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## Understanding **Technological Spaces** Objectmare

Ralf Lämmel Software Languages Team University of Koblenz-Landau

Wednesday, June 20, 12

Grammarware

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Modelware

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Comprehensive understanding of software necessitates understanding of technological Wednesday, June 20, 12 Technological spaces: An initial appraisal

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Understanding Technological Spaces | CWI Amsterdam | Researc... www.cwi.nl/abstract-cwi-lectures-understanding-technological-spaces Comprehensive understanding of software necessitates understanding of technological spaces, i.e., community and technology contexts as they include specific ...

#### TECHNOLOGICAL SPACES

mailman.apnic.net/mailing-lists/s-asia-it/archive/.../msg00007.html To: s-asia-it at apnic dot net; Subject: TECHNOLOGICAL SPACES; From: "Irfan Khan" <KhanIA@super.net.pk>; Date: Sun, 4 Oct 1998 22:01:23 +0500; Sender: ...

Professor Fish: Understanding Technological Spaces professor-fish.blogspot.com/.../understanding-technological-spaces.ht...

#### **Technological Spaces: an Initial Appraisal**•

Ivan Kurtev<sup>1</sup>, Jean Bézivin<sup>2</sup>, Mehmet Aksit<sup>1</sup>

<sup>1</sup> Software Engineering Group (TRESE), University of Twente, The Netherlands {kurtev, aksit}@cs.utwente.nl

<sup>2</sup> Faculty of Sciences, University of Nantes, France bezivin@sciences.univ-nantes.fr

Abstract. In this paper, we propose a high level view of technological spaces (TS) and relations among these spaces. A technological space is a working context with a set of associated concepts, body of knowledge, tools, required skills, and possibilities. It is often associated to a given user community with shared know-how, educational support, common literature and even workshop and conference regular meetings. Although it is difficult to give a precise definition, some TSs can be easily identified, e.g. the XML TS, the DBMS TS, the abstract syntax TS, the meta-model (OMG/MDA) TS, etc. The purpose of our work is not to define an abstract theory of technological spaces, but to figure out how to work more efficiently by using the best possibilities of each technology. To do so, we need a basic understanding of the similarities and differences between various TSs, and also of the possible operational bridges that will allow transferring the results obtained in one TS to other TS. We hope that the presented industrial vision may help us putting forward the idea that there could be more cooperation than competition among alternative technologies. Furthermore, as the spectrum of such available technologies is rapidly broadening, the necessity to offer clear guidelines when choosing practical solutions to engineering problems is becoming a must, not only for teachers but for project leaders as well.

#### **Technological Spaces: an Initial Appraisal**•

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A technological space is a working context with a set of associated concepts, body of knowledge,tools, required skills, and possibilities. It is often associated to a given user community with shared know-how, educational support, common literature and even workshop and conference meetings. It is at the same time a zone of established expertise and ongoing research and a repository for abstract and concrete resources.







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Wednesday, June 20, 12



Technical space comprises one or more modeling spaces

Djuric, D., Gaševic, D., Devedžic, V.,: "The Tao of Modeling Spaces", in *Journal of Object Technology*, vol. 5. no. 8, Novmeber-December 2006, pp. 125-147.<u>http://www.jot.fm/issues/issue\_2006\_11/article4</u>









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http://www.dagstuhl.de/04101 29.02.04 — 05.03.04, Seminar 04101 Language Engineering for Model-Driven Software Development Organizers J. Bézivin and R. Heckel









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**Technological space** = Technology and community context in software engineering

- Objectware
- Modelware
- Grammarware
- XMLware
- Ontoware
- Tableware

## More technological spaces ...

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## More technological spaces ...



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# 101 companies to the rescue

**101companies: a community project on software technologies and software languages** by Jean-Marie Favre, Ralf Lämmel, Thomas Schmorleiz, Andrei Varanovich. In Proceedings of TOOLS 2012. <u>http://softlang.uni-koblenz.de/101companies/inauguration/</u> Kind regards from Jean-Marie Favre

## We have a problem!

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#### Kind regards from Jean-Marie Favre



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## What's IOI companies?

## What's 101 companies?

## The Hitchhiker's Guide to the **Software** Galaxy

lt is ...





# Software developers need to be space travelers!



http://www.nasa.gov/images/content/63114main\_highway\_med.jpg
# Why is space travel a burden?

- Computational models
- Type systems
- Culture
- Conventions, terminology
- Graphs vs. trees vs. ...
- ..
- Accidental complexity

http://upload.wikimedia.org/wikipedia/en/thumb/6/66/E\_t\_the\_extra\_terrestrial\_ver3.jpg/220px-E\_t\_the\_extra\_terrestrial\_ver3.jpg

It is a knowledge resource for technological space travel.



http://upload.wikimedia.org/wikipedia/en/thumb/6/66/E\_t\_the\_extra\_terrestrial\_ver3.jpg/220px-E\_t\_the\_extra\_terrestrial\_ver3.jpg



It is a knowledge resource for technological space travel.





A **community project** aiming at a **knowledge base** about software **technologies and languages** based on implementations of a humanresources management system.

### Why is it called "101 companies"?



101 ways of building a HRMS. Building a HRMS for 101 companies.

### A Human Resources Management System



- Increase salaries
- Cut salaries
- Edit employee data
- Import / export company data

# The IOI companies Repository



# The 101 companies Wiki

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#### Objective

101companies is a community project in computer science (or software science) with the objective of developing a free, structured, online knowledge resource including an open-source repository for different stakeholders with interests in software technologies, software languages, and technological spaces; notably: teachers and learners in software engineering or software languages as well as software developers, software technologists, and ontologists.

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#### Contributions

The project relies on the aggregation, organization, annotation, and analysis of an open-source corpus of contributions to an imaginary *Human Resource Management System*: the so-called *101companies* System, which is prescribed by a set of optional features. Contributions may be 101implementations of system variations and specifications thereof. Each contribution should pick a suitable, typically small set of features and demonstrate original and noteworthy aspects of software technologies and software languages in a focused manner. Contributions are grouped in themes to better apply to varying stakeholders and objectives. The project also relies on contributions in the broader sense of resources for software technologies and software languages, or components of an emerging ontology.

#### Index

- The features of the 101companies System
- The implementations of the 101companies System
- The stakeholders of 101companies Project
- Some themes of contributions
- Some ideas for contributions
- The ontology of the 101companies Project
- Frequently Asked Questions about the 101companies Project
- Comprehensive resources on the 101companies Project

All 101companies content and code is subject to the 101companies license(s).

#### Have a look at the introductory paper for 101companies.

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### Feature model

#### Classification

- [-] 101feature
- [-] Behavioral 101feature
  - Data export Data import
  - Logging
  - Structure-driven query
  - Type-driven query Type-driven transformation
  - **Visualization**
- [+] Meta 101feature
- [-] Quality 101feature
- [+] 101design
- [-] 101execution
- Access control
- Data parallelism
  - Distribution
  - Persistence
- Reliability
- Serialization Task parallelism
- [-] Structural 101feature
- Global invariant
- Graph structure
- Many-to-many
- Tree structure
- Type hierarchy
- [+] UI 101feature

- All features of the 101companies System
  - An export operation for company data
  - An import operation for company data
  - Logging of salary changes
  - A query for the depth of department nesting
  - A query for totaling the salaries of all employees
  - A transformation for a salary cut
  - The visualization of company data
  - Design qualities of the 101companies System
  - Execution qualities of the 101companies System
    - Access control for company data
    - Data parallelism for operations on company data
    - Distribution of company data and operations
    - Persistence for company data
    - Reliability of the system services
    - Serialization for company data
    - Task parallelism for operations on company data
  - A constraint on salaries within the company hierarchy
  - An association between mentees and mentors
  - A friend relationship between employees
  - Tree-like structure of companies and departments
  - A common base type for departments and employees

### Classification

[-] 101feature [-] Behavioral 101feature Data export Data import Logging Structure-driven query Type-driven query Type-driven transformation Visualization [+] Meta 101feature [-] Quality 101feature [+] 101design [-] 101execution Access control

Data parallelism

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Architecture		



### Category: Java mapping theme

Path: Base  $\rightarrow$  101companies  $\rightarrow$  101main  $\rightarrow$  101theme  $\rightarrow$  Java mapping theme

### Intent

--- Java theme of implementations that travel technological spaces ---

### Description

Subject to appropriate bridges, i.e., subject to mapping facilities, any programming language can be made to access and process models, XML, relational database tables, and text (concrete syntax) in a type-based (say, schema-aware or metamodel-aware or grammar-aware) manner. The present theme collects corresponding implementations for the programming language Java.

### Classification

- [-] Java mapping theme antlrObjects emfGenerative hibernate jaxbComposition
- Java theme of implementations that travel technological spaces
  - Object/Text mapping for Java with ANTLR for parsing
  - Model/Object mapping for Ecore and Java with EMF
  - Object/Relational mapping for Java and SQL/HQL with Hibernate

GNU F

Object/XML mapping for Java and XSD with JAXB

#### Category: 101theme

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# The 101 companies Wiki

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<pre>scheme derived classes, the operation out can be improvement with static methods as follows: publics states (up ( publics statics well out)[Despaces()])</pre>	reprinting	and, or way, any bitteria sease constant, for reading, the facts for ranks are manager are another a, therein expressing that a valid department alignit must specify a same and a manager. On log of the
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<pre>blic static veld con(Superiment 4) {     out(d, primerent));;     der (Superimerent);; </pre>	dan o	epartment d : c.prthepartment())
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Architecture		



### 101implementation:jaxbComposition

Path: Base → 101companies → 101main → 101theme → Java mapping theme → 101implementation:jaxbComposition

Github: jaxbComposition

This is an implementation in the 101companies software corpus.

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  - 2 Languages
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  - 4 Features
  - 5 Motivation
  - 6 Illustration
  - 7 Architecture
  - 8 Usage
  - 9 Contributors
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#### Headline

--- Object/XML mapping for Java and XSD with JAXB ---

#### Languages

- XML
- XSD
- Java
- JAXB annotations
- xjc POJOs

### Technologies

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<ul> <li>Type-driven transformation</li> </ul>
Education Control Cont
<ul> <li>Type faced mapping</li> </ul>
<ul> <li>Type prevalue.</li> </ul>
Motivation
IM, import and expert is supported for a laws based implementation its means of IUX mapping. The primary data model
for companies is an XML scheme. The scheme complex up of XMB is used to generate loss classes from the scheme. In this manner, operators of an XML representation of companies can be implemented in sear to repulse (0) fashion while
using a problem specific algost model. In different terms, one can carry aid XM, presseding while essentially staying in th
defined in a manner that the resulting sight model systematically leverages sight composition and no class interfaces.
fact, the scheme-derived classes are very similar to a regular 00 design, see 10 implementation proclampention. It is incomfact to task the file consistence of protection are not incommend as included, similar the small income
modification of schema-derived classes—unless advanced modularization mechanisms were leveraged. Instead, the
operations are impremented as static methods in non-achemic derived classes.
Illustration
The following XMs scheme fragment above the element declaration for departments:
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### Languages

- XML
- XSD
- Java
- JAXB annotations
- xjc POJOs

### Technologies

- JAXB
- xjc (part of JAXB)
- Eclipse
- GNU make

### Features

- Tree structure
- Type-driven query
- Type-driven transformation
- Data import
- Data export
- Type-based mapping
- Type generation

### Motivation

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#### Motivation

XML import and export is supported for a Java-based implementation by means of O/X mapping. The primary data model for companies is an XML schema. The schema compiler xjc of JAXB is used to generate Java classes from the schema. In this manner, operations on an XML representation of companies can be implemented in near-to-regular OO fashion while using a problem-specific object model. In different terms, one can carry out XML processing while essentially staying in the technological space of objectware. It is insightful to compare XML schema and schema-derived classes. The XML schema is defined in a manner that the resulting object model systematically leverages object composition and no class inheritance. In fact, the schema-derived classes are very similar to a regular OO design; see 101implementation:javaComposition. It is important to note that the operations on companies are not implemented as instance methods since this would imply modification of schema-derived classes----unless advanced modularization mechanisms were leveraged. Instead, the operations are implemented as static methods in non-schema-derived classes.

#### Illustration

The following XML schema fragment shows the element declaration for departments:

```
<xs:element name="department">
  <xs:complexType>
    <xs:sequence>
        <xs:element ref="name"/>
        <xs:element name="manager" type="employee"/>
        <xs:element ref="department" maxOccurs="unbounded" minOccurs="0"/>
        <xs:element name="employee"
            type="employee" maxOccurs="unbounded" minOccurs="0"/>
        </xs:element name="employee"
            type="employee" maxOccurs="unbounded" minOccurs="0"/>
        </xs:sequence>
        </xs:sequence>
        </xs:complexType>
</xs:complexType>
</xs:element>
```

That is, department elements line up children elements for name, manager, sub-departments, and employees. There is an XSD type *employee* which is used in two local element declarations: one for managers; another one for regular employees. The schema-derived class for departments looks as follows:

```
@XmlAccessorType(XmlAccessType.FIELD)
@XmlType(name = "",
    propOrder = { "name", "manager", "department", "employee" })
@XmlRootElement(name = "department")
public class Department {
    @YmlElement(magnimed = temp)
```

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```
@XmlAccessorType(XmlAccessType.FIELD)
@XmlType(name = "",
    propOrder = { "name", "manager", "department", "employee" })
@XmlRootElement(name = "department")
public class Department {
    @XmlElement(required = true)
    protected String name;
    @XmlElement(required = true)
    protected Employee manager;
    protected Employee manager;
    protected List<Department> department;
    protected List<Department> department;
    protected List<Employee> employee;
    // Getters and setters omitted
}
```

This class essentially models POJOs for departments in a way similar to regular OO programming. However, the schema compiler injects a number of annotations into the schema-derived classes so that sufficient information is tracked for serialization, and, in fact, XML Schema-based validation. For instance, the fields for name and manager are annotated with required=true, thereby expressing that a valid department object must specify a name and a manager. On top of the schema-derived classes, the operation *cut* can be implemented with static methods as follows:

```
public class Cut {
    public static void cut(Company c) {
        for (Department d : c.getDepartment())
            cut(d);
    }
    public static void cut(Department d) {
        cut(d.getManager());
        for (Department s : d.getDepartment())
            cut(s);
        for (Employee e : d.getEmployee())
            cut(e);
    }
    public static void cut(Employee e) {
        e.setSalary(e.getSalary() / 2);
    }
}
```

### Architecture

# The 101 companies Wiki

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Architecture





### The 101 companies CONTRIBUTORS

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In Tissen

Lyzun Oleksandr

Martijn van Steenbergen

Marius Rackwitz

Martin Leinberger

Mark Hills

Martina Sekulla

Michael Kusenbach

Matt Roberts

Paul Klint

Ralf Lämmel

Rebecca Bindarra

Rodrigo Bonifacio

Sebastian Jackel

Sven Karol

Katharina Naujokat

Mahdi Derakhshanmanesh

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	- non theme of imprementations that travel technological species
	Description
	Perce geometry
	Subject to appropriate integers, i.e., subject to mapping facilities, any programming language can be made to access and
	process match, 201, matching database around, and take (concrete syntax) in a type taxed (asy, schema aware or nationable assets or promote asset) matches. The present livera collects consecutive indemoting interneting on the live
	programming torquipe time.
	Classification
	(a) into manife theme ( ) into theme of independence that have independence
	and others in the second secon
	enformative - Hubs/Diput nasary for loan and loss with DM
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E descritation is described for a loss based on properties to the same of information of the same of the fragments is an effect of the same of the
Headline           - dispect/CRL mapping for 2 weat and 100 webt 2008           Languages           - N           -
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Languages
end     e
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Technologies       9.001       9.002
XXX     X
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Peakures
Tries divolution     Trips divolution     Trips divolution     Trips divolution     Trips divolution     Trips divolution     Seas import     Seas import     Seas import     Trips divolution
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<ul> <li>Type drawk Standardson</li> <li>Sea report</li> <li>Sea report</li> <li>Type generation</li> </ul> Motivation Motivation Motivation Motivation Motivation Motivation Motivation In provide a separate is supported for a large large functionation by means of ((X) mapping). The primary also a for comparison to an USA, subsets, The science complete up of 2008 to case is apprential box (beam from the science).
Eliza super     Type forwardsen     Type generation     Hotivation     Metivation     mon report and expert to supervise for a loss taxed implementation to mass of (b)t mapping. The primary alter     mon report and expert to supervise have the alternative complex op of 2008 to used in generate lase closes from the ultern
Type percention     Type percention     Multivation     Model and expert to asserted for a law based implementation to means of (b) mapping. The primary data is     for compariso to m10%, shown. The scheme complex go of 2008 to percent bare (because how the scheme
Nativation Import and export is supported for a laws based implementation by means of by't mapping. The primary data in for comparison is an IML scheme. The scheme complete (p of 2008 is used is generate laws from the scheme
10% import and expert is supported for a lawsileased implementation to means of GV mapping. The primary data in for companies is an IPA, scheme. The scheme complex (p. of 2438) is used to generate laws cleases from the scheme.
for comparises is an IML scheme. The scheme compiler siz of 2018 is used to generate Java classes from the scheme
this function associations at all 1986, representations of continuous cash by characteristic in cash in cash in the function of
using a problem specific stipol model. In different terms, one can carry out XM, proceeding while maantially staying
defined in a manner that the resulting object model applementary loverages object composition and no clean interfer
Aut, the advance-derived classes are very similar to a regular 00 design; see 100-spectrature/percomposition, important to role that the specializers on comparise are not implemented as indense methods since this would imply
modification of scheme derived classes - unless advanced modularization mechanisms were leveraged. Instead, the secondarization are insteamented as more methods in our advance derived classes.
Illustration
The following XMs scheme fragment above the element declaration for departments:
"merelument name"depertment's
Can expanded
"An eliment same "manager" type "mailment" for
"an alassa sans" spirger" type "approve" and subscript" "abounded" at abounder" 17/9
4/second and year
4/asseptiment/
That is, department elements the up children elements for name, manager, sub-departments, and employees. There 15th type employee which is used in two local element declarations: one for managers, another one for names and
The schema-derived class for departments tasks as follows:
REGARMENTYPE (EndersenType FIELD) REGType (some
prophotes = ( "same", "manager", "department", "employee" )) #EpitionElement(came = "department")
Stallament.(repland = true)
Residented Disting Annes
protocold Supervised Link Department,
7/ Dettary and settary omitted
,
This case essentially models PODS for departments in a way similar to regular 00 programming. However, the complex regula a number of annotations into the achieva derived cases to that sufficient information is tracks
serialization, and, in fact, KMs, Schema based validation, for instance, the facility for name and manager are any resolution from the south description of the south description.
schemp-derived classes, the operation cut can be implemented with dutic methods as follows:
public class (b) (
for (Department d : c. pringeriment())
entitii
public printing wild out (Separates a) (
ent(x)
ent(s): set (s):
public static wold out (Employee a) (
· · · · · · · · · · · · · · · · · · ·
· · · · · · · · · · · · · · · · · · ·
Architecture



### The 101 companies **Ontology**



a technological space focused on XM

# The 101 companies Ontology

- 101 companies contribution X ...
  - ... uses languages L
  - ... uses technology T
  - ... implements features F
  - ... demonstrates concepts C
- 101 companies developer D ...
  - ... has skills regarding language L
  - ... has skills regarding technology T

# The 101 companies Explorer

#### Selection of contribution components and aspects Technologies Files Languages Tags company.java Company.java 7.03% + JAXB 3.30% cut/company 11.87% 18.02% Employee.java Department.java Operations.java Cut.java ObjectFactory.java Employee.java Serialization.java cut/department tests ObjectFactory.java GNU make Cut.java Operations.java package-info.java - Makefile cut/employee features Cut.java Cut.java 63.08% 96.70% Total.java Serialization.java data/company Serialization.java Total.java Company.java Cut.java Operations.java Company.xsd sampleCompany.xml XML data/department README.md sampleCompany.xml Company.xsd Makefile XSD Department.java Company.xsd Company.xsd data/employee Source View 8. 9. public static void cut(Company c) { 10. for (Department d : c.getDepartment()) 11. cut(d); 12. 13. public static void cut(Department d) { 14. cut(d.getManager()); 15. for (Department s : d.getDepartment()) 16. cut(s); 17. for (Employee e : d.getEmployee()) 18. 19. cut(e); 20. 21. public static void cut(Employee e) { 22. 23. e.setSalary(e.getSalary() / 2); 24. 25. 26. } 27.

#### Selection of contribution components and aspects



#### **Source View**

```
8.
             public static void cut(Company c) {
 9.
                     for (Department d : c.getDepartment())
10.
11.
                              cut(d);
12.
13.
14.
             public static void cut(Department d) {
                     cut(d.getManager());
15.
                     for (Department s : d.getDepartment())
16.
17.
                              cut(s);
                     for (Employee e : d.getEmployee())
18.
19.
                              cut(e);
20.
21.
             public static void cut(Employee e) {
22.
                     e.setSalary(e.getSalary() / 2);
23.
24.
```







#### **Source View**

8.	
9. public static void cut(Company c) {	
<pre>10. for (Department d : c.getDepartment())</pre>	
11. cut(d);	
12. }	
13.	
14. public static void cut(Department d) {	
15. cut(d.getManager());	
16. for (Department s : d.getDepartment())	
17. cut(s);	
18. for (Employee e : d.getEmployee())	
19. cut(e);	
20. }	
21.	
22. public static void cut(Employee e) {	
23. e.setSalary(e.getSalary() / 2);	
24. }	
25.	
26. }	
27.	

# What's in for research?

- Megamodeling for software technologies
- Knowledge representation and management
- Education on programming technologies
- Ontologies in the fields PL, SE, SL, ...
- Empirical research
  - Language usage analysis
  - Technology usage analysis
- Generic language technology
Co-initiators

- Co-initiators
  - Jean-Marie Favre (University of Grenoble)

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  - Jean-Marie Favre (University of Grenoble)
  - Dragan Gasevic (Athabasca University)

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  - Jean-Marie Favre (University of Grenoble)
  - Dragan Gasevic (Athabasca University)
- Student of the first hour

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- Student of the first hour
  - Thomas Schmorleiz

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  - ..

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  - Andrei Varanovich
- Students of the current hour
  - Martin Leinberger

Thank you **Paul** for forming me at CWI back then!

Great to work with you JM!

# Understanding Haskellware

### 

## 

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# Understanding +1

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# Understanding + I

© 2012, 101 companies

# Understanding + I \$ ghci -v0

© 2012, 101 companies

# Understanding + I \$ ghci -v0

### Prelude> let inc = (+) 1

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# Understanding + I \$ ghci -v0 Prelude> let inc = (+) 1 Prelude> inc 41



# Understanding + I \$ ghci -v0 Prelude > let inc = (+) 1 Prelude> inc 41



# Understanding + I \$ ghci -v0 Prelude > let inc = (+) 1 Prelude> inc 41 42 Prelude> :q

# Understanding + I

- "Data modeling" for numbers
- "Core functionality" for increment
- "De-/serialization" of numbers

```
$ ghci -v0
Prelude> let inc = (+) 1
Prelude> inc 41
42
Prelude> :q
```

- "Web/CL/GU interface" for incrementing numbers
- "Testing" for incrementing numbers
- "Performance profile" for incrementing numbers

### <u>http://101companies.org/</u> Haskell-based implementations

Impl.	Headline
dph	Data parallelism in Haskell with DPH
haskell	Basic functional programming in Haskell
hdbc	Database programming in Haskell with HDBC
mvar	Concurrent programming in Haskell with MVars
parsec	Parsing in Haskell with Parsec
tmvar	Concurrent programming and STM in Haskell with TMVars
writerMonad	Logging in Haskell with the Writer monad
haskellCGI	CGI style Web programming in Haskell
hxt	In-memory XML processing in Haskell with HXT
wxHaskell	GUI programming in Haskell with wxHaskell
happstack	Web programming in Haskell with Happstack
haskellDB	Schema-aware database programming with HaskellDB
hxtPickler	XML data binding for Haskell with HXTs XML pickler
syb	Generic programming in Haskell with SYB

	<u>http://101companies.org/</u> Language usage of Haskell-based implementations	Implementations
Language	Headline	#
Haskell	An advanced purely-functional programming language	14
CSS	A style sheet language for Web programming	2
SQL	A query language for databases	2
XHTML	A markup language for documents on the Web	2
XML	An extensible markup language	2
Haskell 98	A standardized version of Haskell	1
JavaScript	A dynamic, prototype-based scripting language with first-class functions	1

Tech	<u>http://101companies.org/</u> nology usage of Haskell-based implementations	: Implementations
Technology	Headline	#
GHCi	The Haskell interpreter as part of GHC	12
GHC	A Haskell compiler	5
HDBC	A library for embedded SQL programming in Haskell	2
HXT	A toolkit for tree-based XML processing in Haskell	2
MySQL	A relational database management system	2
ODBC	A standard API for accessing database management systems	2
CGI	A standard for website generation on a web server	1
DBDirect	A program generator that derives Haskell types from database schemas	1
DPH	A GHC extension for data parallelism	1
Happstack	A framework for web programming in Haskell	1
HaskellDB	A combinator library for expressing DBMS queries in Haskell	1
Heist	An XHTML template engine for Haskell	1
Parsec	A parser combinator library in Haskell	1
XML pickler	An XML data binding technology for Haskell	1
wxHaskell	A wxWidgets-based GUI library for Haskell	1





### Chapters



Simon Thompson

Getting started with Haskell and GHCi Basic types and definitions Designing and writing programs Data types tuples and lists Programming with lists Defining functions over lists Playing the game IO in Haskell Reasoning about programs Generalization patterns of computation Higher order functions Developing higher order programs Overloading type classes and type checking Algebraic types Case study Huffman codes Abstract data types Lazy programming Programming with monads Domain Specific Languages Time and space behaviour

$\begin{array}{r} - \text{ action} \rightarrow \text{Action} \\ - \text{ algebraic type} \rightarrow \text{Algebra} \\ - \text{ base case} \rightarrow \text{Base case} \\ - \text{ bool} \rightarrow \text{Boolean} \\ - \text{ calculation} \rightarrow \text{Calculation} \\ - \text{ class} \rightarrow \text{Type class} \\ - \text{ code} \rightarrow \text{Code} \\ - \text{ coding} \rightarrow \text{Programming} \\ - \dots \end{array}$	ic data type	letting started with Haskell and GHCi Basic types and definitions Designing and writing programs Data types tuples and lists Programming with lists Programming with lists Programming functions over lists Ilaying the game IO in Haskell Reasoning about programs deneralization patterns of computation ligher order functions Developing higher order programs Verloading type classes and type checking Agebraic types Developing Huffman codes Abstract data types azy programming with monads Domain Specific Languages Domain Specific Languages
HASKELL         the craft of functional         the craft of functional         the during         Third edition	action algebraic algebraic type base case bool calculation class code coding command complexity constructor	

### Terms

Accumulator, Action, Algebraic data type, Applicative functor, Association list, Base case, Bit, Boolean, Calculation, Catamorphism, Character, Code, Command, Complexity, Condition, Core, Data constructor, Data structure, Data type, Database, Declaration, Directory, Eager evaluation, Equality, Equation, Equational reasoning, Evaluation strategy, Exception, Expression, Factorial, File, Filter function, Float, Fmap function, Fold function, Foreign function interface, Function application, Function definition, Functor, Guard, Haskell package, Haskell script, Head, Higher-order function, I/O system, Identity element, Import, Induction, Infinite list, Input, Integer, Lambda abstraction, Language:XML, Lazy evaluation, List comprehension, Local scope, Loop, MVar, Map function, Maybe type, Module, Monad, Monad transformer, Monadic value, Monoid, Operator, Operator precedence, Output, Parser, Parser combinator, Parsing, Partial application, Pattern, Pattern matching, Performance, Pointer, Polymorphism, Predicate, Prelude, Process, Product function, Profiling, Program design, Program optimization, Programming, Proof, Property, Pure function, Query, Queue, Random number, Recursion, Regular expression, Reverse function, Set, Stack, State, String, Sum function, TCP, Table, Tail, Technology:GHC, Technology:GHCi, Technology:Glade, Technology:HPC, Technology:Parsec, Testing, Text, Thread, Tree, Tuple, Type checking, Type class, Type definition, Type signature, Type system, Type-class instance, UDP, User interface, Zipper



### Terms

**CRAFT only**: Algebraic data type, Base case, Calculation, Code, Complexity, Equality, Equational reasoning, Float, Head, Higher-order function, Infinite list, Local scope, Partial application, Program design, Programming, Proof, Queue, Set, Tuple, Type checking

**PIH only**: Declaration, Equation, Function application, Function definition, Haskell script, Identity element, Lambda abstraction, Parser combinator, Product function, Reverse function, String, Type-class instance

**RWH only**: Association list, Core, Data type, Directory, Exception, Foreign function interface, Language:XML, Loop, MVar, Monad transformer, Operator precedence, Output, Parsing, Performance, Pointer, Polymorphism, Predicate, Process, Profiling, Program optimization, Property, Pure function, Query, TCP, Table, Technology:GHC, Technology:Glade, Technology:HPC, Technology:Parsec, Thread, Type definition, Type signature, Type system, UDP, User interface

**LYAH only**: Accumulator, Applicative functor, Condition, Data structure, Expression, Factorial, Fmap function, Functor, Import, Input, Monadic value, Sum function, Zipper



Term	Headline	# Implementations	Primary resource
Algebraic data type	A type for alternatives of groups of data components	3	
Applicative functor	A kind of functor that models some monad-like computations	1	$\checkmark$
Arrow	A functional programming idiom for composing computations	2	$\checkmark$
CRUD	The basic functions of persistent storage	1	$\checkmark$
Client-server architecture	An architectural pattern divided into client and server	2	$\checkmark$
Closed serialization	Potentially platform-dependent serialization	1	
Concurrent programming	Programming with collections of interacting processes	2	$\checkmark$
Cookie	A client-side file storing data for the server of a web application	2	$\checkmark$
DBMS	A database management system	2	$\checkmark$
Data parallelism	Parallelism focused on distributing data across parallel computing nodes	1	$\checkmark$

We can compare vocabulary coverage of the textbooks and the 101 companies Wiki!

# Megamodels to the rescue

What's the essence of a technology?

### What's the essence of a language?



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### What's the essence of a technology?



## That's a megamodel, too!



http://en.wikipedia.org/wiki/Tombstone\_diagram

© 2012, 101 companies
## Yet another megamodel!





#### http://wiki.eclipse.org/ATL/Concepts#Model\_Transformation

© 2012, 101 companies

## Yet another megamodel!





#### http://wiki.eclipse.org/ATL/Concepts#Model\_Transformation

## Megamodel of O/X mapping with xsd.exe



http://softlang.uni-koblenz.de/mega/

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### Megamodel of a product using xsd.exe



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# Conclusion

- Please:
  - Have a look and spread the message.
  - Don't expect perfect material "yet".
  - Contribute or encourage others to do so.
  - Consider using the project in teaching.
  - Engage in collaboration.

Thanks! Questions?