Tutorial

Diagram with Graphviz

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Tutorial	Actifsource Tutorial – Diagram with Graphviz
Required Time	• 60 Minutes
Prerequisites	• Actifsource Tutorial – Installing Actifsource • Actifsource Tutorial – Simple Service
Goal	• Write a template to generate a UML Class Diagram as Graphviz DOT file • Generate a SVG graphic using GraphvizBuildTask
Topics covered	• Setup Graphviz • Create an UML model • Create a graph template for Graphviz • Add Visibility to Methods and Attributes • Distinguish Association types
Notation	↳ To do ⓘ Information • **Bold**: Terms from actifsource or other technologies and tools • **Bold underlined**: actifsource Resources • Underlined: User Resources • *UnderlinedItalics*: Resource Functions • `Monospaced`: User input • *Italics*: Important terms in current situation
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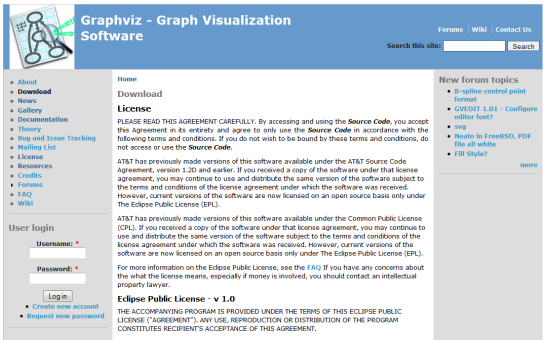
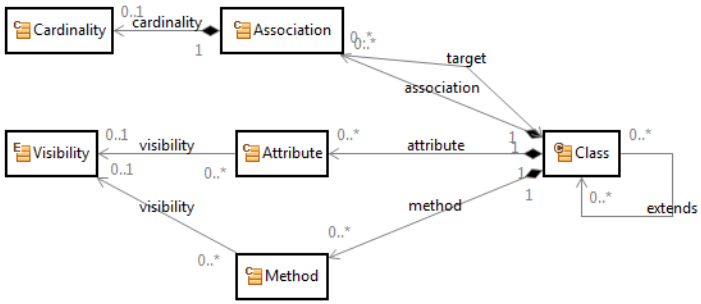
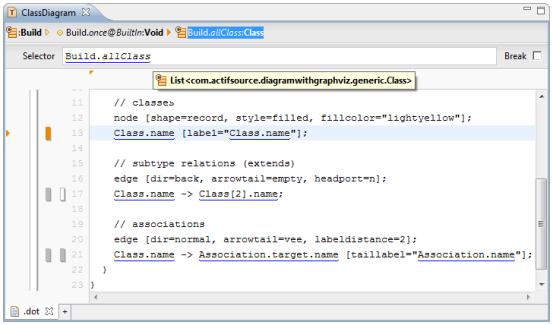
- Setup Graphviz



- Create a UML model



- Create a graph template for Graphviz



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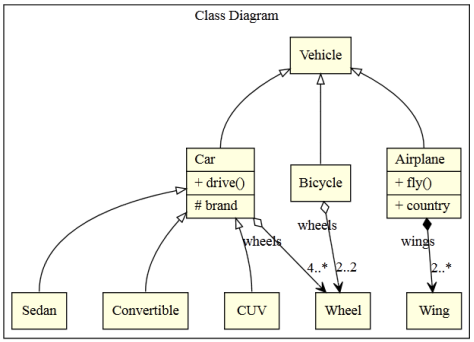
- Add more UML features

```
11      // classes
12      node [shape=record, style=filled, fillcolor="lightyellow"];
13      Class.name [label="{Class.name\l|\
14  Visibility.umlSymbol Method.name()\l\
15  |\
16  Visibility.umlSymbol Attribute.name\l\
17  }"];
18      Class.name [label="Class.name"];
```

Class.method union Class.attribute:**NamedResource**



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Part I: Preparation

- ⓘ Setup the Graphviz software.
- ⓘ Set Built-in Dependencies of an actifsource Project for graph generation.

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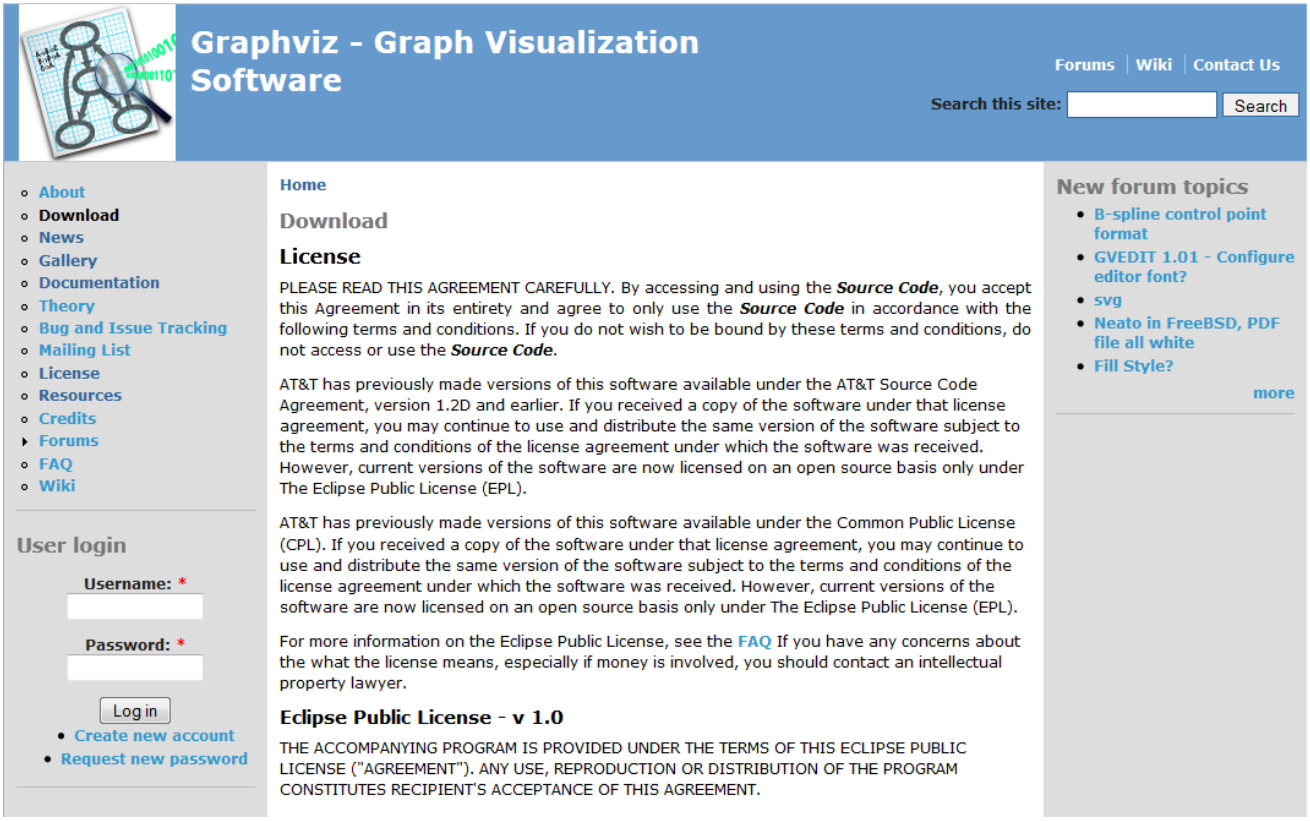
ⓘ Before you can generate UML diagram, you need a running environment of Graphviz. If you already have the Graphviz commands working from command line (with the PATH environment variable set), you can skip the following setup and proceed with the actifsource Project settings.

ⓘ Graphviz is an open source graph visualization software. Previously developed by AT&T it is now available under Eclipse Public Licence.

↳ Start your internet browser and open the address www.graphviz.org.



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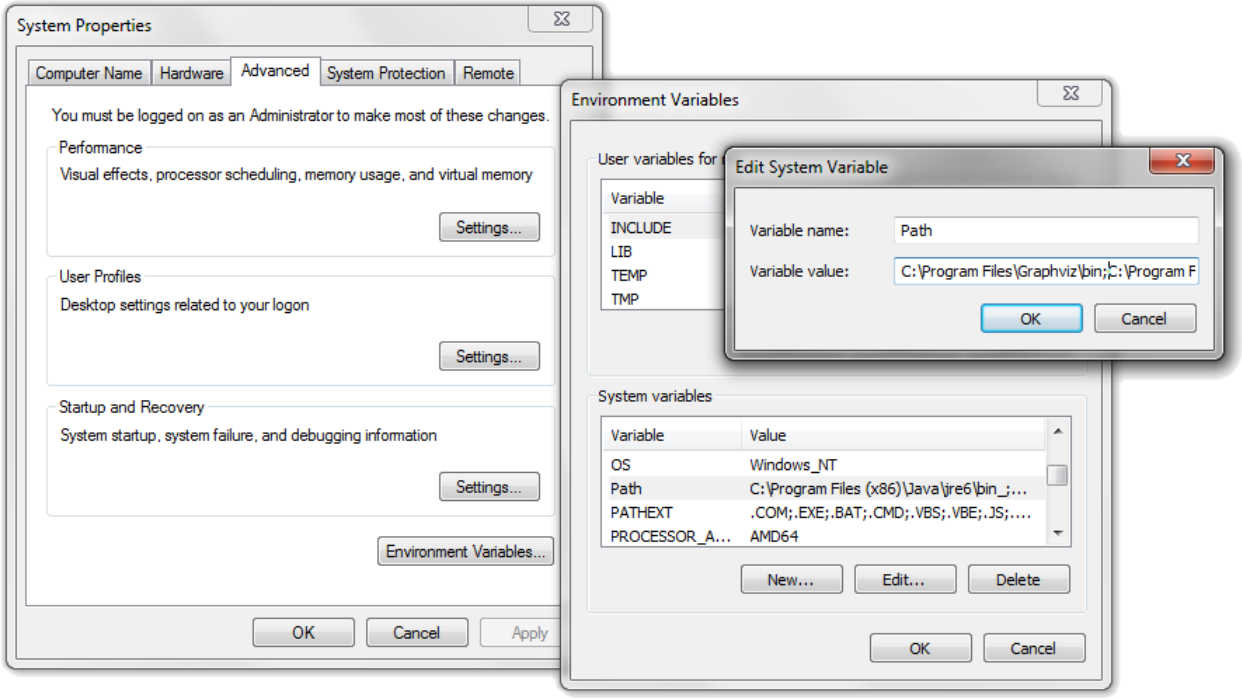
- Goto “Download” and check the licence agreement (Eclipse Public Licence).
- Select the executable package provided for your operating system, download the current release and run it.
- Follow the steps of the installation routine.
- Add the “bin” folder of the installation path (e.g. `C:\Program Files\Graphviz\bin`) to your `PATH` environment variable.



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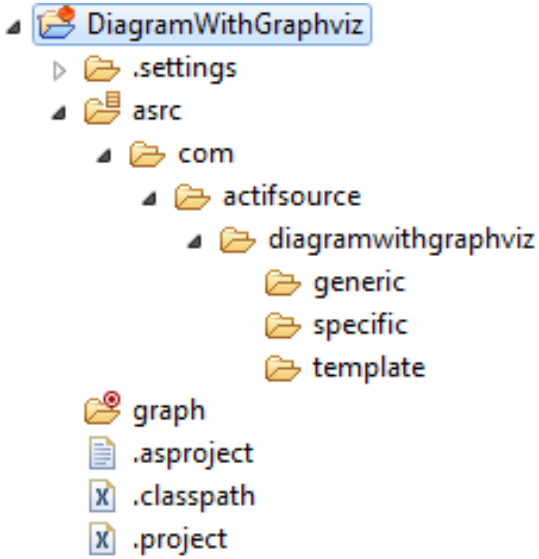
- Prepare a new **actifsource Project** named DiagramWithGraphviz as seen in the *Actifsource Tutorial – Simple Service*
  - Setup the Target Folder *graph*
- Use the following package structure



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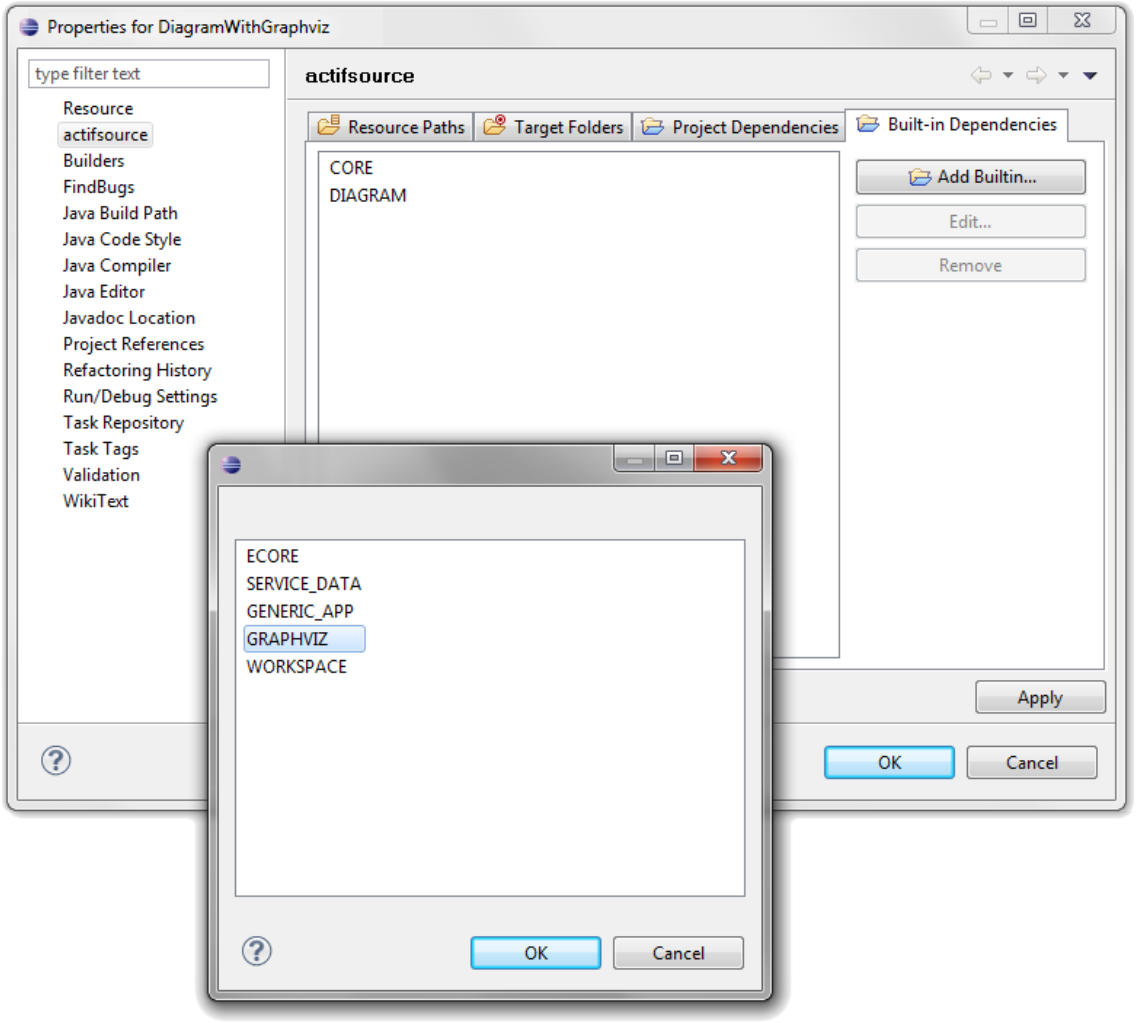
ⓘ There is an optional Built-in for Graphviz providing a build task that compiles the generated graphviz files into SVG graphics.

- Open the Project Properties.
- Select the “actifsource” Settings.
- On the tab “Built-in Dependencies” add GRAPHVIZ.



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Part II: Create a UML Model

- ⓘ We need a metamodel that provides those features we want to get displayed on our UML Class Diagram.
- ⓘ The generated diagram will depend only on this model. So, in order to create a Class Diagram that displays the same classes as the generated code, we will have to write a template that generates for every class in the code a class in the Class Diagram.

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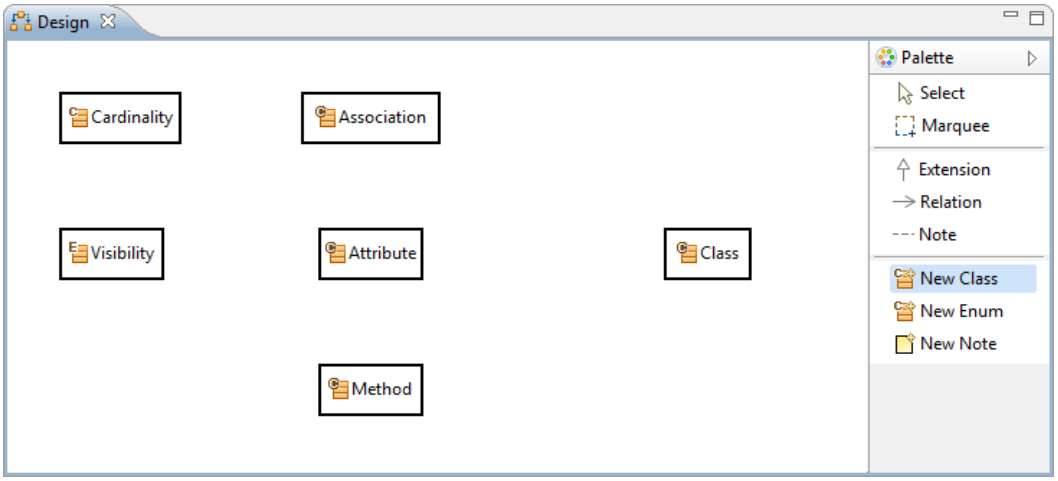
- Create a **ClassDiagram** named `Metamodel`.
- Add a new **Class**es for Class, Method, Attribute, Association and Cardinality.
- Add a new **Enum** Visibility.



ⓘ You don't have to model the UML features explicitly in your real project – but you must be aware how to read those features out of your model. To avoid code duplication, *Functions* as in the *Actifsource Tutorial - Complex Service* might help.

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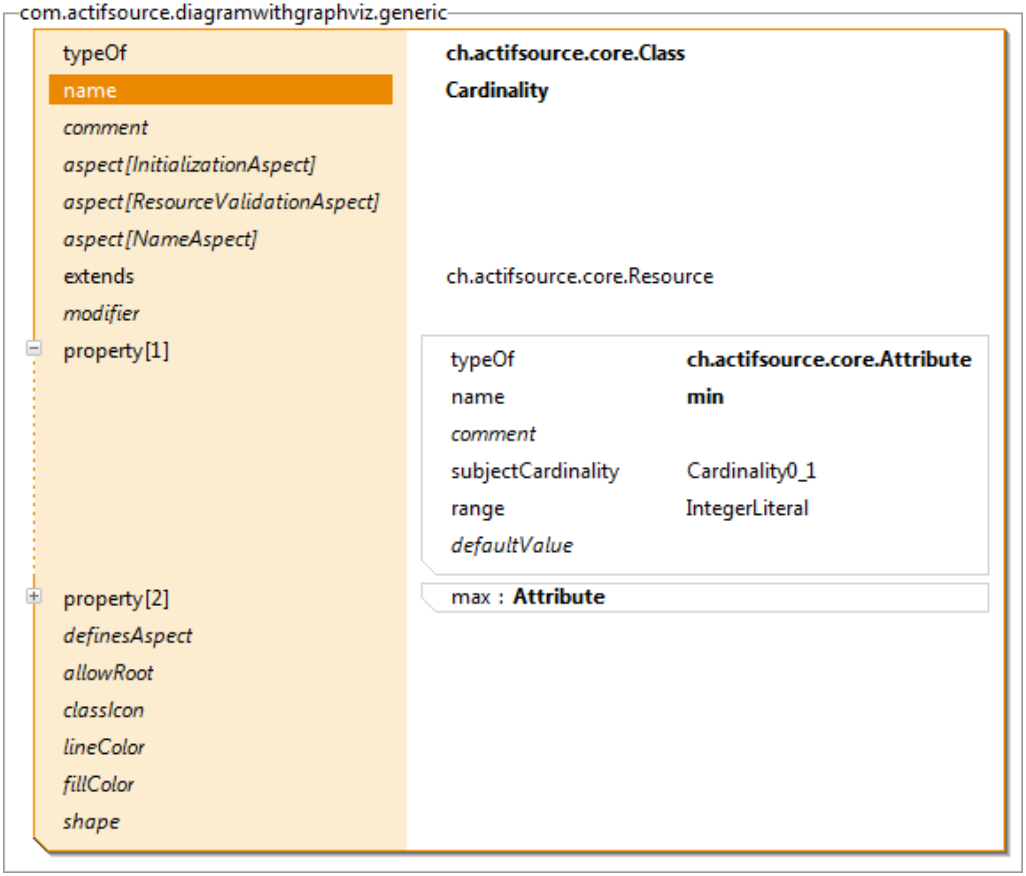
- Ctrl+ Left-Click on Cardinality to edit Cardinality in the Resource Editor.



- Add to **IntegerLiteral**-**Attribute**s named min and max.
- Set the (subject-)Cardinality of both attributes to 0..1.
- Change the supertype **extends** from **NamedResource** to **Resource**, since cardinalities are identified by their minimum and maximum and not by a name.

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- Ctrl+ Left-Click on the **Enum** Visibility to edit Visibility in the Resource Editor.

- Add the values public, protected, private and package to this **Enum**.

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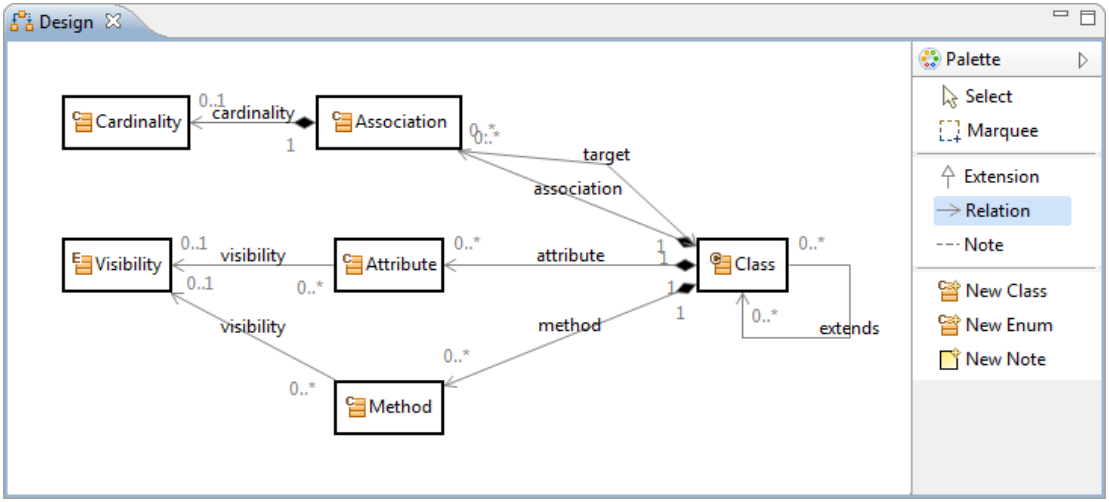
- Add a **UseRelation** extends from Class to itself.
- Add a **OwnRelation** from Class to Association.
- Add a **UseRelation** target back from Association to Class.
- Set the (subject-)cardinality of target to exactly 1.
- Add **OwnRelation**s from Class to Method and Class to Attribute.



- Add a **Relation** from Association to Cardinality, let it be an **OwnRelation** for simplicity sake.
- Add a **UseRelation** from Attribute to Visibility and from Method to Visibility.
- Set the (subject-)cardinality of the 3 **Relation**s to 0..1.

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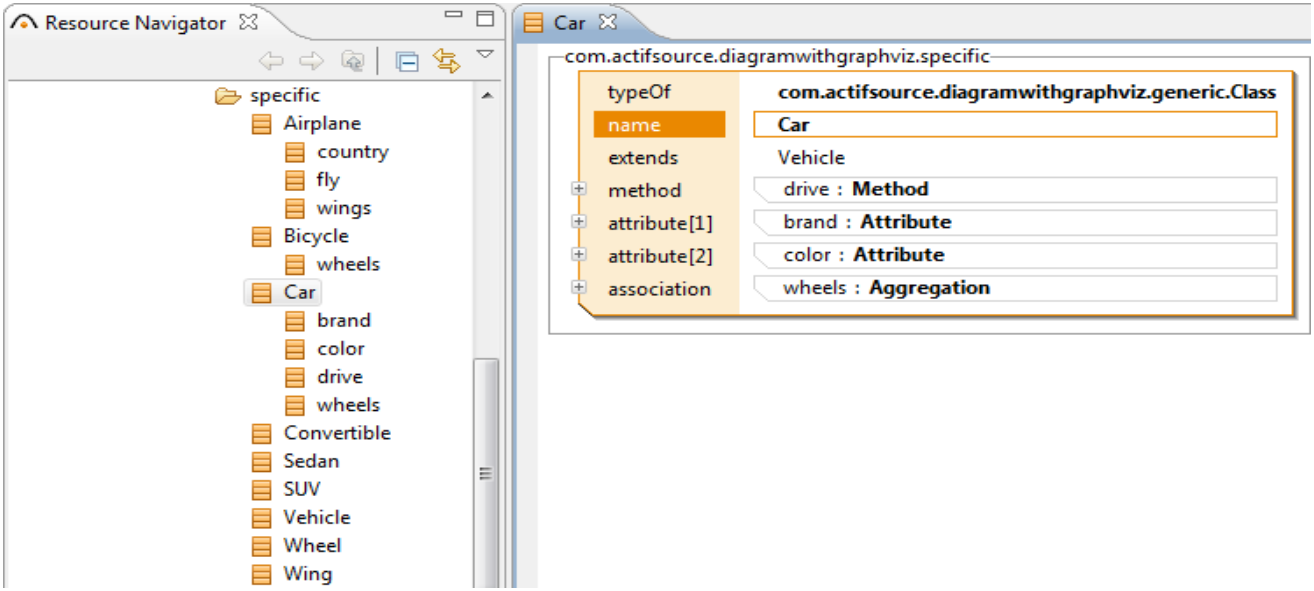
ⓘ Now let us create a Class Model package *com.actifsource.diagramwithgraphviz.specific* that shows the features we want to look at.

- For instance, create a Class Vehicle.
- Create Subclasses Car, Bicycle and Airplane, i.e. Classes having the extends-**Relation** set to Vehicle.
- Create Classes Sedan, Convertible, SUV as Subclasses of Car.



- Create a Class Wheel and a Class Wing.
- Add an Association wheels to both Car and also to Bicycle and set the corresponding target to Wheel.
- Add an Association wings to Airplane which points to Wing.

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Part IV: 16
Create a graph template for Graphviz

- We will generate graph definitions in the Graphviz DOT language and then in layout the graph to define our UML Class Diagram using the Graphviz DOT command. You can find the documentation of the DOT language on the Graphviz homepage.
- Graphviz provides several output formats: raster graphics like PNG, or vector graphics like PostScript or SVG. We will prefer SVG as output format since it can easily be post-processed, and the graphics can be embedded in HTML Pages and contain tooltips and hyperlinks.

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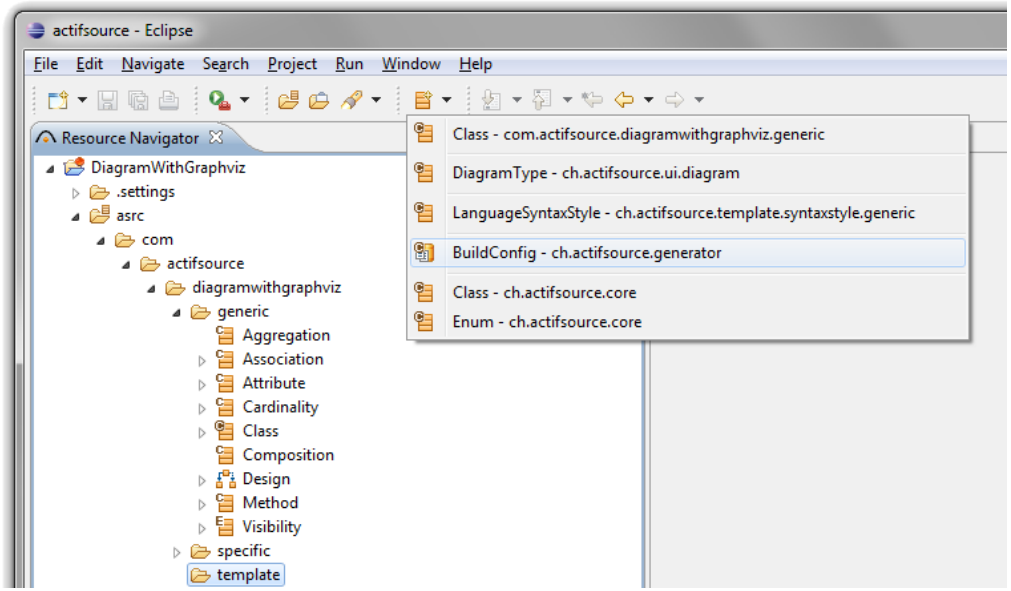
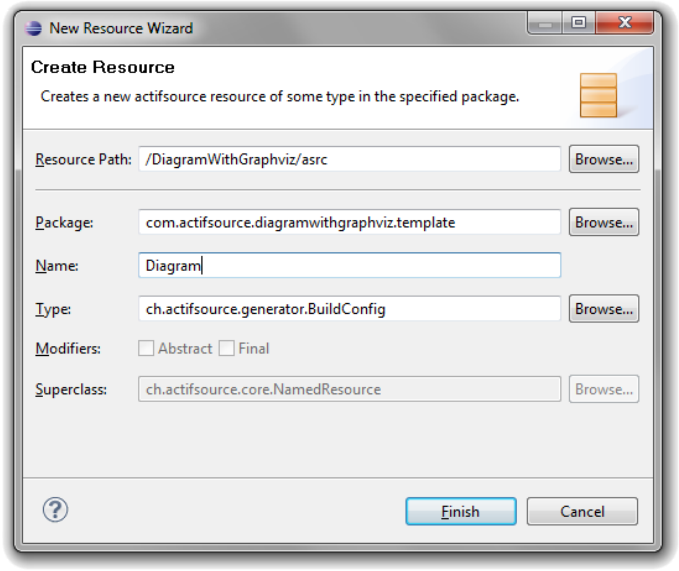
- Select the package *com.actifsource.diagramwithgraphviz.template*.
- Create a new **Resource** of type **BuildConfig** and name it Diagram.





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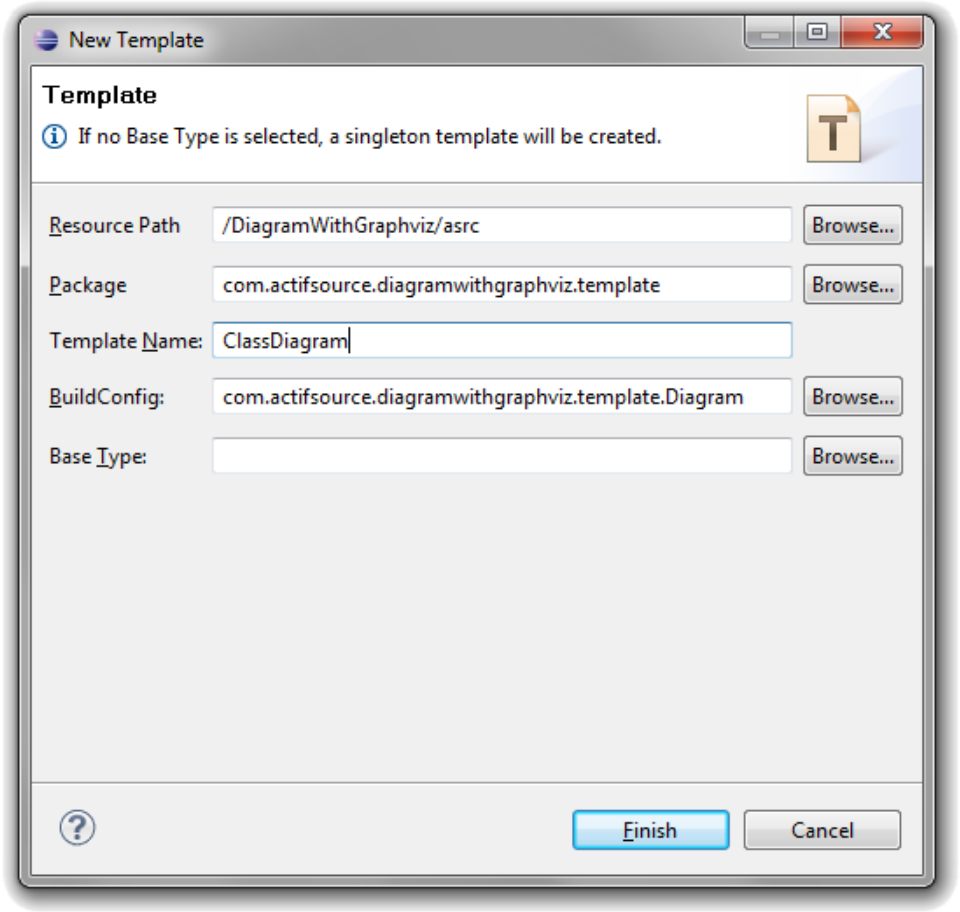
↳ Create a new **Template** named ClassDiagram.



ⓘ The **Template** ClassDiagram is now placed into the selected **BuildConfig** Diagram.

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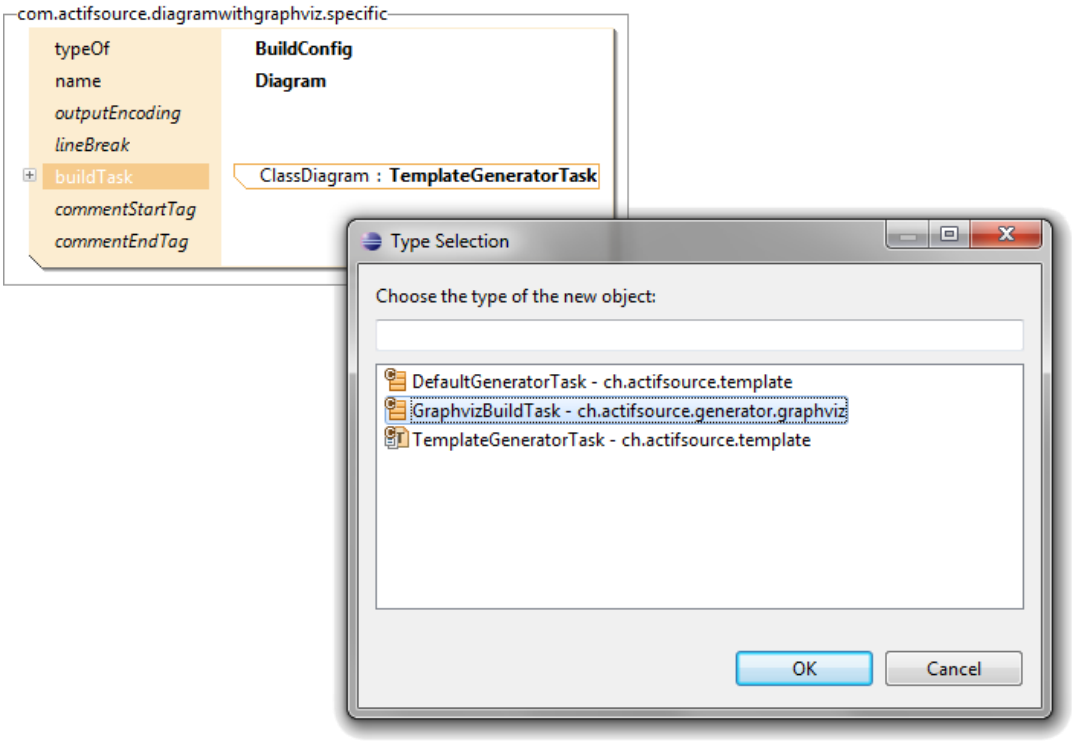
- Select the ClassDiagram **TemplateGeneratorTask**.
- Insert after the selection a **GraphvizBuildTask** with Ctrl+Enter.



ⓘ The **GraphvizBuildTask** will effect that every File with *File Extension .dot* in the **Target Folder** and its subdirectories is processed with the Graphviz *DOT command* and an SVG File with the same name but *File Extension .svg* is written.

ⓘ Note that the **GraphvizBuildTask** has to be executed after all DOT Files have been generated. Therefore it is always the last **BuildTask** in the list. If you add new **Template**s to the **BuildConfig**, move the **GraphvizBuildTask** to the end (by pressing Alt+PgDn).

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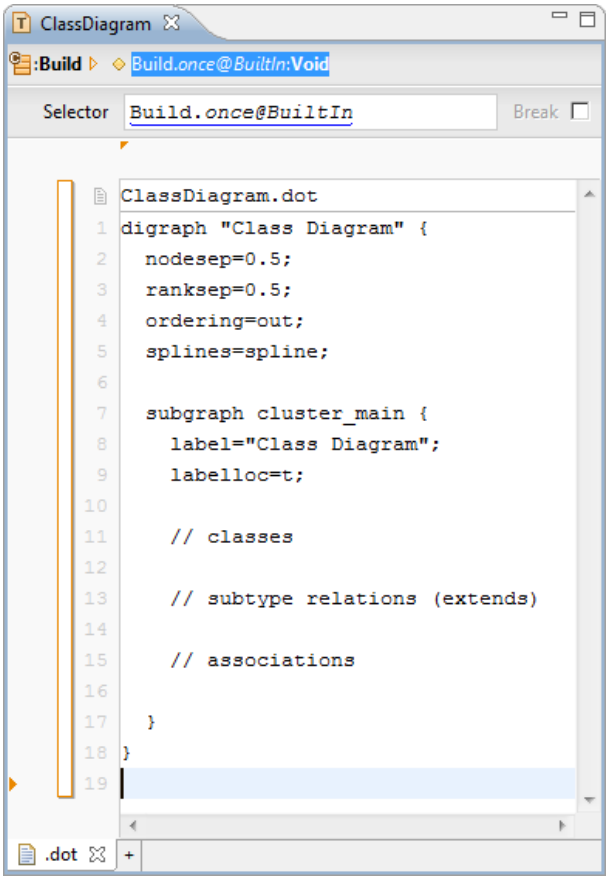
ⓘ If you are interested in the full capabilities of Graphviz, consult the documentation on *www.graphviz.org*.

- Open the ClassDiagram **Template** with the **Template Editor**.
- Create a directed graph (*digraph*) with the following attributes:
  - Default *rankdir* (i.e. *rankdir=TB*: top-bottom), so unconnected nodes (i.e. Classes) will appear on top.
  - *ordering=out*: Preserve the order of the outgoing edges (i.e. left sibling before right sibling, etc.)
  - *nodesep=0.5; ranksep=0.5*: Space among nodes of same rank, Space between ranks
  - *splines=spline*: Draw the edges (i.e. Associations and extends-Relations) as cubic splines.
- Place nothing in it but a single cluster, that will be drawn with a frame around
  - Label this cluster `Class Diagram`.



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- The main elements of a DOT file are *graph*, *node* and *edge*.
  - *graph* Definition: `graph` GraphID `{ … }`
  - *node* Definition: NodeID `[`$attr_1$=$value_1$`, … , `$attr_n$=$value_n$`];`
  - *edge* Definition: $NodeID_{tail}$ `->` $NodeID_{head}$ `[`$attr_1$=$value_1$`, … , `$attr_n$=$value_n$`];`
- The default values of the attributes can be set with special statements:
  - `node` `[`$attr_1$=$value_1$`, … , `$attr_n$=$value_n$`];`
  - `edge` `[`$attr_1$=$value_1$`, … , `$attr_n$=$value_n$`];`

```
// classes
node [shape=record, style=filled, fillcolor="lightyellow"];

// subtype relations (extends)
edge [dir=back, arrowtail=empty, headport=n];

// associations
edge [dir=normal, arrowhead=vee, headport="", labeldistance=2.5];
```

- Set the default attributes for Class: Set its node *shape* to *record* and set fill color to *lightyellow*.
- Set the default attributes for the extends Relation: The arrow should point from bottom to top (*dir=back*) and have an *empty* arrow head.
- Set the default attributes for the Associations: The arrow head should have a V-shape (*vee*).

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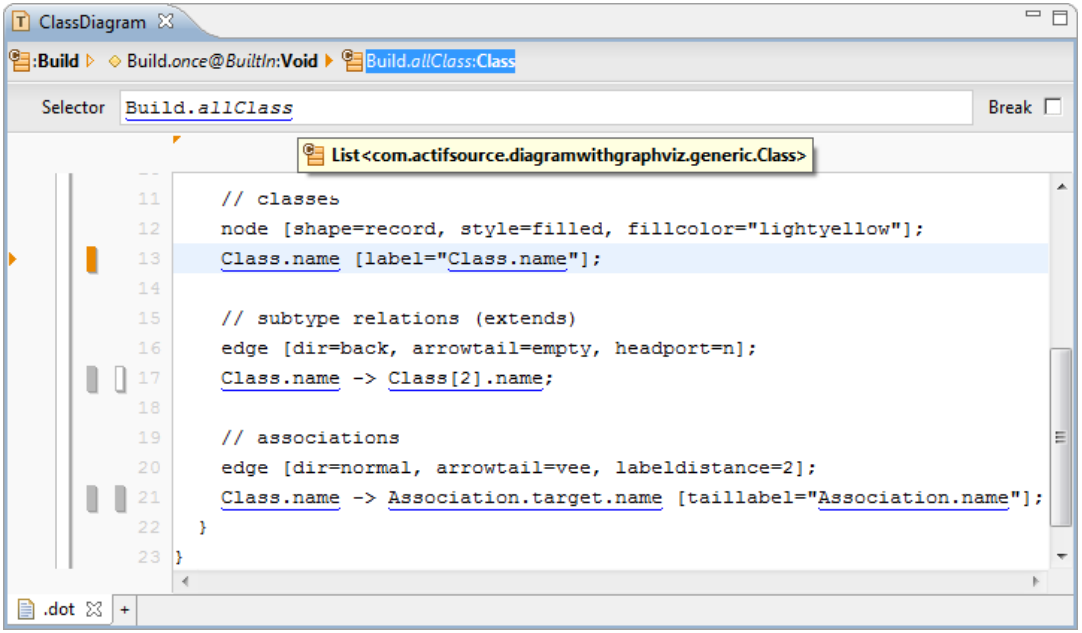
ⓘ Let us now insert line contexts for the UML artifacts we discussed before:



↳ Add a line context for all Classes.

ⓘ Be sure you choose com.actifsource.diagramwithgraphviz.generic.Class and not **ch.actifsource.core.Class**!

↳ Add a line context for all Classes with a nested line context which iterates over Class.extends.

ⓘ The Class of the outer (hidden) context is named in the template editor with *Class[2]*, the Class of the inner context (so the base class) is named with *Class*.

↳ Add an edge statement back from *Class* to *Class[2]*.

↳ Add a line context for all Classes with a nested line context for all Associations.

↳ Add an edge statement from Class to the Association.target labeled with the Association.name.

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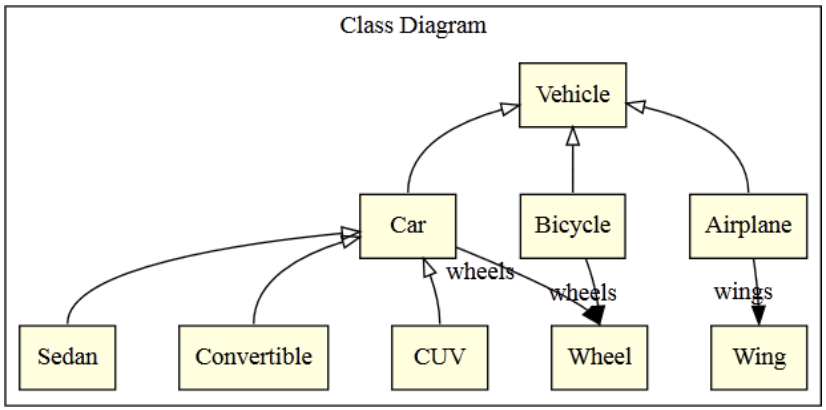
ⓘ The resulting graph will look like this:



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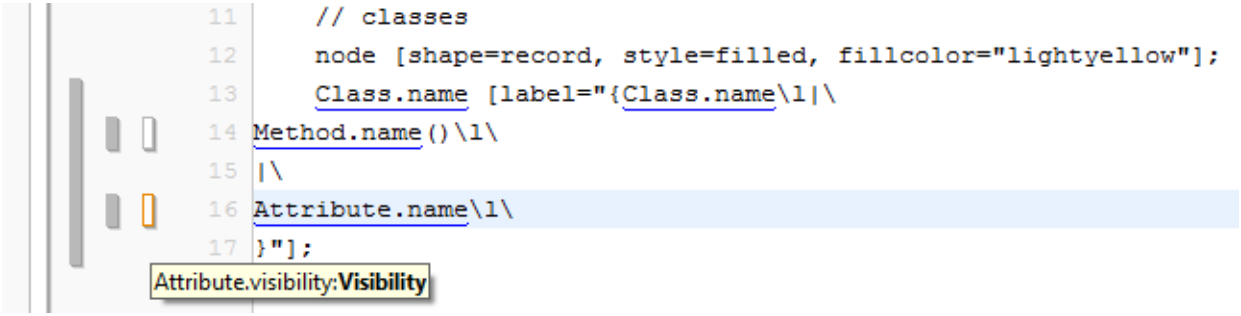
ⓘ We want to subdivide the class nodes to display the methods and attributes. For this feature, it will help we did not choose a simple *rect* shape for class nodes, but a *record* shape: With pipe characters "|" we can subdivide node shapes and with curly brackets "{" and "}" swap the direction of division from left-right to top-bottom and vice versa.

```
// classes
node [shape=record, style=filled, fillcolor="lightyellow"];
Class.name [label="{Class.name\l|\l|\l}"];
```

- Change the label of the class node, so the node is partitioned vertically into 3 fields with the Class.name in the first field, all fields left-justified.

ⓘ It is not possible to have column contexts nested.

- Therefore split the label into three lines using the backslash "\" at the line end.
- Add line contexts to iterate over the Methods of a Class and over the Attributes of a Class.



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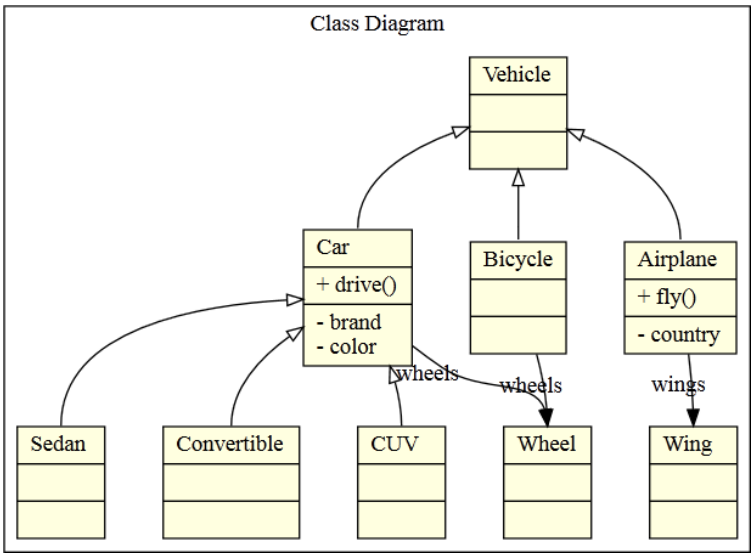
ⓘ The resulting diagram will now look like this:



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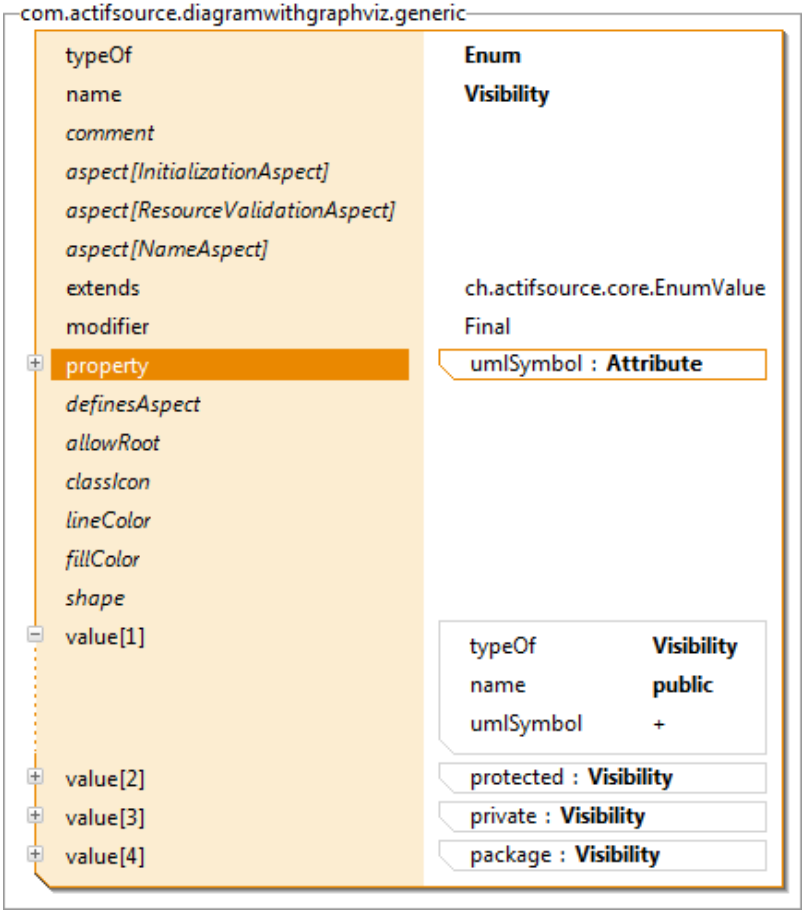
Add Visibility to Methods and Attributes 26

ⓘ We need the visibility symbols in our model in order to display it in the graph. Or, we need a Java function (see *Actifsource Tutorial – Complex Service*) that maps the Visibility elements in the model onto the UML symbols.

- Open the **Enum** Visibility in the **Resource Editor**.
- Add a **StringLiteral** **Property** umlSymbol, with (subject-)cardinality exactly 1.
- Set the umlSymbol of the enumeration values to the respective UML symbols: +, #, −, ~.



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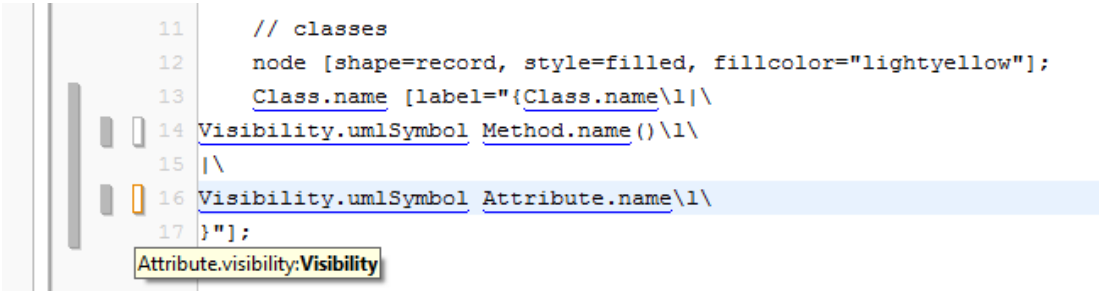
- In the template, insert a new *Column Context* in the Context which iterates over all Methods.
- Select in this *Context* the Method.visibility.
- In this context Insert Visibility.umlSymbol.
- Repeat the 3 steps for Attribute.visibility.



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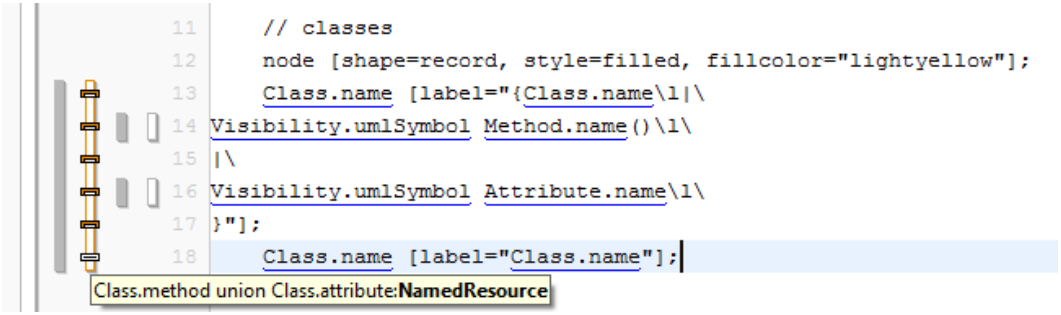
ⓘ You can eliminate the empty record fields in the class nodes of the graph by checking if there are any methods or attributes:



- Add a *Line Context* inside the context which iterates over all Classes.
- Set the **Selector** to Class.method union Class.attribute.
- ⓘ This will iterate over the set union of the Elements in Class.method and those in Class.attribute.
- Choose *First* (Alt + 1), so that this Context is entered at most once.
- Add a line that generates only a simple rect for a Class.
- Choose Empty (Alt + 5), so that this line is evaluated if the *Context* "Class.method union Class.attribute" is empty.

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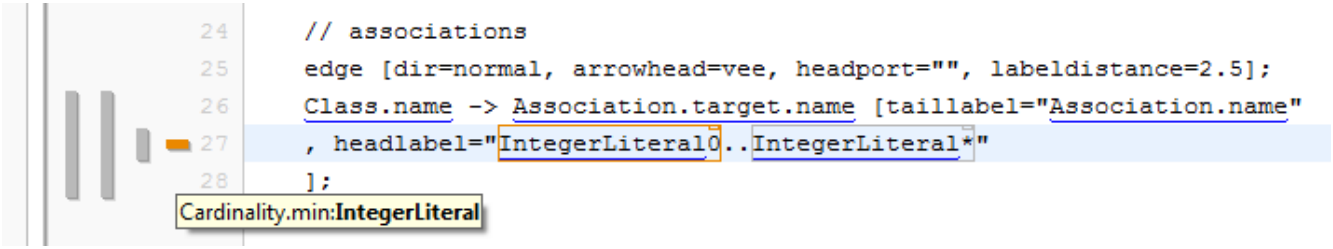
Add Cardinality 29

ⓘ We did not cover cardinalities so far.



- Add a *Line Context* that selects the Association's Cardinality.
- In this Context, add a *headlabel*, that contains the min and max Cardinality:
  - In the label insert a *Column Context* for Cardinality.min and one for Cardinality.max.
  - For empty Cardinality.min context (Alt + 5), insert `0`.
  - For empty Cardinality.max context (Alt + 5), insert `*`.

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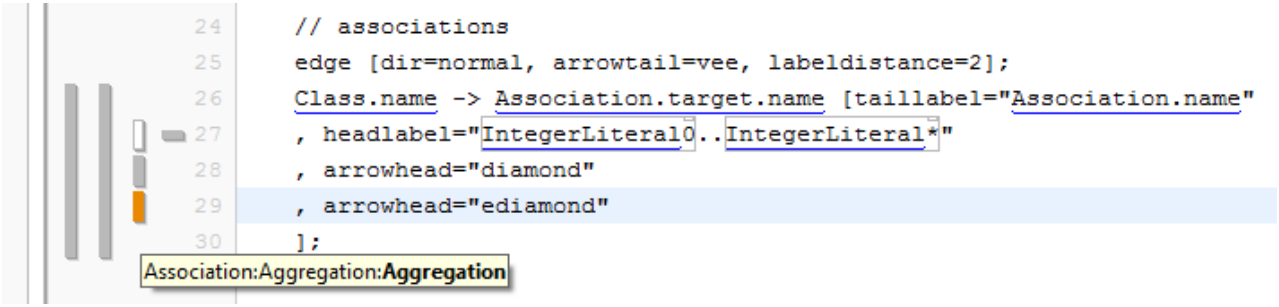
Distinguish Association types 30

ⓘ In UML, associations are marked with a diamond, if they are aggregations or compositions.

- Add the **Class**es Aggregation and Composition which are subclasses of Association.
- Edit the **typeOf Property** of the **Relation**s wheels and wings and replace Association by Aggregation and Composition respectively.



- Add a *Line Context*
- In the **Selector**, cast Association to Aggregation and Composition respectively. The Line Contexts will be entered then only if it os an Aggregation or Composition.
- Set the *arrowhead* attribute to *diamond* and to *ediamond* (=empty diamond).

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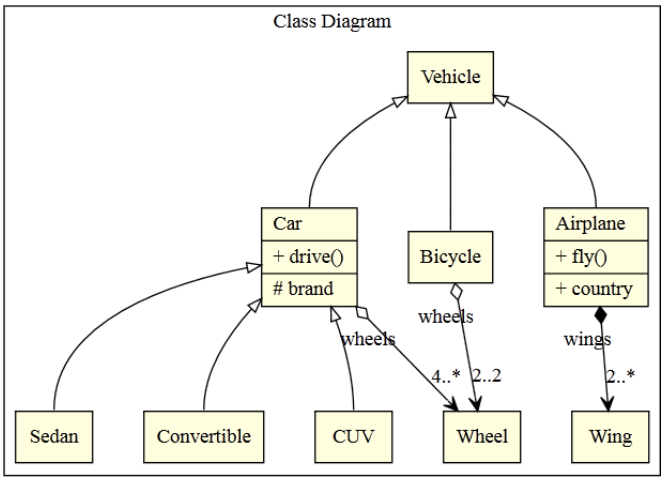
ⓘ The resulting graph will look now similar to this one:



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