Rapidly implementing Java-like languages with Xtext and Xbase

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Motivations for Xbase

- Developing a textual DSL is easy with Xtext
  - Especially for “structures”
  - Highly customizable (by Injection)
- What about Expressions and Behavior?
  - More complex
  - Recurrent task
  - Harder to validate (e.g., type checking)

Xbase
a reusable expression language

- Expression language embeddable in your DSL
  - Grammar
  - Linking and Scoping
  - Java Type System (including generics)
    - Access to Java types
    - Automatic import handling
    - Seamlessly access any existing Java library
  - Type Inference
  - Code generation
  - Eclipse tooling
  - Debugger

Xbase expressions

- Standard expressions
  - Arithmetic
  - Logical
  - Comparisons, etc.
- Conditionals, Loops, Enhanced switch
- OO expressions
  - Object creation
  - Field access and Method invocation
  - Casts, etc.
- Lambda expressions
- Extension methods

Use Xbase grammar in your DSL

```
grammar org.eclipse.xtext.example.domainmodel.Domainmodel
    with org.eclipse.xtext.xbase.Xbase

generate domainmodel "http://www.xtext.org/example/Domainmodel"

DomainModel:
importSection=XImportSection?
elements+=Entity*;

Entity:
'entity' name=ValidID ('extends' superType=JvmParameterizedTypeReference)? '{'
    features+=Feature*
'}';


Feature: Property | Operation;


Property: name=ValidID ':' type=JvmTypeReference;


Operation:
'op' name=ValidID '
    (' (params+=FullJvmFormalParameter (',' params+=FullJvmFormalParameter)*)? ')'
    (':' type=JvmTypeReference)?
    body=XBlockExpression;
```

Inherit from Xbase

Use imports

Refer to Java types

Syntax for parameters

Syntax for Expressions

Example

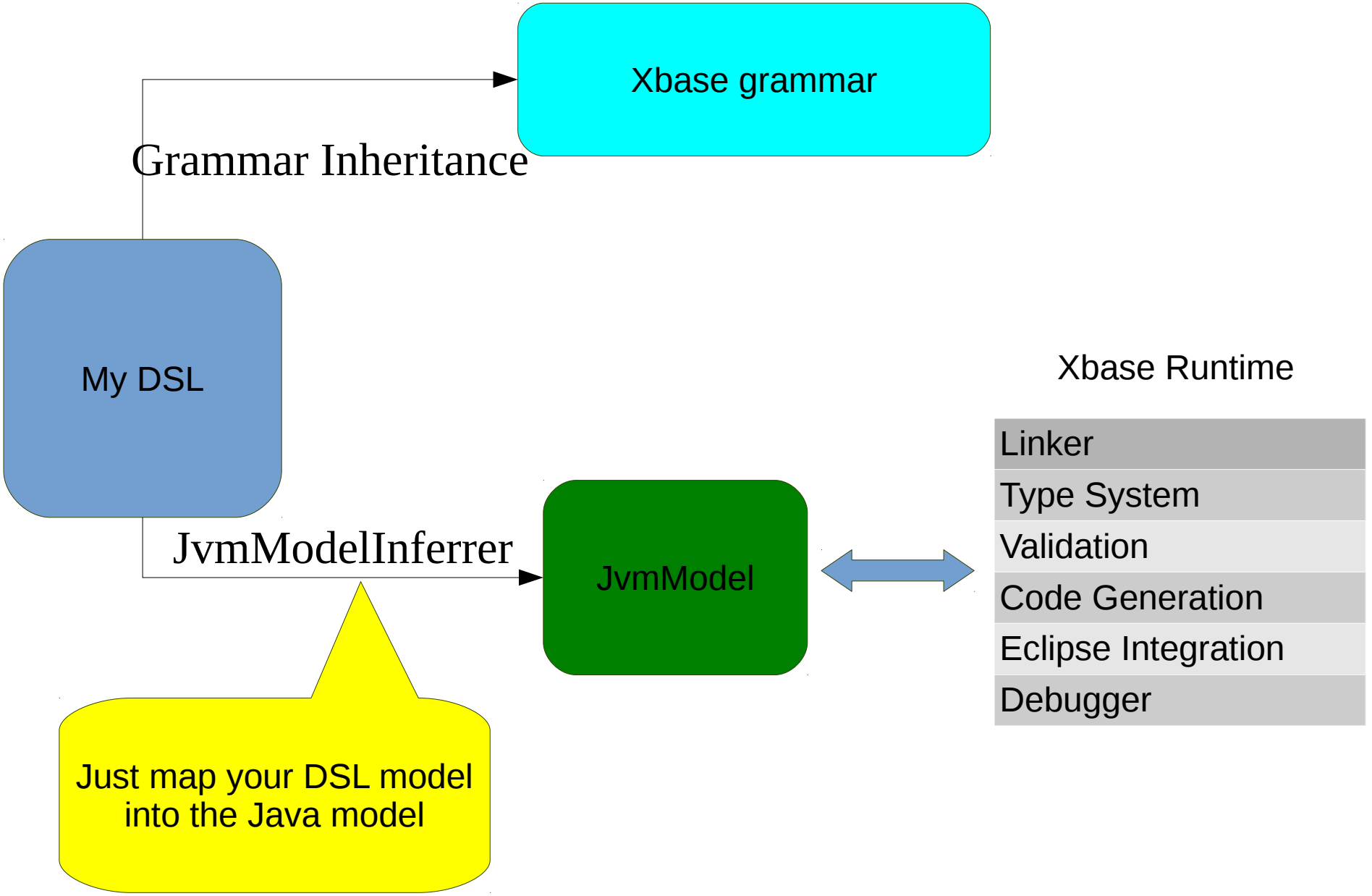
```
import java.util.List

entity Person {
 firstName : String
 lastName : String
 friends : List<Person>

 op getFullName() {
    firstName + " " + lastName
 }

 op sortedFriends() : List<Person> {
    friends.sortBy[fullName]
 }
}
```

Use Xbase infrastructure



Mapping to Java

```
import java.util.List

entity Person {
 firstName : String
 lastName : String
 friends : List<Person>

 op getFullName() {
    firstName + " " + lastName
 }

 op sortedFriends() : List<Person> {
    friends.sortBy[fullName]
 }
}
```

Mapped to a Java class

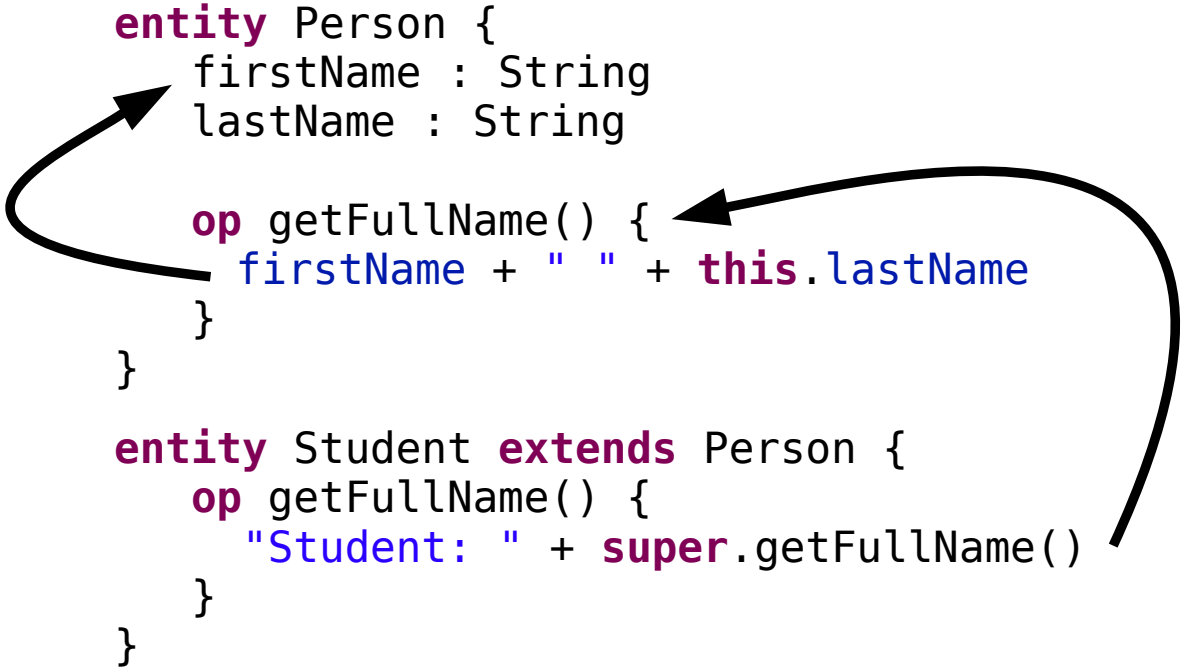
Mapped to a Java field

Mapped to a Java method
...

...
Whose body is the
Xbase expression

This gives the Xbase expression
a context

Automatic Linking

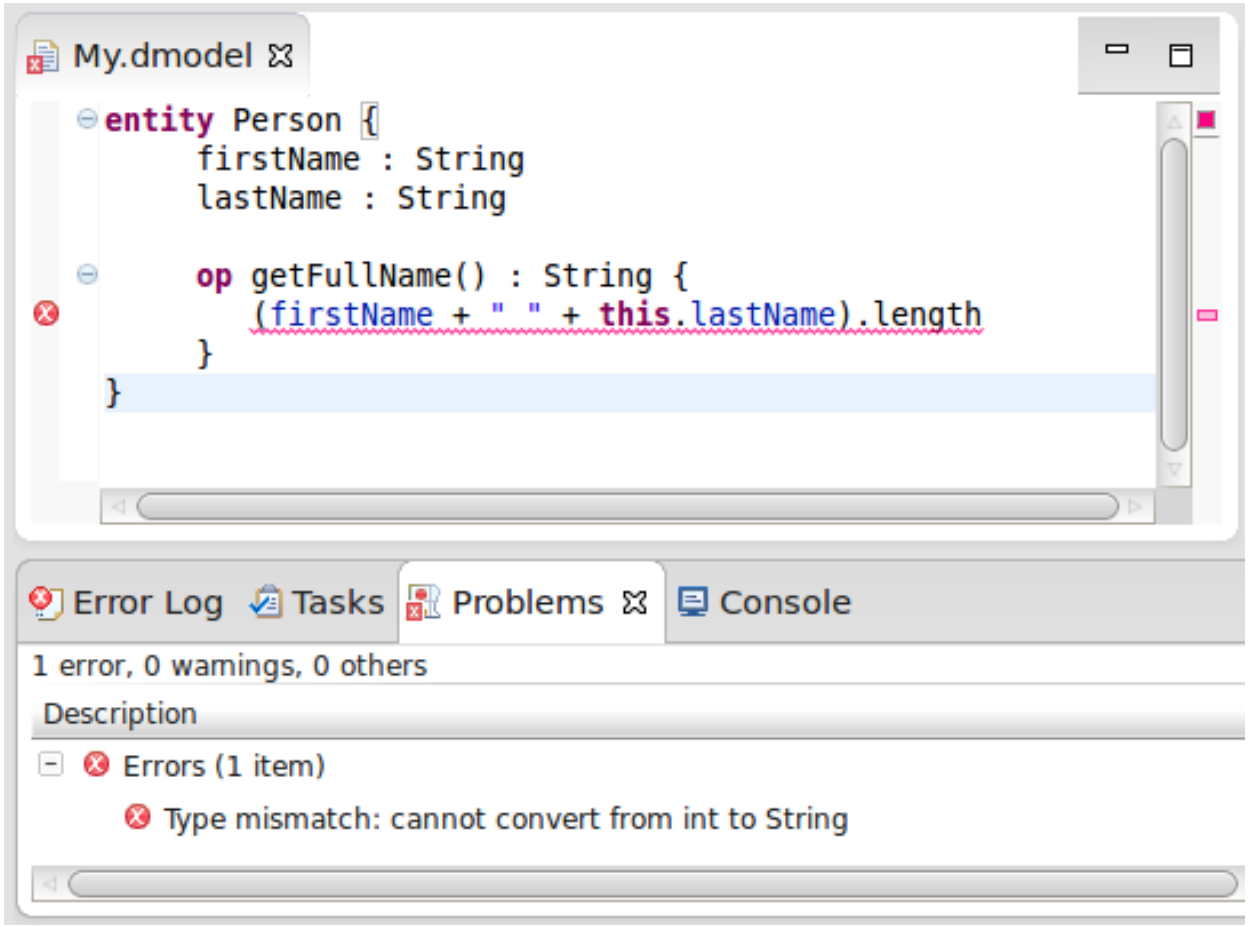


```
entity Person {
   firstName : String
   lastName : String

   op getFullName() {
     firstName + " " + this.lastName
   }
}

entity Student extends Person {
   op getFullName() {
     "Student: " + super.getFullName()
   }
}
```

Automatic Validation (Type Checking)



The method's return type is the expected type of the body

Automatic Code Generation

My.dmodel

```
import java.util.List

entity Person {
	firstName : String
	lastName : String
	friends : List<Person>

	op getFullName() : String {
	   firstName + " " + this.lastName
	}

	op sortedFriends() {
	   friends.sortBy[fullName]
	}
}
```

Person.java

```
public class Person {
  private String firstName;

  public String getFirstName() {
    return this.firstName;
  }

  public void setFirstName(final String firstName) {
    this.firstName = firstName;
  }

  private String lastName;

  public String getLastName() {
    return this.lastName;
  }

  public void setLastName(final String lastName) {
    this.lastName = lastName;
  }

  private List<Person> friends;

  public List<Person> getFriends() {
    return this.friends;
  }

  public void setFriends(final List<Person> friends) {
    this.friends = friends;
  }

  public String getFullName() {
    String _plus = (this.firstName + " ");
    String _plus_1 = (_plus + this.lastName);
    return _plus_1;
  }

  public List<Person> sortedFriends() {
    final Function1<Person,String> _function = new Function1<Person,Str
        public String apply(final Person it) {
          String _fullName = it.getFullName();
          return _fullName;
        }
      };
    List<Person> _sortBy = IterableExtensions.<Person, String>sortBy(th
```

Implementing the mapping

```
class DomainmodelJvmModelInferrer extends AbstractModelInferrer {

@Inject extension JvmTypesBuilder
@Inject extension IQualifiedNameProvider

def dispatch infer(Entity entity, IJvmDeclaredTypeAcceptor acceptor, boolean prelinkingPhase) {
     acceptor.accept(
          entity.toClass( entity.fullyQualifiedName )
     ).initializeLater [
          if (entity.superType != null)
               superTypes += entity.superType.cloneWithProxies
          members += entity.toConstructor() []
          for ( f : entity.features ) {
               switch f {
                    Property : {
                         members += f.toField(f.name, f.type)
                         members += f.toGetter(f.name, f.type)
                         members += f.toSetter(f.name, f.type)
                    }

                    Operation : {
                         members += f.toMethod(f.name, f.type ?: inferredType) [
                              for (p : f.params) {
                                   parameters += p.toParameter(p.name, p.parameterType)
                              }
                              body = f.body
                         ]
                    }
               }
          }
     ]
}
```

Implementing a DSL for the Java Platform

- Give the semantics through translation in Java
  - Perform mapping in the JvmModelInferrer
  - The typing is performed on the mapped model
  - The code generation relies on the mapped model

Additional Validation

- Xbase only validates its expressions
- The “structural” part is up to you
  - Check no duplicate entities
  - Check no duplicate properties
  - …

Extending Xbase

- Extend the grammar of expressions
  - Provide the typing for your expressions
  - Scoping for your expressions
  - Validation for your expressions
  - Compilation for your expressions
  - ...

Xtraitj

Pure Traits for the Java Platform

http://xtraitj.sourceforge.net

Traits

- Introduced in Smalltalk/Squeak
- A mechanism for fine-grained code reuse
- Overcome the limitations of class-based inheritance
- A trait is a set of methods:
  - completely independent from any class hierarchy and
  - can be flexibly used to build other traits or classes by means of a suite of composition operations.

Distinct Roles

- Subtyping on interfaces only
- Classes only play the role of object generators
  - class-based inheritance is not present
- Traits only play the role of units of code reuse
  - they are not types

Some examples

```
trait T1 {
    // required field
    String s;

    // required method
    void print(Object o);

    // provided method
    void m() {
        print(this.s)
    }
}
```

```
trait T2 {
    void print(Object o) {
        System.out.println(o)
    }
}
```

```
class C uses T1, T2 {
    String s = "aString";
}
```

Use it in your Java programs

```
import my.traits.C;

public class Main {
    public static void main(String[] args) {
        new C().m();
    }
}
```

Demo!