Model-based Software Engineering
(02341, spring 2016)

Ekkart Kindler

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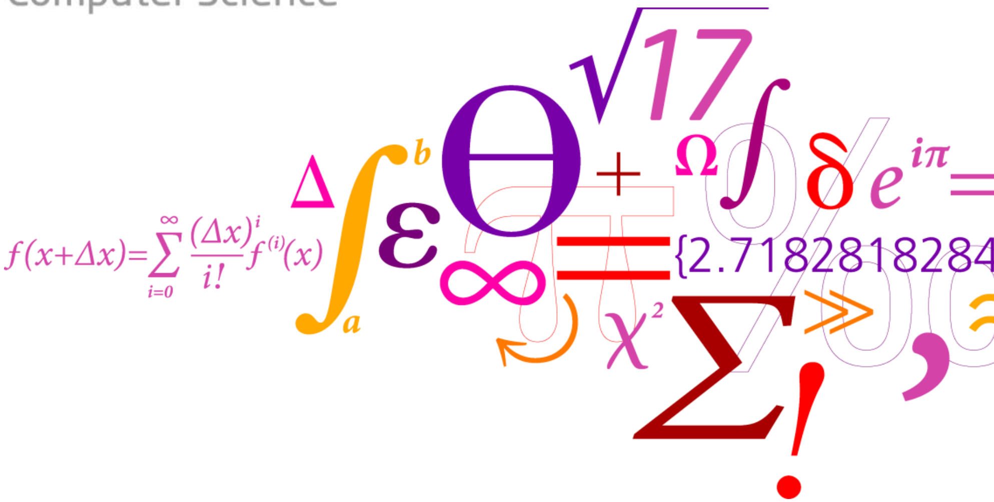

I. Introduction

Recapitulation of lecture 1 and some parts, which were skipped last week.

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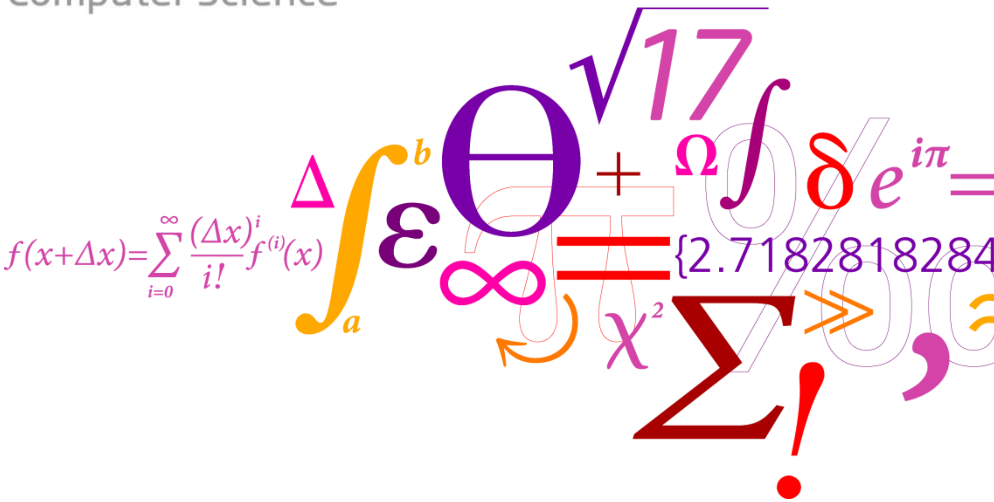


Programmi

Software

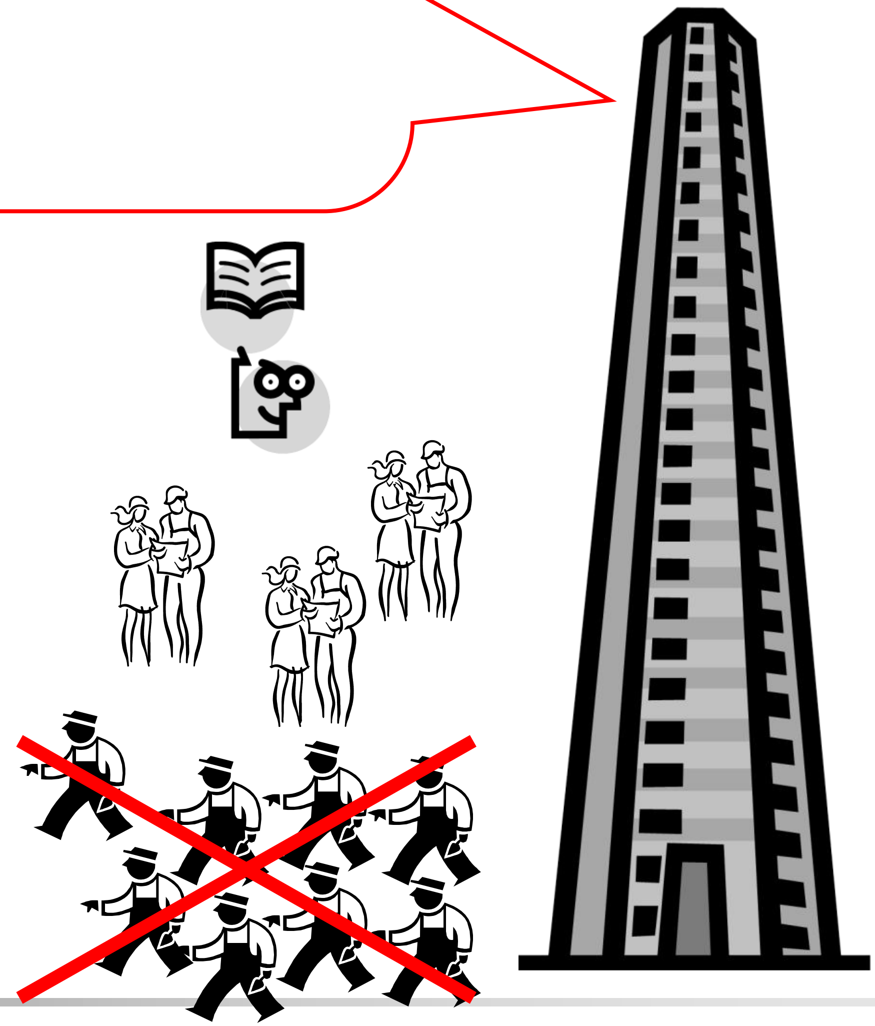
Software Engineer

Software Engineering

Program

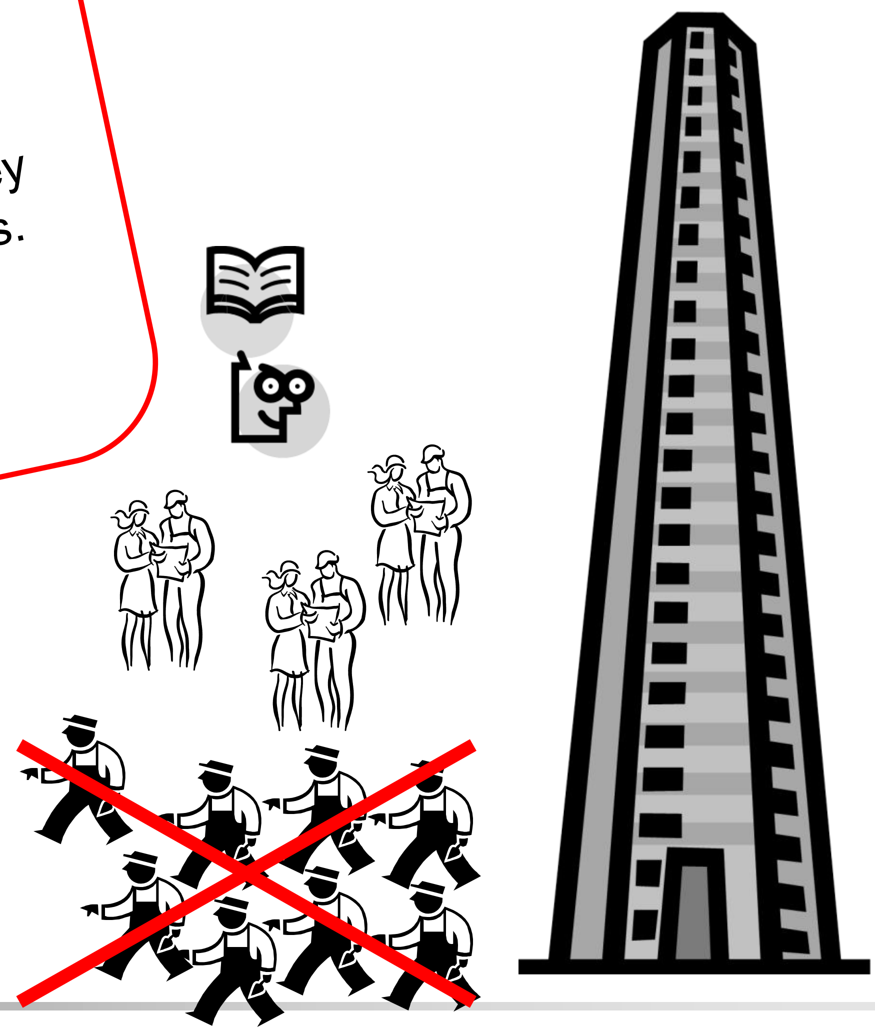
Programmer

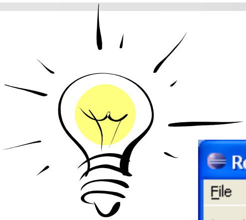
Programming

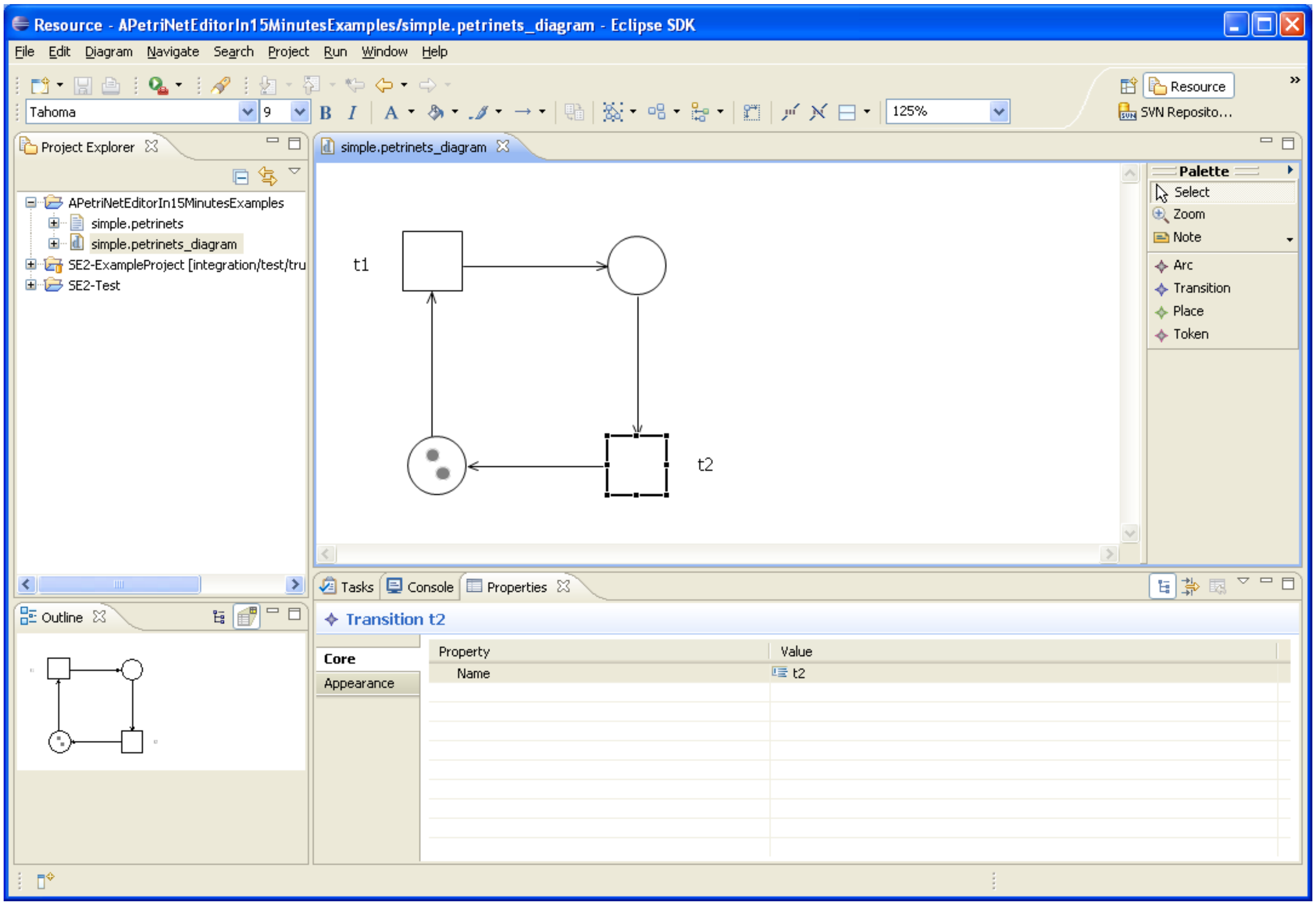


Modelling

Models are the “floor plans” of software engineers, and are the key to the success of software projects.






Resource - APetriNetEditorIn15MinutesExamples/simple.petrinets_diagram - Eclipse SDK
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Project Explorer
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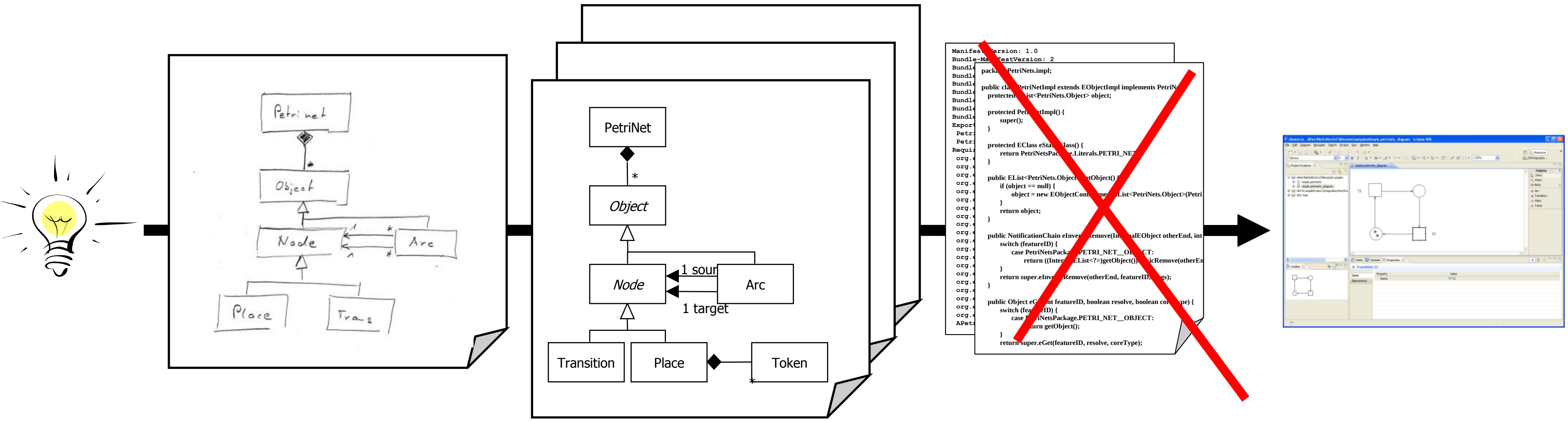


Analysis

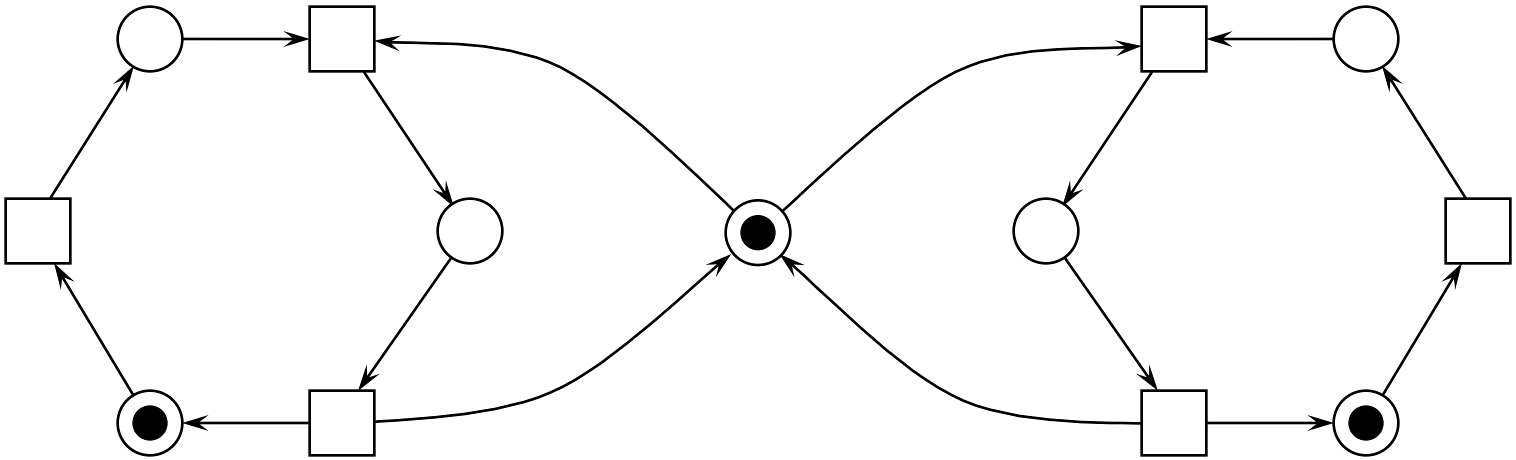
Design

Implementation

Coding

Code is generated

Example of a Petri net



Stages

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- Examples
- Taxonomy (done on blackboard)
- Glossary
- Model (developed on blackboard)

Rule: Never ever start making a UML model without having looked at some examples first and naming the main concepts (taxonomy)!

Models (Meta Models)

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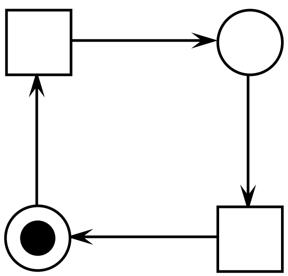
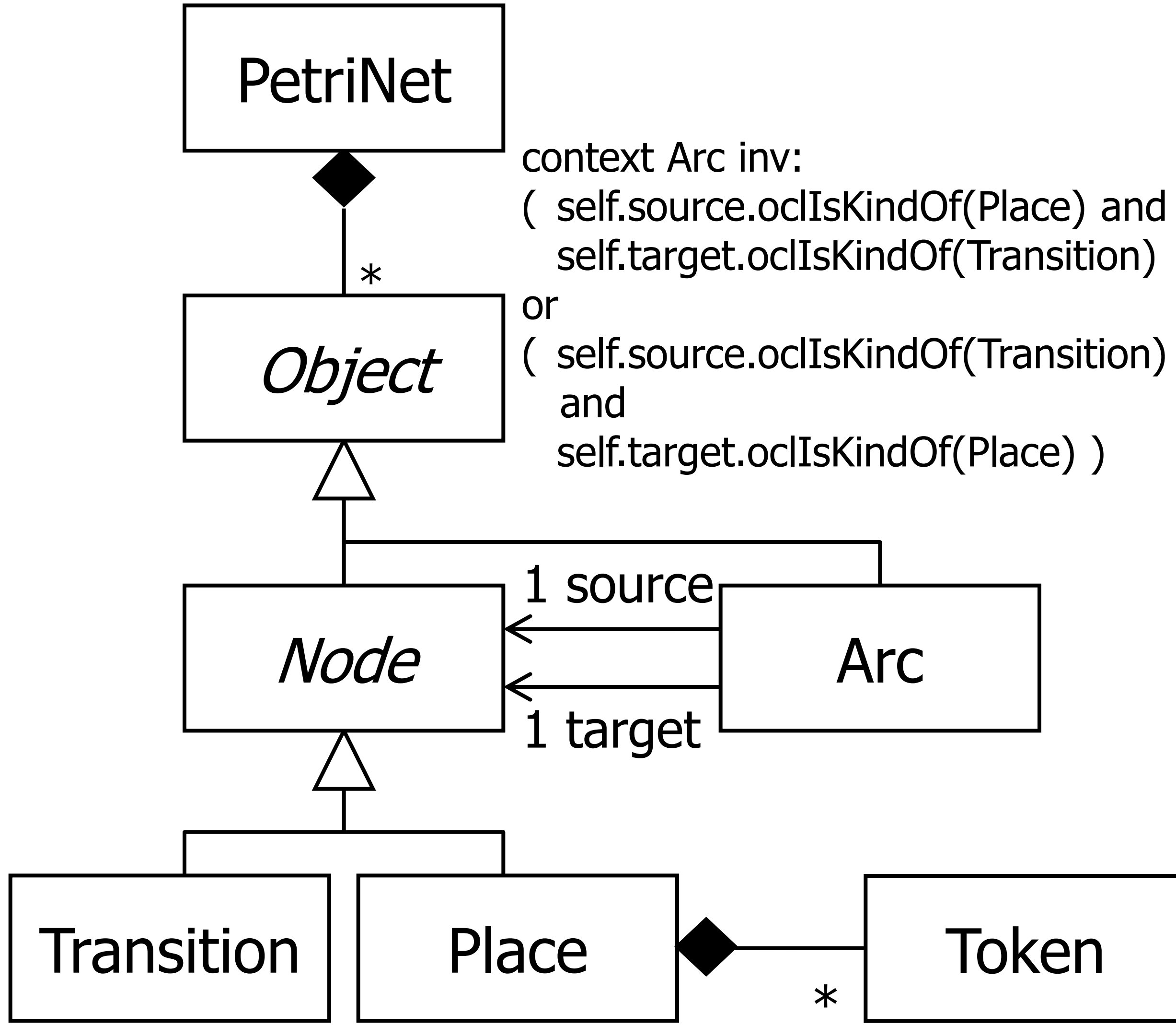


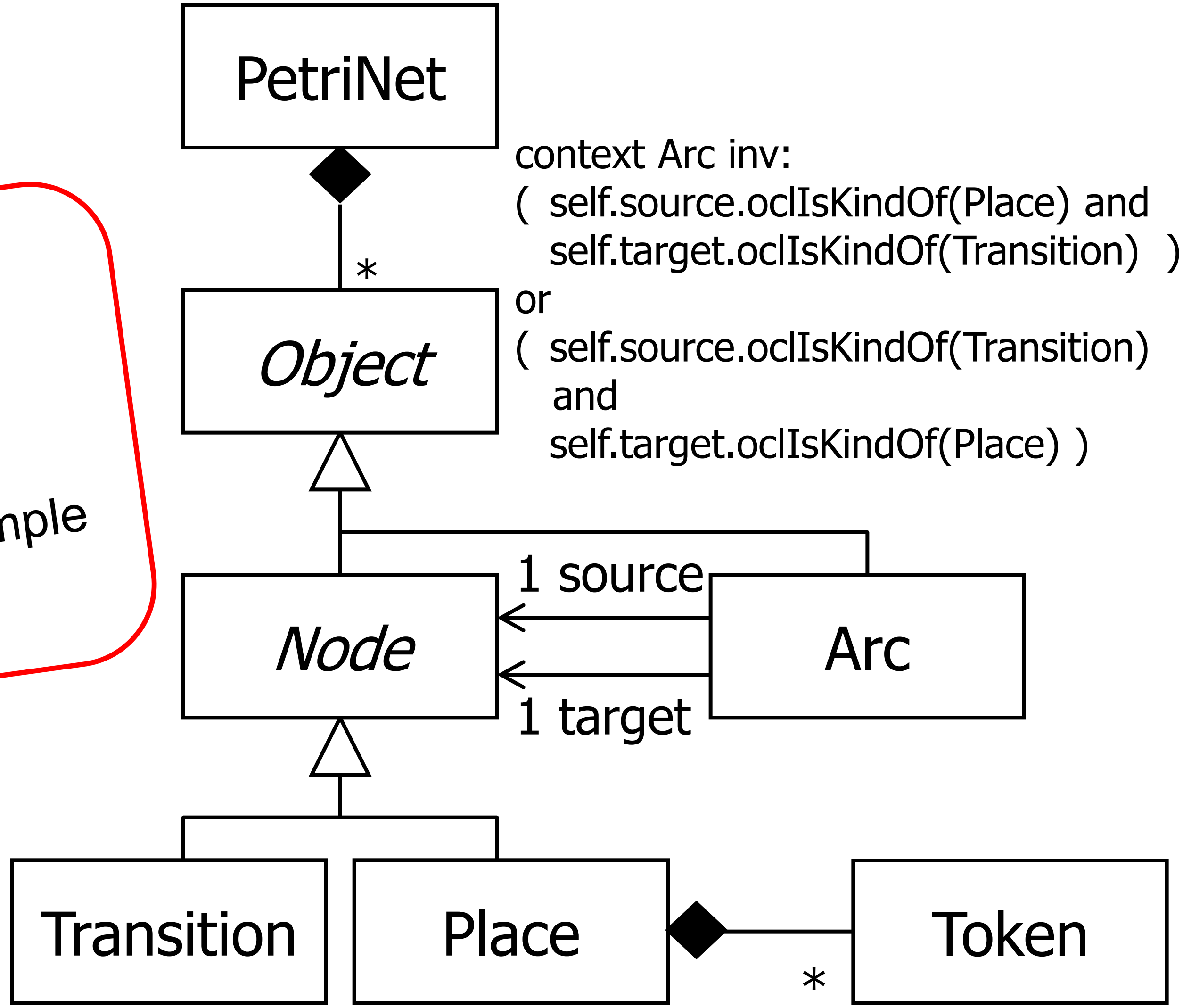



```
context Arc inv:
( self.source.oclIsKindOf(Place) and
  self.target.oclIsKindOf(Transition) )
or
( self.source.oclIsKindOf(Transition)
  and
  self.target.oclIsKindOf(Place) )
```

Meta model for Petri nets

Don’t think models as Java

Rule: Don’t think of programming for now! These models are on concepts **only**: the concepts of ”our” example domain: Petri nets!



Syntax (abstract and concrete)

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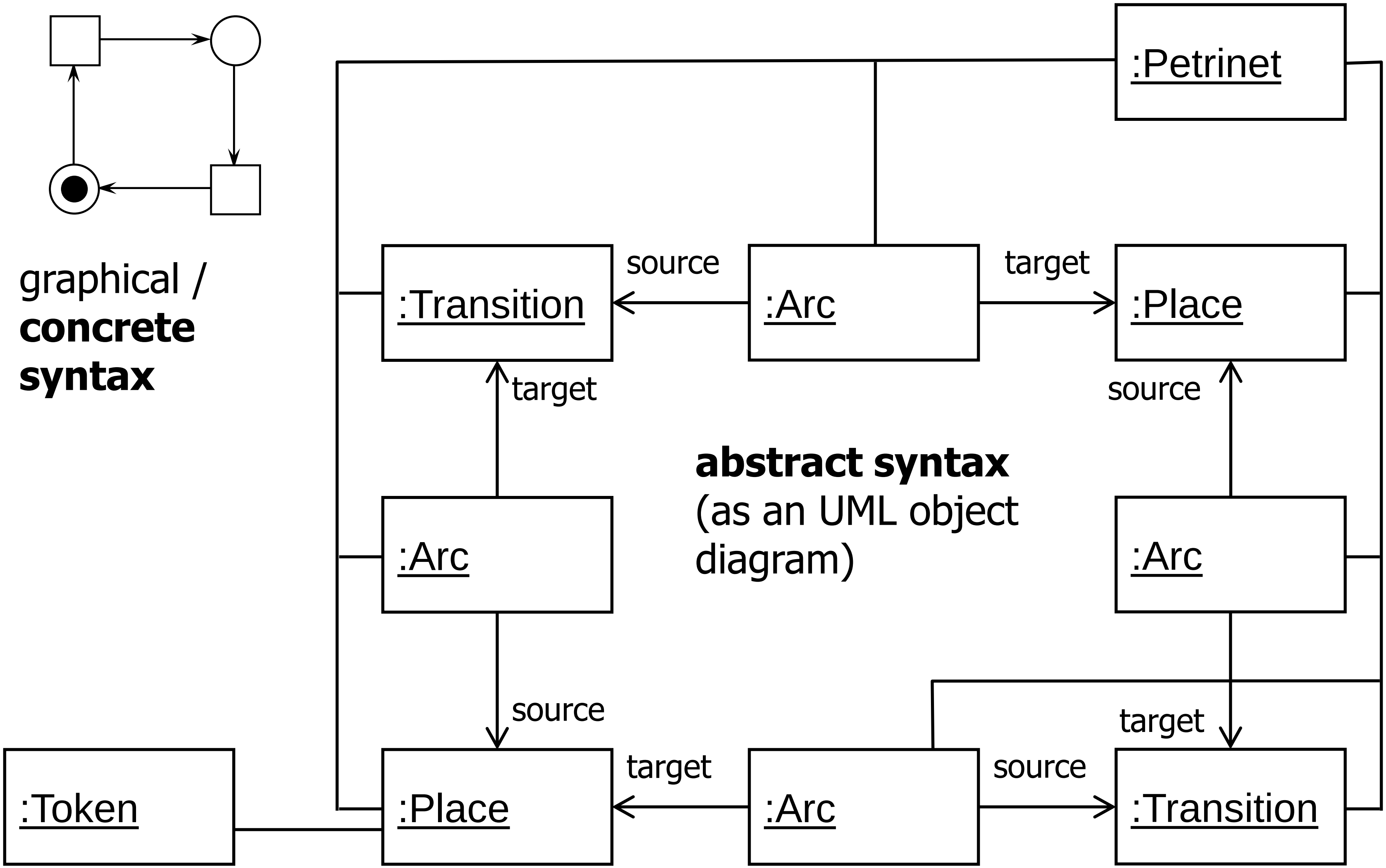


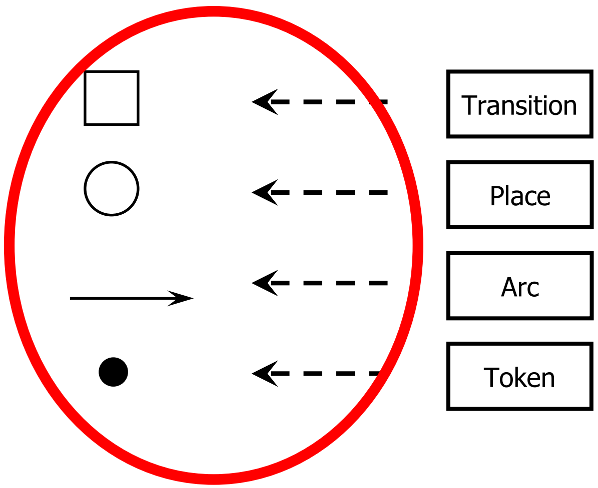
Benefits of Modelling

- Better understanding

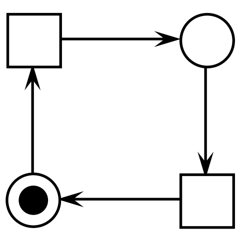
- Mapping of instances to XML syntax (XMI)

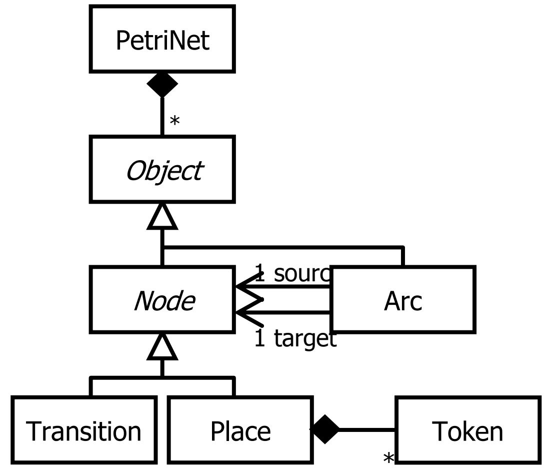
- Automatic code generation
  - API for creating, deleting and modifying model
  - Methods for loading and saving models (in XMI)
  - Standard mechanisms for keeping track of changes (observers)

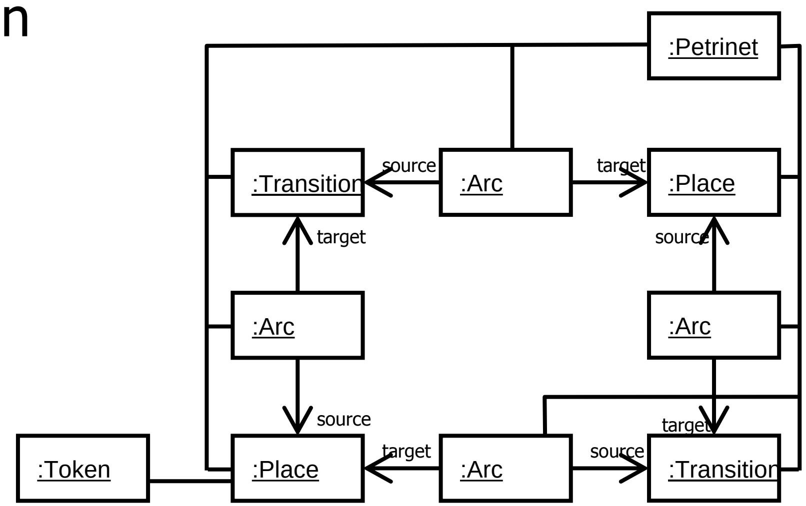
GMF



generate an editor







Benefits of Modelling (cntd.)

- Better Understanding

- Mapping of instances to XML syntax (XMI)

- Automatic Code Generation
  - API for creating, deleting and modifying model
  - Methods for loading and saving models (in XMI)
  - Standard mechanisms for keeping track of changes (observers)
  - Editors and GUIs

”Buzzwords”

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- Model Driven Architecture® (MDA®)
  OMG™ software development approach for separating business logic from platform specific details
  - using models
  - automatic generators (for code and other models)

- Model-based Software Engineering (MBSE)
  General term for making “better” use of models for easing the software development

Ultimately: Getting rid of programming resp. technical artefacts.

Theses

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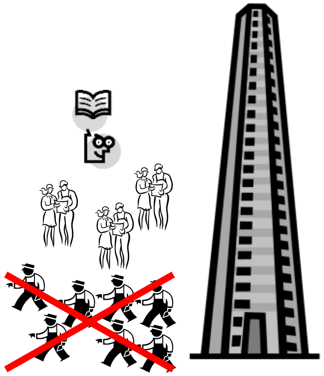
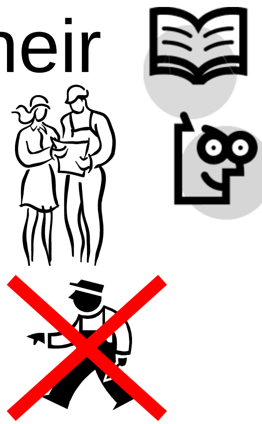
- We will always have programming and programmers!



- We should always teach programming!

- But, software engineers should be trained in their engineering and modelling skills!
- And this is where they should be at their best!
- Most of the rest can be automated!



- Eventually, programming will be for software engineers as assembler is today for programmers.

3. Modelling with a Purpose

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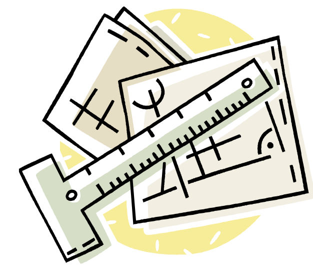
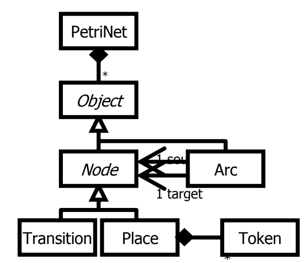
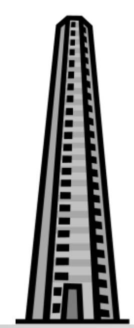
Anologies:

- Models as floor plans (see earlier slides)
  - Architects and construction engineers use quite different kind of plans – driven by the puprose
  - They even use models (miniatures)

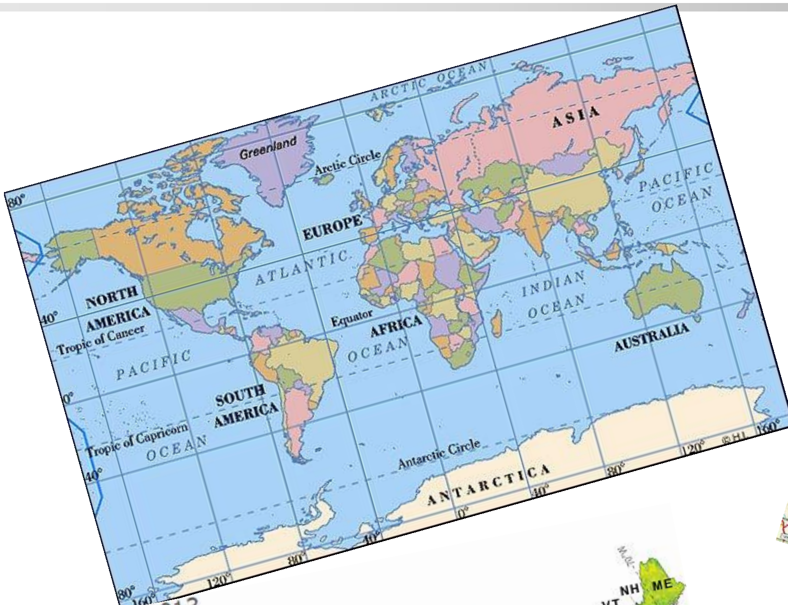


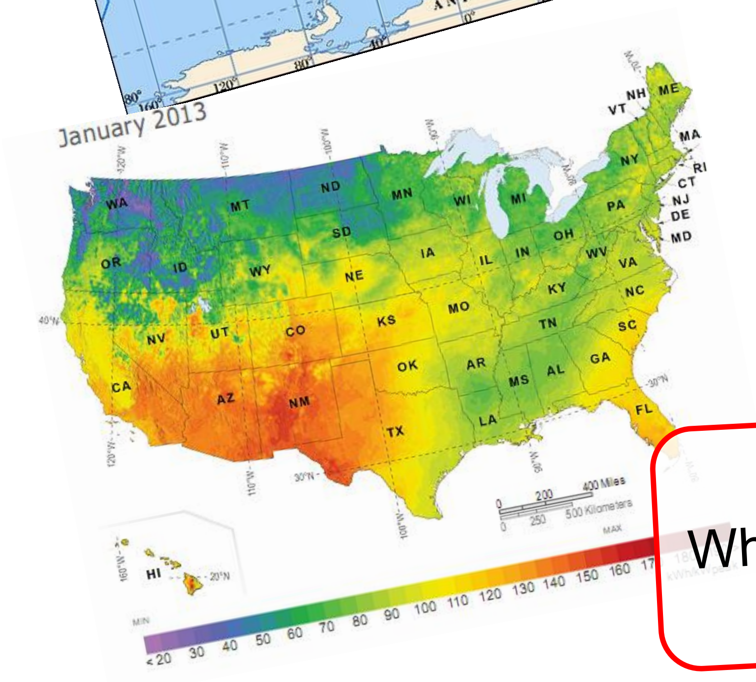
- Models as maps
  - Understand the world (→ domain)
  - Find your way round in the software





Maps





Which of them is the best?

Software vs Programming

- For programs (small software), models are often not needed, and making them might be a waste of time.

- For software, they are essential for building something which works out and the different pieces fit to each other

Tutorial 1: Q & A / Wrap up (BBD)

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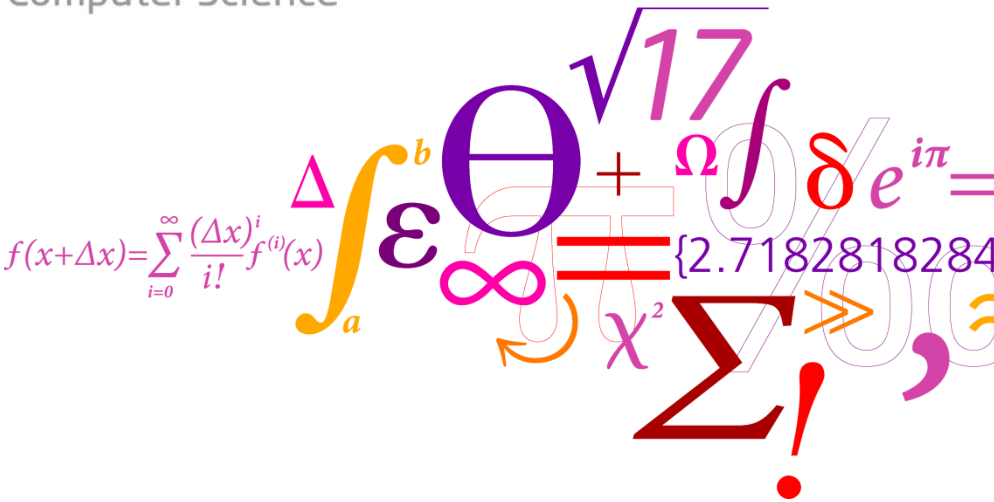

II. Modelling with a Purpose

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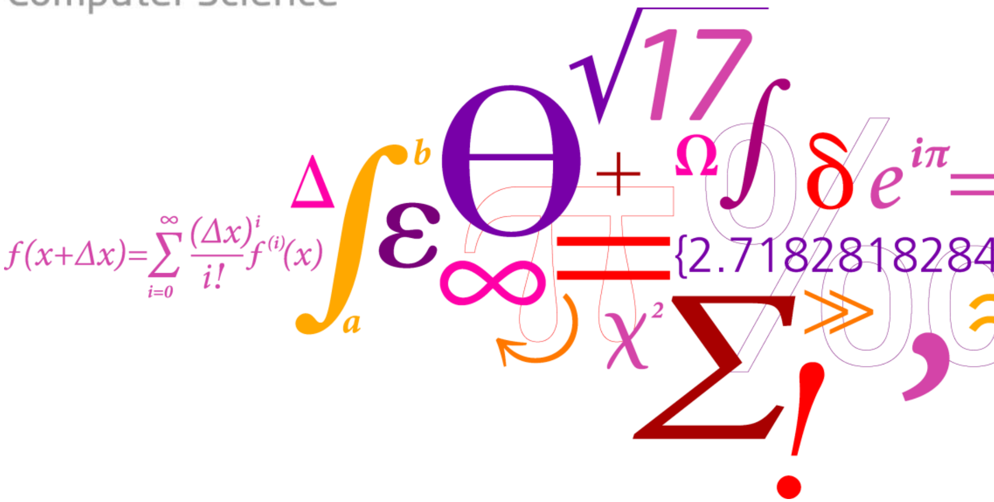

1. Models to which end

- Blackboard Discussion (BBD):

Purpose	Kind of model

2. Domain models

Petri net example revisited (see next two slides)

Discussion:

- Should in/out (opposites of target and source) be in domain model?
- What makes it a domain model?
- What is the difference to a data model or data base schema?

Petri net: Domain model

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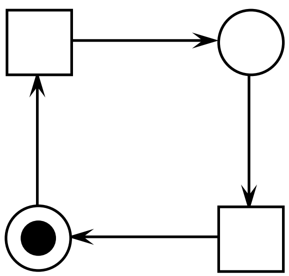
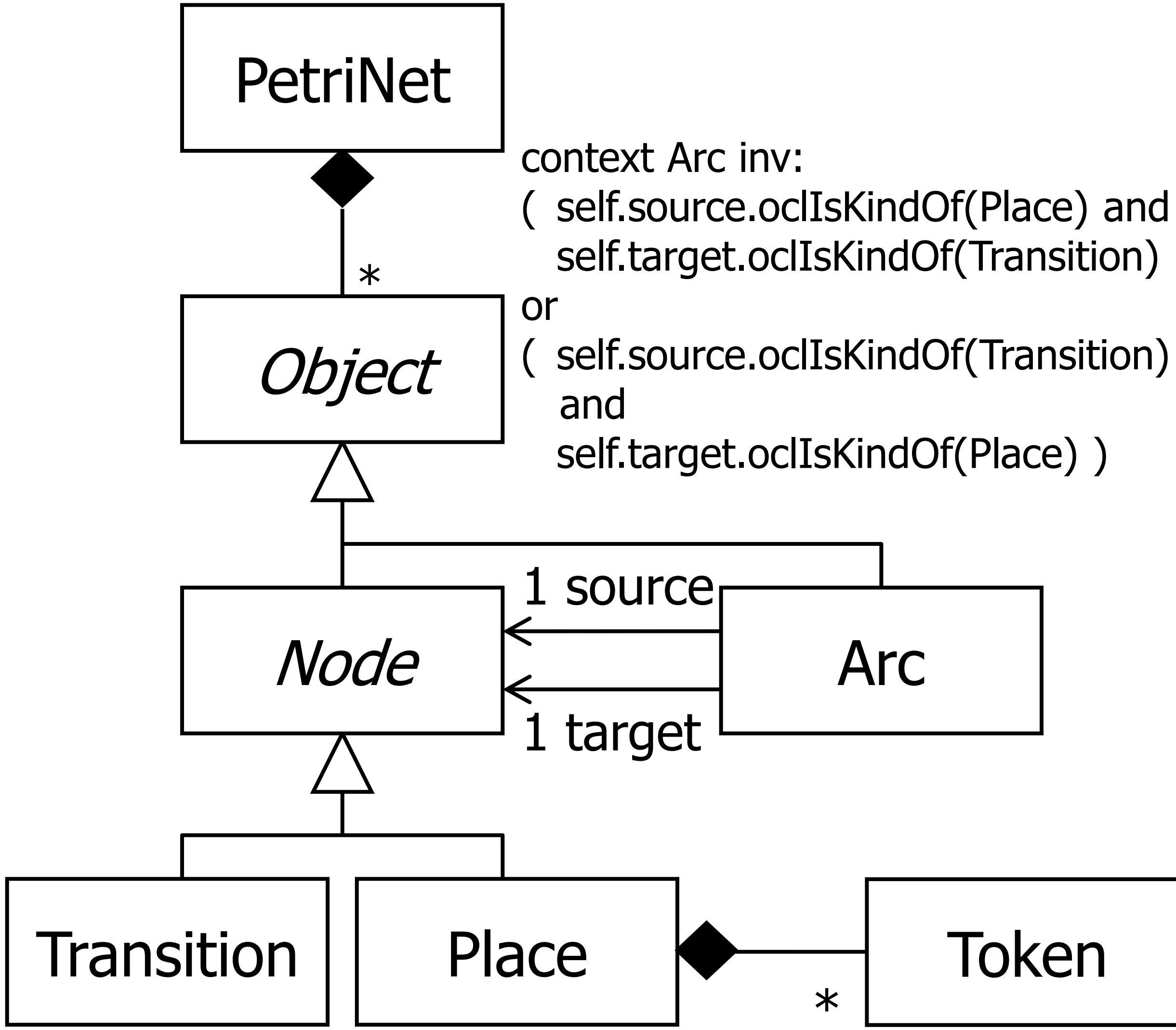
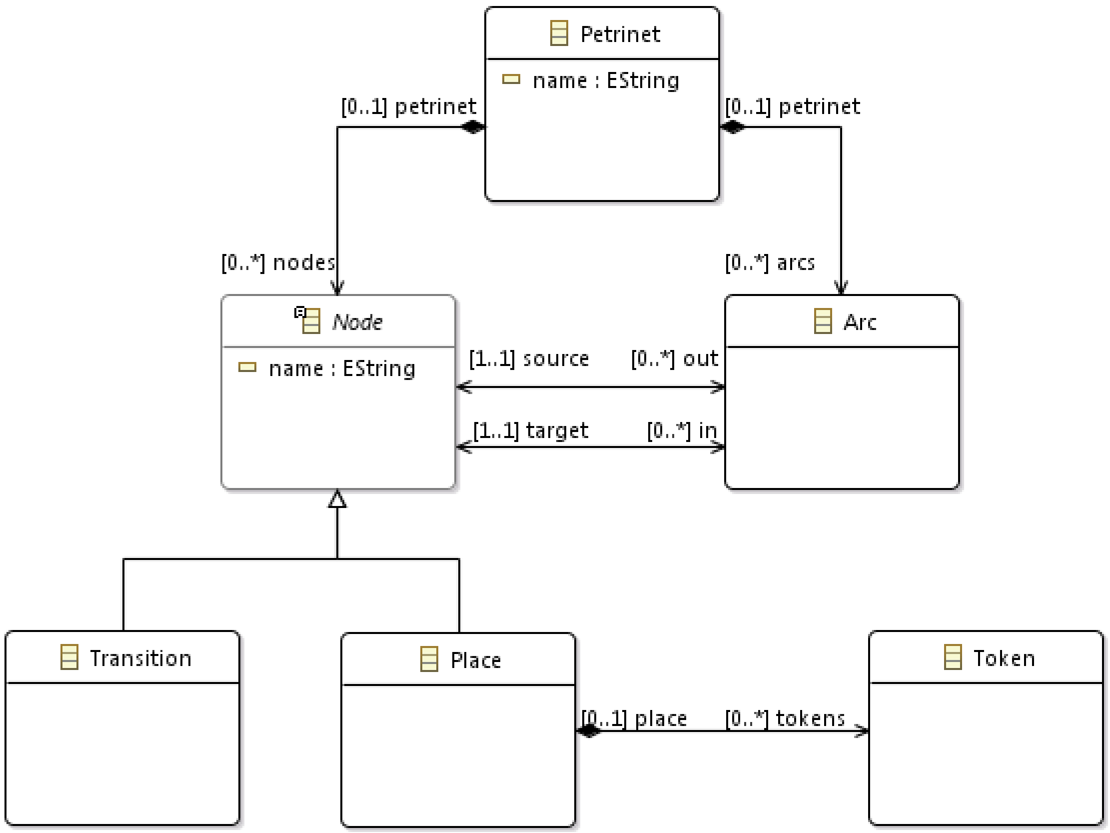




context Arc inv:
(self.source.oclIsKindOf(Place) and
  self.target.oclIsKindOf(Transition))
or
(self.source.oclIsKindOf(Transition)
  and
  self.target.oclIsKindOf(Place))

Ecore model


Petrinet
name : EString
[0..1] petrinet
[0..1] petrinet
[0..*] nodes
[0..*] arcs
Node
name : EString
Arc
[1..1] source
[0..*] out
[1..1] target
[0..*] in
Transition
Place
Token
[0..1] place
[0..*] tokens

Representations of model

Same model can have different representations:

- Graphical / tree (as of Tutorial 1)
- Java
- Ecore
- XML Schema (XSD)

Actually, in our EMF technology, Ecore models can be imported from XML Schema and from annotated Java classes (see Java example on the next slides).

Different representation might serve different purposes and have a different focus!

What would the focus for XSDs, Java and Ecore be?

Also JPA can be considered a model represented in Java (with annotations mapping it to a database schema).

Petrinet.java


```
/** @model */
public interface Petrinet {

  /** @model opposite="petrinet" containment="true" */
  List<Node> getNodes();

  /** @model opposite="petrinet" containment="true" */
  List<Arc> getArcs();

  /** @model */
  String getName();

}
```

Arc.java

```
/** @model */
public interface Arc {

   /** @model opposite="out" required="true" */
   Node getSource();

   /** @model opposite="in" required="true" */
   Node getTarget();

   /** @model opposite="arcs" transient="false" */
   Petrinet getPetrinet();

}
```

Node.java

```
/** @model abstract="true" */
public interface Node {

  /** @model opposite="nodes" transient="false" */
  Petrinet getPetrinet();

  /** @model opposite="target" */
  List<Arc> getIn();

  /** @model opposite="source" */
  List<Arc> getOut();

  /** @model */
  String getName();
}
```

Transition.java

```
/**
 * @model
 */
public interface Transition extends Node {

}
```

Place.java


```
/**
 * @model
 */
public interface Place extends Node {

  /**
   * @model opposite="place" containment="true"
   */
  List<Token> getTokens();

}
```

Token.java


```
/**
 * @model
 */
public interface Token {

  /**
   * @model opposite="tokens" transient="false"
   */
  Place getPlace();

}
```

```
/** @model */
public interface Petrinet {

  /** @model opposite="petrinet" containment="true" */
  List<Node> getNodes();

  /** @model opposite="petrinet" containment="true" */
  List<Arc> getArcs();

  /** @model */
  String getName();

}
```

Petri net example (cntd.): Models for

- (small part of) the generated code
- framework the generated code uses

Two objectives:

- Understand (a bit) the generated code and the framework behind it
- See how models can be used for that purpose

3.1. Eclipse: JFace

- "JFace is a UI toolkit with classes for handling many common UI programming tasks." [https://wiki.eclipse.org/JFace]
- Viewers are a core part of editors (there are different kinds of viewers), which are generic.
- Here, we discuss the TreeViewer, which is the basis for the automatically generated tree editor for Petri nets.

TreeViewer

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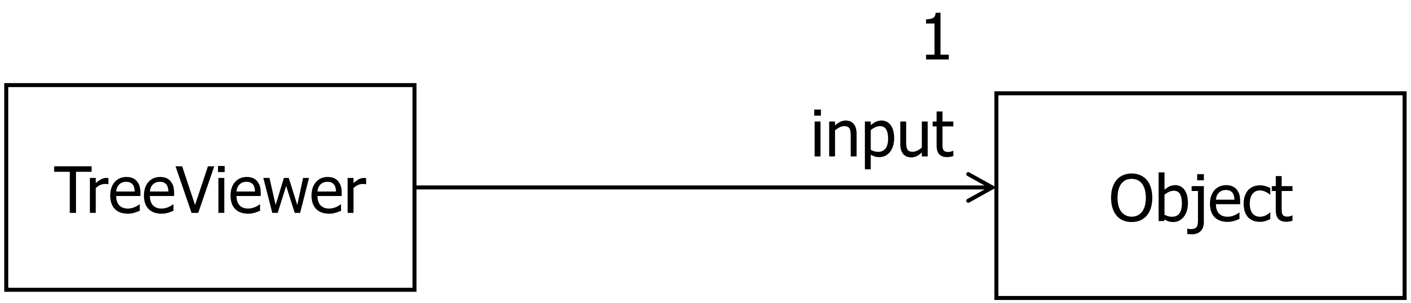
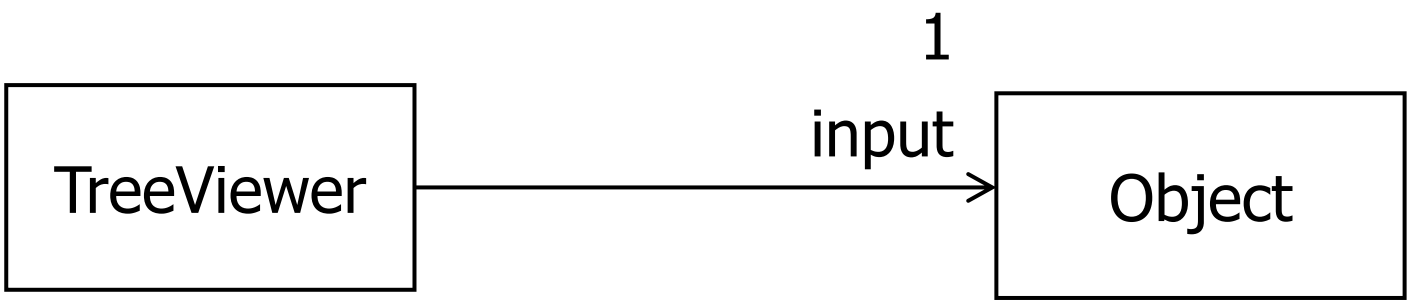


Assuming that the input object (model) is a Petri net

TreeViewer



Shows the input as a tree (with all the features of a tree view like opening and closing sub-trees, etc)

Root object of the tree which is to be shown in the TreeViewer

How???

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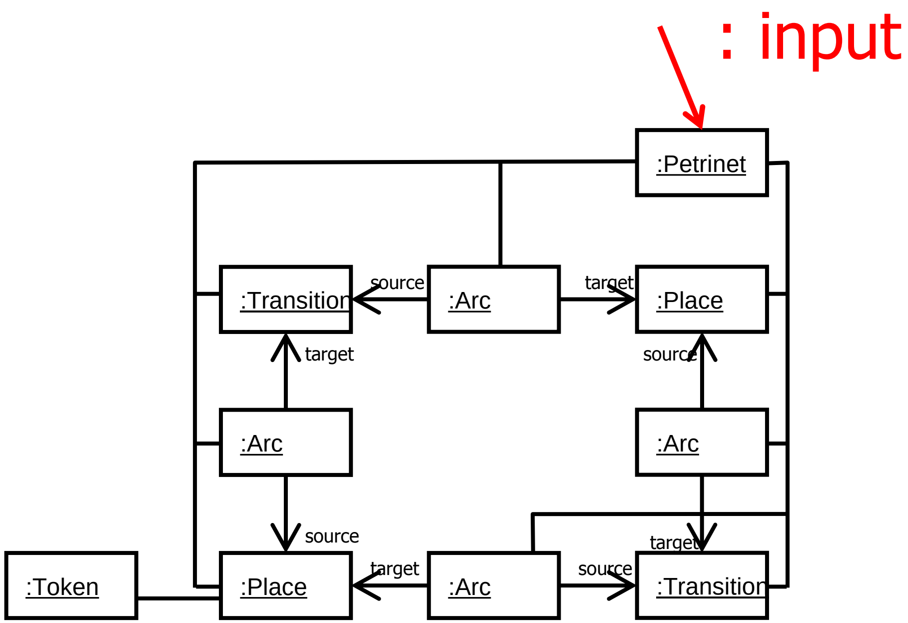
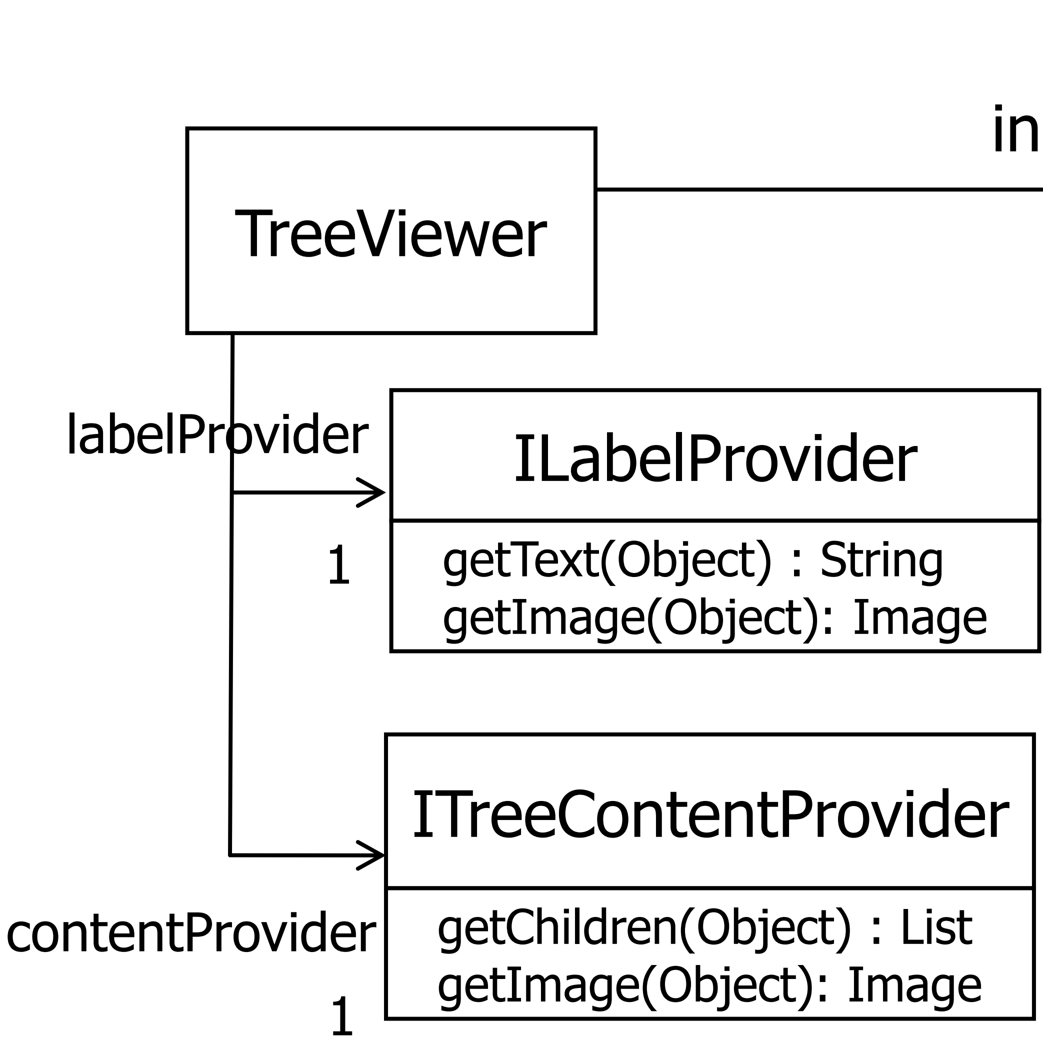
- How could the TreeViewer, which does not know anything about Petri nets (and the classes representing the concepts of Petri nets), know how this tree shloud be shown?



TreeViewer



Provides the label and the icon for each object

For each object, provides the current list of children.

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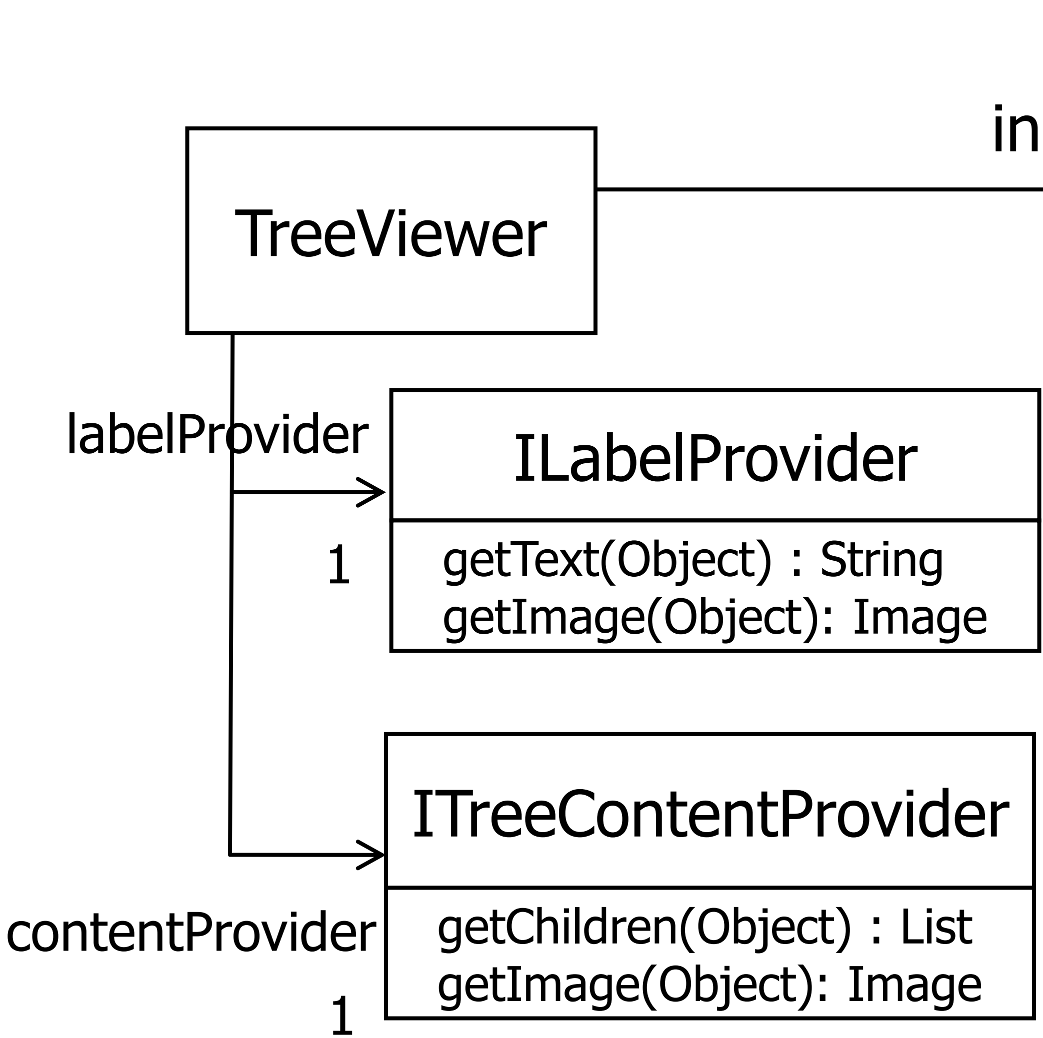

Will come from the generated code (**ItemProviders** for each kind of object in the model): edit code

In the tutorial, you will change the item provider for Arcs for changing the labels for arcs.

Similarly for Properties

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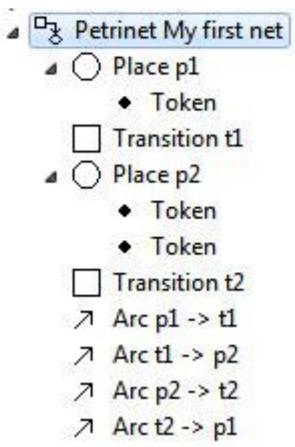

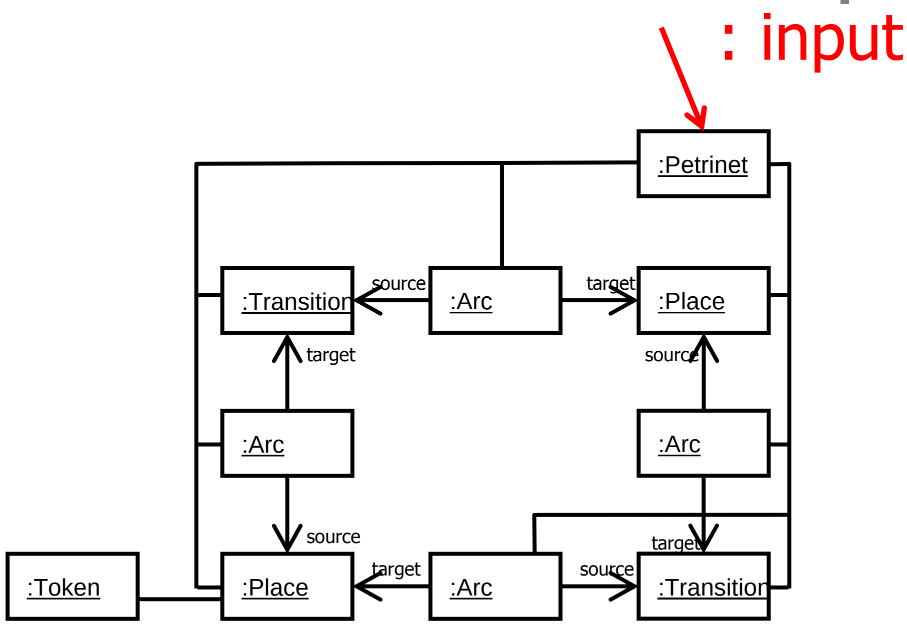

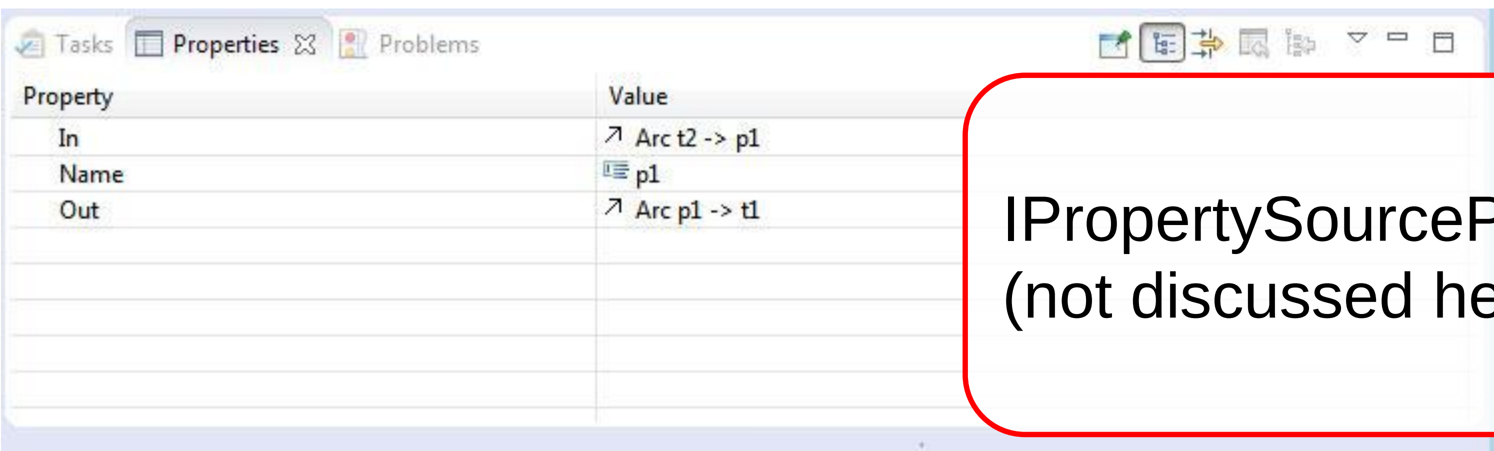

IPropertySourceProvider
(not discussed here)

3.2 EMF: Use of TreeViewer

- In EMF, this is even more complicated: using a generic ContentProvider, which creates the respective ItemProviders and delegates to them

Idea is discussed on blackboard (BBD)

3.3 Update Viewer on Changes

- In order to make sure that the viewer properly updates, whenever changes occur, it registers itself as listener to the respective elements (actually to their ItemProviders.

Idea is discussed on blackboard (BBD); more details next time