Special thanks also to Thomas Schmorleiz and Andrei Varanovich (with whom I work on **101companies**).

Understanding Programming Technologies by Analogy, Examples, and Abstraction

Ralf Lämmel (Uni of Koblenz-Landau)

This talk has emerged from a SLE/GTTSE 2010 tutorial joint work with Jean-Marie Favre and Dragan Gasevic. (Thanks, Jean-Marie for some of the cool slides!)


We have a problem.
XPATH
TXL
Sesame
JPA
Jena
Rose
JDBC
EMF.gen
XText
jDOM
JAXB
Jersey
RDF(S)
UTF8
Jena
ODM
XSD
MOF
JeanBeans
Teneo
UML
VLDB
BNF
Stratego
xerces
GWT
SLE2010
Json
OCL
sax
Ralf
RDFS
saxon
OWL
OWL
Ecore
Rest
RDF
Jean
OMG
MySQL
XMI
ORACLE
JMI
JMF
EMF
XSD
ArgoUML
xalan
ODBC
SparQL
XMLSpy
Yacc
RDFa
LALR
Prolog
XSLT
JAXP
Protégé
CFG
SBVR
DOM
Java
ATOM
ER
SQL DDL
Dragan
SQL
Antlr
QVT
TENEO
XLST
Awk
DTD
TCS
sed
Saxon
grep
ASCII
XSD
Hibernate
XQuery

Today's Issues

- **Silos of knowledge**
- **Combining technologies**
- **Complexity of technologies**
- **Entering a new space**
- **Teaching technologies?**

Why would you study computer science,
if your ultimate destiny is
to **get lost in space and technology**?

Popular opinion 1

Practice is just inherently complex.

University (say, theory or research) should not bother

Popular opinion 2

Practice is just incidentally complex.

University must not bother.

Popular opinion 3

Practice is just incredibly complex.

University can not bother.

(As yet) unpopular opinion

Practice is just amazingly complex and does not go away.

University and research must, should, and can help.

A course on Programming (Techniques and) Technologies

- The Expression Problem
- The Visitor Design Pattern
- Parsing
- XML Processing
- XML Validation
- XML Data Binding
- Database Access
- O/R Mapping
- Model View Controller
- More Design Patterns
- Reflection
- Aspect-Oriented Programming
- Functional OO Programming
- Combinator Libraries
- Generic Programming
- Programming with Threads
- Distributed Programming
- WebService Programming

Today's Issues

- **Silos of knowledge**
- **Combining technologies**
- **Complexity of technologies**
- **Entering a new space**
- **Teaching technologies?**

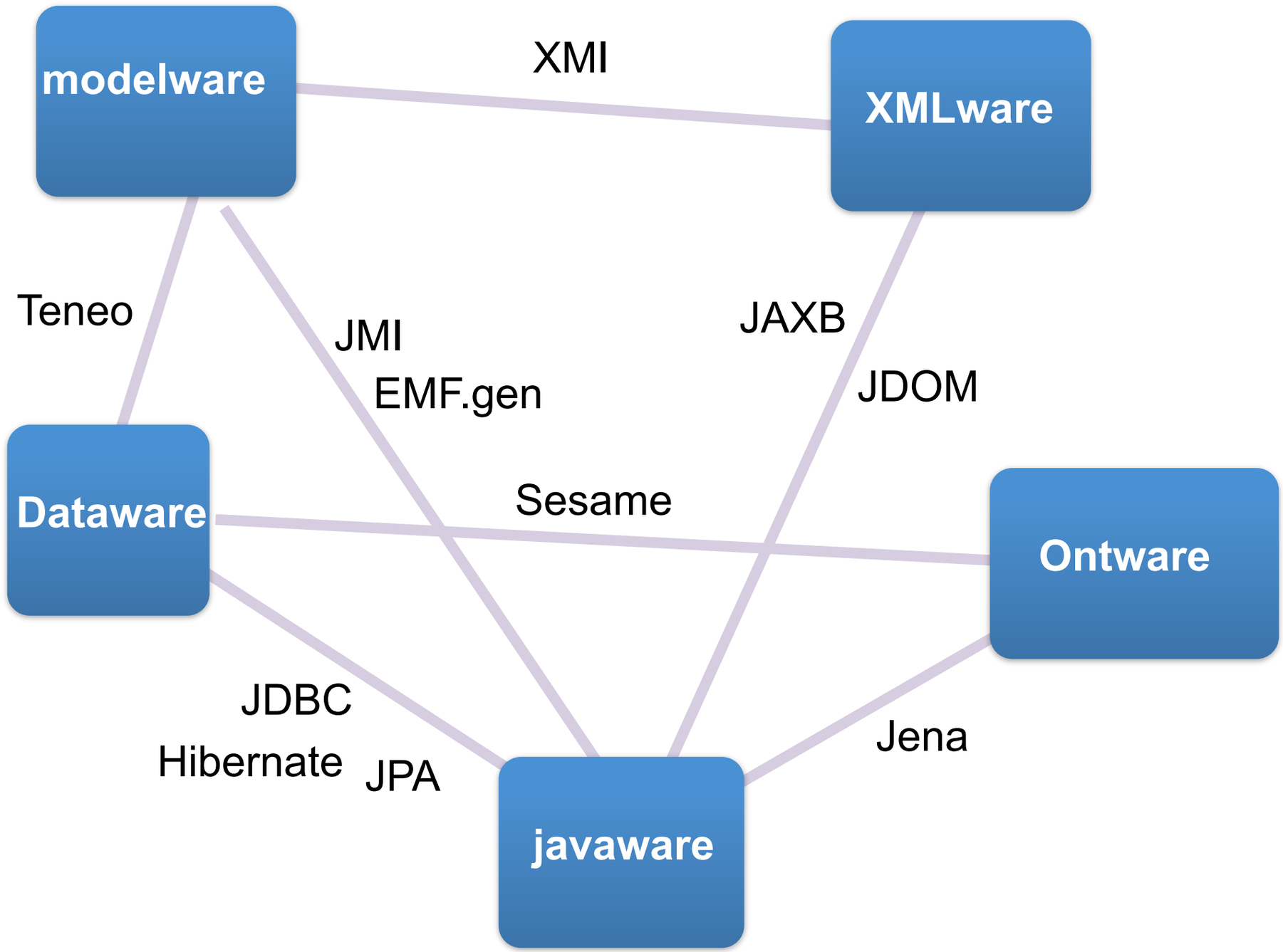
Our Approach

- **Analogy**
- **Examples**
- **Abstraction**

Working by analogy

	Modelware	*XMLware*	*Ontoware*	*Dataware*	*Grammarware*
Meta language	**MOF**	**XSD**	**RDFS**	**SQL.DDL**	**EBNF**
Navigation	**OCL**	**XPath**			
Query		**XQuery**	**SPARQL**	**SQL**	
Transfo.	**QVT**	**XSLT**			**TXL** **ASF**
Toolkit	**ArgoUML** **Rose**	**XMLSpy** **VS-XML**	**Protégé** **Topbeard**	**MySQL** **Oracle**	**MetaEnv.**
Conferences	**MoDELS** **ECMDA**	**XML** **VLDB**	**ICSW** **ESWC**	**VLDB** **SIGMOD**	**CC** **POPL**

From one space to another…



We need a catalog of concrete examples.

101companies

Summary

http://sourceforge.net/apps/mediawiki/developers/index.php?title=101companies

- *101companies* is a software corpus for company modeling and processing.
- Many different models and scenario implementations are exercised.
- The diversity feeds into a major megamodeling effort.

First major release immanent!

What's a company?

- A *company* is a nested structure of *departments* with *employees* as leafs.
- Employees are characterized by *name*, *salary*, and possibly other properties.
- Companies and departments have names, too.
- Each department has a *manager*.
- Employees may be associated with *mentees*.

Implementations may differ with regard to the level of detail.

A sample company

This company is named ***meganalysis***.

For what it matters, *meganalysis* is into megamodeling (as opposed to selling ice cream).

We only capture some basic structural facets of *meganalysis* below.

```
company "meganalysis" {
        department "Research" {
                manager "Craig" {
                        address "Redmond"
                        salary 123456
                }
                employee "Erik" {
                        address "Utrecht"
                        salary 12345
                }
                employee "Ralf" {
                        address "Koblenz"
                        salary 1234
                }
        }
        department "Development" {
                manager "Ray" {
                        address "Redmond"
                        salary 234567
                }
                department "Dev1" {
                        manager "Klaus" {
                                address "Boston"
                                salary 23456
                        }
                        department "Dev1.1" {
```

...

Company scenarios

- *total*: Total all salaries in a company.
- *cut*: Cut all salaries in half.
- *depth*: Determine depth of department nesting.
- *containment*: Check that tree topology holds for the instance.
- *precedence*: Check that salaries increase with rank in hierarchy.

Implementations do not need to cover all scenarios.

Implementations

All implementations are *labeled* for consistency of reference.

The implementations are listed in alphabetical order.

- *alpha*: a simple POJO object model for companies with methods for some of the scenarios.
- *antlr*: an ANTLR-based acceptor for a human-readable notation for companies.
- *antlr2*: a variation on *antlr* that actually constructs ASTs over some generic object model.
- *antlr3*: a variation on *antlr2* that constructs ASTs according to an object model for companies.
- *atl*: Ecore/ATL-based model transformations for some of the company scenarios.
- *atl2*: a variation on *atl* that uses a slightly different metamodel (with proper subtyping).
- *atl3*: a variation on *atl[2]* that uses KM3 instead of Ecore; this option is potentially obscure.
- *dom*: in-memory XML processing in Java with the DOM API.
- *emf*: EMF/Java-based model queries and transformations.
- *gwt*: C/S (Browser/Server) architecture for a WebApp based on GWT (Google Web Toolkit).
- *haskell*: model companies and implement company scenarios in Haskell 98 + SYB (using GHC).
- *hibernate*: maintain companies in RDBMS and access them through hibernate's O/R mapping.
- *hibernate2*: variation on *hibernate* to illustrate a different O/R mapping.
- *jaxb*: represent companies in XML and access them through JAXB's XML data binding.
- *jaxb2*: variation on ``jaxb *to illustrate a different X/O mapping.*
- *jdbc*: Relational database programming in Java with JDBC.
- *jdbc2*: A sophistication of *jdbc* to approach to O/R mapping in a homegrown manner.
- *jena*: in-memory RDF processing in Java with the Jena API (RDF part).
- *jena2*: a further use of *jena* which leverages Jena's query engine / ARQ implementation of SPARQL.
- *library*: a collection of third-party libraries that are leveraged by the implementations.
- *prolog*: model companies and implement company scenarios through logic programming in SWI-Prolog.
- *sax*: push-based XML processing in Java with the SAX API.
- *sql*: SQL DML-based implementation of some of the company scenarios.
- *swing*: a simple GUI for navigating companies and performing scenarios based on Swing/AWT.
- *xpath*: in-memory XML processing in Java with the XPath embedding into DOM.
- *xslt*: XSLT-based XML processing.
- *xquery*: XQuery-based XML processing.

Implementations

All implementations are *labeled* for consistency of reference.

The implementations are listed in alphabetical order.

- *alpha*: a simple POJO object model for companies with methods for some of the scenarios.
- *antlr*: an ANTLR-based acceptor for a human-readable notation for companies.
- *antlr2*: a variation on *antlr* that actually constructs ASTs over some generic object model.
- *antlr3*: a variation on *antlr2* that constructs ASTs according to an object model for companies.
- *atl*: Ecore/ATL-based model transformations for some of the company scenarios.
- *atl2*: a variation on *atl* that uses a slightly different metamodel (with proper subtyping).
- *atl3*: a variation on *atl[2]* that uses KM3 instead of Ecore; this option is potentially obscure.
- *dom*: in-memory XML processing in Java with the DOM API.
- *emf*: EMF/Java-based model queries and transformations.
- *gwt*: C/S (Browser/Server) architecture for a WebApp based on GWT (Google Web Toolkit).

Code snippets

The *total* scenario in XQuery:

```
<result>
        {sum(//salary)}
</result>
```

The *cut* scenario in SQL DML:

```
UPDATE employee SET salary = salary / 2;
```

The *total* scenario with Jena's RDF API:

```
        public static double total(CompanyModel c) {
                double total = 0;
                StmtIterator i =
                        c.getModel().listStatements(
                                new SimpleSelector(
                                        null, c.SALARY, (RDFNode) null));
                while (i.hasNext()) {
                        Statement s = i.next();
                        total += s.getDouble();
                }
                return total;
        }
```

A few variation points

- X vs. O vs. R vs. λ etc.
- Static typing vs. dynamic typing
- Textual vs. abstract vs. visual syntax
- GPPL vs. DSL vs. embedding vs. API
- Instance- vs. operation-based mapping
- Type checking vs. inference vs. reasoning
- Code first vs. schema first vs. mapping only
- In-memory processing vs. push vs. pull parsing
- Pure vs. impure transformations (or in between)
- Code vs. generative vs. model-driven vs. mapping

DEMO

Plan of demo

1.a Haskell implementation

2.a Java implementation

3.101implementation:haskell

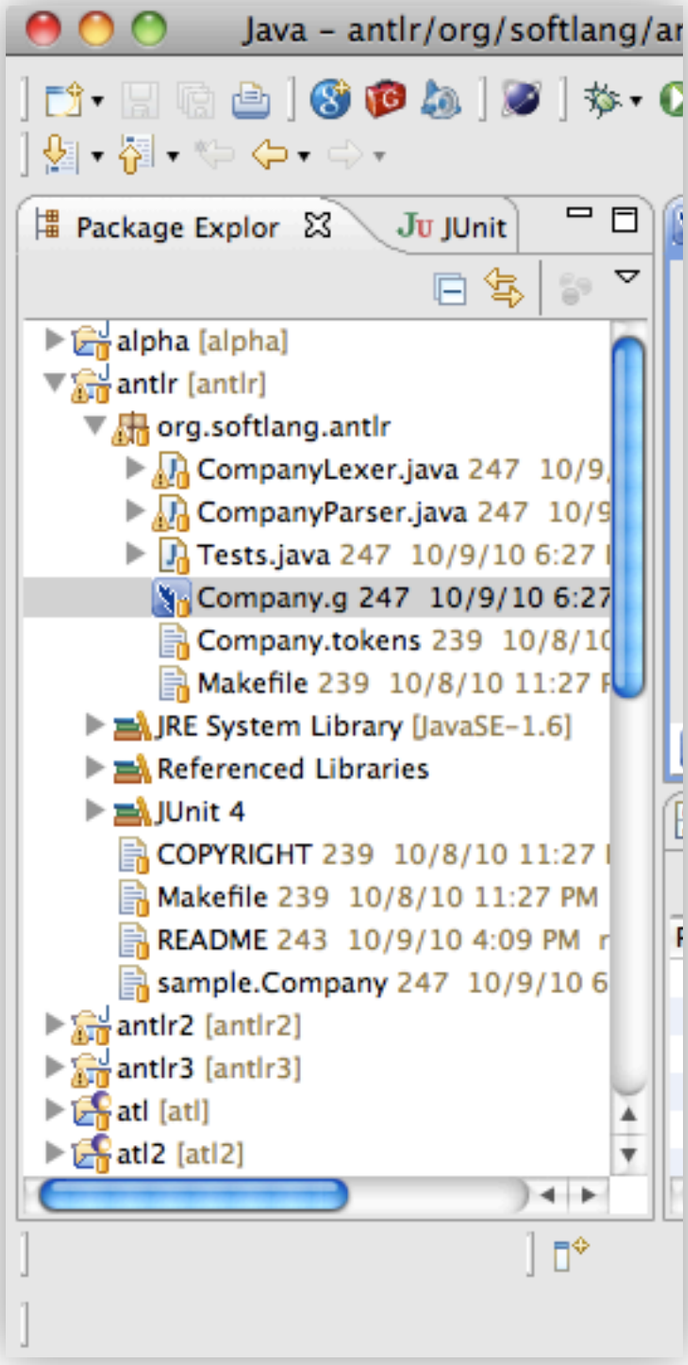
4.101companies:System

5.101companies:Ontology

We need modeling.

We need **mega**modeling.

Empirical megamodeling



(ANTLR)

Company.g

company : ...

accept (or parse)

sample.Company

company "meganalysis" { ...

Meganalysis company

A megamodel

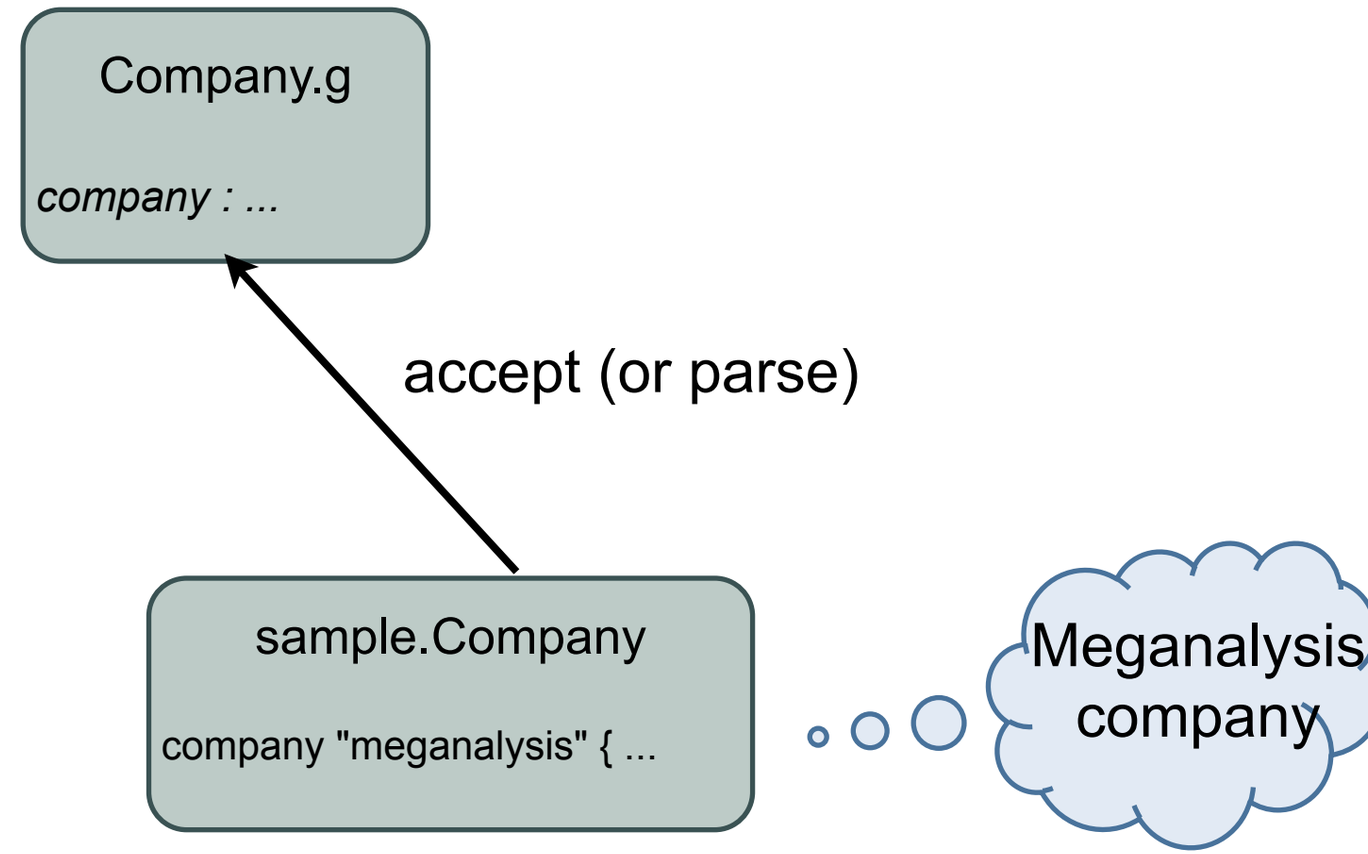
Specific megamodeling

$w \in L(G_{Company})$

...

A megamodel

(ANTLR)



A megamodel

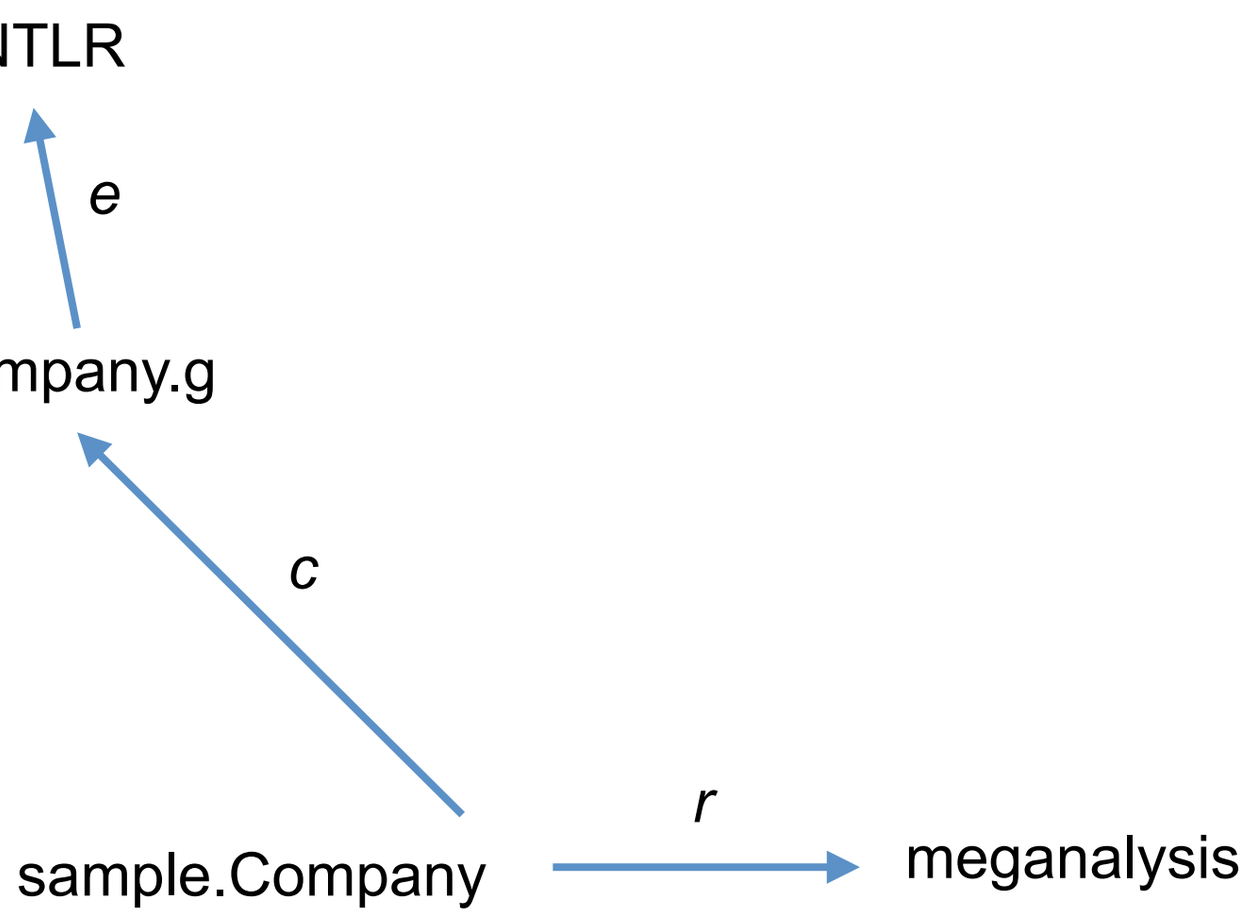
We need to be more precise and more abstract.

Precise megamodeling

r ... “represents”

c ... “conforms to”

e ... “element of”



The megamodel metamodel

a megamodel

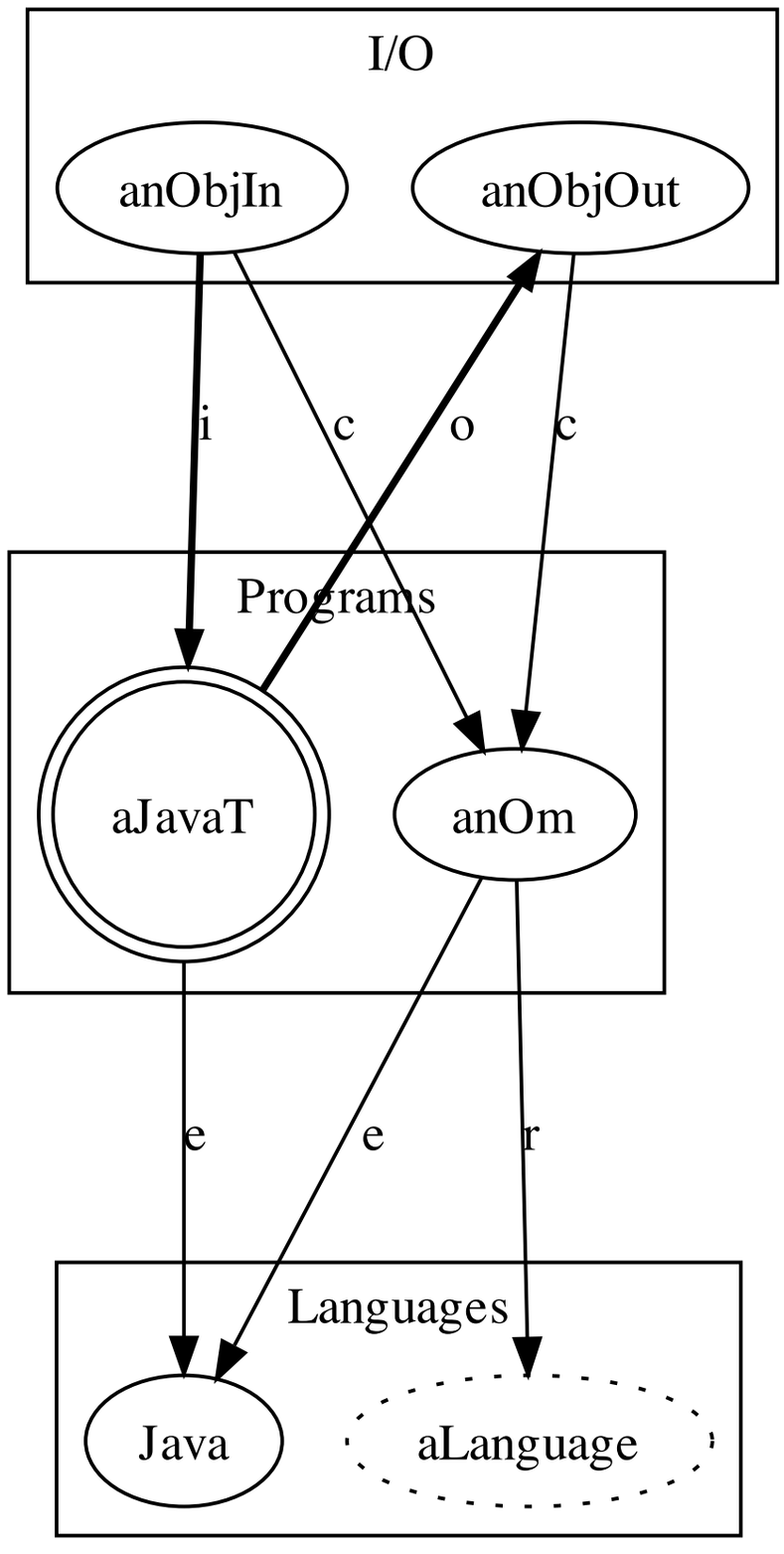
Relationships (all binary)

- e "element of" (in set-theoretic sense)
- s "subset of" (in set-theoretic sense)
- c "conforms to" (in the sense of generative semantics)
- r "represents" (in information-theoretic+structural sense)
- i "input for" (... a transformation, essentially a function)
- o "output for" (... a transformation, essentially a function)

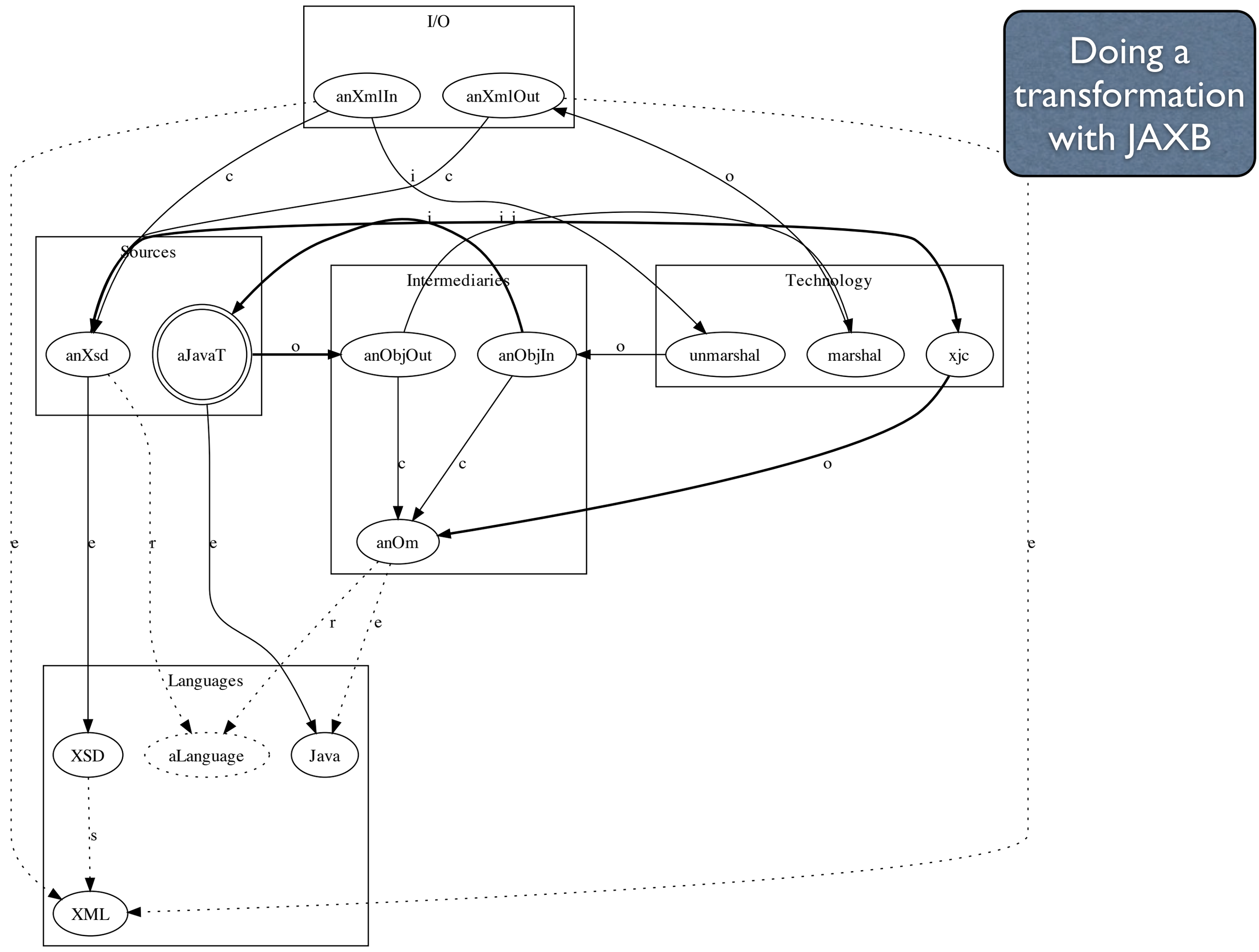
Entities

- Languages
  - in a set-theoretic sense
  - in an intentional sense
- Elements of languages
- Functions (for transformations, for example)
- Interpretable entities (as functions)

Doing a transformation with Java



Doing a transformation with JAXB



Thanks!
Questions or comments?