ATL:
Atlas Transformation Language

User Manual

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- working draft -

Content

1 Introduction

1.1 The ATL Language

ATL, the Atlas Transformation Language, is the ATLAS INRIA & LINA research group answer to the OMG MOF [5]/QVT RFP [6]. It is a model transformation language specified both as a metamodel and as a textual concrete syntax. It is a hybrid of declarative and imperative. The preferred style of transformation writing is declarative, which means simple mappings can be expressed simply. However, imperative constructs are provided so that some mappings too complex to be declaratively handled can still be specified. An ATL transformation program is composed of rules that define how source model elements are matched and navigated to create and initialize the elements of the target models.

2 Programming an ATL Module

An ATL module file has the header section, the imports section, as well as helpers and rules. For an ATL module only the header section is mandatory. The ATL module is stored in a file with the extension *.atl*.
Please note:

- To navigate from an element to its attribute, write the name of the element, then "." and the name of the attribute.
- If an identifier (variable name, metamodel name, model element name, etc.) is in conflict with a keyword, it has to be marked with apostrophes.
- The ATL parser is case sensitive. This concerns the file names as much as the source code itself.
- Comments are marked with double dashes "--".

2.1 Preparation

Before an ATL program can be written you must have the target and the source metamodels. For the scope of this manual, the *Book to Publicatio*n transformation example (see Figure 1 for the *Book* metamodel and Figure 2 for the *Publication* metamodel) is used to illustrate ATL. Ecore models can be defined with KM3 [2].

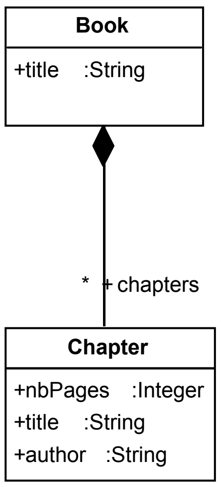


Figure 1 The Book metamodel

The *Book* metamodel contains the class *Book* which contains a set of *Chapters*. *Books* and *Chapters* have *titles*. Additionally, *Chapters* have a number of pages, *nbPages*, and *author*.

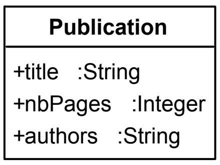


Figure 2 The Publication metamodel

The metamodel *Publication* consists of the class *Publication* which has a *title*, a number of pages, *nbPages*, and *authors*. The attribute *authors* is a String that contains the names of authors separated with the word *and*.
In the following it will be shown step by step how to program an ATL module that transforms *Book* models into *Publication* models. An ATL module begins with the header section and ends with the rules section.

2.2 Header Section

The header section defines the names of the transformation module and the variables of the source and target metamodels.
The following ATL source code represents the header of the *Book2Publication.atl* file, thus the ATL header for the transformation from *Book to Publication*:

```
module Book2Publication;
create OUT : Publication from IN : Book;
```

The keyword *module* defines the module name.
The keyword *create* introduces the target models declaration.
The keywords *from* introduces the source models declaration.
Please note:

- The ATL file name (here: *Book2Publication.atl*) has to correspond to the module name (here: Book2Publication) and must end with the extension *.atl*. The same applies to the project configuration. When using the ATL IDE for Eclipse, the module (here: Book2Publication.atl), the metamodel variable names (here: *IN* and *OUT*) and metamodel variable names (here: *Publication* and *Book*) have to correspond to the launch configuration (see paragraph 3.4).

2.3 Import Section

The import section declares what libraries have to be imported. For instance, to import the *strings* library, one would write:

```
uses strings;
```

The keyword *uses* declares the libraries that have to be imported. There can be several import declarations.
Please note:

- Do not declare imports that are not necessary.
- The *string.atl* library contains many useful functions for Strings but is not necessary for the *Book to Publication* example.
- The launch configuration (see paragraph 3.4) must indicate where the imports are to be found. Otherwise imports cannot be uploaded.

2.4 Helpers

Helpers can be used to define (global) variables and functions. Helper functions are OCL expressions. They can call each other (recursion is possible) or they can be called from within rules (see section 2.5). In general, they serve to define repetitive pieces of code in one place.
A helper function has the following structure:

- It starts with the keyword *helper* and ends with a semicolon. In between is an OCL expression.
- The notion of the term *context* is similar to OCL and it may be compared to an input parameter of a method. A context variable is specified with the help of the ATL path expression *metamodel!element* and is accessible via the self variable. If no *context* is specified, the module itself it taken as context.
- The function name is introduced with *def :* and is followed by brackets.
- The return type is between a colon and an equals sign that serves as starting point for the function implementation.
- The function finishes with a semicolon.

For the *Book to Publication* example, a *getAuthor* function has to be implemented. Its task is to iterate over the different *Chapters* of *Book* in order to build a String containing all *Authors' names*. The word *and* separates the *Authors' names*:

```
helper context Book!Book def : getAuthors() : String =
       self.chapters->collect(e | e.author)->
                                 asSet()->
                                 iterate(authorName; acc : String = '' |
                                       acc +
                                         if acc = ''
                                           then authorName
                                           else ' and ' + authorName
                                         endif)
;
```

The context variable *self* is instance of the class *Book!Book*. The collect method gets all *author* attributes of all *Chapters*. The *asSet* method eliminates all doublets by converting the sequence to a set. The *iterate* operation is well known from OCL and iterates over a *Collection* while accumulating data. In this case it iterates over the *author* attributes of all *Chapters* of a *Book* and collects the *Authors' names*. The variable *authorName* references the *Author's name* of the current iteration. The variable *acc* severs to accumulate all *authorNames*. The *if* expression returns an instance of *String* containing the *authorName* if *acc* is empty. Otherwise, it concatenates '*and'* with the *authorName*. The *getAuthors* function returns the result of the last iteration containing the concatenation of all *Authors' names*.

Please note:

- Each function must have a name and a return type definition. There may be functions with the same name but a different context.
- If the context is not otherwise specified, implicitly the module itself is taken as context.
- If the helper has no context defined, the helper has to be called with "thisModule.".

2.5 Rules

Rules describe the transformation from a source model to a target model by relating metamodels. Each rule contains a unique name. It is introduced by the keyword *rule* that is followed by the rule's name. Its implementation is surrounded by curly brackets.
In the *source pattern* (*from* part), rules declare which element type of the source model has to be transformed.
The *source pattern* consists of the keyword *from*, an *in* variable declaration and optionally of a filter. A *filter* is an OCL expression restricting the rule to elements of the source model that satisfy certain constraints. The filter is written behind the in variable declaration and surrounded by brackets.
In the *target pattern* (the *to* part), rules declare to which element(s) of the target model the *source pattern* has to be transformed to. The implementation of the *target pattern* declares the details of the transformation. It may contain one or several *target pattern elements* (see paragraph 2.6.1).
An *target pattern element* consists of a variable declaration and a sequence of bindings (assignments). These bindings consist mainly of left arrow constructs. Usually, an attribute of the target model *out* (on the left side of the arrow) receives a return value of an OCL expression (on the right side of the arrow) that is based on the *in* variable. In this sense, the right side of the arrow may consist of an attribute of the *in* variable or a call to a helper function (which is an OCL expression).
For the *Book to Publication* example, a rule is required that transforms a *Book* to a *Publication*. Only *Books* with more than two pages are considered as *Publications*. The titles of *Books* and *Publications* have to correspond. The *authors* attribute of *Publication* contains all *authors* of all *Chapters*. For the latter, the function *getAuthors* (see section 2.4) and the *getNbPages* (see annex I) can be reused. The number of pages of a *Publication* is the sum of all pages of the *Chapters* of a *Book*.

```
rule Book2Publication {
	from
		b : Book!Book (
			b.getNbPages() > 2
		)
	to
		out : Publication!Publication (
			title <- b.title,
			authors <- b.getAuthors(),
			nbPages <- b.getNbPages()
		)
}
```

Please note:

- Each rule must have a name that is unique within the module.
- Assignments are separated with comma ",". The last assignment in a block of statements does not end with a comma.
- The attribution of values is performed with the left arrow operator "<-".

2.6 *ATL Advanced Features*

The advanced features will be explained using new examples that are (will be) described in "ATL by Examples" because the Book2Publication example is too simple for this purpose.

2.6.1 Rules with Multiple Instantiations

If for one *source pattern* (the *from* part of a *rule*) several *target pattern elements* (the *to* part of a *rule*) have to be instantiated we speak of multiple instantiations. Multiple instantiations are defined using several *target pattern elements* in one and the same rule.
In the Class to Relational transformation there is a rule that for each *Class* a *Table* has to be created. Additionally, each *Table* has to have a *key* set containing at least one *key*. In this example the *key* is a *Column* with the name *objectID*. However, Classes of the source metamodel do not have persistent identifiers (surrogates) such as keys. In this sense, for each *Class* not just a *Table* but also a *key Column* has to be instantiated. Consequently, for the *Class2Table* rule two *target pattern elements* are needed, namely *out* for the creation of the *Table* instance and *new_key* for the creation of the *key*. Please note, that the *key* attribute of *Table* which is a set of Columns can be initialized with *new_key* which is a *Column*.

```
rule Class2Table {
      from
            c : Class!Class
      to
            out : Relational!Table (
                  name <- c.name,
                  key <- Set {new_key}
                  -- further value attributions
            ),
            new_key : Relational!Column (
                  name <- 'objectId'
                  -- further value attributions
            )
}
```

2.6.2 Queries and the Generation of Text

The ATL programs shown so far are all modules. However, there are also ATL query programs. Queries allow to analyse models and to calculate an output that is not necessarily a model. This makes them very handy to generate text or code from a model.
ALT query programs must start with a query instantiation which consist of the keyword *query,* a query variable, an equal sign and an OCL expression initializing the query variable.
In the following example you see an extract of the XQuery2Code program which transforms XQuery models to code. With the *allInstances* function it runs through all elements of XQuery models. The *collect* function calls the *toString* helper functions and concatenates the *String* values that they return. The *writeTo* function writes the concatenation into a dedicated file.
Please note that there are several *toString* helper functions. During the execution, the helper function with the context type that fits best (here: to the type of the *e* variable) will be chosen for execution.
In general one can say that this approach simplifies the generation of text or code because the programmer is supported in treating the coding of each metamodel types separately.

```
query XQuery2Code = XQuery!XQueryProgram.allInstances()->
                        collect(e | e.toString().
                        writeTo('C:/test.xquery'));
```

```
helper context XQuery!XQueryProgram def: toString() : String =
      self.expressions->iterate(e; acc : String = '' |
            acc + e.toString() + '\n'
      );

helper context XQuery!ReturnXPath def: toString() : String =
      '{' + self.value + '}';

helper context XQuery!BooleanExp def: toString() : String =
      self.value;
```

3 The ATL IDE for Eclipse

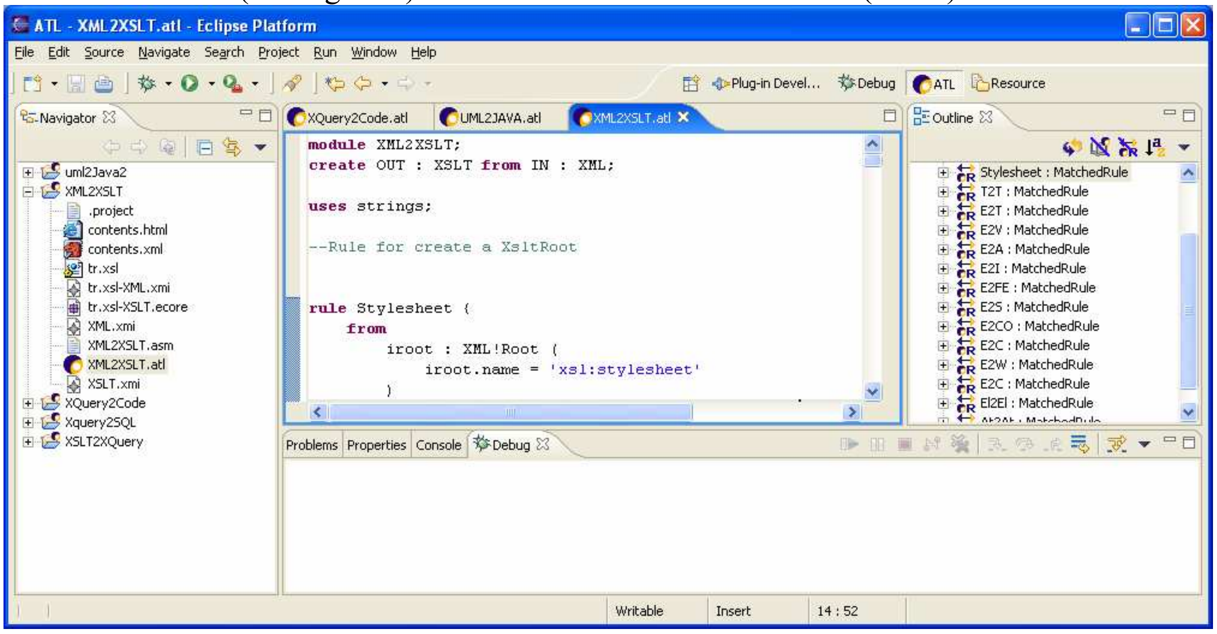
Eclipse is an open universal tool platform for software development and in particular for the construction of IDEs, integrated development environments. It has been chosen to build the ATL IDE [1] with.

3.1 *Installing the ATL IDE for Eclipse*

For the installation of the ATL IDE for Eclipse, please consult the ATL installation instructions in [3].

3.2 *Basic Features*

The Eclipse environment contains a set of tools and features which have been adapted and extended to best suit the needs of ATL development. The principal work environment is called workbench (see Figure 3) that contains several subwindows (views) and toolkits.



```
module XML2XSLT;
create OUT : XSLT from IN : XML;

uses strings;

--Rule for create a XsltRoot


rule Stylesheet (
    from
        iroot : XML!Root (
            iroot.name = 'xsl:stylesheet'
        )
```

Figure 3 ATL IDE for Eclipse

3.2.1 Perspectives

In Eclipse, the notion of perspective refers to a workbench configuration that is arranged in order to optimise the handling of a certain task. For ATL development there are two perspectives of importance, namely the ATL perspective and the debug perspective. Depending on your Eclipse workbench these perspectives may already be available via buttons in the thumb index on the top right hand side of your workbench. Otherwise a left

mouse click on the perspective icon (displaying a window with subwindows and a yellow cross, accessible on the top right hand side of your workbench) leads you to a context menu from which *Other* and then *ATL* (for the ATL development) or *Debug* (for the ATL execution in debug mode) can be chosen to obtain the corresponding perspective. If ATL is not within the selectable perspectives, the ATL plugin has not been successfully installed (please reinstall, see paragraph 3.1).
Please note:

- Only the perspectives ATL or debug should be used for developing projects with ATL or KM3.

3.2.2 Navigator

The Eclipse navigator shows you the files of your workbench. With a right mouse click on a file you obtain a context menu showing you possible actions, e.g. the possibility to open a file in a text editor, to display an ATL file with the ATL editor, to debug or run an ATL file or to import the Ecore model from a KM3 file.

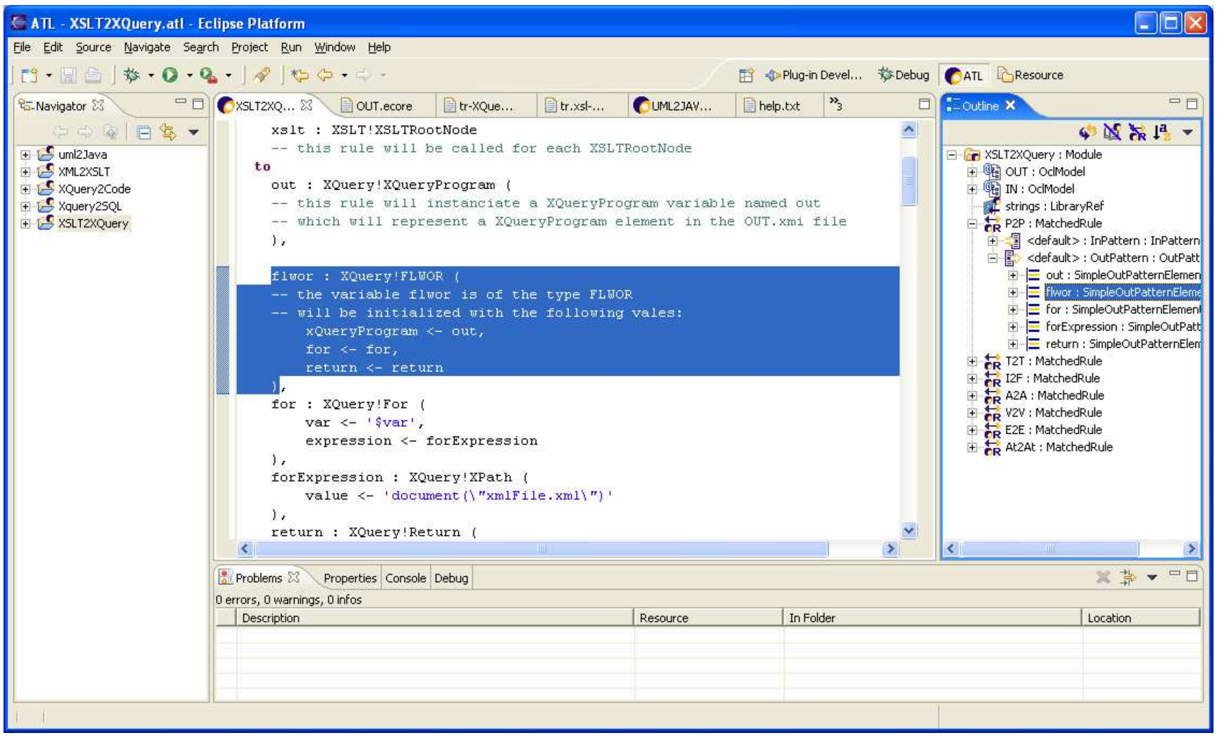
3.2.3 Editors

Eclipse facilitates the development of powerful source editors. Concerning the ATL development, an ATL editor has been implemented that performs syntax highlighting, runtime parsing, compilation and error detection. Modifications of the ATL file that lead to a syntactically correct ATL program will immediately trigger the compilation and thus the generation of a new assembler file (at latest when the file is saved). An assembler file has the extension *.asm* and contains the compiled code of the corresponding ATL file.
Please note:

- For the display of ATL files the ATL editor is recommended.

3.2.4 Outline

The Eclipse outline view gives an overview over the structural elements of the active file in the Eclipse editor with which it is to be synchronized. In this sense the ATL editor is in permanent communication with the outline view. Adding the code for a new structural element such as a rule or a helper context function in the ATL editor will automatically lead to a corresponding addition in the outline view (at latest when the file is saved). Furthermore, the cursors in the ATL editor and the outline view will always point to the same structural element (see Figure 4). If the cursor is moved in one (meaning the ADT editor or the outline), the other will replace its cursor correspondingly.
In the outline view it is possible to set breakpoints for debugging that are marked in the ATL editor with green points.



```
    xslt : XSLT!XSLTRootNode
    -- this rule will be called for each XSLTRootNode
  to
    out : XQuery!XQueryProgram (
    -- this rule will instanciate a XQueryProgram variable named out
    -- which will represent a XQueryProgram element in the OUT.xmi file
    ),

    flwor : XQuery!FLWOR (
    -- the variable flwor is of the type FLWOR
    -- will be initialized with the following vales:
        xQueryProgram <- out,
        for <- for,
        return <- return
    ),
    for : XQuery!For (
        var <- '$var',
        expression <- forExpression
    ),
    forExpression : XQuery!XPath (
        value <- 'document(\"xmlFile.xml\")'
    ),
    return : XQuery!Return (
```

```
XSLT2XQuery : Module
    OUT : OclModel
    IN : OclModel
    strings : LibraryRef
    P2P : MatchedRule
        <default> : InPattern : InPattern
        <default> : OutPattern : OutPatt
            out : SimpleOutPatternElemen
            flwor : SimpleOutPatternEleme
            for : SimpleOutPatternElement
            forExpression : SimpleOutPatt
            return : SimpleOutPatternElem
    T2T : MatchedRule
    I2F : MatchedRule
    A2A : MatchedRule
    V2V : MatchedRule
    E2E : MatchedRule
    At2At : MatchedRule
```

0 errors, 0 warnings, 0 infos

Description	Resource	In Folder	Location

ATL - XSLT2XQuery.atl - Eclipse Platform
File Edit Source Navigate Search Project Run Window Help
Plug-in Devel... Debug ATL Resource
Navigator
uml2Java
XML2XSLT
XQuery2Code
Xquery2SQL
XSLT2XQuery
XSLT2XQ... OUT.ecore tr-XQue... tr.xsl-... UML2JAV... help.txt
Outline
Problems Properties Console Debug

Figure 4 Synchronized Cursors of Outline and ATL Editor

3.2.5 Console

The Eclipse console shows the output of programs that have been triggered form subordinate runtime workbenches. This is a helpful feature for debugging ATL programs that make use of the *output* <- feature. For the creation a subordinate runtime workbench, use the right mouse button to pop up the context menu and choose *Run* in the submenu *Run*. In the run configuration view select *Run-Time Workbench* and click the *New* button. Then select the newly created instance and trigger the subordinate runtime workbench with the button *Run*. As a consequence, the standard output of programs running in the subordinate runtime workbench will be displayed in the console of the original workbench.

3.3 Creating an ATL Project

An ATL project is created with the following actions:

- In the Eclipse *File* menu choose the item *New*.
- In the appearing view choose *ATL Project* within the *ATL* folder and click on *Next*.
- Give the project a sensible name (by concatenating the source model name, the character *2* and the target model name, e.g. XSLT2XQuery) and push the *Finish* button.

Eclipse creates for each project a new folder with the project name. This folder can be opened with a double click. At the beginning it contains but a *.project* file that the ATL programmer may ignore. However, for the basic transformation scenario you need an ATL program in the form of an *.atl* file that should bear the same name as the project itself, the source and the target metamodels in EMF [4] or MDR [8], formatted in XMI [5]. For testing the transformation at least one source model should be available. For the development of ATL programs, the ATL editor is recommended (see paragraph 3.2.3).

The creation of an empty file is performed with the following steps:

- Choose the item *New* in the Eclipse *File* menu or in the Navigator context menu.
- Select the item *File*.

- In the appearing view enter the file name and the intended extension (e.g. *xmi*, *.atl* or *.km3*).
- Make sure that the correct project folder is marked.
- Push the *Finish* button.

3.4 Compilation

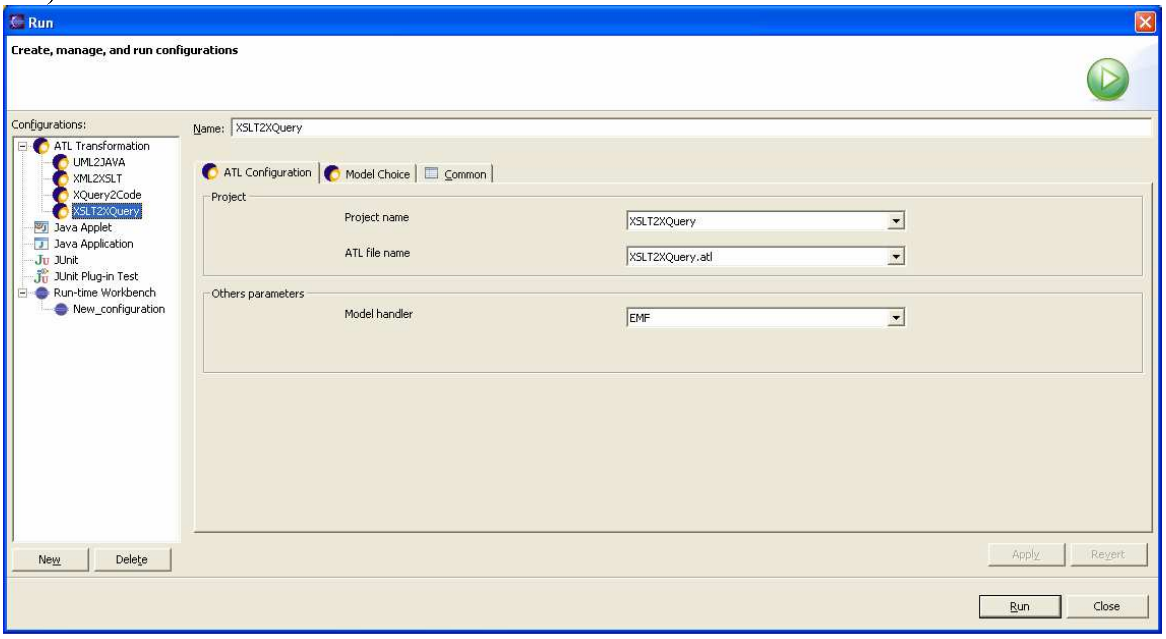
In the Eclipse environment the compilation of an ATL program to an ASM bytecode file is automatically done in the background (e.g. when saving the ATL program).

3.5 Setting up a Launch Configuration

The ATL debug and run environment can be set up once you have created the ATL file and the corresponding metamodel and model files. To obtain the launch configuration view you can use the context menu in the navigator:

- A right mouse click in the navigator view opens the context menu.
- In the context menu choose *Run...* in the submenu of *Run* or choose *Debug...* in the submenu of *Debug*.

Having reached the launch configuration view (see Figure 5), an ATL transformation is created by selecting the *ATL Transformation* instance in the configuration tree at the left hand side of the view and pushing the *New* button below. Give to the configuration the same name as to its project, choose the corresponding *.atl* file and specify the metametamodel (EMF or MOF).


Run

Create, manage, and run configurations

Name: XSLT2XQuery

Project
Project name: XSLT2XQuery
ATL file name: XSLT2XQuery.atl

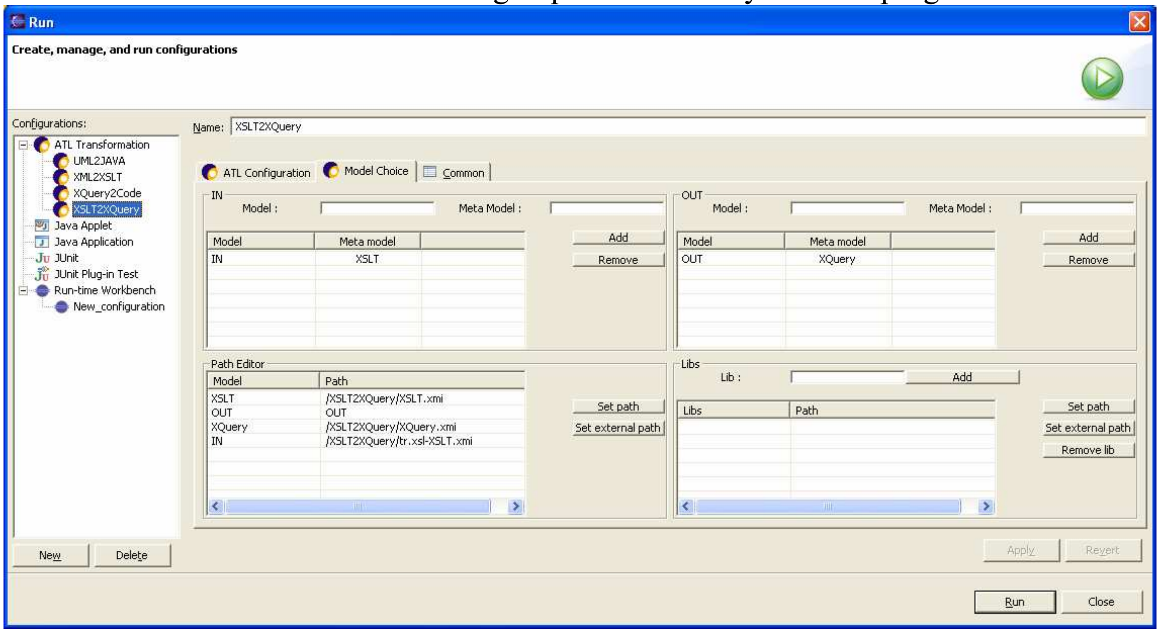
Others parameters
Model handler: EMF

Figure 5 ATL Configuration

The next step to take is to specify the metamodels and the models. To do so, pick the *Model Choice* panel in the configuration view (see Figure 6) and follow these steps:

- Define the IN metamodel(s) and model variables by writing their names in the designated fields of the IN box add press the *Add* button. For the model and the metamodel names use the same variable name as specified in your ATL file. The added variables will be displayed in the path editor table.
- Define the OUT metamodel and model variables by writing their names in the designated fields of the OUT box add press the *Add* button. For the model and the metamodel names use the same variable name as specified in your ATL file. For The added variables will be displayed in the path editor table.

- In the path editor select the different variables and attribute the corresponding files. Push the *Set path* button and specify their name. If the path is not within the workspace, use *Set external path*.
- Define the libraries used in the *Libs* panel. Please use the corresponding *.asm* files and make sure that the naming import section of your ATL program.



Name: XSLT2XQuery

IN — Model : Meta Model :

Model	Meta model	
IN	XSLT	

OUT — Model : Meta Model :

Model	Meta model	
OUT	XQuery	

Path Editor

Model	Path
XSLT	/XSLT2XQuery/XSLT.xmi
OUT	OUT
XQuery	/XSLT2XQuery/XQuery.xmi
IN	/XSLT2XQuery/tr.xsl-XSLT.xmi

Libs — Lib :

Libs	Path

Figure 6 ATL Model Configuration

3.6 Running an ATL Launch Configuration

ATL programs can be launched from the navigator:

- Right mouse click in the navigator view.
- In the context menu choose *Run...* in the submenu of *Run*.
- Choose the configuration needed and run it by pressing the *Run* button on the right bottom of the view.

Another possibility to trigger the execution of an ATL program is to use the run icon (depicting a white play forward sign on a green background) displayed in the bar underneath the main menu.

3.7 Debugging an ATL Module

For debug actions it is recommended to switch to the debug perspective. Additional to the editor and the outline, it contains the debug window that displays the processes (terminated or not) and the control window that lists all chosen *breakpoints* and *debug variables* of ATL programs.

An essential instrument for debugging is the partial execution step by step or with breakpoints. The latter are set with a right mouse button click on a structural element (e.g. a rule) in the outline view and then selecting the "add breakpoint" item. To trigger the partial execution use the debug feature by clicking the debug icon.

You may additionally use the standard output display described in the previous paragraph as a means for debugging.

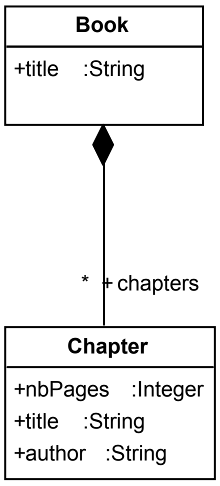
3.8 Log File

ADT log files are contained in your workspace log file (your_workspace/.metadata/.log).

You can access the error log file via the *Help* menu. Choose *About Eclipse Platform*, then *Configuration Details* and finally *View Error Log*.

I Example Code

In this manual, the *Book to Publicatio*n transformation example (see Figure 7 for the *Book* metamodel and Figure 8 for the *Publication* metamodel) serves to illustrate the use of ATL.



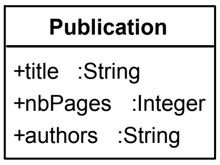


Figure 8 The Publication metamodel

Figure 7 The Book metamodel

The *Book to Publication* code transforms *Books* with mode than two pages to *Publications*. The titles of *Books* and *Publications* have to correspond. The *authors* attribute of *Publication* contains all *authors* of all *Chapters*. The number of pages of a *Publication* is the sum of all pages of the *Chapters* of a *Book*.

```
module Book2Publication;
create OUT : Publication from IN : Book;

helper context Book!Book def : getAuthors() : String =
       self.chapters->collect(e | e.author)->
                              asSet()->
                              iterate(authorName; acc : String = '' |
                                    acc +
                                    if acc = ''
                                          then authorName
                                          else ' and ' + authorName
                                    endif)
;

helper context Book!Book def : getNbPages() : Integer =
      self.chapters->collect(f|f.nbPages)->
                              iterate(pages; acc : Integer = 0 |
                        acc + pages)
;

rule Book2Publication {
      from
            b : Book!Book (
                  b.getNbPages() > 2
            )
      to
            out : Publication!Publication (
                  title <- b.title,
                  authors <- b.getAuthors(),
                  nbPages <- b.getNbPages()
            )
}
```

II Figures

III References

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