



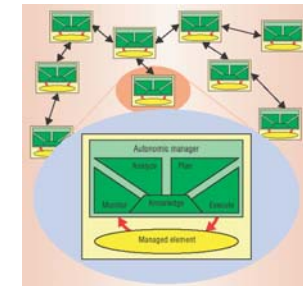
RETR'05

# Requirements-Driven Configuration of Software Systems



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# Overview

0. The context of the story
1. Motivation: *Complexity shift*
2. *Process, Abstraction and Automation*
3. A Case Study: Mozilla *Firefox*
4. Summary

# 0. Context of the story:

## A Software Engineering Course

- <http://www.cdf.toronto.edu/~csc408h/summer>
- The chosen course project is to *automatically reconfigure a large-scale software system (e.g. Firefox, Eclipse)*
- A project is divided into 3 phases:
  - Phase A: reverse engineer the high-level requirements of the software
  - Phase B: create a detailed configuration based on a user profile
  - Phase C: automate the configuration by generating proper values of the parameters of the software.
- Phase A, C are done by the same team, while the module of phase B must be “purchased” from another team

# 1. Motivation: Complexity Shift

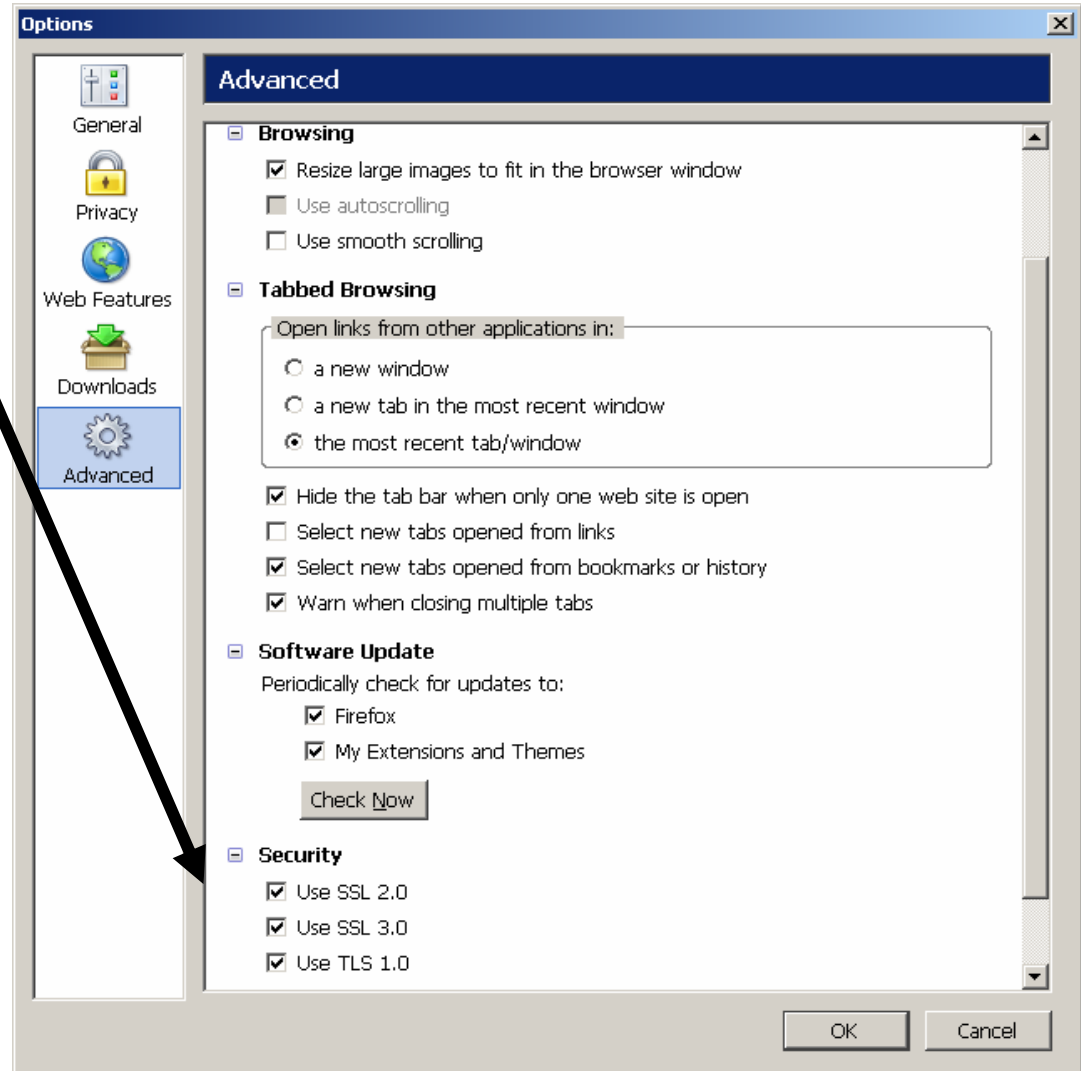
- Moore's law on hardware:  
*CPU speed doubles every 18 to 24 months*
- The 2<sup>nd</sup> Lehman's laws on software development:  
*Complexity of software systems increases*
- The relative cost of managing software complexity increases by a speed of *Moore \* Lehman*
- How to reduce the cost? Shift the complexity from end-users to the software can gradually make it disappear from users: *the **variability** of the system increases!*

# Complexity in configurations

## E.g. Firefox

- What does it mean by SSL 2.0, SSL 3.0 and TLS 1.0?
- Not to mention the number of parameters for “about:config”:

*“... This system is for use by people who know what they are doing only, by changing a value incorrectly you may damage or destroy your Firefox installation! Look to Help sites for handy preferences to tweak to customize Firefox further”.*



# about:config

RETR'05

about:config - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

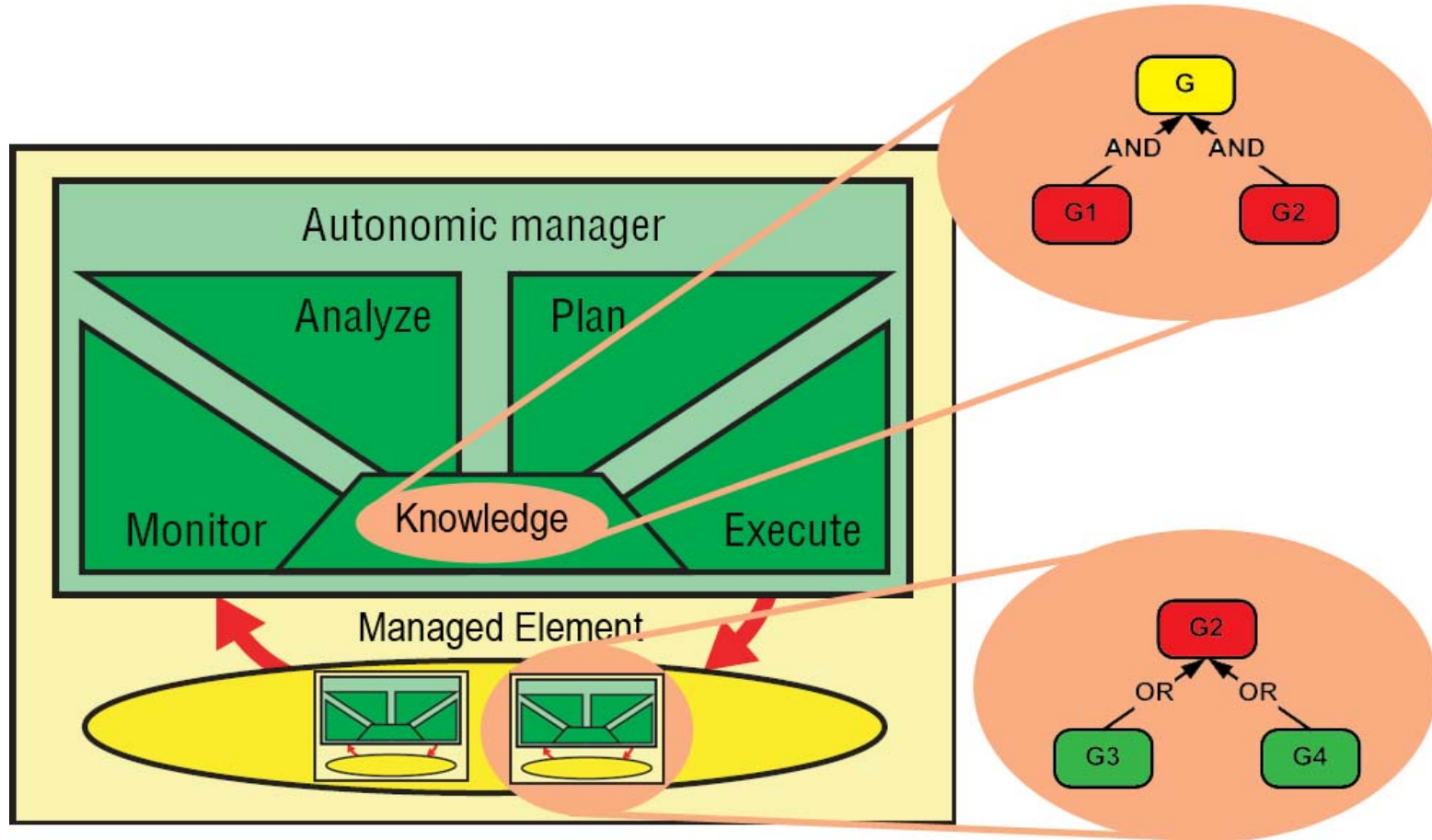
Filter:  Show All

Preference Name	Status	Type	Value
accessibility.accesskeycausesactivation	default	boolean	true
accessibility.browsewithcaret	default	boolean	false
accessibility.tabfocus	default	integer	7
accessibility.tabfocus_applies_to_xul	default	boolean	false
accessibility.typeaheadfind	default	boolean	false
accessibility.typeaheadfind.autostart	default	boolean	true
accessibility.typeaheadfind.enable sound	default	boolean	true
accessibility.typeaheadfind.enabletimeout	default	boolean	true
<b>accessibility.typeaheadfind.flashBar</b>	<b>user set</b>	<b>integer</b>	<b>0</b>
accessibility.typeaheadfind.linksonly	default	boolean	false
accessibility.typeaheadfind.soundURL	default	string	default
accessibility.typeaheadfind.startlinksonly	default	boolean	false
accessibility.typeaheadfind.timeout	default	integer	5000
accessibility.usebrailledisplay	default	string	
accessibility.usetexttospeech	default	string	
accessibility.warn_on_browsewithcaret	default	boolean	true
<b>adblock.patterns</b>	<b>user set</b>	<b>string</b>	<b>http://www.creaders.net/image/* http://marketing.888.com/* http://*maxserving.com/* http...</b>
advanced.mailftp	default	boolean	false
advanced.system.supportDDEExec	default	boolean	true
alerts.height	default	integer	50
alerts.slideIncrement	default	integer	1
alerts.slideIncrementTime	default	integer	10
alerts.totalOpenTime	default	integer	4000
allinonegest.autoscrollCursor	user set	boolean	false
allinonegest.autoscrollNoMarker	user set	boolean	false
allinonegest.autoscrollRate	user set	integer	0
allinonegest.autoscrolling2	user set	boolean	true
allinonegest.autoscrollpref	user set	integer	0
allinonegest.dragAlaAcrobat	user set	boolean	false
allinonegest.evenOnLink	user set	boolean	false
allinonegest.focusMode	user set	integer	0
allinonegest.functionString	user set	string	0 1 2 3 4 7 1 76 9 54 59 10 12 11 82 47 13 52 69 18 17 79 35 57 58 6 61 7 26 14 1...
allinonegest.gestureString	user set	string	L R UD UDU LU  U  DUD UL UR  RLDUR  DR RLR  +RUL  D  DU RUDR RU DL  +RU R...
allinonegest.gestureTrails	user set	boolean	true
allinonegest.goUpInNewTab	user set	boolean	false
allinonegest.leftDefault	user set	boolean	false
allinonegest.mouse	user set	boolean	true
allinonegest.mouse2buttons	user set	boolean	false
allinonegest.mousebuttonpref	user set	integer	2
allinonegest.neverWarnOnCloseOtherTabs	user set	boolean	false
allinonegest.nextsString	user set	string	next >
allinonegest.noAltGest	user set	boolean	true
allinonegest.noHorizScroll	user set	boolean	false
allinonegest.openInCurrTab	user set	boolean	false
allinonegest.panning	user set	boolean	false
allinonegest.prevsString	user set	string	prev <
allinonegest.reverseScrolling	user set	boolean	false
allinonegest.rockersString	user set	string	0 1 73 72
allinonegest.rockertypepref	user set	integer	0

Done

Adblock

# An Autonomic Element for self-management



# 2. Towards self-configuring

Software dependent



Goals

A fact that is either true (satisfied) or false (denied)

Softgoals

A fact that can be partially satisfied as long as its fulfillment is above a threshold (expectation)

Rules

A logic rule such as AND, OR, +, -, ++, --

Goal model

Skills

The capability of the user to fulfill the delegated goals.

Preferences

The partial order between goals to set priority for the planning.

User profile



Requirements Configurator (reasoning & tradeoffs)

Software independent

Selected leaf goals

Tasks

Between leaf goals and parameters

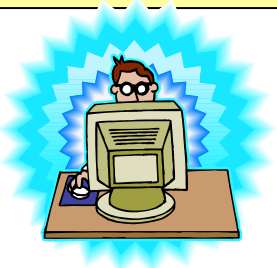
Mappings

Goal configuration

Software Configurator

Software dependent

Parameters  
Software Configuration





2. Configuration

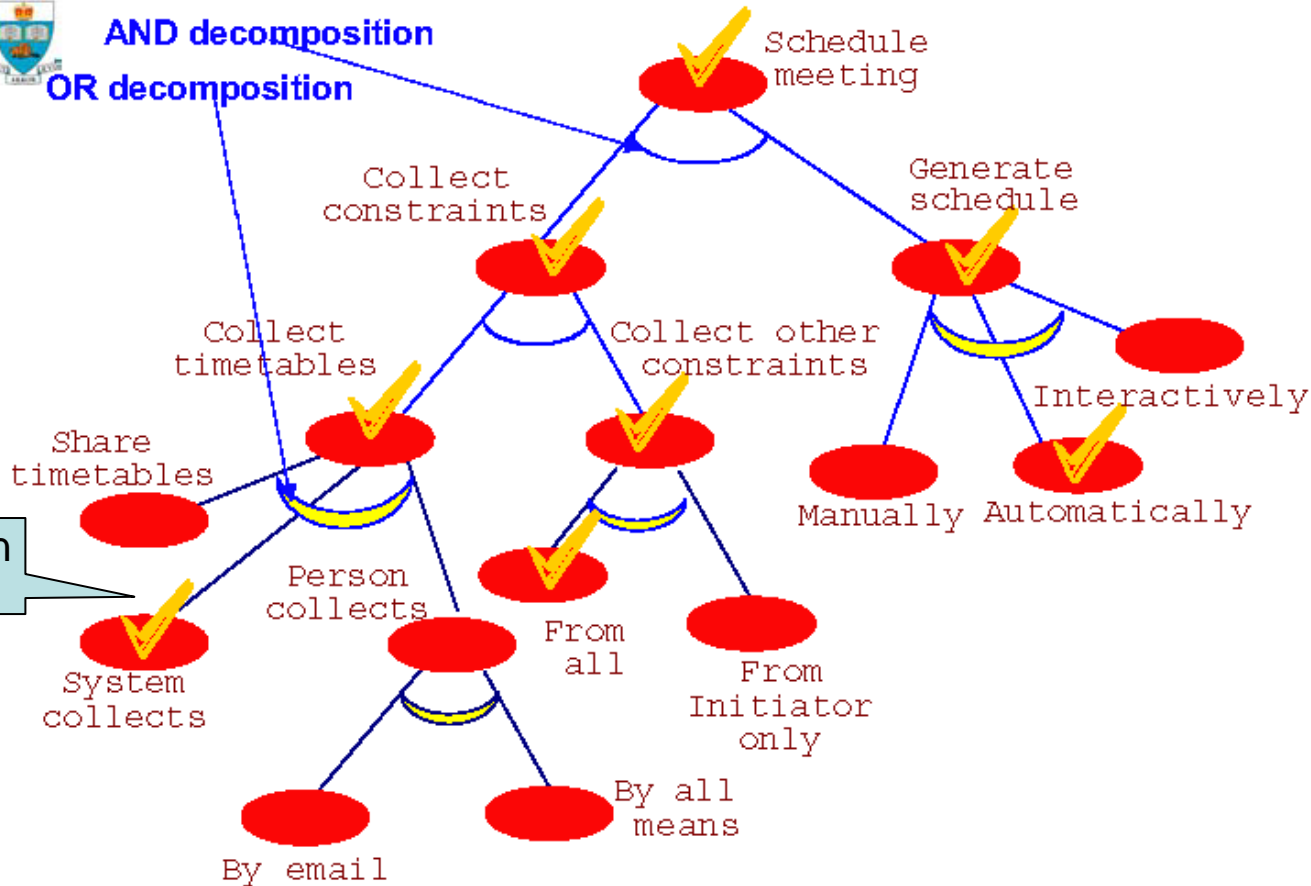
# 2.1 Abstraction: goal model (1)

Conceptual Modeling

GSC2507



AND decomposition  
OR decomposition

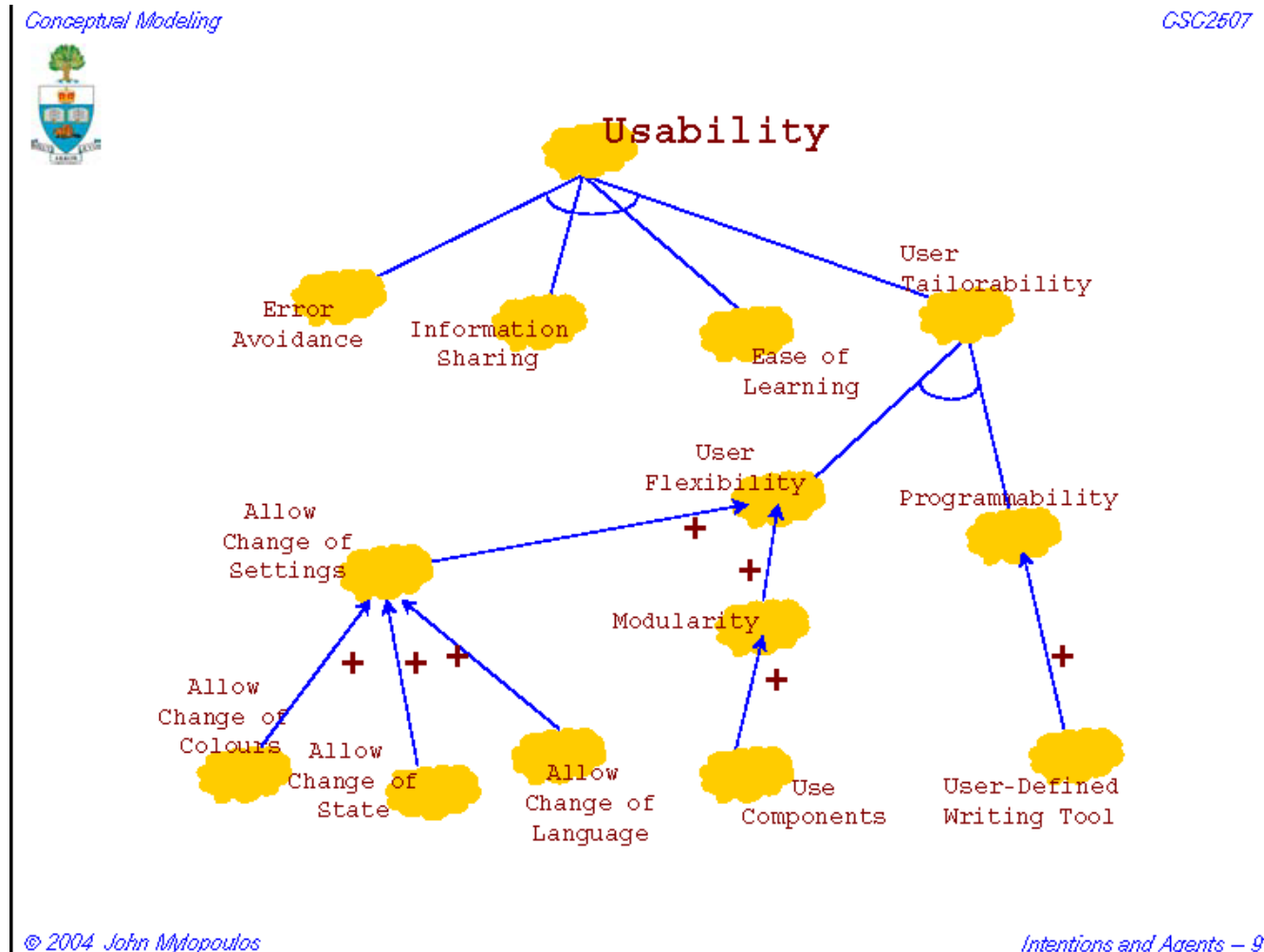


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Intentions and Agents – 6

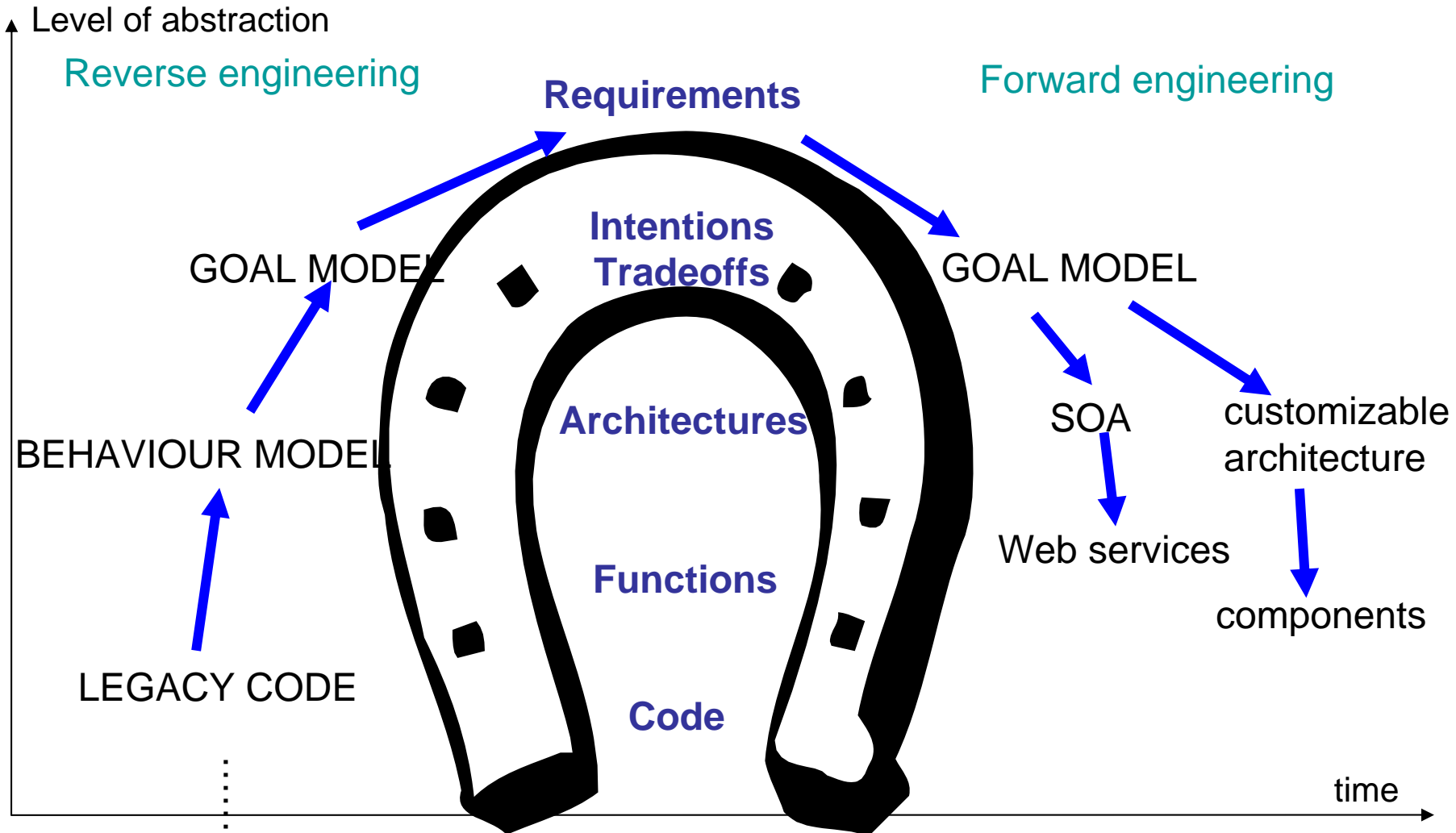
## 2. Configuration

## 2.1 Abstraction: goal model (2)



2. Configuration

# 2.1 Abstraction: goal model (3)



## 2.2 Automation

1. Given a goal model, a user's skills, preferences and expectations, can we find a task configuration automatically?
2. Given a task configuration, can we find a set of configuration items (parameter values) that satisfy these tasks automatically?
3. Given a set of configuration items, can we automatically reconfigure the subject software without changing its source code?

## 2.2 Automation

### 2.2.1 Algorithms for reasoning and tradeoffs

- Label propagation using logic rules:  
For example:  $g = \text{AND}(g1, g2)$ 
  - Bottom-up reasoning [Giorgini et al @ ER'02]  
*If  $g1, g2$  are both satisfied, then  $g$  is satisfied*
  - Top-down reasoning [Sebastini et al @ CAiSE'04]  
*If  $g$  is to be satisfied, then both  $g1, g2$  are to be satisfied*
- Fitness function design
  - A goal/softgoal is not satisfied if (after label propagation) its label is below expectations (skills or thresholds)
  - Preferred goals have heavier weight than less important ones
  - *Good-enough* versus *Optimal* to allow quick switch between alternatives
- A modified genetic algorithm
  - Populations, Fitness, Crossover, Mutation, etc. are classic GA
  - Termination condition is changed (to stop at good enough solutions)

## 2.2 Automation

### 2.2.2 Map tasks to configuration items

- A leaf goal has a Boolean value
- A configuration item can be in any domain, such as integer, string, etc.
- A Boolean expression is used to link a configuration item to a leaf goal
  - Bottom-up: reflect a configuration item into the satisfaction of a leaf goal ??? Example figure
  - Top-down: choose a *default* value of the configuration item to satisfy the leaf goal ??? Example figure
- Such mappings have to be given by domain experts

## 2.2.3 Generating configuration scripts

- A software can be reconfigured without changing its source code by:
  - Changing its default settings at deployment time (E.g. a properties file, or a few command line options)
  - Changing the settings that are monitored by the software
- A “script” here means either a batch file or property file for the first case, or a sequence of API calls for the second case
- It is generated based on the settings of configuration items

## 3. Mozilla Firefox

- It is a large-scale open-source software
- It has a large user base (~100 Million users, or 10% of the Internet surfers)
- The configuration complexity for the software is huge
- Different needs and tastes make it hard to predict how to configure the individual parameters to satisfy a particular user



# An example input

## GOAL MODEL

```

<input:model>
<soft name= "Performance">
<rule op="AND"/>
<soft name= "Browsing Performance"/>
<soft name= "System Performance"/>
</soft>
<soft name= "Usability">
<rule op="OR"/>
<soft name= "Ease of Search"/>
<soft name= "Convenient access to Information"/>
<soft name= "User Tailorability">
  <rule op="OR"/>
  <soft name= "Programmability"/>
  <soft name= "User Flexibility"/>
</soft>
</soft>
<soft name= "Security">
<rule op="HURT" target="System Performance"/>
<rule op="HURT" target="Browsing Performance"/>
</soft>
<soft name= "Allow changes in Content Appearance">
<rule op="HELP" target="User Flexibility"/>
</soft>
<goal name= "Filter Advertisement/Spyware/Popups">
<rule op="HELP" target="Performance"/>
<rule op="HELP" target="Security"/>
<rule op="HURT" target="Content Availability"/>
</goal>
</input:model>

```

## PROFILE

```

<input:profile>
<soft name="Security" rank="4" value="6" />
<soft name="Allow Interactive Content" rank="8"
  value="8" />
<soft name="Convenient Access to Information"
  rank="10" value="10" />
<soft name="Performance" rank="9" value="1" />
<soft name="Content Availability" rank="1"
  value="10" />
<soft name="Allow changes in Content Appearance"
  rank="6" value="4" />
<soft name="User Flexibility" rank="3" value="6" />
<soft name="Speed" rank="7" value="3" />
<soft name="Programmability" rank="3" value="8" />
<soft name="Modularity" rank="5" value="1" />
<soft name="Usability" rank="2" value="6" />
</input:profile>

```

# The profile elicitation

**Profile Name**  
New Profile

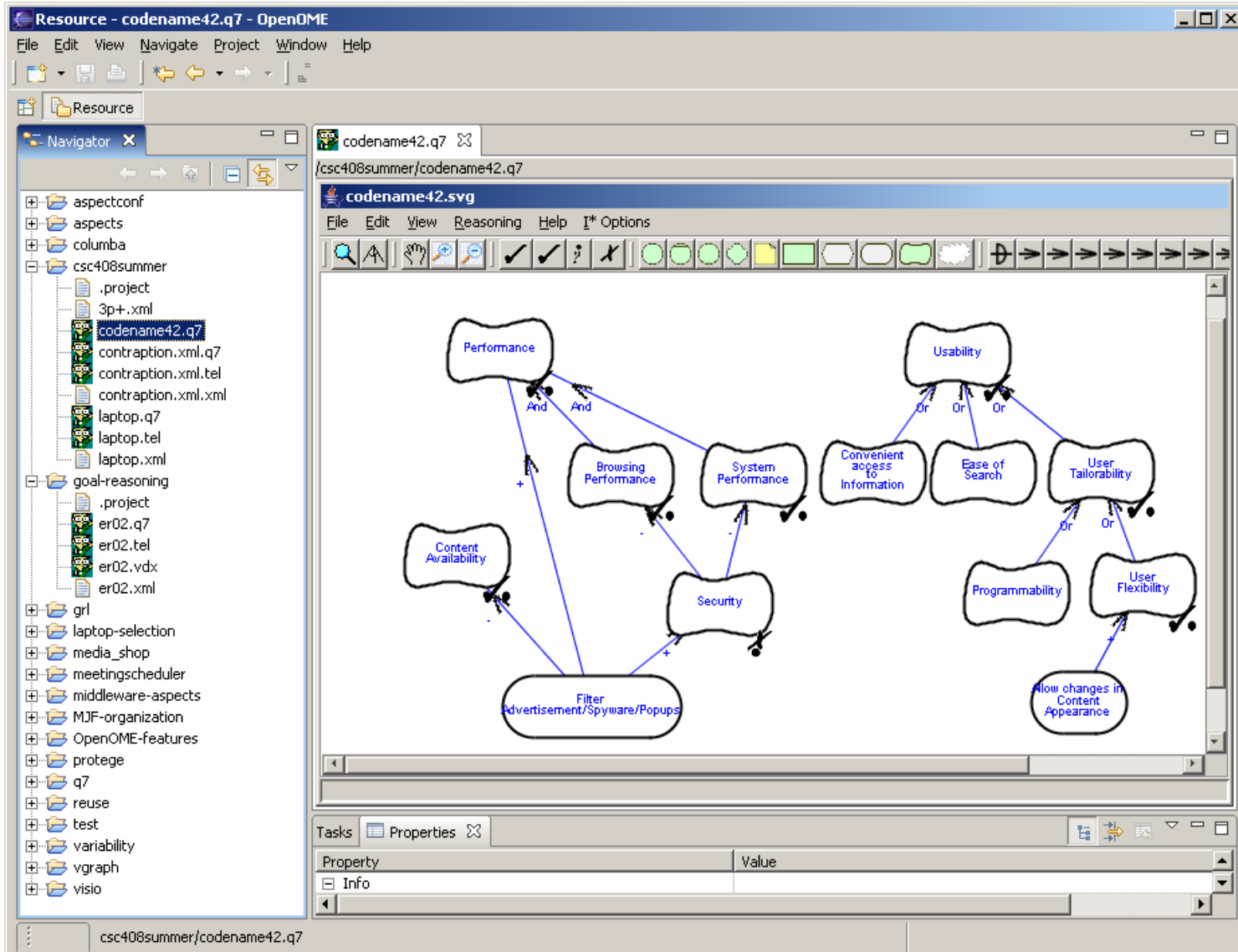
Goal Name	Value	Rank
Performance	1	1
Usability	1	1
Speed	1	1
Security	1	1
Allow changes in Content Appearance	1	1
Allow Interactive Content	1	1
Modularity	1	1
Content Availability	1	1
Programmability	1	1
User Flexibility	1	1
Convenient Access to Information	1	1

**Profiles**

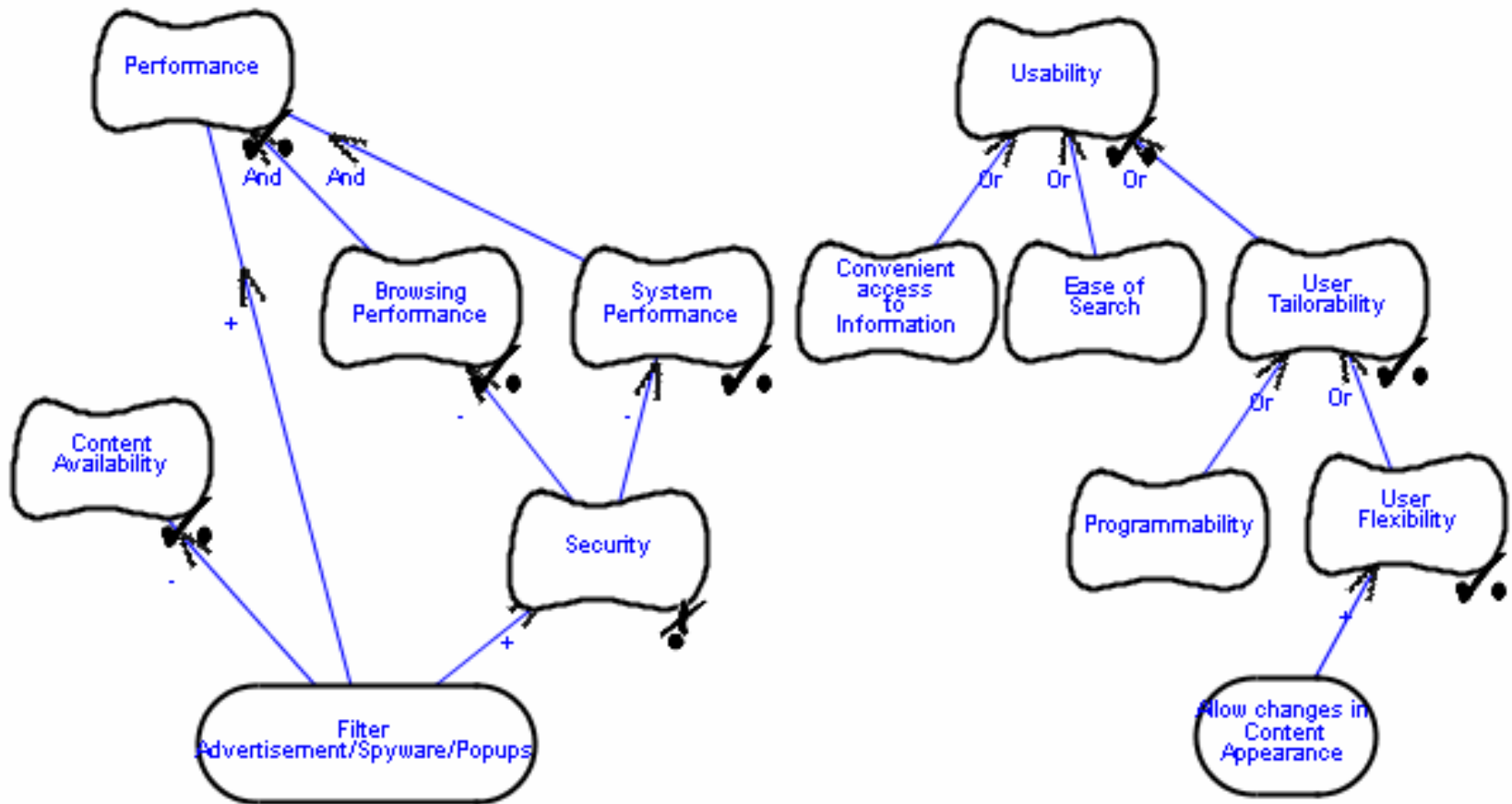
- ◆ New Profile
- ▼ test\_profile1
- ▼ test\_profile2
- ▼ test\_profile3
- ▼ test\_profile4

Save Preference Profile      Apply Preference Profile      Delete Preference Profile

# The goal reasoning



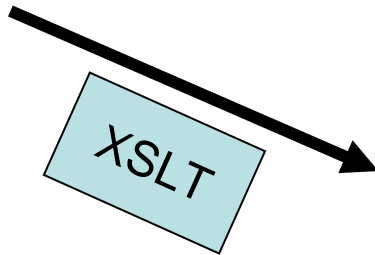
# Softgoal interdependency graph



# The resulting configuration

## PARAMETERS

```
<output:configuration>  
<goal name="adFilterStrength" value="on" />  
<goal name="tabBrowsingOn" value="off" />  
<goal name="cookiesEnabled" value="off" />  
<goal name="daysToCachePages" value="on" />  
</output:configuration>
```



## JAVASCRIPTS

```
user_pref("network.image.imageBehavior", 2);  
user_pref("network.cookie.cookieBehavior", 2);  
user_pref("webdeveloper.disabled", false);  
user_pref("browser.display.use_document_colors", true);  
user_pref("javascript.enabled", false);  
user_pref("webdeveloper.disabled", false);  
user_pref("adblock.enabled", true);  
user_pref("tidy.options.browser_disable", false);  
user_pref("font.size.variable.x-western", 19);  
user_pref("image.animation_mode", "normal");  
user_pref("extensions.prefbar.display_on", 0);  
user_pref("security.enable_java", false);  
user_pref("security.default_personal_cert", "Select  
Automatically");  
user_pref("browser.cache.disk.enable", false);
```

## 4. Summary and Future work

- *Through the Mozilla Firefox case study we've shown how goal-oriented requirements can be used to guide the configuration process automatically*
- *The goal models are provided by domain experts, the user profiles are obtained by the users directly through a simplified user interface, and the configuration is carried out without further human intervention*
- *Currently, we are investigating*
  - *how to apply the mechanism to other applications*
  - *how to detect side effects when it is performed at runtime.*
  - *to implement a Firefox extension for the massive user community*
  - *to solicit feedback from users.*