" type="radio"/> JAVA</p> <p><input type="radio"/> PHP</p> <p><input type="radio"/> None.</p>		



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# Importance of ontological semantics (3)



Bad FIM

Wiki Wizard

Choose your Wiki

License

Storage

Hosting

Should you want to use Open Source as your storage system?

Select your License:

Yes. Proprietary License  
No. Local  
None.

Should your hosted service provide a Domain?

Yes.  
No.

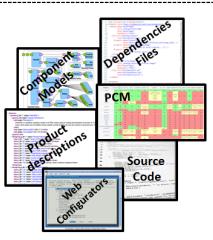
Choose your MySQL database:

JAVA  
PHP  
None.

Hosting

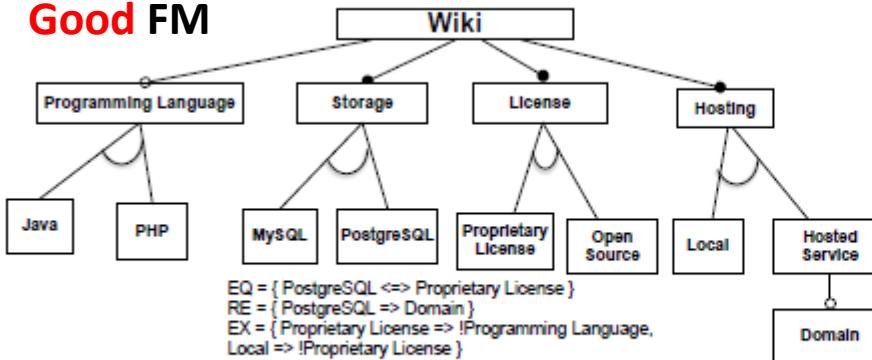
Communication  
Comprehension  
Forward engineering (e.g., generation)



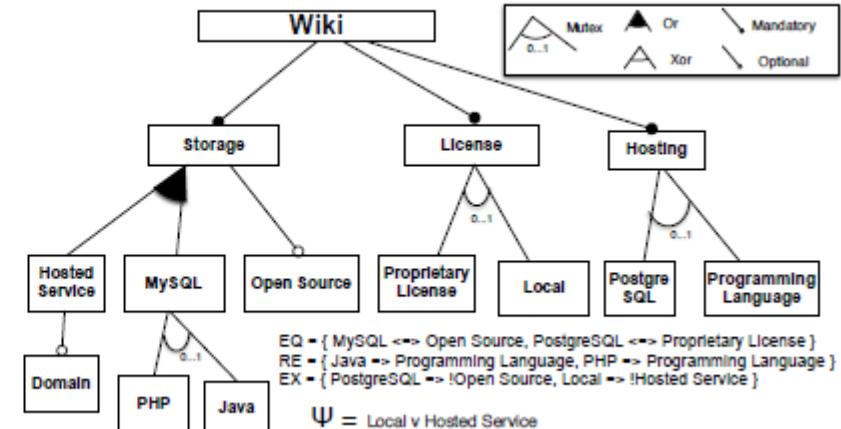


# Importance of ontological semantics (4)

**Good FM**



**Bad FM**



**Good configuration interface**

Wiki Wizard

### Choose your Wiki

Storage	License	Hosting
Select your storage system : <input checked="" type="radio"/> MySQL <input type="radio"/> PostgreSQL	Select your License: <input type="radio"/> Proprietary License <input checked="" type="radio"/> Open Source	Select your Hosting : <input checked="" type="radio"/> Local <input type="radio"/> Hosted Service  Should your hosted service provide a Domain ? <input type="radio"/> Yes. <input checked="" type="radio"/> No.
<b>Programming Language</b>  Select the programming Language : <input checked="" type="radio"/> JAVA <input type="radio"/> PHP <input type="radio"/> None.		

**Bad configuration interface**

Wiki Wizard

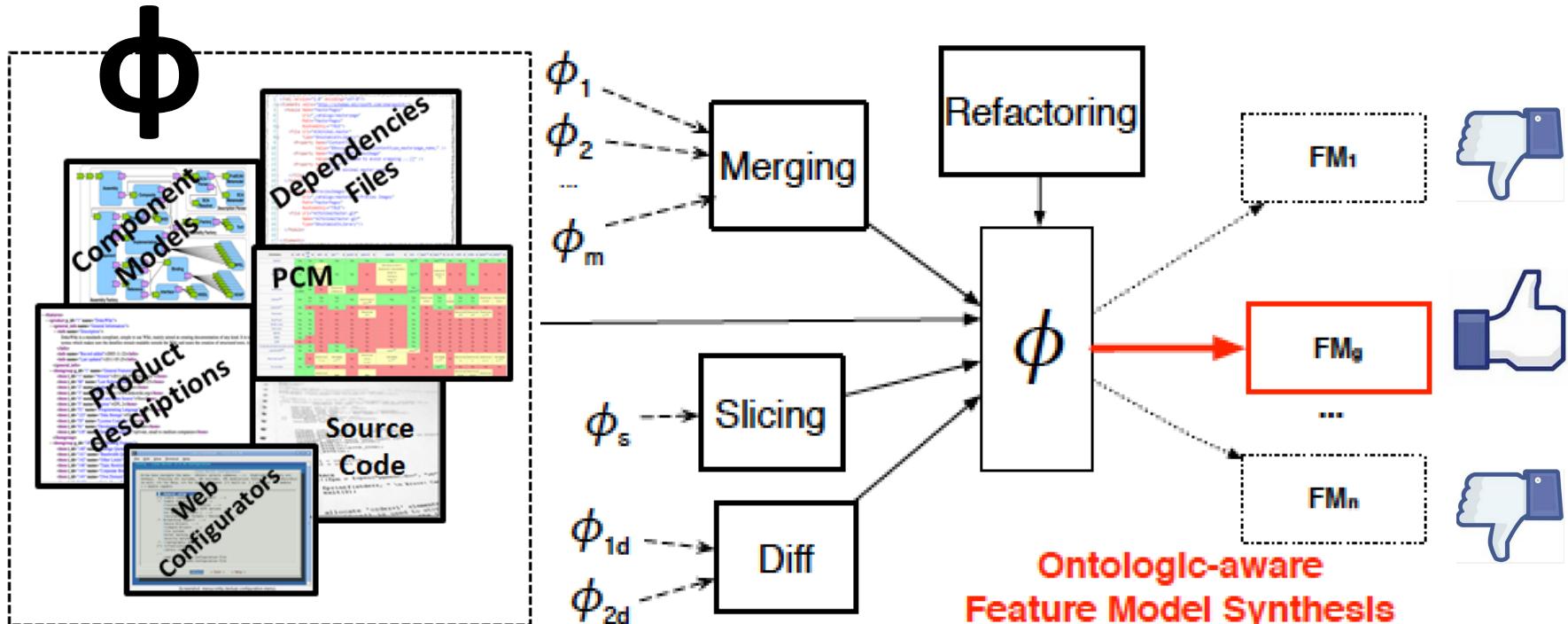
### Choose your Wiki

Storage	License	Hosting
Do you want to choose Open Source as your storage system? <input checked="" type="radio"/> Yes, I want. <input type="radio"/> No.	Select your License: <input type="radio"/> Proprietary License <input checked="" type="radio"/> Local <input type="radio"/> None	What would you like to choose? <input type="radio"/> PostgreSQL <input checked="" type="radio"/> Programming Language <input type="radio"/> None.
Should your hosted service provide a Domain ? <input checked="" type="radio"/> Yes. <input type="radio"/> No.	Choose your MySQL database: <input checked="" type="radio"/> JAVA <input type="radio"/> PHP <input type="radio"/> None.	

Two product configurators generated from two FMs with the **same** configuration semantics but **different** ontological semantics.

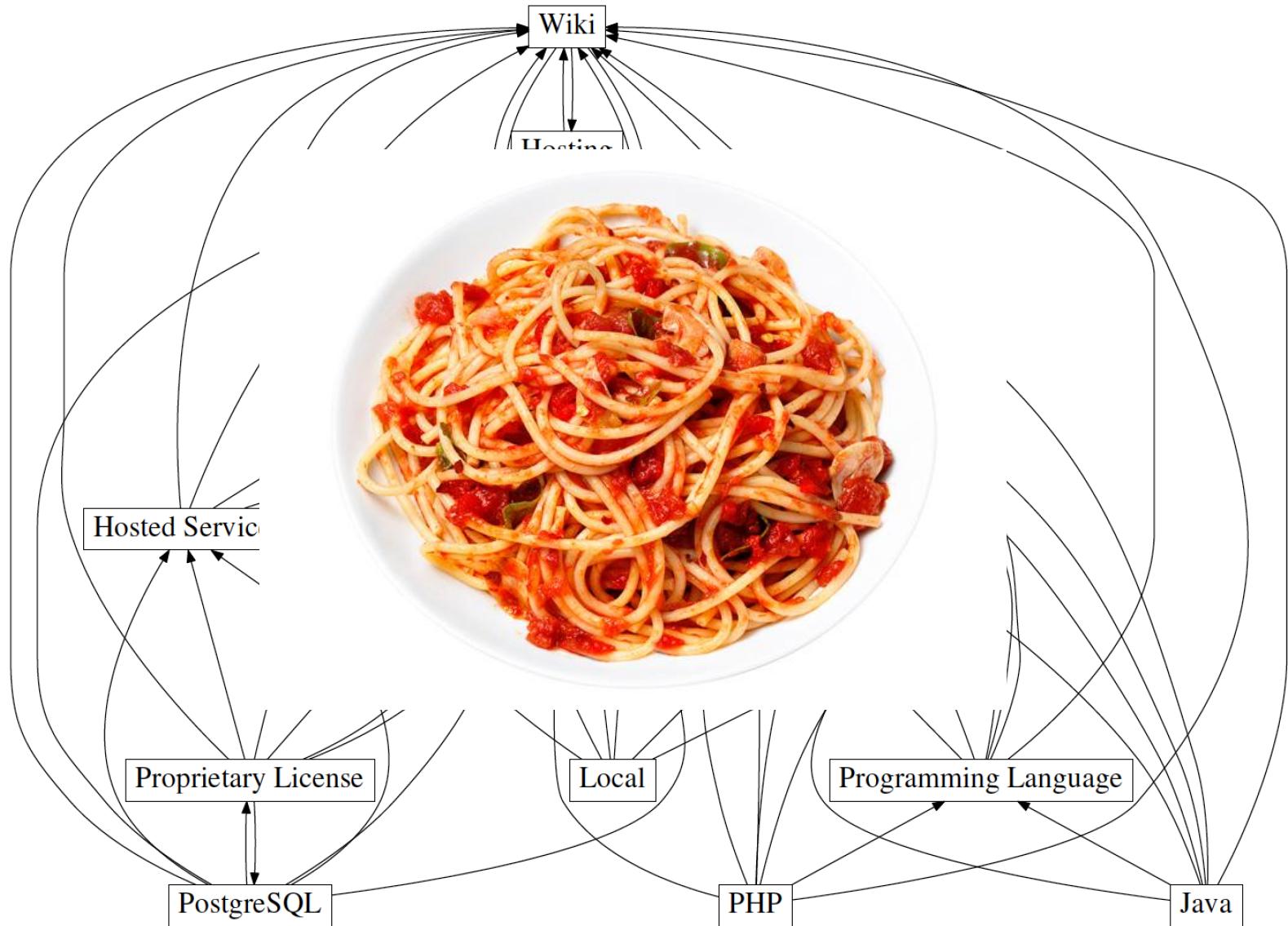
Most of the existing approaches neglect either configuration or ontological semantics.

We want both!



# Fundamental Problem

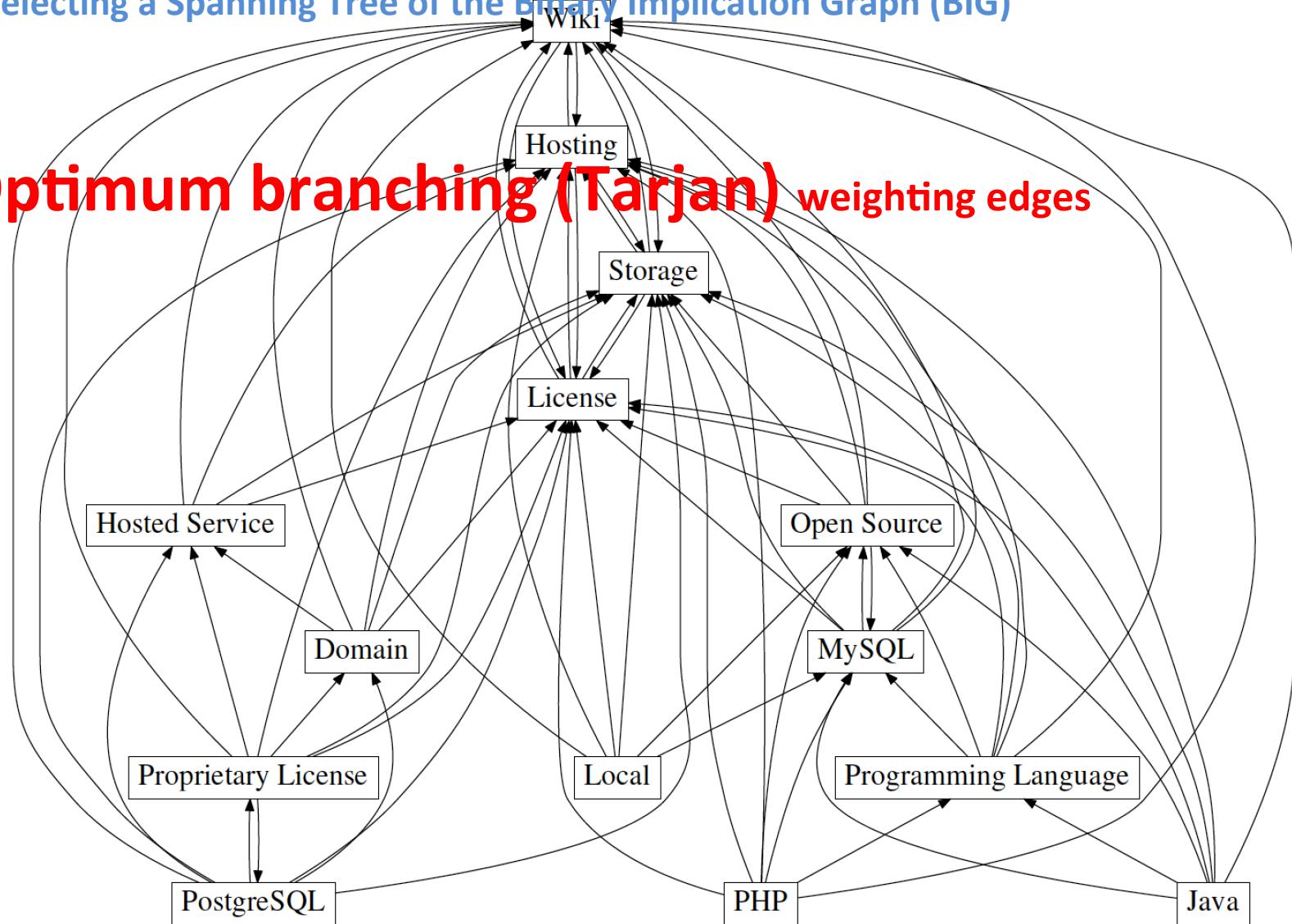
Selecting a Spanning Tree of the Binary Implication Graph (BIG)



# Fundamental Problem

Selecting a Spanning Tree of the Binary Implication Graph (BIG)

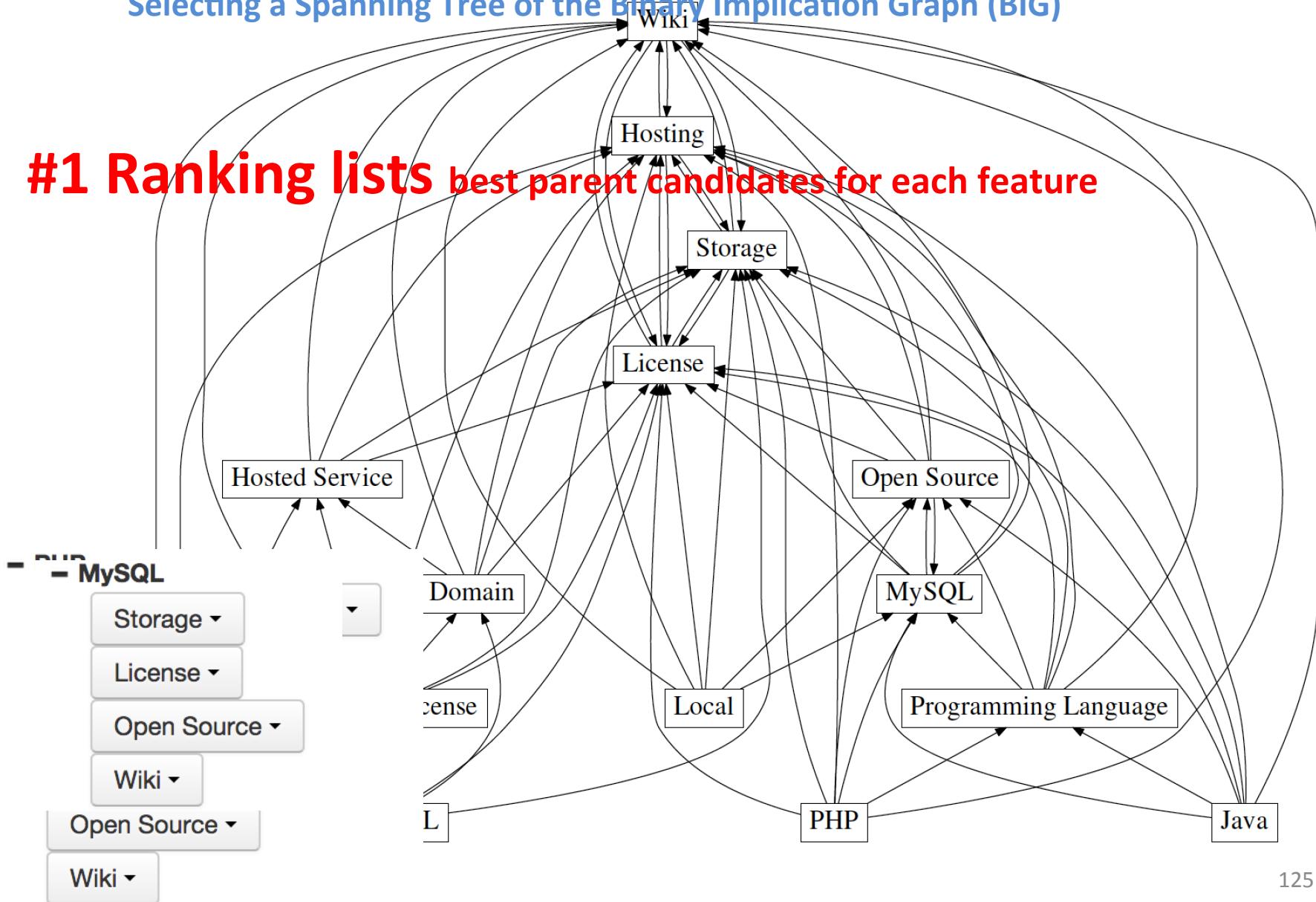
#0 Optimum branching (Tarjan) weighting edges



# Fundamental Problem

Selecting a Spanning Tree of the Binary Implication Graph (BIG)

#1 Ranking lists best parent candidates for each feature



# Fundamental Problem

Selecting a Spanning Tree of the Binary Implication Graph (BIG)

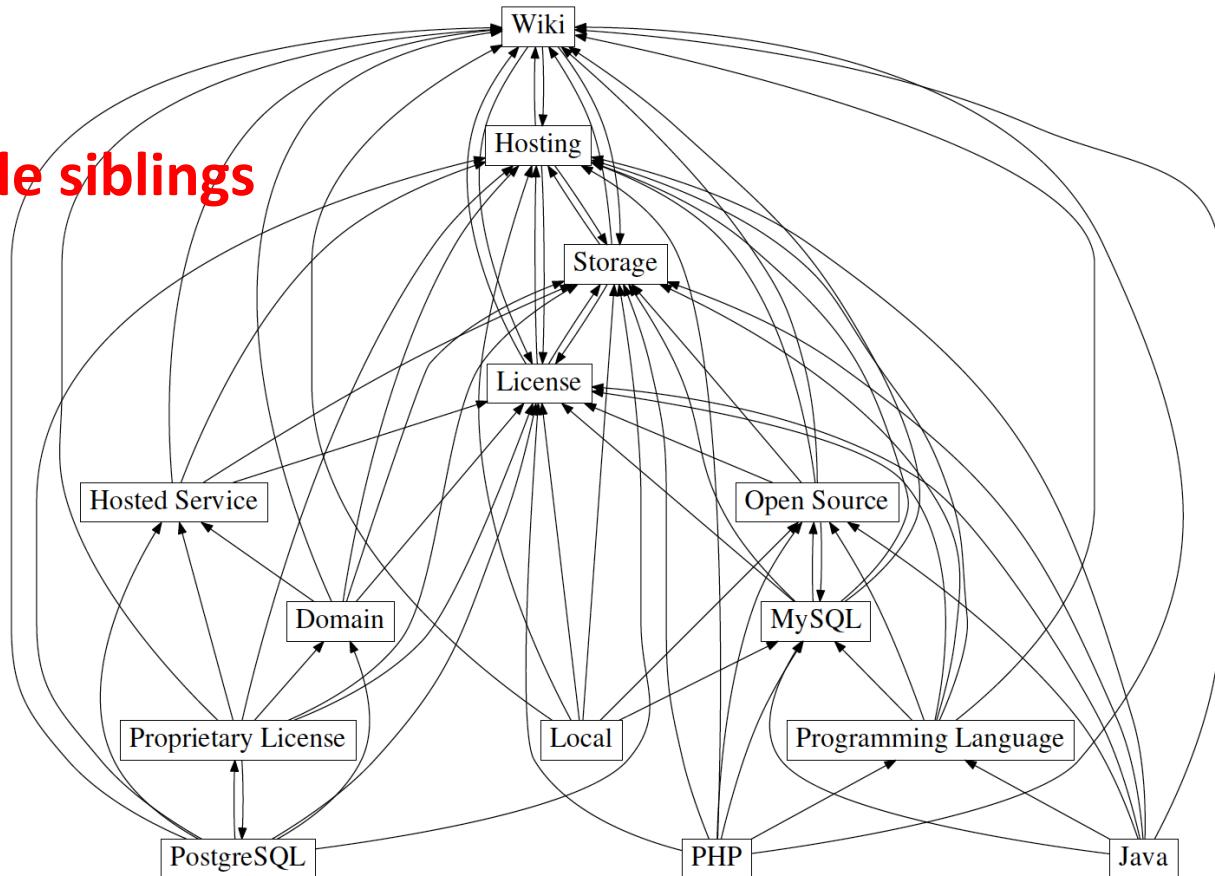
#2 Clusters ~possible siblings

## Clusters



- License
- Proprietary License

- PostgreSQL
- MySQL



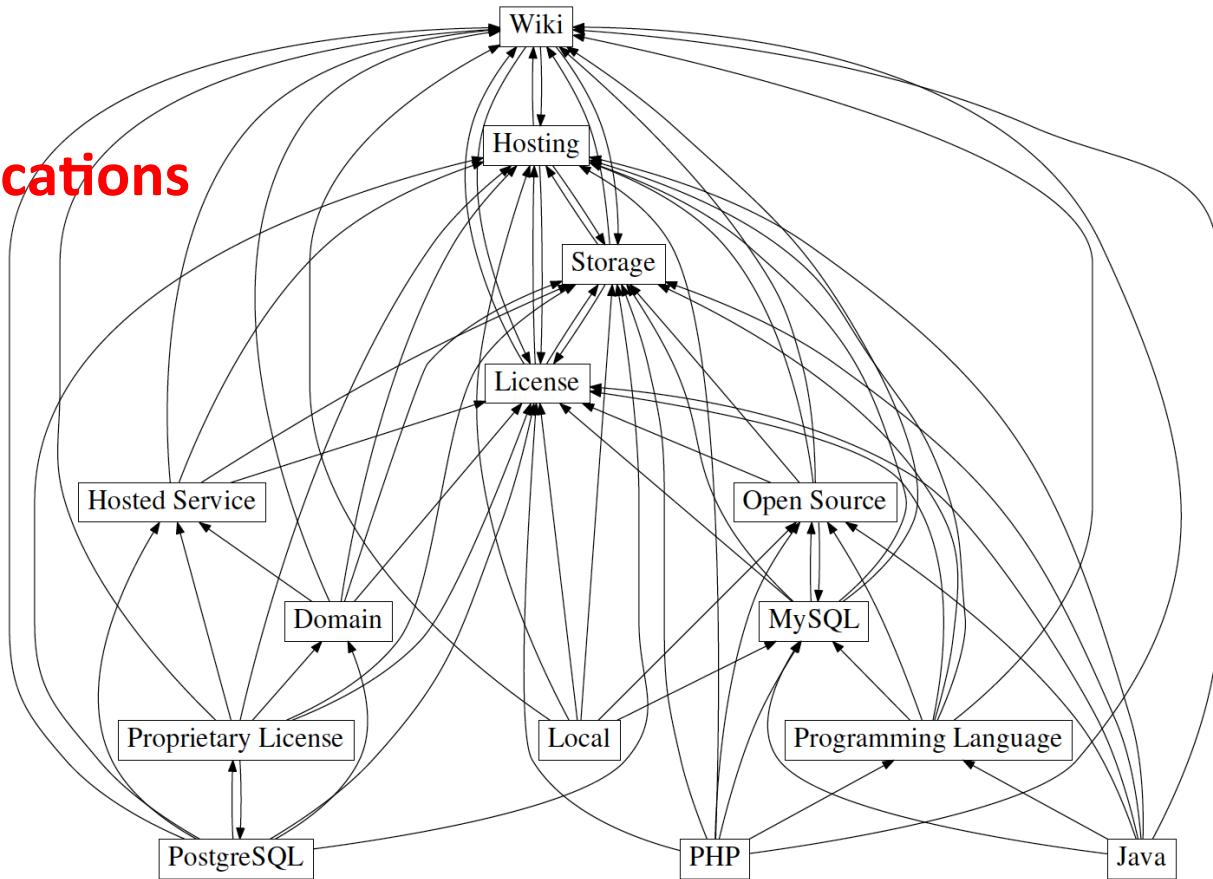
# Fundamental Problem

Selecting a Spanning Tree of the Binary Implication Graph (BIG)

#3 Cliques ~bi-implications

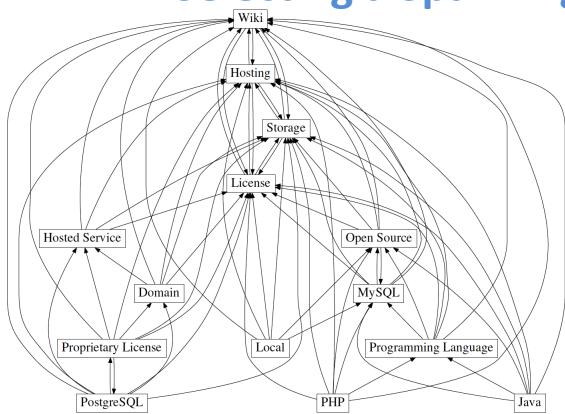
## Cliques

- - Storage
  - License
  - Wiki
- - PostgreSQL
  - Proprietary License
- - MySQL
  - Open Source

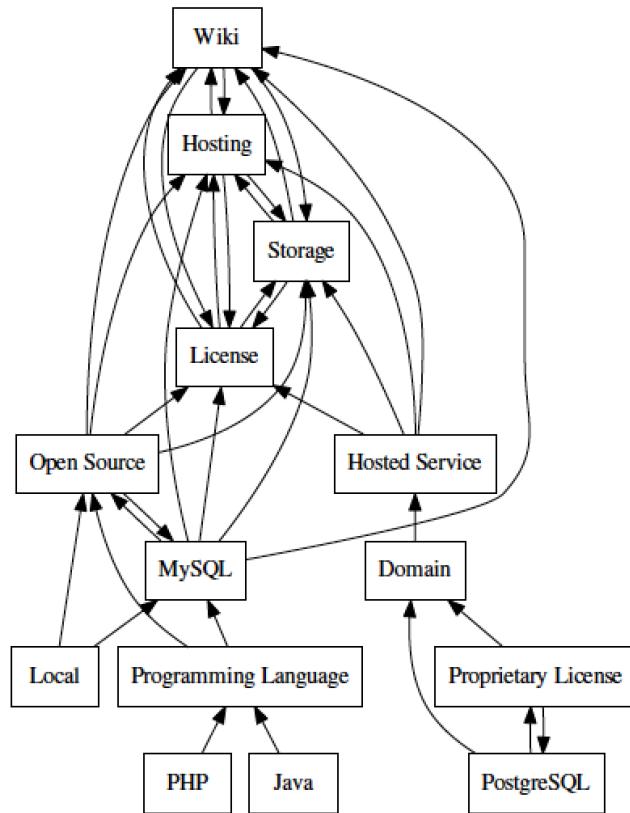


# Fundamental Problem

Selecting a Spanning Tree of the Binary Implication Graph (BIG)



#4 small BIG

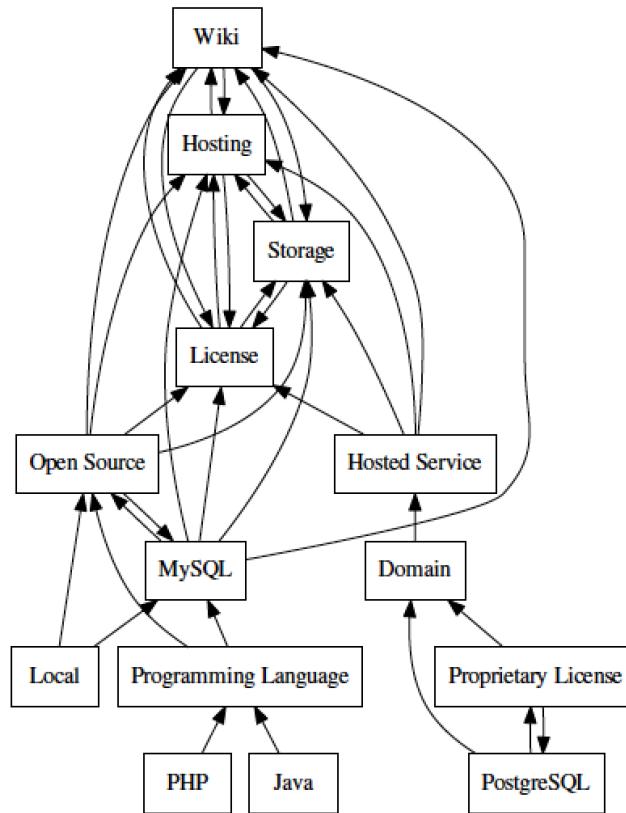
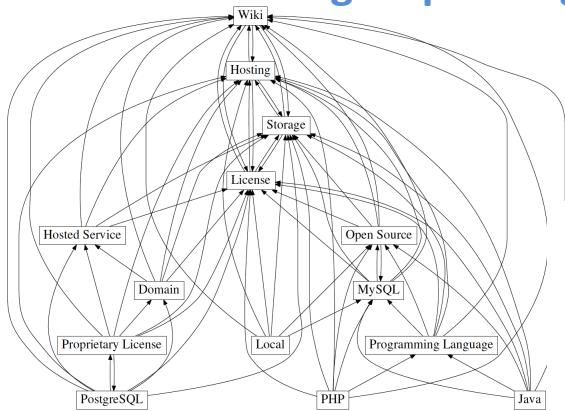


# Fundamental Problem

Selecting a Spanning Tree of the Binary Implication Graph (BIG)

#4 reduced BIG

incomplete but dramatically reduce the problem



# Ontological Heuristics

- For optimum branching, computing ranking lists and clusters
  - ~ « closedness » of features based on their names
- Syntactical heuristics
  - Smith-Waterman (SW) and Levenshtein (L)
- Wordnet
  - PathLength (PL) and Wu&Palmer (WP)
- Wikipedia Miner offers an API to browse Wikipedia's articles and compute their relatedness
  - Wiktionary (Wikt)

40 GB!

# WebFML FAMILIAR

Familiar Toggle Console

repository  
fmwiki.dimacs  
user\_study.fml  
fm2.dimacs  
fmwiki.fml  
fm1.dimacs

B FML Editor C KSynthesis  
Ranking lists Smith Waterm Clustering Smith Waterm 0,5 D Undo Redo Complete Save  
fmwiki badfmwiki  
Wiki: License Storage ["Programming Language"] ; License: ("Proprietary License")|"Open Source") ; Storage: (PostgreSQL|MySQL) ; "Programming Language": (Java|PHP) ; ("Proprietary License" -> !"Programming Language"); (PostgreSQL <-> "Proprietary License");

**Preview**

```
graph TD; Wiki[Wiki] --> PL[Programming Language]; Wiki --> L[License]; Wiki --> S[Storage]; PL --> Java[Java]; PL --> PHP[PHP]; L --> OS[Open Source]
```

E

**Ranking Lists**

- Proprietary License
  - License
  - Wiki
  - Storage
  - PostgreSQL
- + PostgreSQL
- + MySQL

F

**Clusters**

- >
  - License
  - Proprietary License
  - Storage  G ✓ ✗
  - PostgreSQL
  - MySQL

H

**Cliques**

- >
  - Storage
  - License
  - Wiki
- >
  - PostgreSQL
  - Proprietary License
- >
  - MySQL
  - Open Source

I

FAMILIAR interpreter  
Synthesising in progress... over fmwiki  
fm1> compare fmwiki badfmwiki  
res1 = REFACTORING  
fm1>

# Support and Empirical Study (1)

**Goal: evidence and empirical insights of what heuristics are effective and what support is needed in WebFML**

- Dataset
  - 120+ feature models of SPLOT
  - 30+ product comparison matrices from Wikipedia (see Becan et al. ASE'14 and ASE'13)
  - Ground truths are known
- Effectiveness of techniques (reduced BIG + ontological heuristics)
  - One shot synthesis
  - Quality of the ranking lists (top 2), clusters
  - Comparison with randomized and existing techniques

# Support and Empirical Study (2)

**Default heuristics/support has been determined through an empirical study**

- Dataset
  - 120+ feature models of SPLOT
  - 30+ product comparison matrices from Wikipedia (see Becan et al. ASE'14 and ASE'13)
  - Ground truths are known
- Effectiveness of techniques (reduced BIG + ontological heuristics)
  - One shot synthesis
  - Quality of the ranking lists (top 2), clusters
  - Comparison with randomized and existing techniques

# Support and Empirical Study (3)

**Default heuristics/support has been determined through an empirical study**

- One-step synthesis is far from the ground truth
  - despite state-of-the-art techniques we have developed
  - interactive support is thus crucial
- State-of-the-art heuristics for ranking lists and clusters
- Empirical insights on « cliques » and BIG reduction
  - e.g., support for unfolding of cliques

# Support and Empirical Study (3)

## Breathing Ontological Knowledge Into Feature Model Synthesis: An Empirical Study

Guillaume Bécan, Mathieu Acher, Benoit Baudry, Sana Ben Nasr

### ► To cite this version:

Guillaume Bécan, Mathieu Acher, Benoit Baudry, Sana Ben Nasr. Breathing Ontological Knowledge Into Feature Model Synthesis: An Empirical Study. Empirical Software Engineering, Springer Verlag (Germany), 2015, pp.51. <10.1007/s10664-014-9357-1>. <hal-01096969>

A screenshot of a GitHub repository page for 'FAMILIAR-pl'. The repository has 2 contributors. A commit by 'gbecan' dated Jul 11 is shown, updating links to KSynthesis. The commit message is "Update links to KSynthesis". The repository contains 37 lines (26 sloc) and 2.867 kb.

## Empirical Evaluation of Ontologic-aware Feature Model Synthesis

### How to reproduce the experiments

To reproduce the experiments you have to clone two github repositories:

- KSynthesis repository (version used: ESE-evaluation).
- FAMILIAR (version used: ESE-evaluation)

The first repository contains the algorithms and heuristics for synthesizing a correct and meaningful FM. It also contains an Evaluation project with the two FM datasets (SPLOT and PCM) and the necessary code to run the experiments. The second repository is a dependency for the algorithms.

The SPLOT dataset contains 126 FMs encoded in SXFM format. The PCM dataset contains 30 FMs encoded in *fmlbdd* format.

To use heuristics based on Wikipedia, you need to install additional files.



[http://tinyurl.com/  
OntoFMEExperiments](http://tinyurl.com/OntoFMEExperiments)

## Clusters

### Preview

- Undirected
- Connected
- Directed
- Strongly Conn.

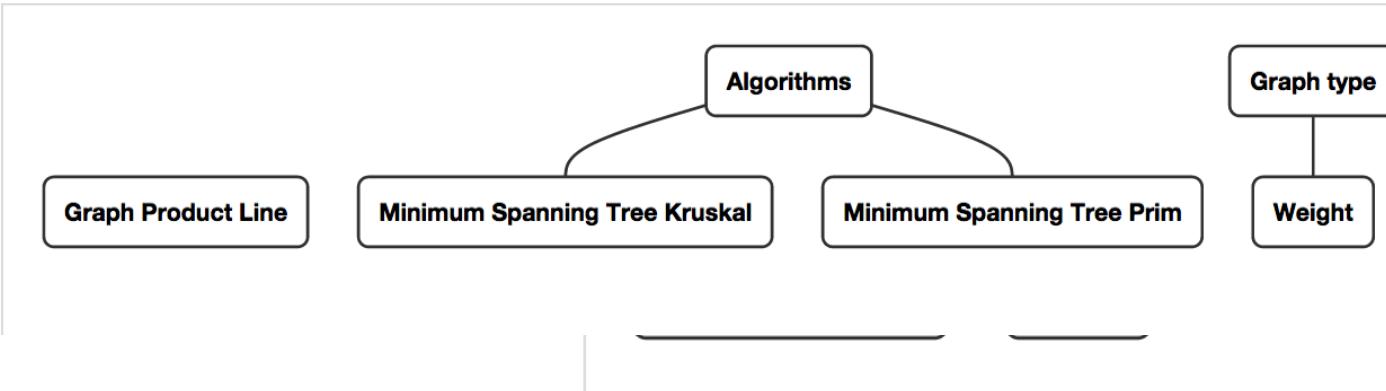
- Graph Product Line
- Graph type

- Weight
- Weighted
- Unweighted

- Search
- Depth-First Search
- Breadth-First Search



- Minimum Spanning Tree Prim
- Minimum Spanning Tree Kruskal

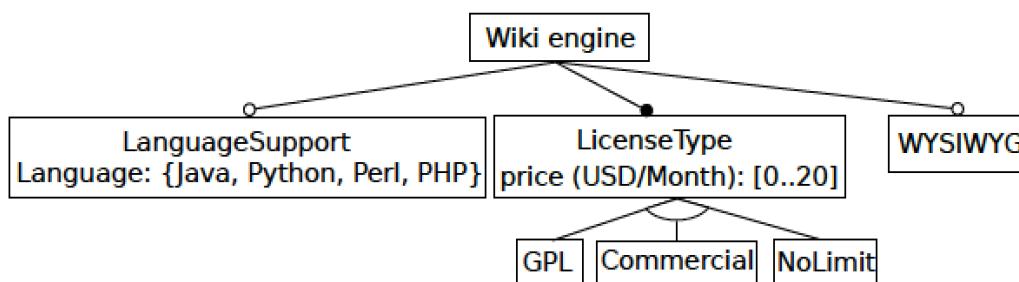


Algorithms

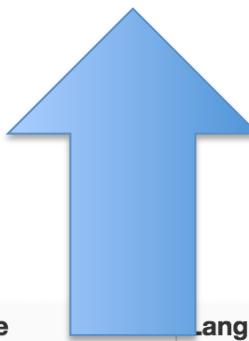
A dropdown menu with a blue border. To its right are two buttons: a green one with a checkmark icon and a red one with an X icon.

- Minimum Spanning Tree Prim
- Minimum Spanning Tree Kruskal

# Synthesising Attributed Feature Models



$\text{Commercial} \Leftrightarrow \text{LicenseType.price} = 10$     $\text{GPL} \Rightarrow \text{LanguageSupport}$   
 $\text{Commercial} \Leftrightarrow \text{Java}$     $\text{NoLimit} \Rightarrow \text{LicenseType.price} \geq 10$   
 $\text{GPL} \Rightarrow \text{LicenseType.price} \leq 10$     $\neg \text{PHP} \Rightarrow \text{WYSIWYG}$   
 $\text{NoLimit} \Leftrightarrow \neg \text{LanguageSupport}$     $\text{Python} \Rightarrow \text{LicenseType.price} = 0$   
 $\Phi = \neg \text{WYSIWYG} \Leftrightarrow \text{PHP} \wedge \text{LicenseType.price} = 0$

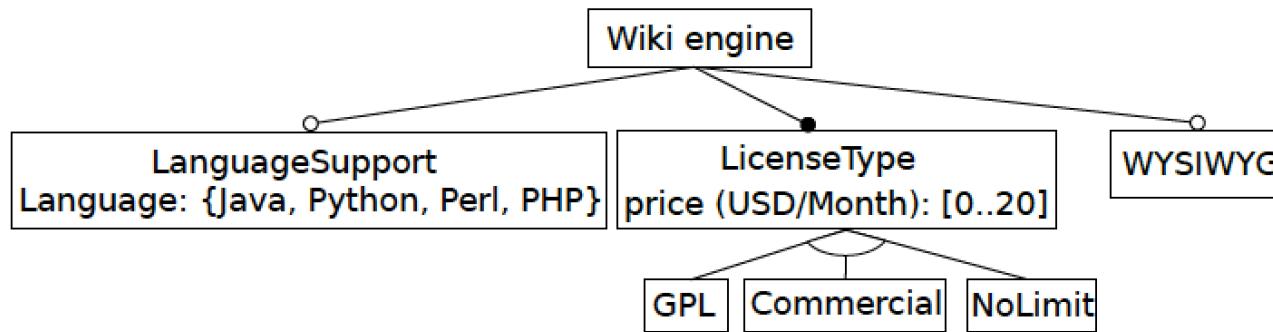


Product	License	Price	Language Support	Language	WYSIWIG
Find	<input type="button" value="🔍"/>	<input type="button" value="☰"/>	<input checked="" type="checkbox"/> <input type="checkbox"/>	<input type="button" value="🔍"/>	<input checked="" type="checkbox"/> <input type="checkbox"/>
W1	Commercial	10	Yes	Java	Yes
W2	NoLimit	20	No		Yes
W3	NoLimit	10	No		Yes
W4	GPL	0	Yes	Python	Yes
W5	GPL	0	Yes	Perl	Yes
W6	GPL	10	Yes	Perl	Yes
W7	GPL	0	Yes	PHP	No
W8	GPL	10	Yes	PHP	Yes

Guillaume Bécan, Razieh Behjati, Arnaud Gotlieb, and Mathieu Acher. Synthesis of Attributed Feature Models From Product Descriptions (2015). In 19th International Software Product Line Conference (SPLC'15) (research track, long paper)

Identifier	LicenseType	LicenseType.price	Language Support	Language	WYSIWYG
Confluence	Commercial	10	Yes	Java	Yes
PBwiki	NoLimit	20	No	–	Yes
MyWiki	NoLimit	10	No	–	Yes
MoinMoin	GPL	0	Yes	Python	Yes
TWiki	GPL	0	Yes	Perl	Yes
MyWiki2	GPL	10	Yes	Perl	Yes
MediaWiki	GPL	0	Yes	PHP	No
MyWiki3	GPL	10	Yes	PHP	Yes

(a) A configuration matrix for Wiki engines.



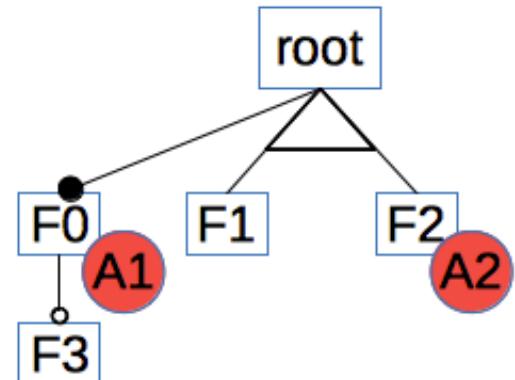
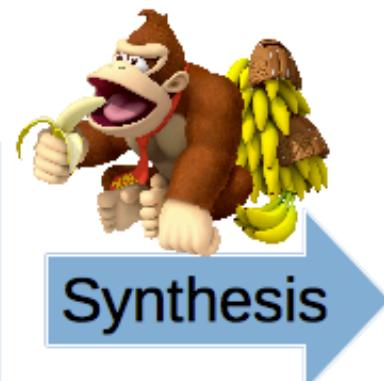
$\text{Commercial} \Leftrightarrow \text{LicenseType.price} = 10$      $\text{GPL} \Rightarrow \text{LanguageSupport}$   
 $\text{Commercial} \Leftrightarrow \text{Java}$                           $\text{NoLimit} \Rightarrow \text{LicenseType.price} \geq 10$   
 $\text{GPL} \Rightarrow \text{LicenseType.price} \leq 10$                   $\neg\text{PHP} \Rightarrow \text{WYSIWYG}$   
 $\text{NoLimit} \Leftrightarrow \neg\text{LanguageSupport}$               $\text{Python} \Rightarrow \text{LicenseType.price} = 0$   
 $\Phi = \neg\text{WYSIWYG} \Leftrightarrow \text{PHP} \wedge \text{LicenseType.price} = 0$

(b) An attributed feature model representing the configuration matrix in Figure 2(a)

Guillaume Bécan, Razieh Behjati, Arnaud Gotlieb, and Mathieu Acher. Synthesis of Attributed Feature Models From Product Descriptions (2015). In 19th International Software Product Line Conference (SPLC'15) (research track, long paper)

#	root	F0	F1	F2	F3	A1	A2
	Feature	Feature	Feature	Feature	Feature	Attribute	Attribute
	Null value	0	0				
0	Yes	Yes	Yes	No	Yes	3	0
1	Yes	Yes	No	Yes	Yes	2	2
2	Yes	Yes	Yes	No	No	2	0
3	Yes	Yes	No	Yes	No	0	8

root	F0	F1	F2	F3	A1	A2
Yes	Yes	Yes	No	Yes	3	0
Yes	Yes	No	Yes	Yes	2	2
Yes	Yes	Yes	No	No	2	0
Yes	Yes	No	Yes	No	0	8



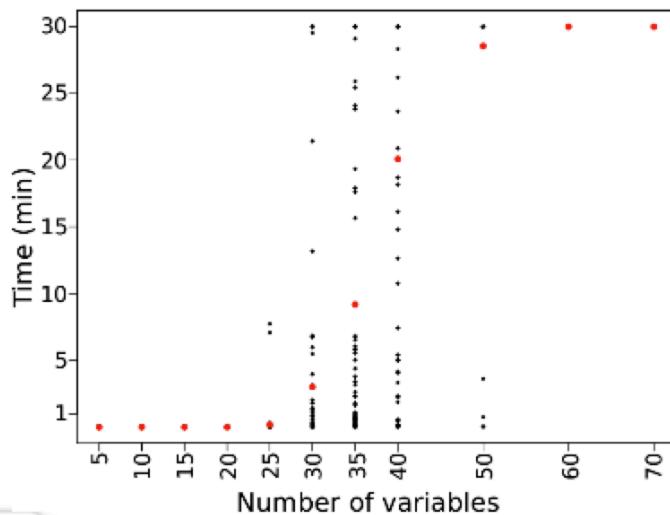
$$A2 < 8 \Rightarrow A1 \geq 2$$

$$A1 > 0 \Rightarrow A2 \leq 2$$

# Scalability

## Random dataset

- Generator of configuration matrices
  - Number of variables (features + attributes)
  - Number of configurations
  - Maximum domain size (number of distinct values in a column)
- Execution time of or-group computation



= default heuristics only

- 1000 configurations
- max domain size of 10

Timeout always reached with more than 60 variables

Or groups do not scale !

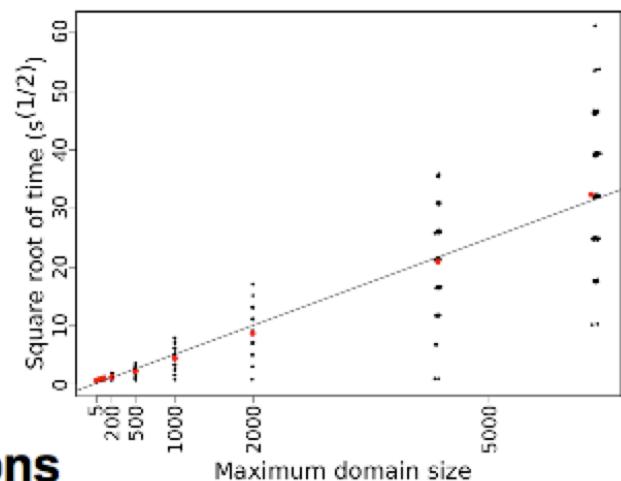
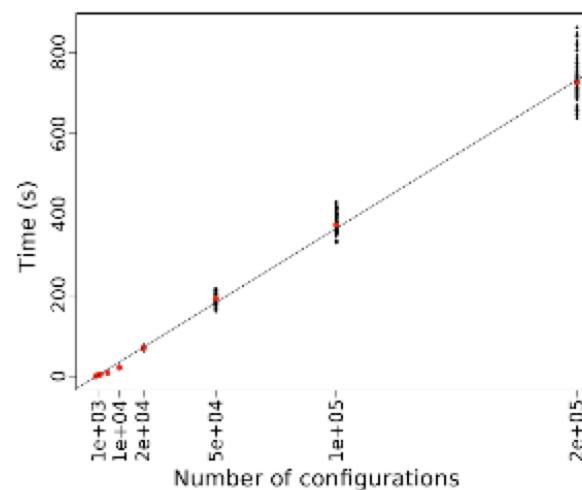
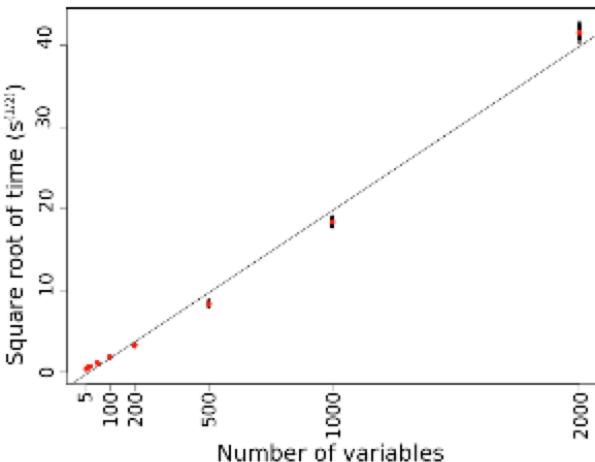
# Scalability

## Random dataset

- Execution time (no or-groups)



= default heuristics only



- Up to 2,000 variables
- 1,000 configurations
- Max domain size of 10

- 100 variables
- Up to 200,000 configurations
- Max domain size of 10

- 10 variables
- 10,000 configurations
- Up to 6000 distinct values

On all experiments:

Average: 2.6 min

Max: 62 min

# Scalability

Best Buy dataset

- 242 matrices
- < 25% of empty cells
- Interpretation of empty cells



= default heuristics only

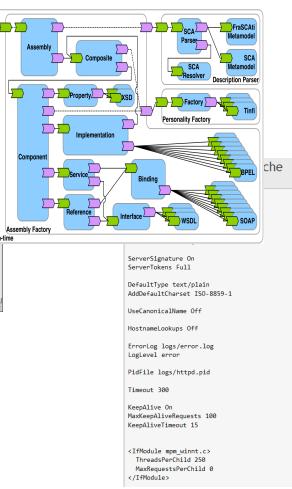
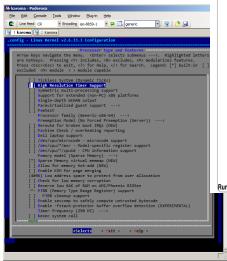
Media Card Reader	Yes	Yes	Yes
Number Of Ethernet Ports	1	1	
Number Of HDMI Outputs	1	1	1
Number Of USB Port(s)	3	3	3
Number Of VGA Ports	1		
Operating System	Windows 8.1	Windows 8.1	Windows 8.1

Execution time of 2.1s for the most challenging matrix:

- 77 variables
- 185 configurations
- Maximum domain size of 185

Execution time is similar to the random dataset

# Mining Product Comparison Matrices

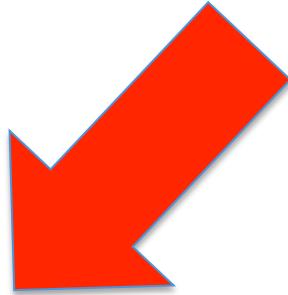
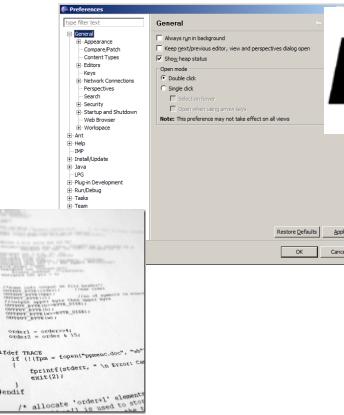


NEW KANGOO VAN RANGE

01 Preferences    02 Version    03 Equipment & options

**OPTIONS**

- > COMFORT
  - Central storage console & armrest between seats £20.00
  - Electric door mirrors £3.00
- > DRIVING
- > SAFETY & SECURITY
  - ESC (Electronic Stability Control) with traction and understeer control £200.00



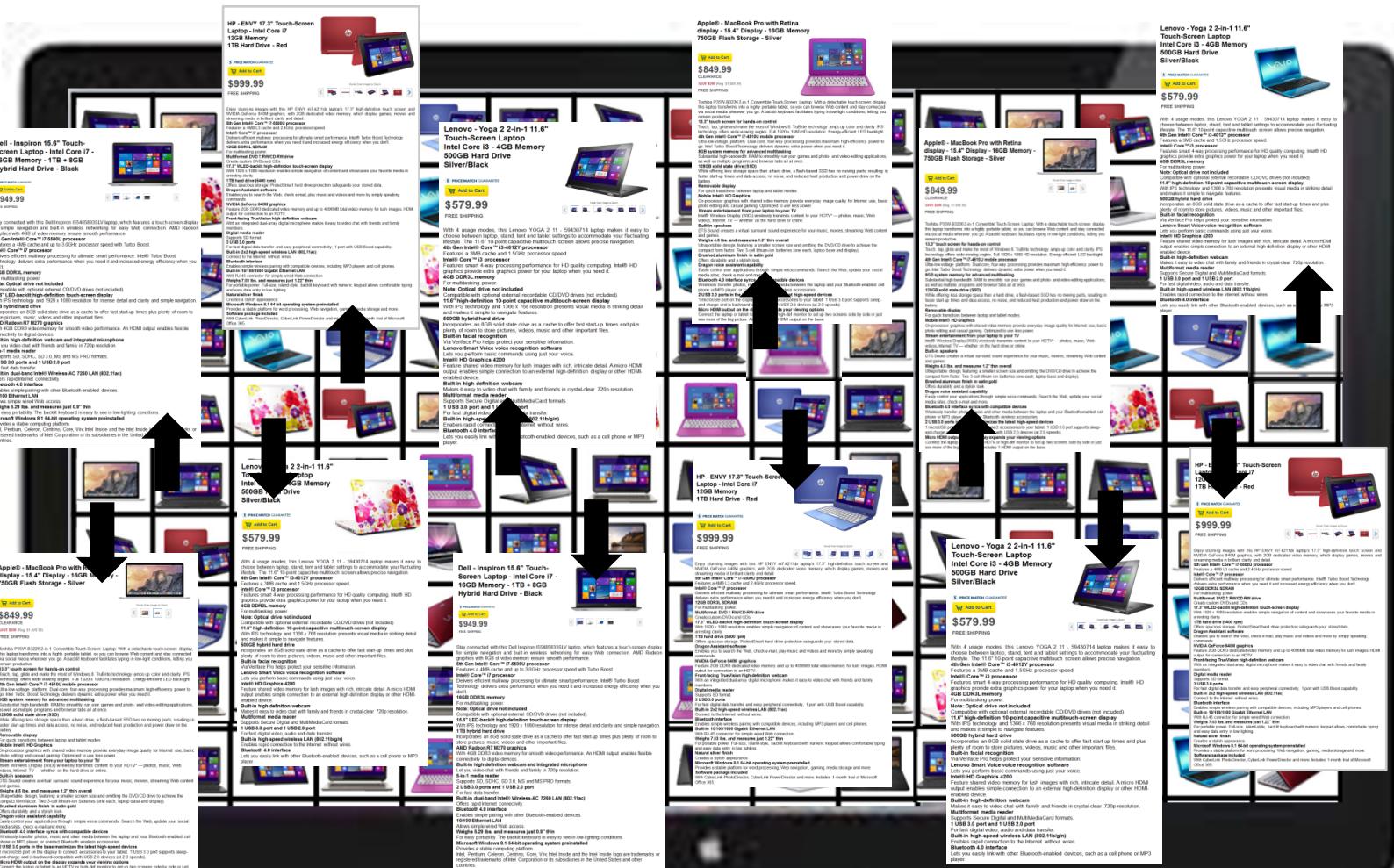
# Mining/Extracting Extracting/Encoding Synthesising



Product	License	Price	Language Support	Language	WYSIWIG
W1	Commercial	10	Yes	Java	Yes
W2	NoLimit	20	No		Yes
W3	NoLimit	10	No		Yes
W4	GPL	0	Yes	Python	Yes
W5	GPL	0	Yes	Perl	Yes
W6	GPL	10	Yes	Perl	Yes
W7	GPL	0	Yes	PHP	No
W8	GPL	10	Yes	PHP	Yes

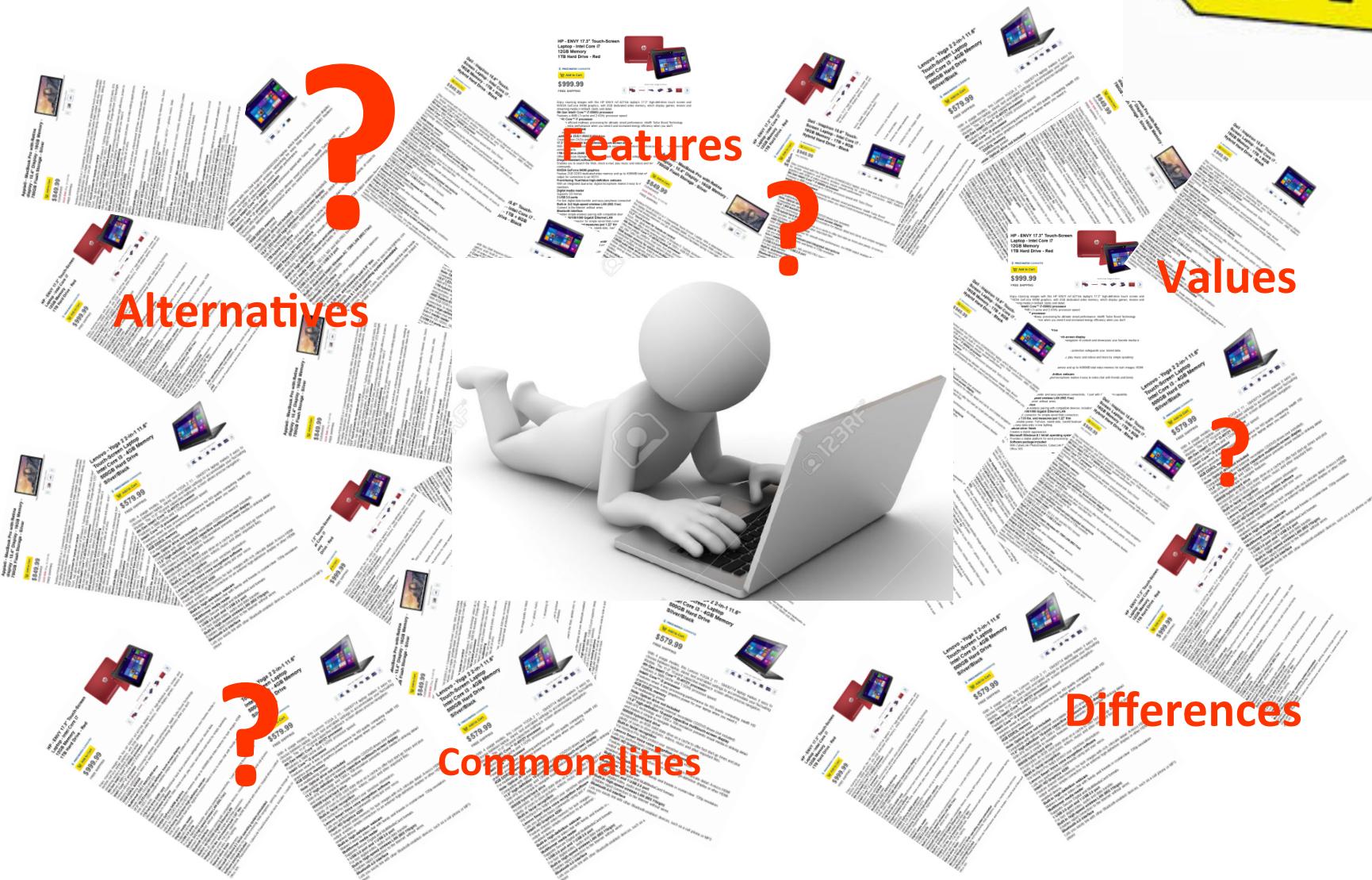
OpenCompare

**Choose your BEST Laptop ..**



The Best Buy logo, which consists of the words "BEST BUY" in a bold, black, sans-serif font, all contained within a yellow octagonal price tag.

# Choose your BEST Laptop..



Alternatives

Features

Values

Commonalities

Differences

# Manual case-by-case review of each product ☹

Manually identifying features

HP - ENVY 17.3" Touch-Screen  
Laptop - Intel Core i7  
12GB Memory  
1TB Hard Drive - Red



Hover Over Image to Zoom

Enjoy stunning images with this HP ENVY m7-k211dx laptop's 17.3" high-definition **touch screen** and NVIDIA GeForce 840M graphics, with 2GB dedicated video memory, which display games, movies and streaming media in brilliant clarity and detail.

**5th Gen Intel® Core™ i7-5500U processor.** Features a 4MB L3 cache and **2.4GHz processor speed.**

Intel® Core™ i7 processor. Delivers efficient multiway processing for ultimate smart performance. Intel® Turbo Boost Technology delivers extra performance when you need it and increased energy efficiency when you don't.

**12GB DDR3L SDRAM memory.** For multitasking power. Multiformat DVD±RW/CD-RW drive. Create custom DVDs and CDs.

17.3" WLED-backlit high-definition touch-screen display

With **1920 x 1080 resolution** enables simple navigation of content and showcases your favorite media in arresting clarity.

**1TB hard drive** (5400 rpm). Offers spacious storage. ProtectSmart hard drive protection safeguards your stored data.

NVIDIA GeForce 840M graphics. Feature 2GB DDR3 dedicated video memory and up to 4096MB total video memory for **high-quality images**. HDMI output for connection to an HDTV.

**Front-facing TrueVision high-definition webcam.** With an integrated dual-array digital microphone makes it easy to video chat with friends and family members.

**Digital media reader.** Supports SD format.

**Microsoft Windows 8.1 64-bit operating system** preinstalled. Provides a stable platform for word processing, Web navigation, gaming, media storage and more.

Software package included. With CyberLink PhotoDirector, CyberLink PowerDirector and more. Includes 1-month trial of Microsoft Office 365.

# MatrixMiner: A Red Pill to Architect Informal Product Descriptions in the Matrix (Ben Nasr et al., ESEC/FSE'15 tool)

<http://matrix-miner.variability.io/>

MATRIX-MINER

Choose a sample

Dataset	manual-dataset	Category	TVs	Filter 1	Filter-Category	Filter 2	LED	PCM	LED4	Load
	space		1080p	service	mid-sized		60			
	connection	ultra hd-level	4k	service			4		sony xbr-55x800b 4k	
1	connection		720p	service			60			
1	connection		720p				60			
picture	space	clear	1080p		mid-sized	impressive				120hz
motion	space	overall	1080p		midsize					120hz
1	connection		720p				60			20w
1	connection		1080p					usb		two 10w
	connection		1080p	service		full	60			two 6w
	connection	ultra hd-level	2160p	service			4		sony xbr-65x800b 4k	240hz

## Textual overview

47-58" screen (measured diagonally from corner to corner)

A great size for a living room or mid-sized home theater space.

LED displays perform well in all lighting conditions

They also deliver plasma-like deep blacks and rich colors.

**1080p resolution** for stunning HD images

Watch Blu-ray movies and **1080p** HD content at their highest level of detail.

**60Hz refresh rate**

Images refresh 60 times per second for basic performance during fast-motion scenes.

**Motionflow XR 240 technology**

Offers realistic scene movement.

**Built-in Wi-Fi Smart TV means a huge world of entertainment**

Stream movies, music and more.

**Experience a crisp, clear picture**

X-Reality PRO technology delivers rich colors and exceptional details.

**Clear Audio+ technology**

Creates robust sound.

**4 HDMI inputs for the best home theater connection**

High-speed HDMI delivers a full **1080p** picture and digital surround sound in one convenient cable. HDMI cable not included.

**2 USB inputs**

Easily connect your digital camera, camcorder or other USB device.

**Web-based services and content require high-speed Internet service. Some services may require a subscription.**

## Specification

Feature	Value
Maximum Resolution	1920 x 1080
Vertical Resolution	1080p

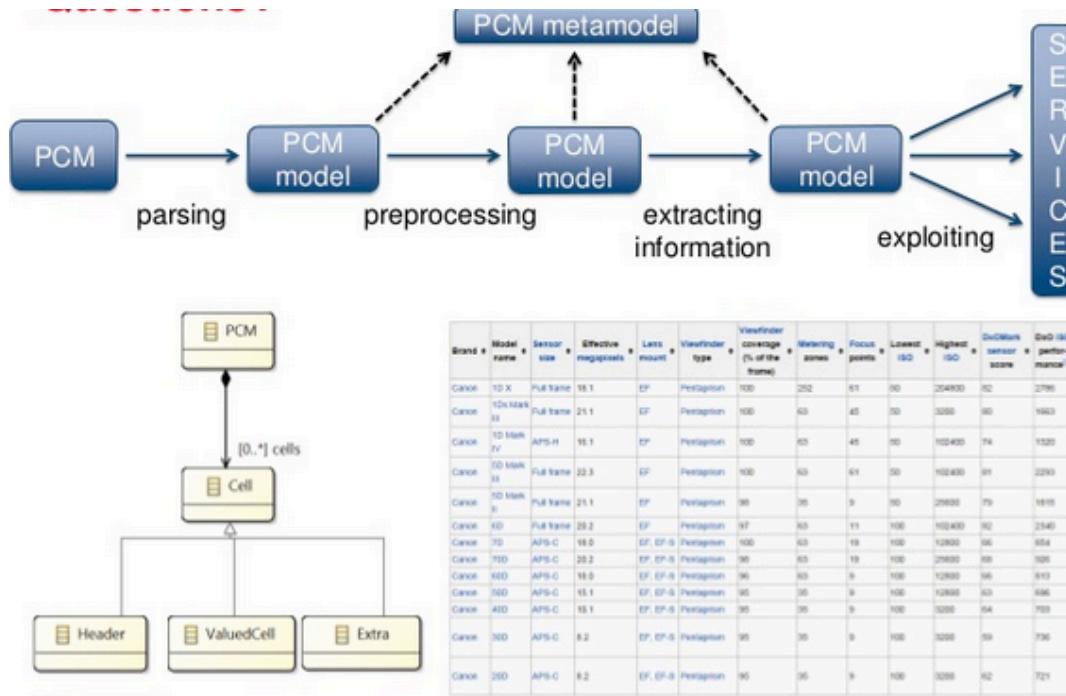
Brand	Model name	Sensor size	Effective megapixels	Lens mount	Viewfinder type	Viewfinder coverage (% of the frame)	Metering zones	Focus points	Lowest ISO	Highest ISO	DxOMark sensor score	DxO ISO performance <sup>[1]</sup>	
Canon	1D X	Full frame	18.1	EF	Pentaprism	100	252	61	50	204800	82	2786	
Canon	1Ds Mark III	Full frame	21.1				63	45	50	3200	80	1663	
Canon	1D Mark IV	APS-H	16.1				63	45	50	102400	74	1320	
Canon	5D Mark III	Full frame	22.3				63	61	50	102400	81	2293	
Canon	5D Mark II	Full frame	21.1				35	9	50	25600	79	1815	
Canon	6D	Full frame	20.2				63	11	100	102400	82	2340	
Canon	7D	APS-C	18.0				63	19	100	12800	66	854	
Canon	70D	APS-C	20.2				63	19	100	25600	68	926	
Canon	60D	APS-C	18.0				63	9	100	12800	66	813	
Canon	50D	APS-C	15.1		EF, EF-S	Pentaprism	95	35	9	100	12800	63	696
Canon	40D	APS-C	10.1		EF, EF-S	Pentaprism	95	35	9	100	3200	64	703
Canon	30D	APS-C	8.2		EF, EF-S	Pentaprism	95	35	9	100	3200	59	736
Canon	20D	APS-C	8.2		EF, EF-S	Pentaprism	95	35	9	100	3200	62	721



Guillaume Bécan, Nicolas Sannier, Mathieu Acher, Olivier Barais, Arnaud Blouin, and Benoit Baudry.  
 Automating the Formalization of Product Comparison Matrices (2014). In 29th IEEE/ACM International Conference on Automated Software Engineering (ASE'14)

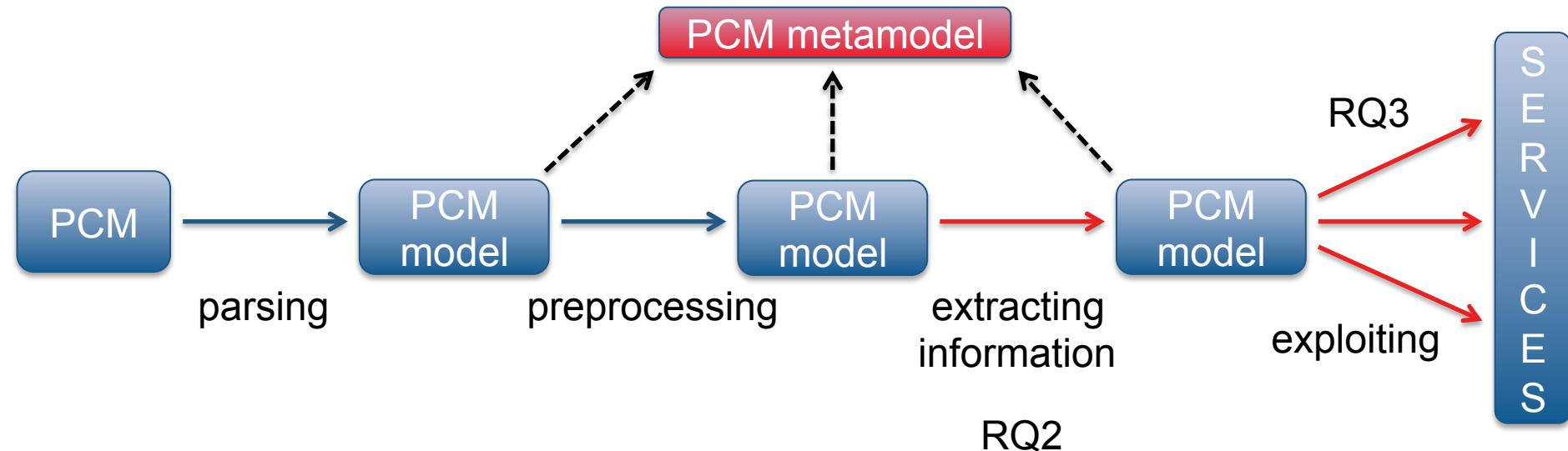
# Product Comparison Matrix (PCM)

- Initial points: VaMoS'12 (VariCell), ASE'13 (we coined the term), VaMoS'14 (comparators)
- Metamodel for encoding PCMs and developing services (eg editors), cross-validated by users



# Evaluation

RQ1



## Experimental settings:

- 75 Wikipedia pages
- Headers specified manually
- Automated extraction of information



**WIKIPEDIA**  
The Free Encyclopedia

# Evaluation

## Experimental settings:

- Evaluated by 20 persons (researchers and engineers)
- Online editor

Experimentnull_0						
feature	Type	Number of doors	Color	Automatic headlights	0 to 100 km/h	
Car 1	4x4	5	black, white, red	yes	9.5	
Car 2	sedan	5	black, white, red...	no	6.3	
Car 3	sedan	5	grey	yes	5.6	
Car 4	city car	3	black, white, green	no	8.3	
Car 5	sport	3	black, white	no	3.9	
Car 6	sedan		2 doors	yes (premium ve...	N/A	

black, white	no	3.9
2 doors	yes	...
And : VariabilityConceptRef(black) : VariabilityConceptRef(white) : :		

black, white	no
2 doors	Validate
	Correct

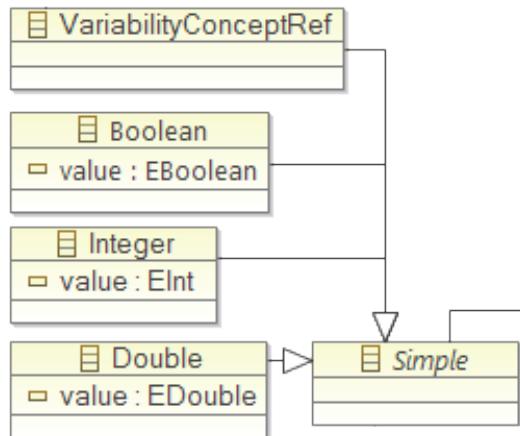
# Evaluation

## RQ1: How to formalize data contained in PCMs?

95.72% cells are valid or corrected with concepts from the metamodel

4.28% are invalid and the evaluators proposed a new concept

- Dates
- Dimensions and units
- Versions



### Solution:

- Add corresponding data types to the metamodel
- Create new rules for interpreting cells

# Evaluation

## RQ2: How to automate the formalization of PCMs?

93,11% of the cells are correctly formalized

The rest can be manually formalized with an editor

Formalization errors arise from 4 main areas:

- Overlapping concepts (e.g. what does an empty cell mean?)
- Missing concepts (e.g. dates, versions...)
- Missing interpretation rules
- Bad rules

# Evaluation

## RQ3: What kind of tools and services can be built on top of formalized PCMs?

### Editing and formalizing PCMs

Contact	Experimentnull_0	Comments				
feature	Type	Number of doors	Color	Automatic headlights	0 to 100 km/h	
Car 1	4x4	5	black, white, red	yes	9.5	
Car 2	sedan	5	black, white, red...	no	6.3	
Car 3	sedan	5	grey	yes	5.6	
Car 4	city car	3	black, white, green	no	8.3	
Car 5	sport	3	black, white	no	3.9	
Car 6	sedan		2 doors	yes (premium ve...	N/A	

# Evaluation

## RQ3: What kind of tools and services can be built on top of formalized PCMs?

Providing guidance during edition or refactoring

Detect inconsistent cells to provide warnings

Contact	Experiment	Technical specifications_0	Comments			
feature	Screen type	Resolution (px)	Color depth (bpp)	Navigation	Speaker	
iPod touch	TFT LCD	480 × 320 (4th gen.)	24 (4th gen.) 18 ...	Multi-touch screen	Yes (ex. 1st gen.)	
Gigabeat T-Series	TFT LCD	320 × 240	18	D-pad, 4 buttons	No	
GP2X F-200	TFT LCD	320 × 240	16	8-way d-pad/touch	Yes	
iPod classic	TFT LCD	320 × 240	16	Click wheel, 1 click	Clicker only	
Archos 405	TFT LCD	320 × 240	Predecessor: 24	D-pad, 6 two-whe...	No	
Archos 105	OLED	160 × 128	18	D-pad, 7 buttons	No	
Cowon Q5W	TFT LCD	800 × 480	24	Touchscreen	Yes	
iPod nano 6G	TFT LCD	240 × 240		Multi-touch screen	No	

# Evaluation

## RQ3: What kind of tools and services can be built on top of formalized PCMs?

### Metamodel

- Feature/product oriented
- Clear semantics



### Comparing products

1 183 ISO vs 793 ISO

80.0 vs 65.0

13 EV vs 11,5 EV

23,5 bits vs 22,1 bits

Yes vs No

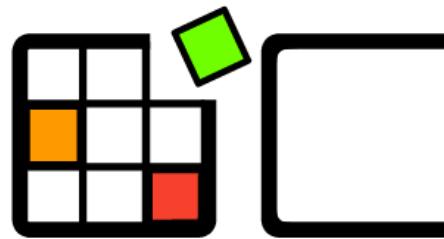
Contrast detection vs None

APS-C 23.6x15.6mm vs APS-C 22.3x14.9mm

### Translate PCMs to variability models

# Let us do it seriously ;-)

Contact	Experiment	Technical specifications_0	Comments			
FF	feature	Screen type	Resolution (px)	Color depth (bpp)	Navigation	Speaker
iPod touch	TFT LCD	480 × 320 (4th gen.)	24 (4th gen.)	18 ...	Multi-touch screen	Yes (ex. 1st gen.)
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Cowon Q5W	TFT LCD	800 × 480	24		Touchscreen	Yes
iPod nano 6G	TFT LCD	240 × 240			Multi-touch screen	No



## OpenCompare

[OpenCompare.org](http://OpenCompare.org)

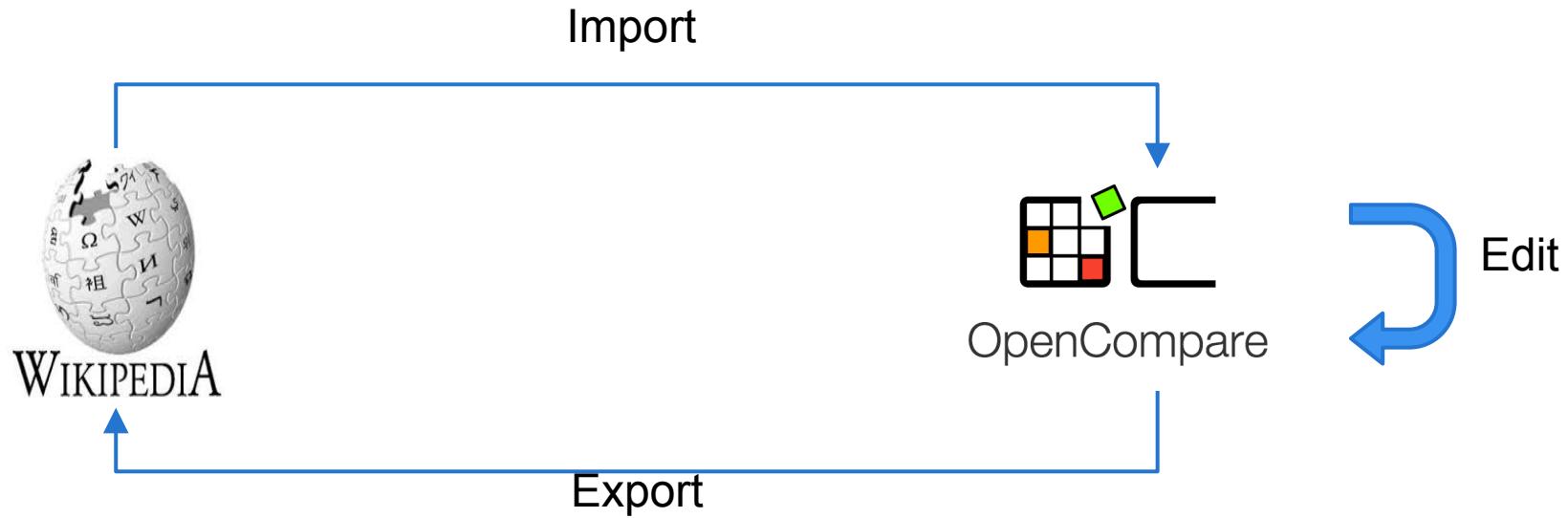
# OpenCompare.org

standard format  
collaborative edition  
import/export of numerous formats  
embeddable editor  
**open source** (<https://github.com/gbecan/OpenCompare>)  
**open data** ([opencompare.org/api/get/](http://opencompare.org/api/get/)**ID**)



**innovative services** (e.g., for visualizing, configuring, filtering and  
« playing » with comparisons; ways to share, collaborate, and easily create comparisons)

# Current case study: Wikipedia



```
| -  
! {{rh}} | [[KickassTorrents]]  
| {{yes|None}}  
| {{no}}  
| {{yes}}  
| {{no}}<ref>{{cite web|url=http://kickass.so/  
dmca/|title=KAT DMCA|work=kickasstorrents}}</  
ref>  
| {{sort|0000076|76}}<ref>[http://www.alexa.com/  
siteinfo/kickass.so KickassTorrents] at Alexa</  
ref>  
| -
```

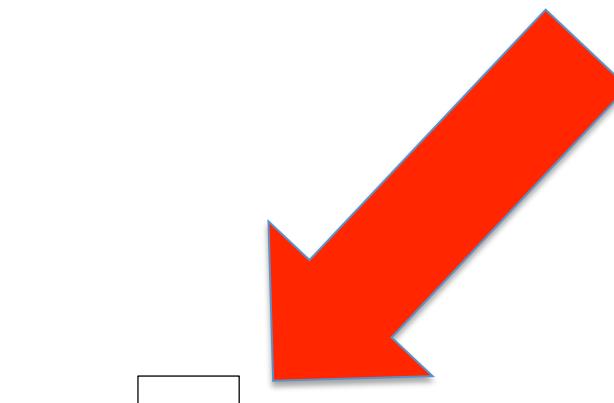
Title:  
Comparison of BitTorrent sites - Site comparison

+ Feature + Product ⚙ C

Product	Sortable	Multi-Tracker Ind.	Rss	Specialization
Find	Yes <input type="checkbox"/> No <input type="checkbox"/>	Yes <input type="checkbox"/> No <input type="checkbox"/>	Yes <input type="checkbox"/> No <input type="checkbox"/>	<input type="checkbox"/>
Buhaypirata Netw...	Yes	Yes	Yes	Philippine Media
1337x	No	Yes	No	None
YTS	Yes	No	Yes	Movies
AnimeSuki	Only new torrents	No	Yes	Anime & otaku sub...
Old Pirate Bay	Yes	No	Yes	None
T411	Yes	Yes	No	None
TorrentUs	Yes	Yes	Yes	None
rarbg	No	Yes	Yes	None
waffles.fm	Yes	No	Yes	Music
Seedpeer	?	?	?	?
Torrent Reactor	Yes	No	Yes	None
zoolze.org	?	?	?	?
YourBitTorrent	Yes	Yes	Yes	None

# Summary and Conclusion

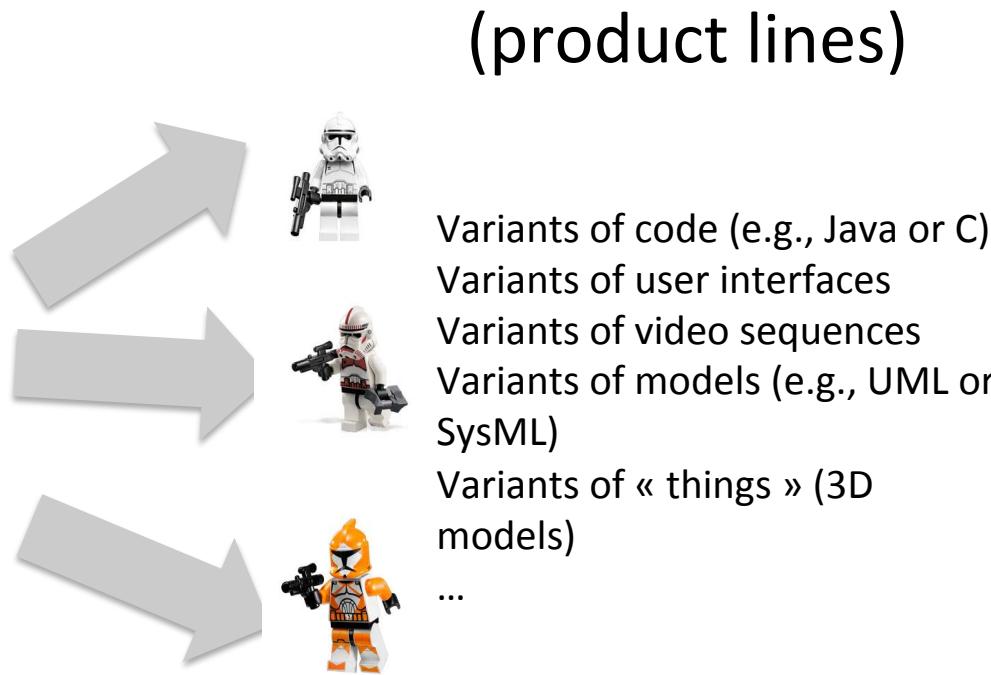
# Modeling and Reverse Engineering Variability

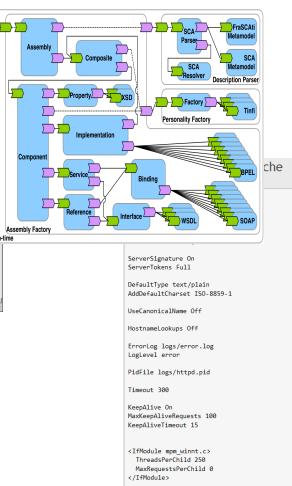
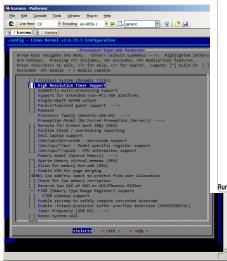


not, and, or, implies

Product	License	Price	Language Support	Language	WYSIWIG
W1	Commercial	10	Yes	Java	Yes
W2	NoLimit	20	No		Yes
W3	NoLimit	10	No		Yes
W4	GPL	0	Yes	Python	Yes
W5	GPL	0	Yes	Perl	Yes
W6	GPL	10	Yes	Perl	Yes
W7	GPL	0	Yes	PHP	No
W8	GPL	10	Yes	PHP	Yes

Feature models  
or Product Matrices





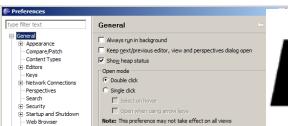
NEW KANGOO VAN RANGE



01 Preferences    02 Version    03 Equipment & options

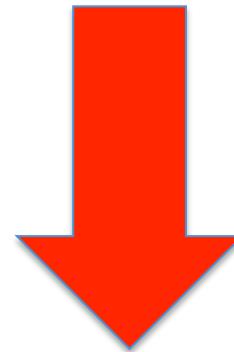
**OPTIONS**

- > COMFORT
  - Cool storage console & armrest between seats £20.00
  - Electric door mirrors £3.00
  - ESC (Electronic Stability Control) with traction and understeer control £200.00

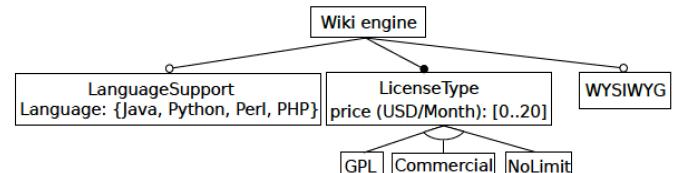


# maven

Mining/Extracting  
Extracting  
Encoding/Formalizing  
Synthesising



Product ▲	License	Price	Language Support	Language	WYSIWIG
Find					
W1	Commercial	10	Yes	Java	Yes
W2	NoLimit	20	No		Yes
W3	NoLimit	10	No		Yes
W4	GPL	0	Yes	Python	Yes
W5	GPL	0	Yes	Perl	Yes
W6	GPL	10	Yes	Perl	Yes
W7	GPL	0	Yes	PHP	No
W8	GPL	10	Yes	PHP	Yes



Commercial  $\Leftrightarrow$  LicenseType.price = 10    GPL  $\Rightarrow$  LanguageSupport  
 Commercial  $\Leftrightarrow$  Java    NoLimit  $\Rightarrow$  LicenseType.price  $\geq 10$   
 GPL  $\Rightarrow$  LicenseType.price  $\leq 10$      $\neg$  PHP  $\Rightarrow$  WYSIWYG  
 NoLimit  $\Leftrightarrow \neg$  LanguageSupport    Python  $\Rightarrow$  LicenseType.price = 0  
 $\Phi = \neg$  WYSIWYG  $\Leftrightarrow$  PHP  $\wedge$  LicenseType.price = 0

# FAMILIAR

(FeAture Model script Language for manipulation and Automatic Reasoning)

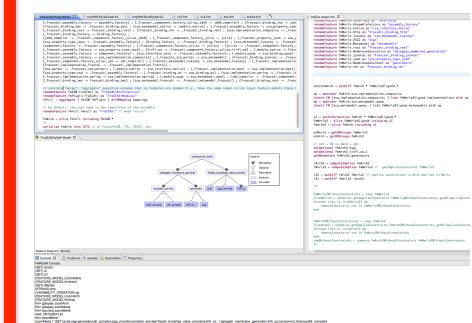
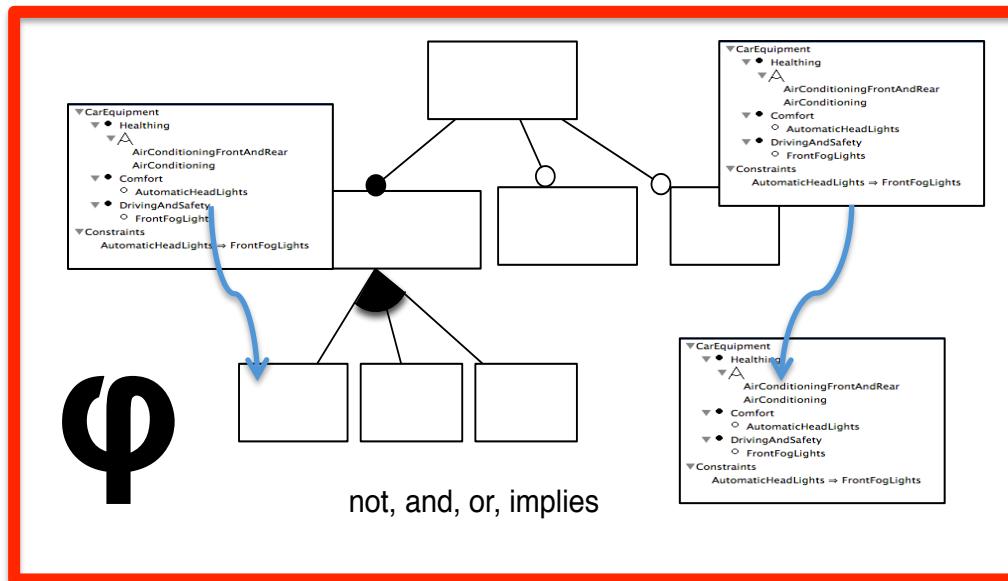
<http://familiar-project.github.com/>



S.P.L.O.T.  
Software Product Lines Online Tools

IDE  
Feature

TVL  
DIMACS

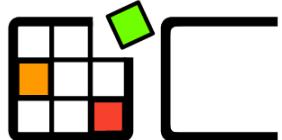


importing, exporting, composing, decomposing, editing, configuring,  
reverse engineering, computing "diffs", refactoring, testing,  
and reasoning about (multiple) variability models

# (Agent Smith)

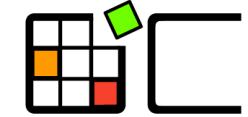


# Mining Comparison Matrices on the Web



OpenCompare





standard format

collaborative edition

import/export of numerous formats

embeddable editor

open source (<https://github.com/gbecan/OpenCompare>)

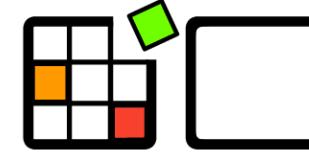
open data ([opencompare.org/api/get/{ID}](http://opencompare.org/api/get/{ID}))



innovative services (e.g., for visualizing, configuring, filtering and « playing » with comparisons; ways to share, collaborate, and easily create comparisons)

# Modeling and Reverse Engineering Product Lines

Product ▾	First name	Age	Country	Title	Breton
Find	<input type="text"/>	<input type="button" value="🔍"/>	<input type="button" value="≡"/>	<input type="button" value="🔍"/>	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/>
Acher	Mathieu	30	France	Associate Professor	no
Allier	Simon	28	France	Postdoc	no
Barais	Olivier	34	France	Professor	no
Baudry	Benoit	38	France	Scientist	yes
Becan	Guillaume	24	France	PhD student	yes
Behjati	Razieh	?	Iran	Postdoc	no
Blouin	Arnaud	32	France	Associate Professor	no
Combemale	Benoit	34	France	Scientist	no
Davril	Jean-Marc	?	Belgium	PhD student	no
Degueule	Thomas	24	France	PhD student	no (Poitou)
Filho	Bosco	28	Brazil	Postdoc	no
Galindo	Jose	28	Spain	Postdoc	no
Gotlieb	Arnaud	?	France	Scientist	no
Heymans	Patrick	?	Belgium	Professor	no
Jezequel	Jean-Marc	50	France	Professor	yes
Sana	Ben Nasr	24	Tunisia	PhD student	no
Sannier	Nicolas	33	France	Postdoc	no



OpenCompare

FAMILIAR



Inria  
INSTITUTS DU NUMÉRIQUE

UNIVERSITÉ DE  
RENNES 1

INSA  
RENNES

CNRS