

OpenArchitectureWare 4.1 Extend Language Reference

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Introduction

Like the expressions sub language that summarizes the syntax of expressions for all the other textual languages delivered with the openArchitectureWare framework, there is another commonly used language called Extend.

This language provides the possibility to define rich libraries of independent operations and no-invasive metamodel extensions based on either Java methods or oAW expressions. Those libraries can be referenced from all other textual languages, that are based on the expressions framework.

Extend files

An extend file must reside in the Java class path of the used execution context. Additionally it's file extension must be *.ext. Let's have a look at an extend file.

```
import my::metamodel;
extension other::ExtensionFile;

/**
 * Documentation
 */
anExpressionExtension(String stringParam) :
    doingStuff(with(stringParam))
;

/**
 * java extensions are just mappings
 */
String aJavaExtension(String param) :
    JAVA my.JavaClass.staticMethod(java.lang.String)
;
```

The example shows the following statements:

- import statements
- extension import statements
- expression or java extensions

Comments

We have single- and multi-line comments.

The syntax for single line comments is:

```
// my comment
```

Multi line comments are written like this:

```
/* My  
multi line  
comment */
```

Import Statements

Using the import statement one can import name spaces of different types.(see expressions framework reference documentation).

Syntax is:

```
import my::imported::namespace;
```

Extend does not support static imports or any similar concept. Therefore, the following is incorrect syntax:

```
import my::imported::namespace::*; // WRONG!  
import my::Type; // WRONG!
```

Extension Import Statement

You can import another extend file using the extension statement. The syntax is:

```
extension fully::qualified::ExtensionFileName;
```

Note, that no file extension (*.ext) is specified.

Reexporting Extensions

If you want to export extensions from another extension file together with your local extensions, you can add the keyword 'reexport' to the end of the respective extension import statement.

```
extension fully::qualified::ExtensionFileName reexport;
```

Extensions

The syntax of a simple expression extension is as follows:

```
ReturnType extensionName(ParamType1 paramName1, ParamType2...):  
expression-using-params  
;
```

Example:

```
String getterName(NamedElement ele) :  
'get'+ele.name.firstUpper()  
;
```

Extension Invocation

There are two different ways, of how to invoke an extension. It can be invoked like a function:

```
getName(myNamedElement)
```

The other way to invoke an extension is through the „member syntax“:

```
myNamedElement.getName()
```

For any invocation in member syntax, the target expression (the member) is mapped to the first parameter. Therefore, both syntax forms do the same thing.

It's important to understand, that extensions are not members of the type system, hence, they are not accessible through reflection and you cannot specialize or overwrite operations using them.

The expression evaluation engine first looks for an appropriate operation before looking for an extension, in other words operations have higher precedence.

Type Inference

For most extensions, you don't need to specify the return type, because it can be derived from the specified expression. The special thing is, that the static return type of such an extension depends on the context of use!

For instance, if you have the following extension

```
asList(Object o) : {o};
```

the invocation of

```
asList('text')
```

has the static type List[String]. This means you can call

```
asList('text').get(0).toUpperCase()
```

The expression is statically type safe!

Recursion

There is only one exception: For recursive extensions the return type cannot be inferred, therefore you need to specify it explicitly:

```
String fullyQualifiedName(NamedElement n) :  
    n.parent == null ? n : fullyQualifiedName(n)+'::'+n  
;
```

Recursive extensions are non-deterministic in a static context, therefore it is necessary to specify a return type.

Cached Extensions

If you call an extension without side effects very often, you would like to cache the result for each set of parameters, in order to improve the performance. You can just add the keyword 'cached' to the extension in order to achieve this:

```
cached String getName(NamedElement ele) :  
    'get'+ele.name.firstUpper()  
;
```

The getName will be computed only once for each NamedElement.

Private Extensions

By default all extensions are public, i.e. they are visible from outside the extension file. If you want to hide extensions you can add the keyword 'private' in front of them:

```
private internalHelper(NamedElement ele) :  
    // implementation...  
;
```

Java Extensions

In some rare cases one does want to call a Java method from inside an expression. This can be done by providing a Java extension:

```
Void myJavaExtension(String param) :  
    JAVA my.Type.staticMethod(java.lang.String)  
;
```

The signature is the same as for any other extension. The implementation is redirected to a public static method in a Java class.

Its syntax is:

```
JAVA fully.qualified.Type.staticMethod(my.ParamType1,  
                                        my.ParamType2,  
                                        ...)
```

Note that you cannot use any imported namespaces. You have to specify the type, its method and the parameter types in a fully qualified way.

Example:

If you have defined the following Java extension:

```
Void dump(String s) :  
    JAVA my.Helper.dump(java.lang.String)  
;
```

and you have the following Java class:

```
package my;
public class Helper {
    public final static void dump(String aString) {
        System.out.println(aString);
    }
}
```

the expressions

```
dump('Hello world!')
'Hello World'.dump()
```

both result are invoking the Java method void dump(String aString)

Create Extensions (Model Transformation)

Since Version 4.1 the Xtend language supports additional support for model transformation. The new concept is called 'create extension' and is explained a bit more comprehensive as usual.

Elements contained in a model are usually referenced multiple times. Consider the following model structure

```

  P
 / \
C1  C2
 \ /
  R
```

A package P contains two classes C1 and C2. C1 contains a reference R of type C2 (P references C2).

We could write the following extensions in order to transform an Ecore (EMF) model to our metamodel (Package, Class, Reference).

```
toPackage(EPackage x) :
    let p = new Package :
        p.classifiers.addAll(c.eClassifiers.toClass()) ->
        p;
toClass(EClass x) :
    let c = new Class :
        c.attributes.addAll(c.eReferences.toReference()) ->
        c;
toReference(EReference x) :
    let r = new Reference :
        r.setType(c.eType.toClass()) ->
        r;
```

For an.ecore model of the structure from above, the result would be:

```

  P
 / \
C1  C2
 |
R - C2

```

What happens? The C2 class has been created 2 times (one time for the package containment and another time for the Reference's reference). We can solve the problem by adding the 'cached' keyword to the second extension:

```

cached toClass(EClass x) :
  let c = new Class :
    c.attributes.addAll(c.eAttributes.toAttribute()) ->
  c;

```

The process goes like this:

- start create P
 - start create C1 (contained in P)
 - start create R (contained in C1)
 - start create C2 (referenced from R)
 - end (result C2 is cached)
 - end R
 - end C1
 - start get cached C2 (contained in P)
- end P

So this works very well. We will get the intended structure. But what about circular dependencies? For instance, C2 could contain a Reference R2 of type C1 (bidirectional references):

The transformation would occur like this:

- start create P
 - start create C1 (contained in P)
 - start create R (contained in C1)

- start create C2 (referenced from R)
 - start create R2 (contained in C2)
 - start create C1 (referenced from R1)... OOPS!

C1 is already in creation and will not complete until the stack is reduced. Deadlock! The problem is that the cache caches the return value, but C1 was not returned so far, because it is still in construction. The solution: **create extensions**

The syntax is as follows:

```
create Package toPackage(EPackage x) :
    this.classifiers.addAll(x.eClassifiers.toClass());
create Class toClass(EClass x) :
    this.attributes.addAll(x.eReferences.toReference());
create Reference toReference(EReference x) :
    this.setType(x.eType.toClass());
```

This is not only a shorter syntax but it also has the needed semantics:

The created model element will be added to the cache **before** evaluating the body. The return value is always the reference to the created and maybe not completely initialized element.

Calling Extensions From Java

The previous section showed how to implement Extensions in Java. This section shows how to call Extensions from Java.

```
// setup
XtendFacade f = XtendFacade.create("my::path::MyExtensionFile");

// use
f.call("sayHello", new Object[]{"World"});
```

The called extension file looks like this:

```
appendStuff(String s) :
    "Hello " + s;
```

This example uses only features of the BuiltinMetaModel, in this case the „+“ feature from the StringTypeImpl.

Here is another example, that uses the JavaBeansMetaModel strategy. This strategy provides as additional feature the access to properties using the getter and setter methods.

For more information about type systems see the Expressions Reference Documentation.

We have one javaBean-like meta model class:

```
package mypackage;
public class MyBeanMetaClass {
    private String myProp;
    public String getMyProp() { return myProp; }
    public void setMyProp(String s) { myProp = s; }
}
```

Additional to the already builtin metamodel type system, we register the JavaMetaModel with the JavaBeansStrategy for our facade. Now we can use also this strategy in our extension:

```
// setup facade
XtendFacade f = XtendFacade.create("myext::JavaBeanExtension");

// setup additional type system
JavaMetaModel jmm =
    new JavaMetaModel("JavaMM", new JavaBeansStrategy());
f.registerMetaModel(jmm);

// use the facade
MyBeanMetaClass jb = MyBeanMetaClass();
jb.setMyProp("test");
f.call("readMyProp", new Object[]{jb});
```

The called extension file looks like this:

```
import mypackage;

readMyProp(MyBeanMetaClass jb) :
    jb.myProp;
```

WorkflowComponent

With the additional support for model transformation it makes sense to invoke Xtend within a workflow. A typical workflow configuration of the Xtend component looks like this:

```
<component class="oaw.xtend.XtendComponent">
    <metaModel class="oaw.type.emf.EmfMetaModel">
        <metaModelFile value="metamodel1.ecore"/>
    </metaModel>
    <metaModel class="oaw.type.emf.EmfMetaModel">
        <metaModelFile value="metamodel2.ecore"/>
    </metaModel>
    <invoke value="my::example::Trafo::transform(inputSlot)"/>
    <outputSlot value="transformedModel"/>
</component>
```

Note that you can mix and use any kinds of metamodels (not only EMF metamodels).

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