

Generating Domain-Specific Model Editors with Complex Editing Commands

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1 Overview

In software system development, domain-specific visual notations are increasingly used and need a tool environment consisting of visual editors, simulators, model transformers, etc. Several ECLIPSE projects head for a meta technology to define domain-specific modeling languages. The ECLIPSE Modeling Framework (EMF) [5] can be used to define the underlying models of visual editors. Given an EMF model, a set of Java classes for manipulating the model and a basic, tree based editor for model instances are generated. The generated classes provide CRUD functionality for model elements. To realize a graphical editor, the editor code may be hand-coded on the basis of GEF, the ECLIPSE Graphical Editor Framework [3], which offers basic and advanced editor functionalities. As another alternative, a visual editor may be generated using the *Graphical Modeling Framework (GMF)* [4] which started recently as Eclipse technology subproject aiming at providing an infrastructure for generating visual editors in ECLIPSE. In essence, GMF forms a bridge between EMF and GEF, whereby a diagram definition is linked to a domain model which serves as input to the generation of a visual editor.

GMF-generated editors offer basic editing commands to create, edit, move and delete single model elements (basic editing). Graph transformation-based editors (see e.g. TIGER [6]) show that the generation of editors with complex editing commands is also possible. Editing e.g. control flow graphs, there might be editing commands available which insert or delete a complete decision structure in one step.

In this documentation, we describe how meta model-based editor design and generation performed by GMF (<http://www.eclipse.org/gmf>), can be extended by graph transformation concepts to define and generate complex editing commands to be used in GMF-generated visual editors.

2 Examples for Complex Editing Commands

Activity diagrams are used to describe the control flow within a system, based on activities. In the following, we consider the editor generation process for a

simple variant of activity diagrams consisting of start, end, decision and simple activities.

The visual editor generated by pure GMF (without the extension for complex editing commands) is shown in Fig. 6 (a). It contains an example for an activity diagram with different kinds of activities mentioned above. We used the usual design process for visual editors offered by GMF. Considering the palette on the right of the generated editor, we notice that creation commands for each of the model elements are offered. Moreover, the context menus contain commands for editing and deleting model elements. Up to now, there is no way to design and generate more complex editing commands.

Complex editing commands for activity diagrams can help to easily edit the diagrams in mind. For example, a well-formed activity diagram contains at least one start and one end activity. Moreover, well-formed activity diagrams contain decision branches which are explicitly merged by a decision activity, only. An example for a well-formed activity diagram is shown in Fig. 6.

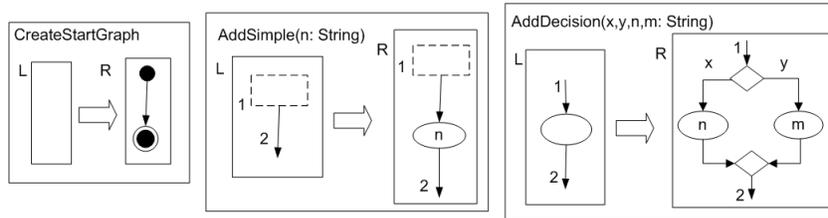


Fig. 1. Specification of complex editing commands

Fig. 1 shows the before and after patterns for sample complex editing commands. We define one editing command *CreateStartGraph* to generate the start diagram which consists of exactly one start and one end activity, connected by a next-relation. This command is executable in the empty editor panel only. Editing command *AddSimple* inserts a simple activity after another activity, where $\boxed{\quad}$ is a symbol for an abstract figure which stands for one of the following concrete figures \bullet (start activity) or \circ (simple activity). The name of the new activity is given by input parameter n . Please note that the source activity of next-relation 2 changes after insertion. Editing command *AddDecision* replaces a simple activity by a decision activity with two branches. Each branch contains one simple activity. The branches are merged afterwards by another decision activity. The *AddDecision* command has four input parameters: two arc inscriptions x and y , and two names n and m for the new simple activities in both branches.

3 Extending GMF by Complex Editing Commands

In this section, we discuss how GMF-based editor generation can be extended by graph transformation concepts supporting the specification of complex editor commands.

3.1 Extension of the GMF Development Environment

A language model is described in GMF by defining an EMF model, the so-called *domain model*, while the layout is specified in the *graphical definition model*. Now, an additional visual editor for defining complex editing commands is provided, where EMF transformation rules for complex editing commands can be defined as transformation rules based on the domain model. This step is optional. The *tooling definition model* is used to define the commands for the editor palette. After having defined all these models separately, the *mapping model* establishes a connection between them and is the input for the generation process. Fig. 2 shows an overview of the design workflow in the extended GMF using a dashboard, where the original GMF workflow is extended by the specification of a *Transformation Rule Model*.

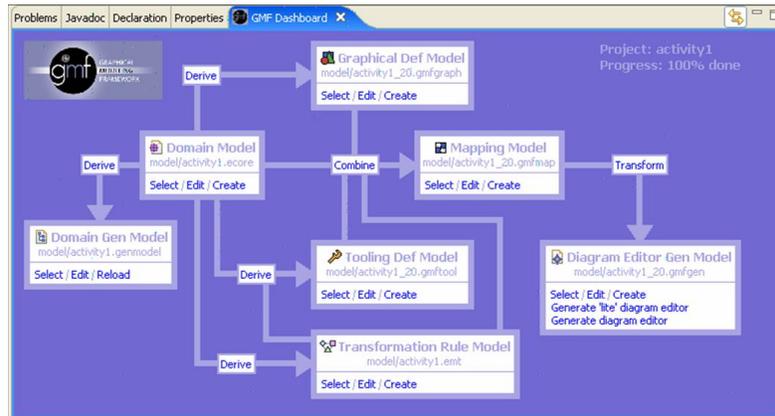


Fig. 2. GMF dashboard extended by transformation rule model for editing commands

Before discussing the specification of concrete editing commands, we present the EMF model transformation approach [1] used to manipulate the underlying EMF models. The transformation concept is closely related to algebraic graph transformation. The main reason for this design decision is the basic opportunity to validate EMF model transformations on the basis of graph transformation. Basically, an EMF transformation is a rule-based modification of an EMF source model resulting in an EMF target model. Both, the EMF source and target models are typed over an EMF core model. All modifications are made in-place,

i.e. the source model is not copied before modification. For efficient execution of model transformations, the rules can be translated to Java code to be integrated into generated EMF classes. Fig. 3 shows a designer for EMF transformations where the underlying meta model is depicted at the bottom and one of the transformation rules, i.e. a rule for inserting a start diagram, is shown at the top. A negative application condition ensures that this rule is applied only to the empty activity diagram.

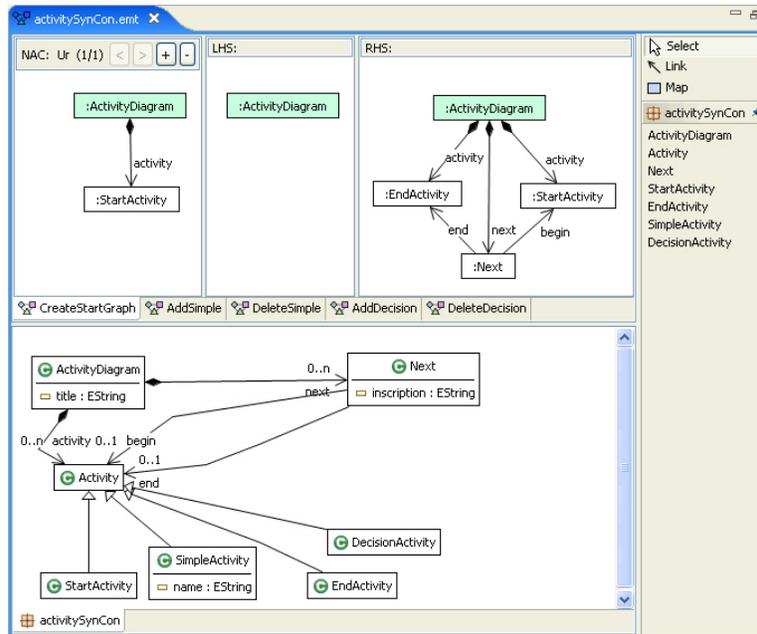


Fig. 3. Tool environment for EMF transformation

The editing rule for inserting new decision structures (compare Fig. 1) is shown in Fig. 4, and includes a wizard to define the names of the newly created branch activities.

After having defined all required editing commands analogously, all those which should show up in the palette have to be identified in the GMF tooling model. To this end, the tooling definition wizard is extended by a Rule Tool Definition Wizard, shown in the left window of Fig. 5. Moreover, the GMF mapping model is extended by the definition of the transformation model (see right window of Fig. 5).

3.2 Extension of the GMF Runtime Environment

The editor generation process in the extended GMF version results in an editor as shown in Fig. 6 (b) where default editing operations as well as specifically

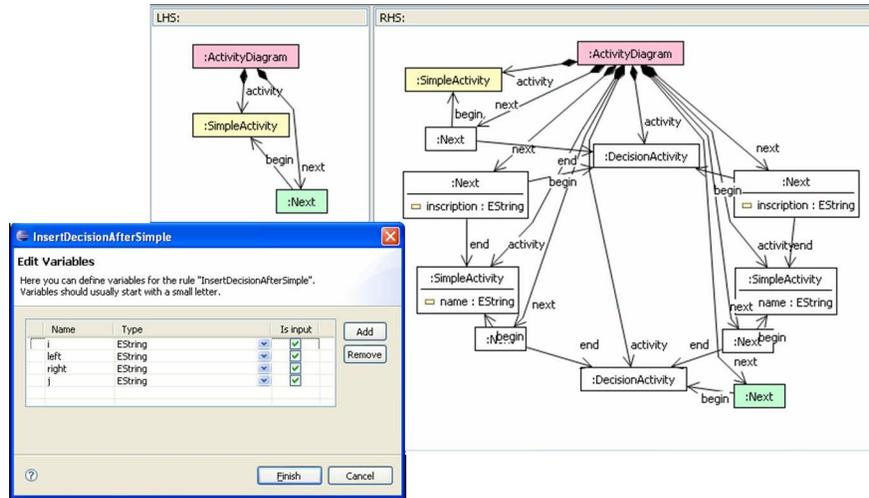


Fig. 4. Example for an EMF transformation rule inserting a complete decision structure

designed ones are provided by the palette. Please note that the editor designer selects those commands to be included in the palette.

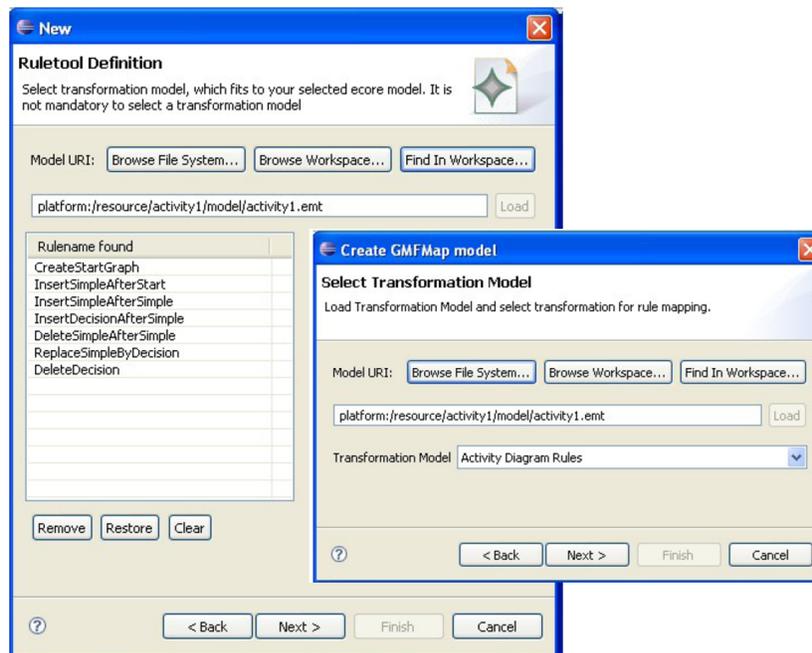


Fig. 5. Rule Tool Definition Wizard for extended GMF Tooling and Mapping Model

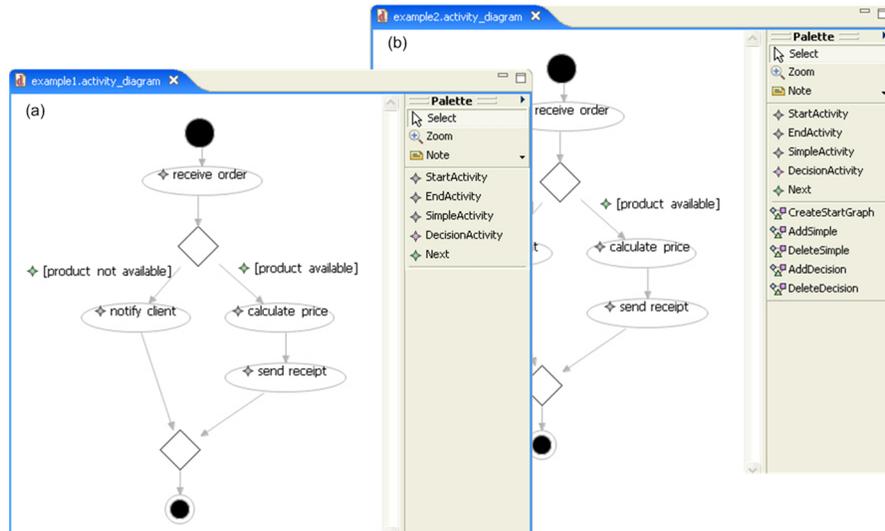


Fig. 6. Generated editors for activity diagrams without (a) and with (b) complex editing commands

We describe the usage of the generated editor in the extended GMF version along our running example. A sequence of steps to create our sample activity diagram are shown in Fig. 7.

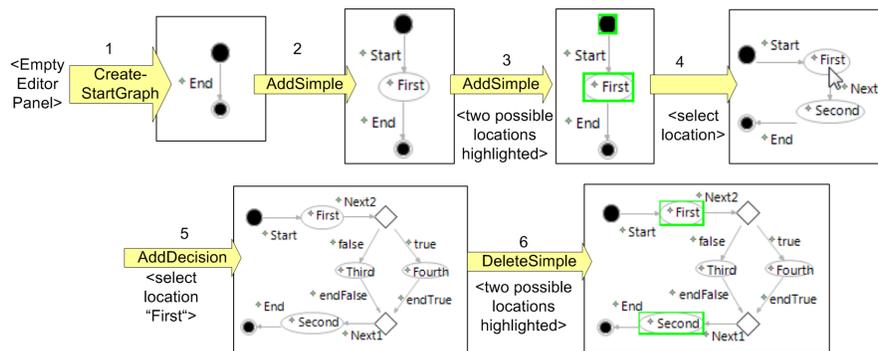


Fig. 7. Editing steps using complex editing operations in extended GMF

In step 1, we start with an empty editor panel and select command *CreateStartGraph* from the palette. Immediately, the start activity diagram appears in the editor panel. Step 2 selects command *AddSimple* to add a simple activity node. This node is added after the start activity, because the negative application

condition of the rule forbids to insert an activity node after a final node. Since we have only one non-final activity node, the location to apply this command is unique in the current situation. In Step 3, we select command *AddSimple* again, but this time it can be applied at two locations: the new activity node can be inserted either after the start activity, again, or after the new simple activity node named “First”. Thus, instead of applying the rule, the editor now highlights the two possible locations. In step 4, one of the highlighted nodes is selected per mouse click, and the command is applied accordingly. Step 5 combines two atomic steps: command *InsDecision* is selected, and the activity nodes “First” and “Second” are clicked on to specify between which two activity nodes the complete decision structure is to be inserted. Afterwards, in step 5, command *DeleteSimple* is selected in the palette. This leads to two activity nodes being highlighted, which may be deleted by the rule.

What happens, if an activity node is selected in the editor which is not highlighted as possible rule application location, is shown in Fig. 8: the rule is not applied, and an error message is shown.

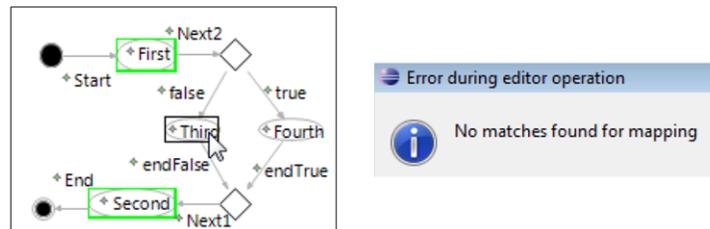


Fig. 8. Error message if no rule application is possible

4 Installation Requirements and Extension Points

For basic installation instruction we refer to <http://tfs.cs.tu-berlin.de/emftrans/gmftrans>. Currently, the installation requirements are:

- Java 5.0 or later,
- Eclipse 3.3 M2,
- GMF 2.0 M3 and all required plug-ins

A project set file as well as a zip archive containing all required plug-ins is available on the project website <http://tfs.cs.tu-berlin.de/emftrans/gmftrans/>.

5 Outlook

Using pure GMF, a visual editor may be generated which offers basic editor commands for each model element, only. In this documentation, we described

an extension of GMF for generating visual editors which provide complex editing commands. For the generation of complex editor commands an additional model is needed. We use EMF transformation rules to formulate commands based on the given domain model. To the best of our knowledge, no other meta CASE tool based on meta models offers the possibility to define complex editing commands.

Besides pure editing commands, also model optimizations such as model refactorings, may be realized with the proposed approach. Moreover, simulation of behaviour models can be defined by this approach. Thus, this work can be considered as a starting point for the generation of powerful and flexible domain-specific visual editors in Eclipse.

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