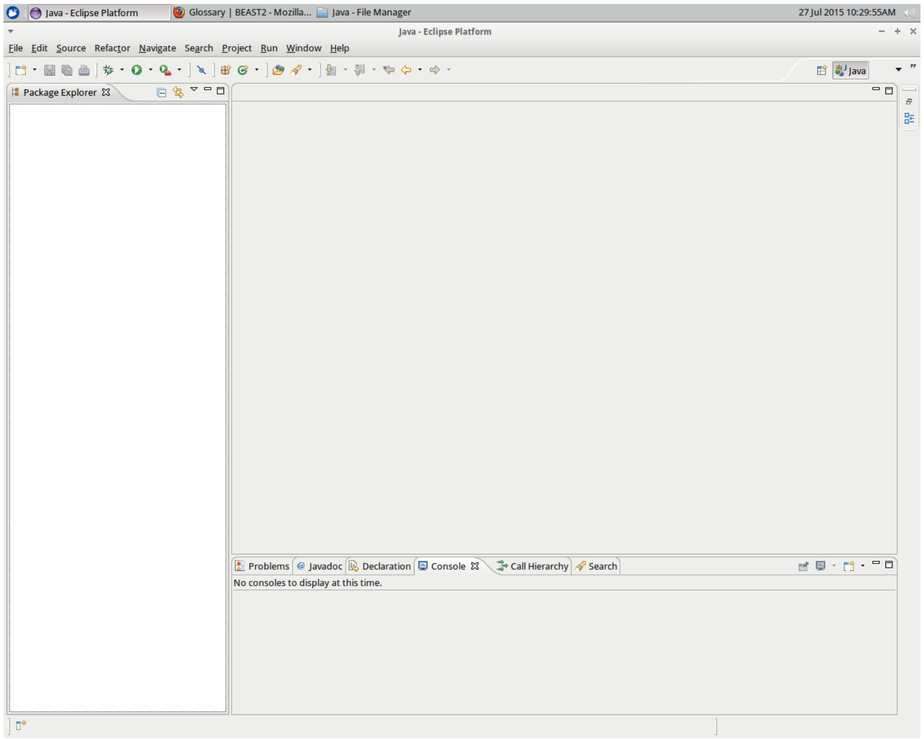
How to add a tree prior to BEAST2?

This tutorial follows the same wording and structure as BEAST2: how to write a BEAST2 package, but for a tree prior instead.

Empty Package Explorer

When starting Eclipse in a new workspace, the Package Explorer is still empty. In this example, my workspace is `~/GitHubs/Java`.



No consoles to display at this time.

Figure 1: Eclipse with an empty package explorer

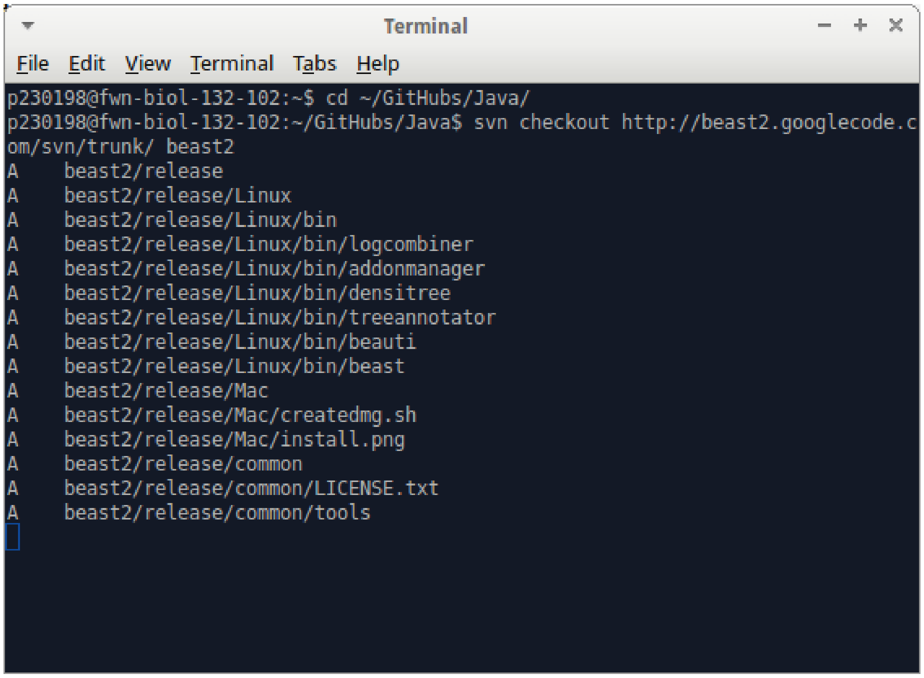
Adding BEAST2 to the Package Explorer

To add BEAST2 to the Package Explorer, it must first be downloaded, then put into a Java project.

Download BEAST2

In this example, I download BEAST2 from the SVN repository from withing the '~/GitHubs/Java' folder:

`cd ~/GitHubs/Java svn checkout http://beast2.googlecode.com/svn/trunk/ beast2` This will create a folder called `beast2`.



```
p230198@fwn-biol-132-102:~$ cd ~/GitHubs/Java/
p230198@fwn-biol-132-102:~/GitHubs/Java$ svn checkout http://beast2.googlecode.c
om/svn/trunk/ beast2
A    beast2/release
A    beast2/release/Linux
A    beast2/release/Linux/bin
A    beast2/release/Linux/bin/logcombiner
A    beast2/release/Linux/bin/addonmanager
A    beast2/release/Linux/bin/densitree
A    beast2/release/Linux/bin/treeannotator
A    beast2/release/Linux/bin/beauti
A    beast2/release/Linux/bin/beast
A    beast2/release/Mac
A    beast2/release/Mac/createdmg.sh
A    beast2/release/Mac/install.png
A    beast2/release/common
A    beast2/release/common/LICENSE.txt
A    beast2/release/common/tools
```

Figure 2: Start downloading BEAST2

Put BEAST2 into a Java project

First, we will add `beast2` to the Package Explorer.

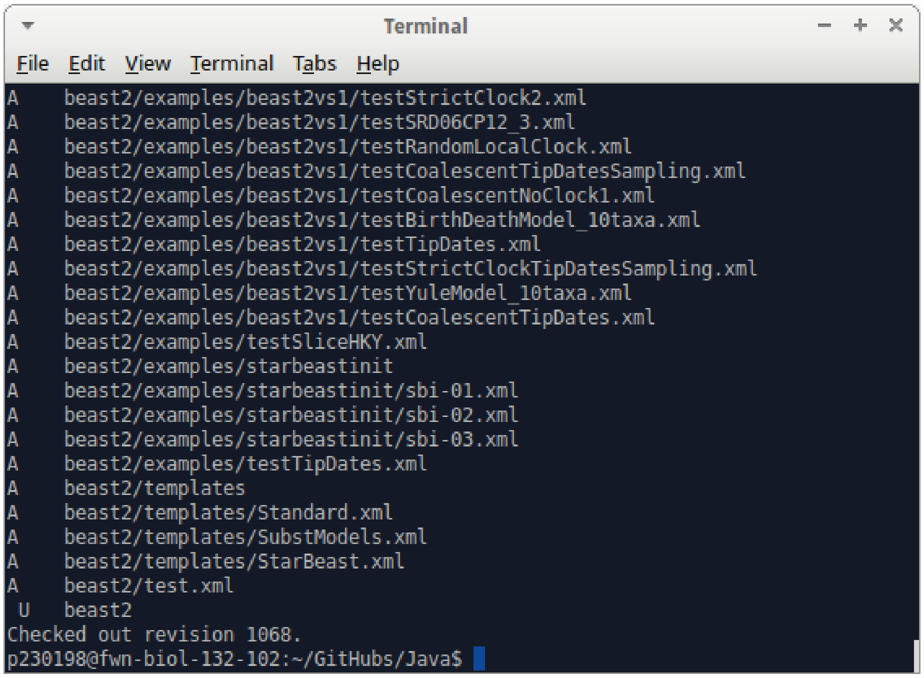
Select `File | New | Java Project`:

This is how the 'Create a Java Project dialog' looks like:

Just type in the word `beast`. It will detect there is a folder called `beast2` and the dialog will change:

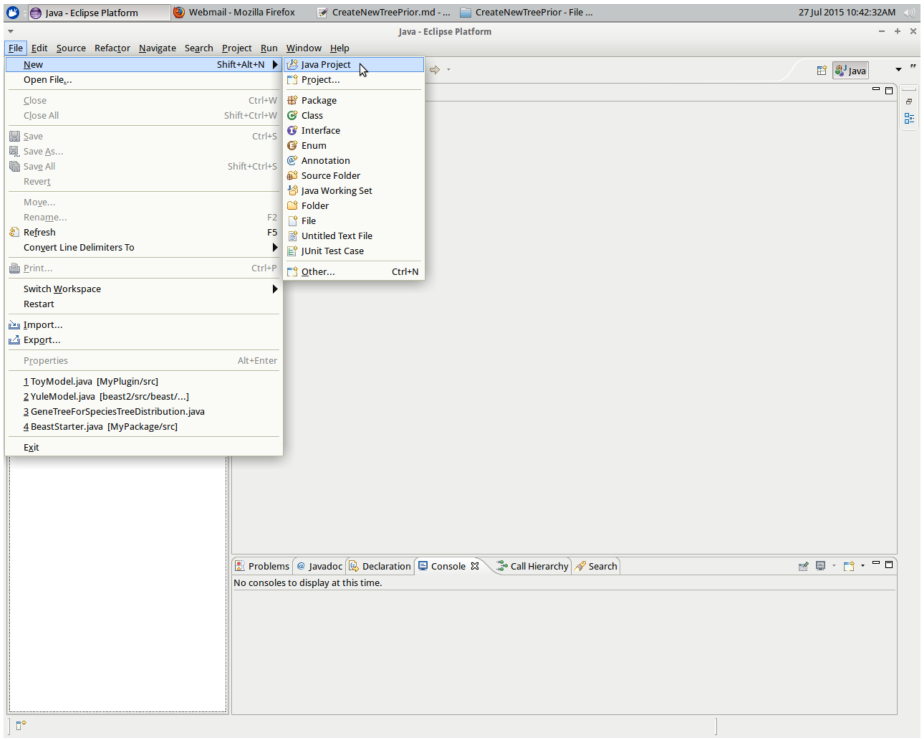
Just press `Finish`.

Now, the Eclipse Package Explorer shows the project `beast2`. Well done!



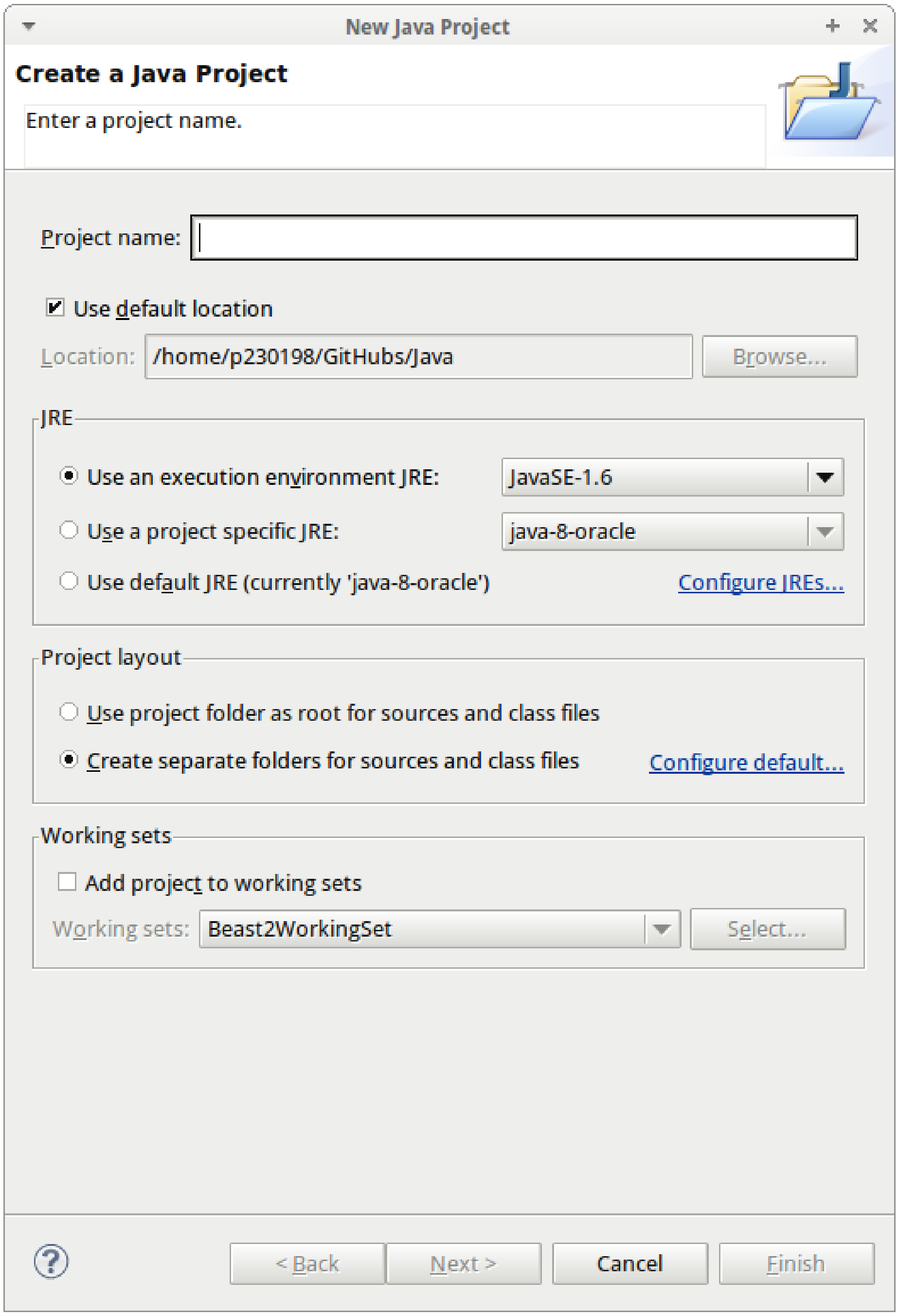
```
A    beast2/examples/beast2vs1/testStrictClock2.xml
A    beast2/examples/beast2vs1/testSRD06CP12_3.xml
A    beast2/examples/beast2vs1/testRandomLocalClock.xml
A    beast2/examples/beast2vs1/testCoalescentTipDatesSampling.xml
A    beast2/examples/beast2vs1/testCoalescentNoClock1.xml
A    beast2/examples/beast2vs1/testBirthDeathModel_10taxa.xml
A    beast2/examples/beast2vs1/testTipDates.xml
A    beast2/examples/beast2vs1/testStrictClockTipDatesSampling.xml
A    beast2/examples/beast2vs1/testYuleModel_10taxa.xml
A    beast2/examples/beast2vs1/testCoalescentTipDates.xml
A    beast2/examples/testSliceHKY.xml
A    beast2/examples/starbeastinit
A    beast2/examples/starbeastinit/sbi-01.xml
A    beast2/examples/starbeastinit/sbi-02.xml
A    beast2/examples/starbeastinit/sbi-03.xml
A    beast2/examples/testTipDates.xml
A    beast2/templates
A    beast2/templates/Standard.xml
A    beast2/templates/SubstModels.xml
A    beast2/templates/StarBeast.xml
A    beast2/test.xml
 U   beast2
Checked out revision 1068.
p230198@fwn-biol-132-102:~/GitHubs/Java$
```

Figure 3: End of downloading BEAST2



No consoles to display at this time.

Figure 4: Start a new Java Project



New Java Project

Create a Java Project

Enter a project name.

Project name:

☑ Use default location

Location: /home/p230198/GitHubs/Java

JRE

● Use an execution environment JRE: JavaSE-1.6

○ Use a project specific JRE: java-8-oracle

○ Use default JRE (currently 'java-8-oracle')

Project layout

○ Use project folder as root for sources and class files

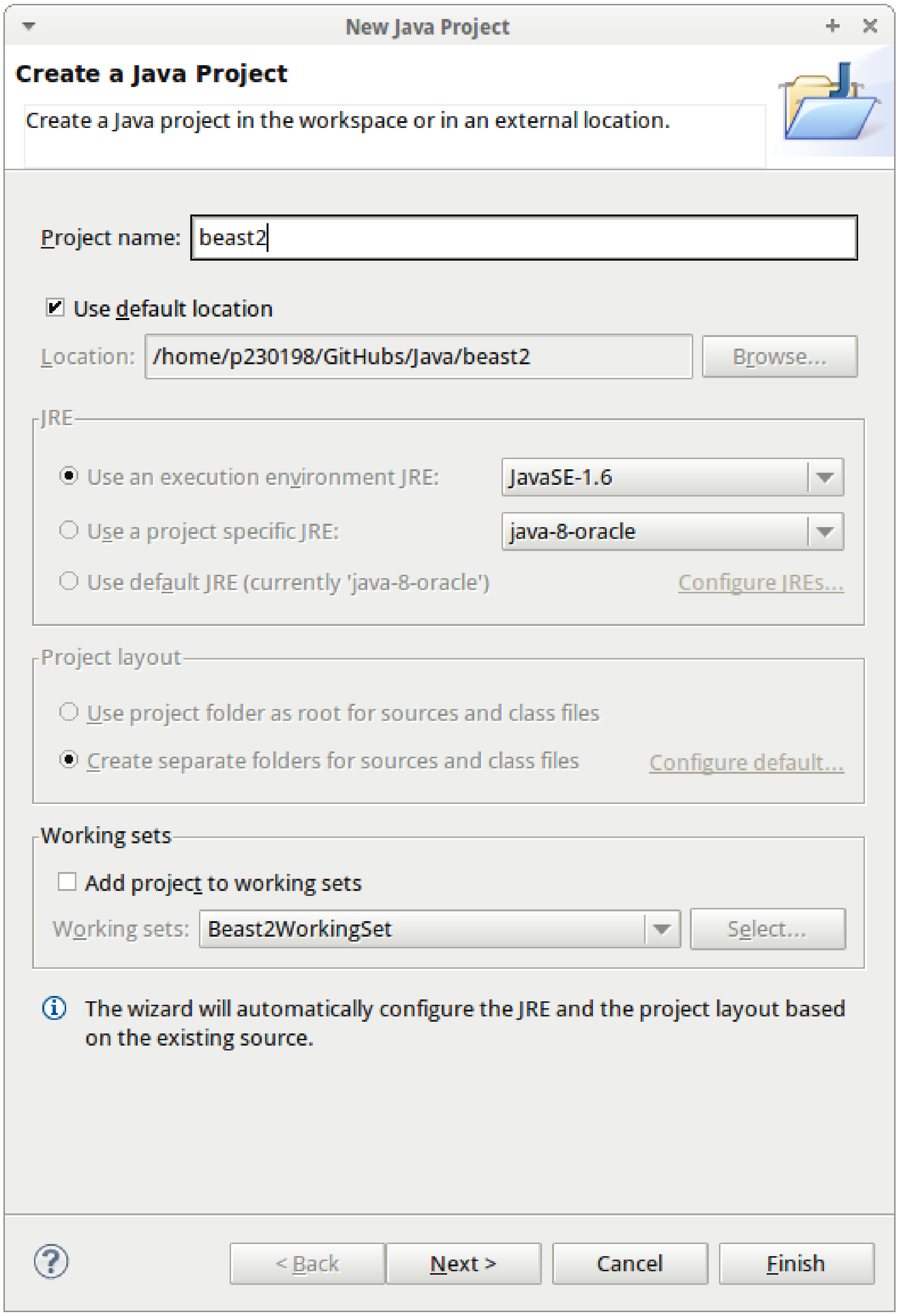
● Create separate folders for sources and class files

Working sets

□ Add project to working sets

Working sets: Beast2WorkingSet

Figure 5: Create a Java Project



New Java Project

Create a Java Project

Create a Java project in the workspace or in an external location.

Project name: beast2

☑ Use default location

Location: /home/p230198/GitHubs/Java/beast2

JRE

● Use an execution environment JRE: JavaSE-1.6

○ Use a project specific JRE: java-8-oracle

○ Use default JRE (currently 'java-8-oracle')

Project layout

○ Use project folder as root for sources and class files

● Create separate folders for sources and class files

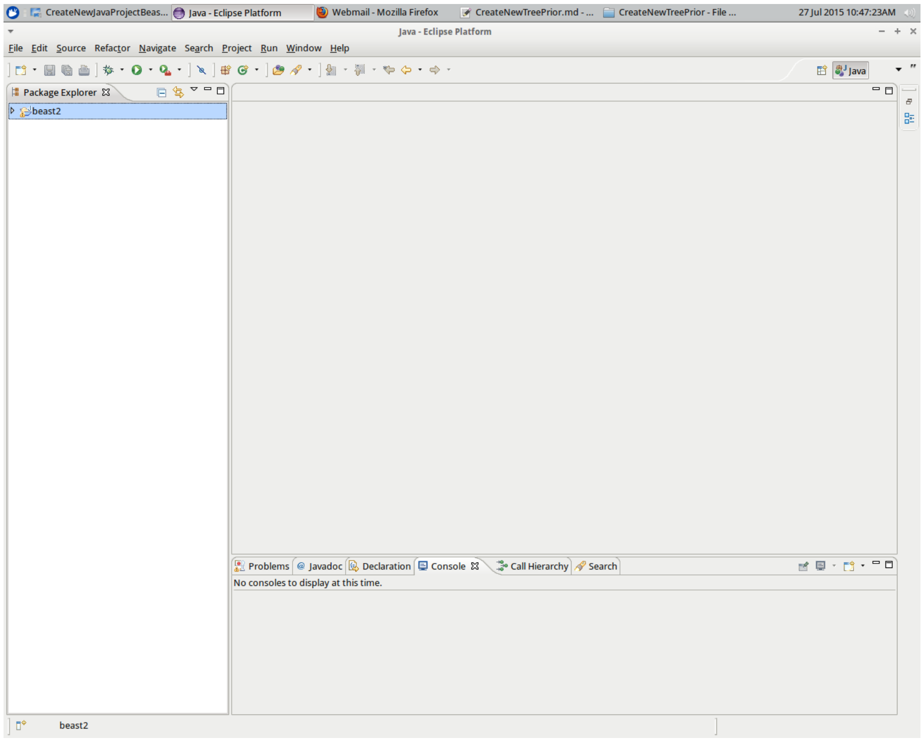
Working sets

□ Add project to working sets

Working sets: Beast2WorkingSet

The wizard will automatically configure the JRE and the project layout based on the existing source.

Figure 6: Create a BEAST2 Java Project


CreateNewJavaProjectBeas...
Java - Eclipse Platform
Webmail - Mozilla Firefox
CreateNewTreePrior.md - ...
CreateNewTreePrior - File ...
27 Jul 2015 10:47:23AM
Java - Eclipse Platform
File Edit Source Refactor Navigate Search Project Run Window Help
Java
Package Explorer
beast2
Problems
Javadoc
Declaration
Console
Call Hierarchy
Search
beast2

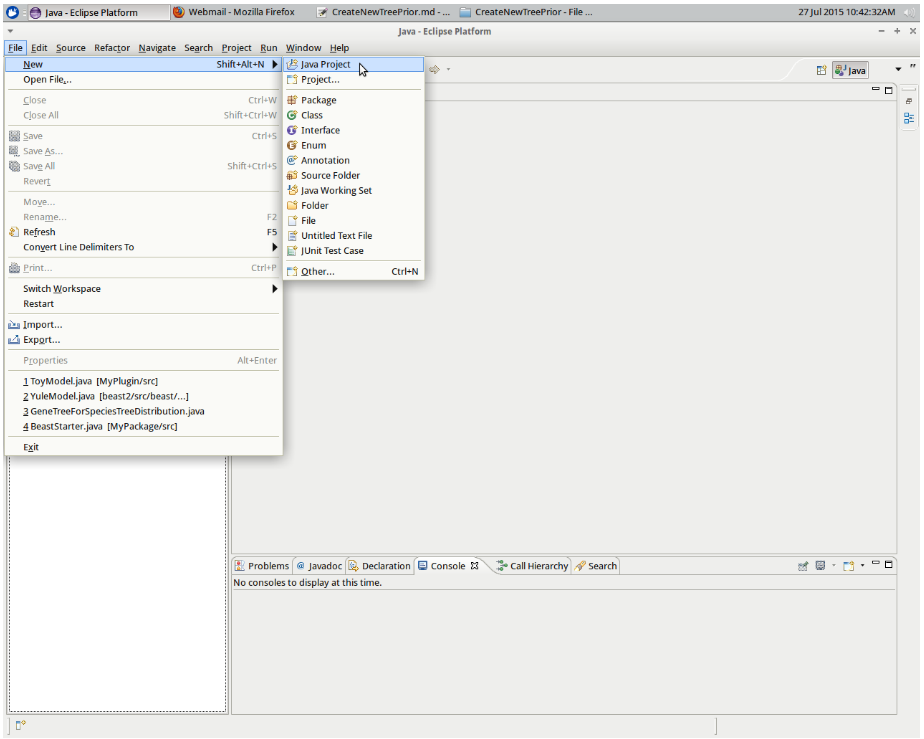
No consoles to display at this time.

Figure 7: Eclipse with BEAST2 in the package explorer

Creating your own project

Now you need to create an Eclipse project for your package and make it depend on the `beast2` project.

Select `File | New | Java Project`:



No consoles to display at this time.

Figure 8: Start a new Java Project

In `Project name`, type in the name, for example `MyProject`. For the JRE, be sure `JavaSE-1.6` or something higher is checked. Click Finish.

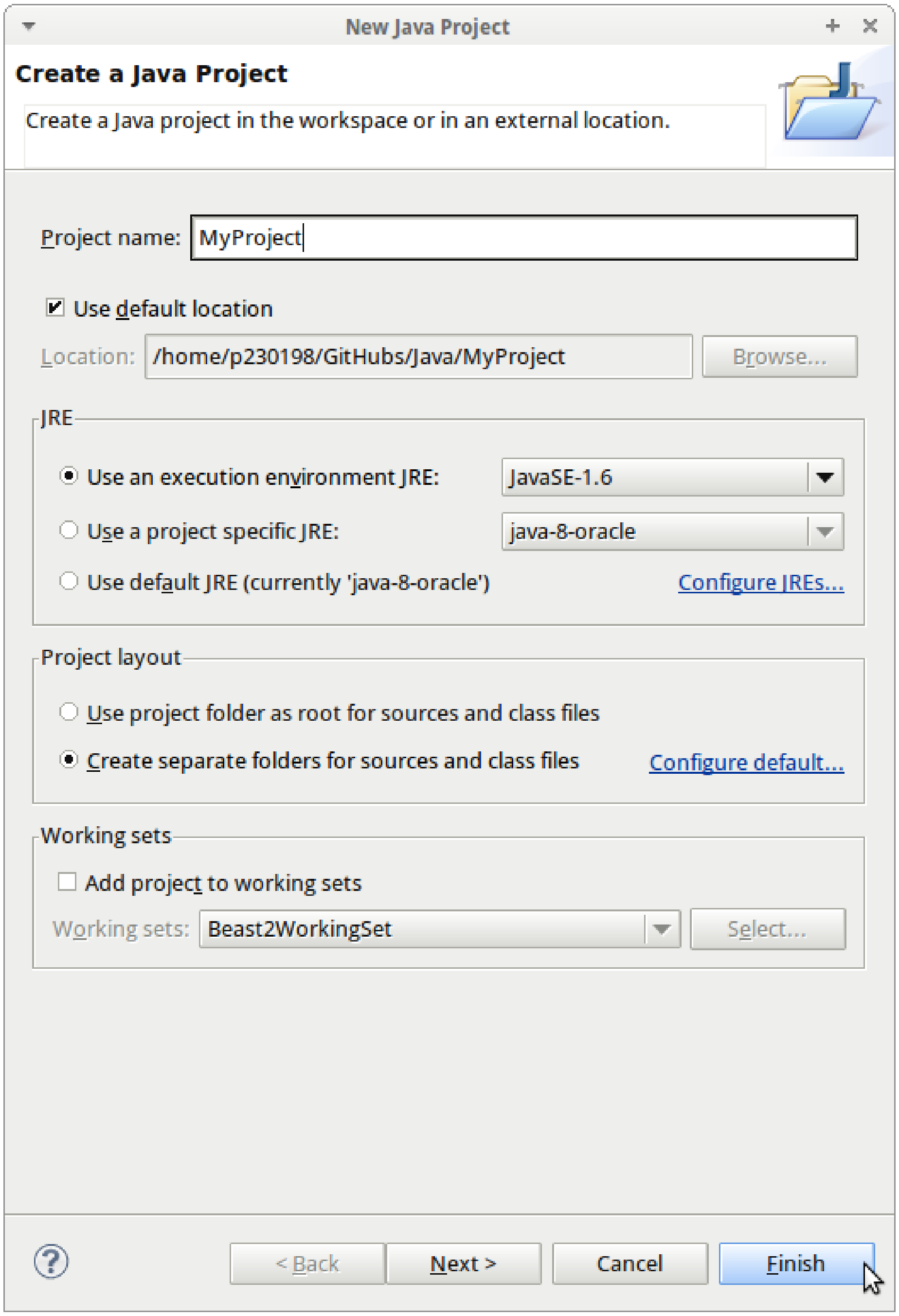
Now you should see two projects in the Package Explorer pane: `beast2` and `MyProject`.

Add BEAST2 to your own project

Right-click `MyProject` and choose `Properties` from the pop-up menu that appears

Go to `Java build path | Projects` and click `Add`.

Add `beast2` to your project build path:



Create a Java Project

Create a Java project in the workspace or in an external location.

Project name: MyProject

☑ Use default location

Location: /home/p230198/GitHubs/Java/MyProject

JRE

● Use an execution environment JRE: JavaSE-1.6

○ Use a project specific JRE: java-8-oracle

○ Use default JRE (currently 'java-8-oracle')

Project layout

○ Use project folder as root for sources and class files

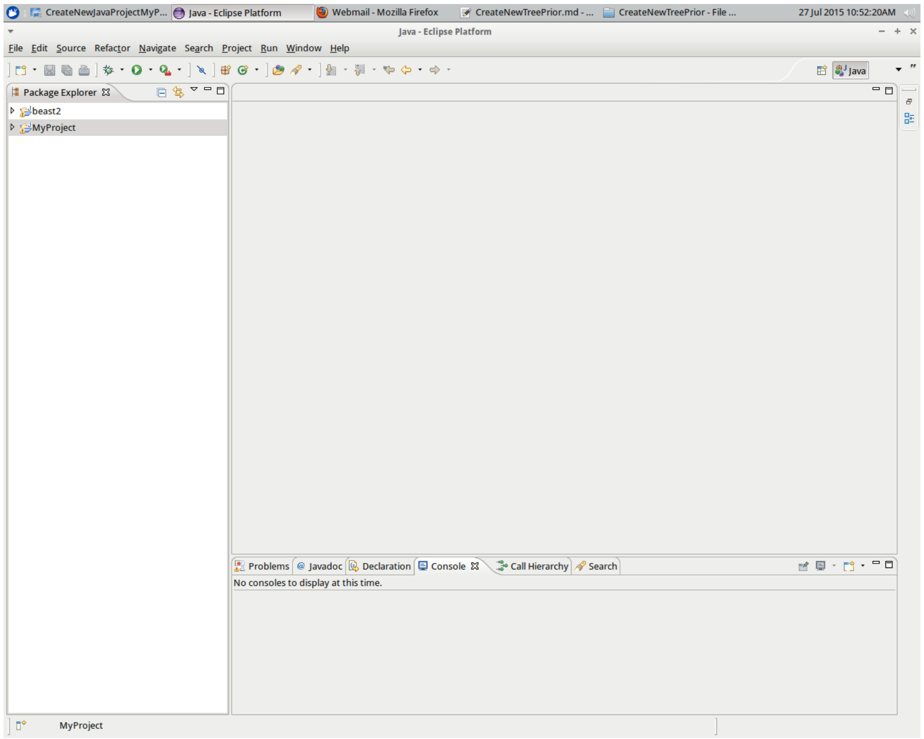
● Create separate folders for sources and class files

Working sets

□ Add project to working sets

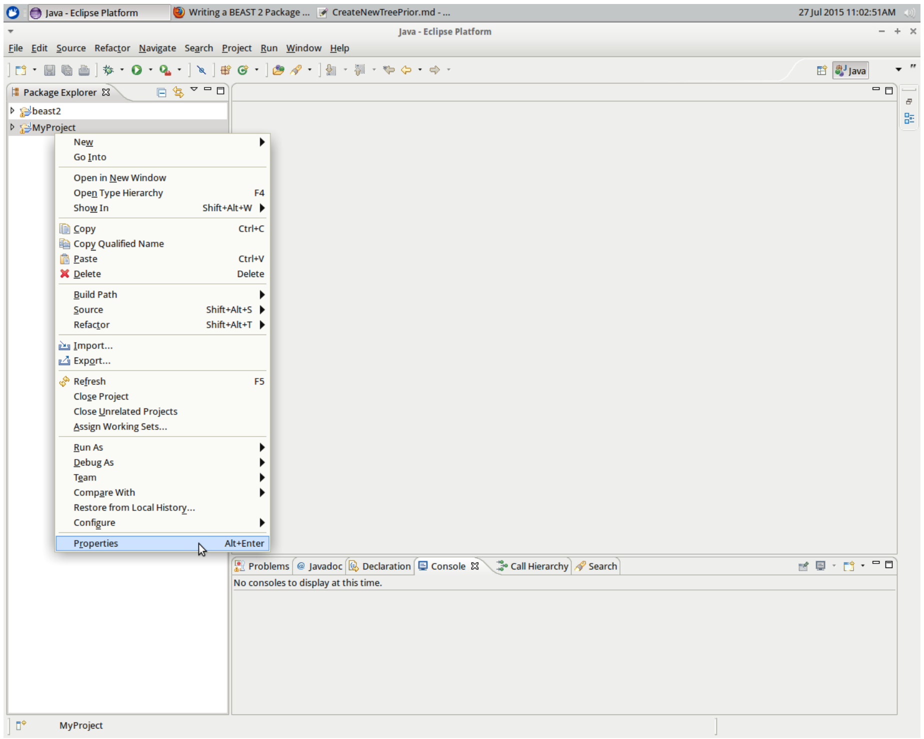
Working sets: Beast2WorkingSet

Figure 9: Create a Java project: MyProject


CreateNewJavaProjectMyP...
Java - Eclipse Platform
Webmail - Mozilla Firefox
CreateNewTreePrior.md - ...
CreateNewTreePrior - File ...
27 Jul 2015 10:52:20AM
Java - Eclipse Platform
File Edit Source Refactor Navigate Search Project Run Window Help
Java
Package Explorer
beast2
MyProject
Problems
Javadoc
Declaration
Console
Call Hierarchy
Search
MyProject

No consoles to display at this time.

Figure 10: Package Explorer with BEAST2 and MyProject



No consoles to display at this time.

Figure 11: Modify the project properties

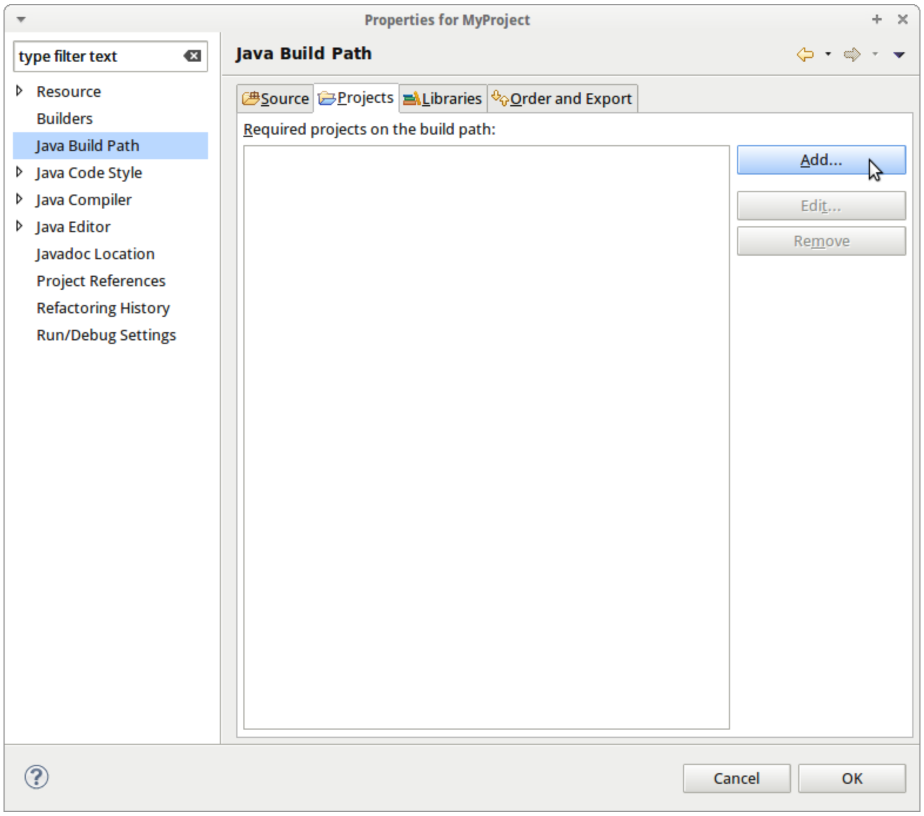
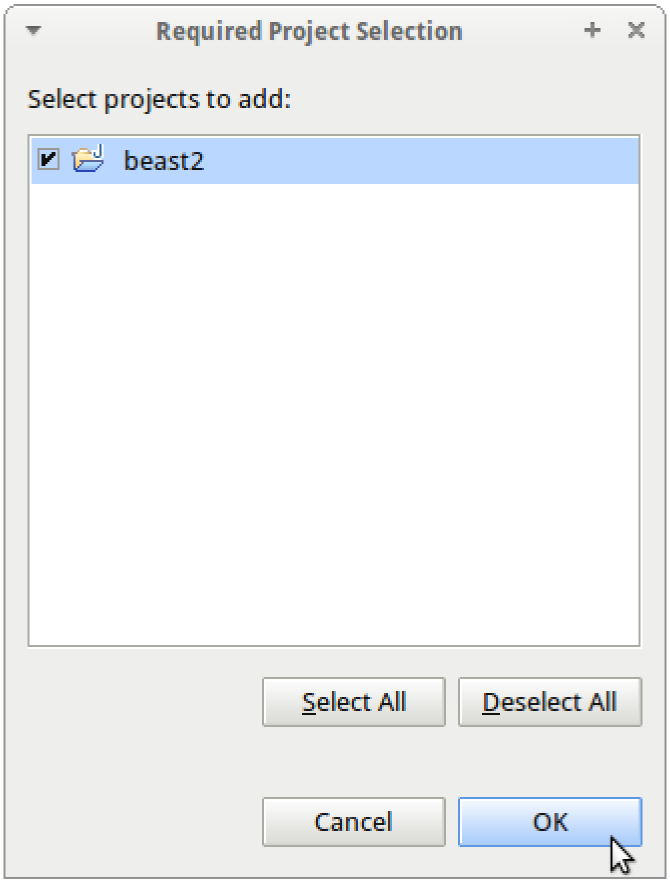


Figure 12: Adding a build path to MyProject



Select projects to add:

☑ beast2

Figure 13: Adding BEAST2 to your project build path

Now BEAST2 is in your project build path, click `OK`.

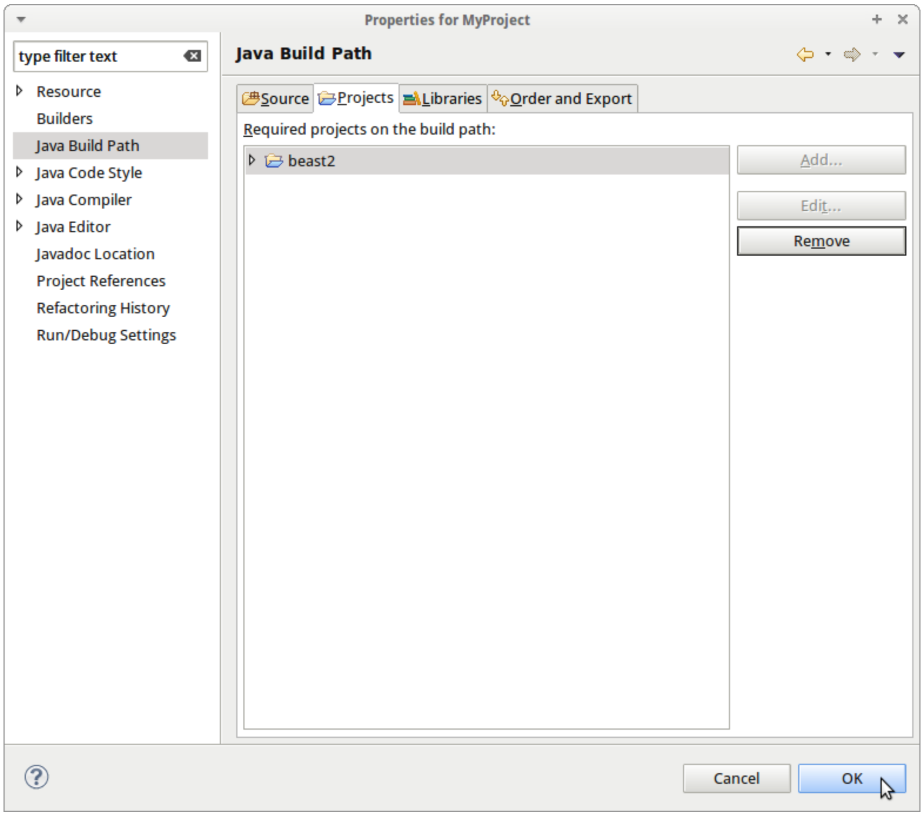


Figure 14: Added BEAST2 to your project build path

This takes you back to the Package Explorer pane.

Create a new tree prior

To create a new tree prior, I will use the Yule model already present in BEAST2.

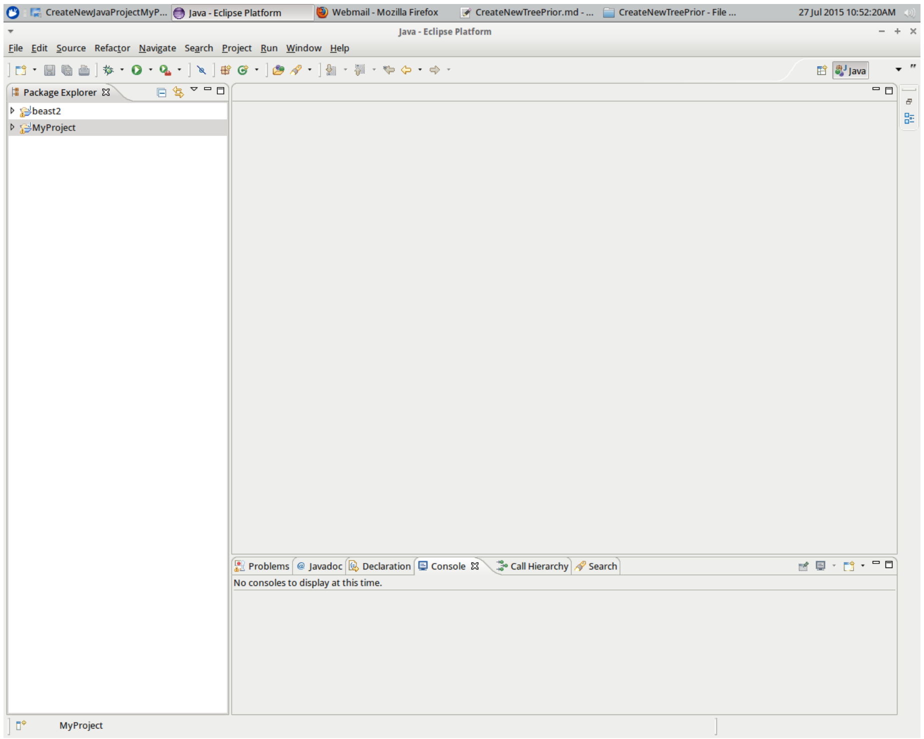
Select `MyProject` in the Package Explorer, right-click and select 'New | Class'

Change the class name to `MyTreePrior`. Ignore all the warnings (as we won't use the generated code anyways) and click `Finish`.

Now you will see the initial code of `MyTreePrior`:

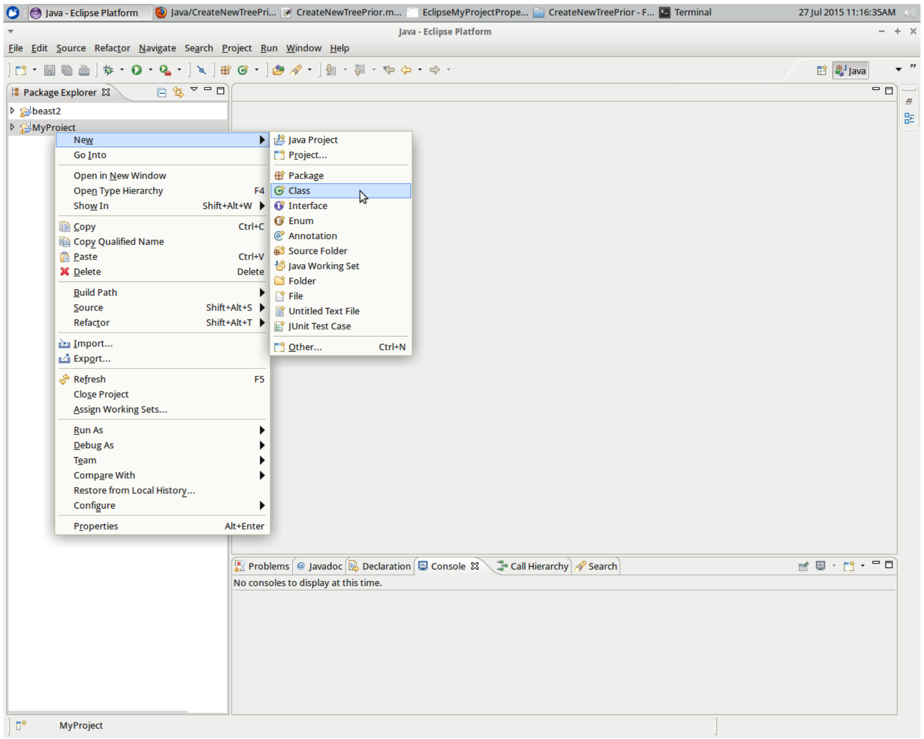
This initial code, however, will be replaced soon.

I will replace the initial code by the Yule tree prior. In the Package Explorer, find the Yule tree prior code. It is under `beast2 | src | beast.evolution.speciation`.


CreateNewJavaProjectMyP...
Java - Eclipse Platform
Webmail - Mozilla Firefox
CreateNewTreePrior.md - ...
CreateNewTreePrior - File ...
27 Jul 2015 10:52:20AM
Java - Eclipse Platform
File Edit Source Refactor Navigate Search Project Run Window Help
Java
Package Explorer
beast2
MyProject
Problems
Javadoc
Declaration
Console
Call Hierarchy
Search
MyProject

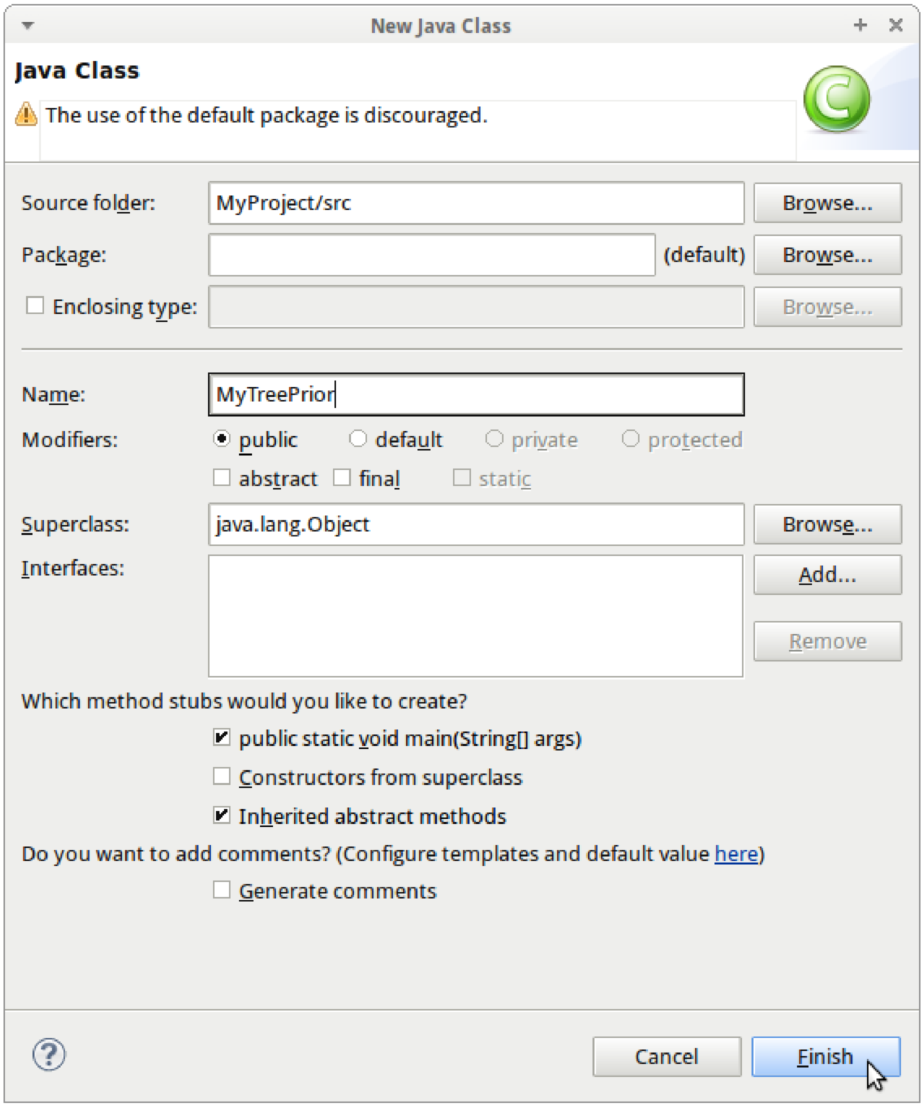
No consoles to display at this time.

Figure 15: Package Explorer with BEAST2 and MyProject



No consoles to display at this time.

Figure 16: Create a new class



Java Class

⚠ The use of the default package is discouraged.

Source folder: MyProject/src

Package: (default)

□ Enclosing type:

Name: MyTreePrior

Modifiers: ● public ○ default ○ private ○ protected

□ abstract □ final □ static

Superclass: java.lang.Object

Interfaces:

Which method stubs would you like to create?

☑ public static void main(String[] args)

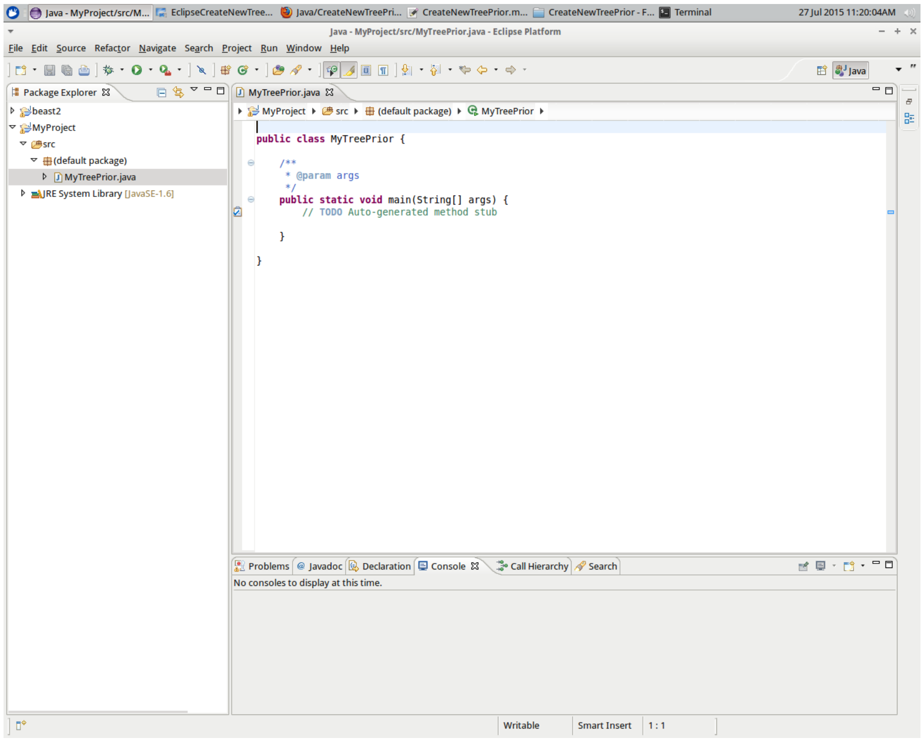
□ Constructors from superclass

☑ Inherited abstract methods

Do you want to add comments? (Configure templates and default value here)

□ Generate comments

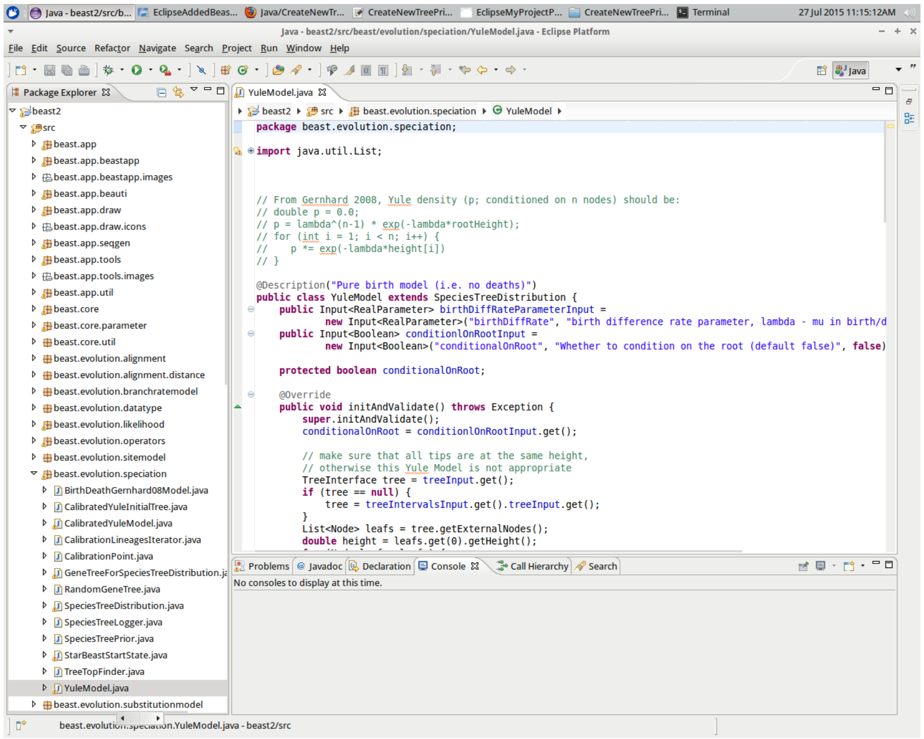
Figure 17: Create a new MyTreePrior class



```
public class MyTreePrior {

    /**
     * @param args
     */
    public static void main(String[] args) {
        // TODO Auto-generated method stub

    }

}
```

No consoles to display at this time.

Figure 18: Initial code of MyTreePrior

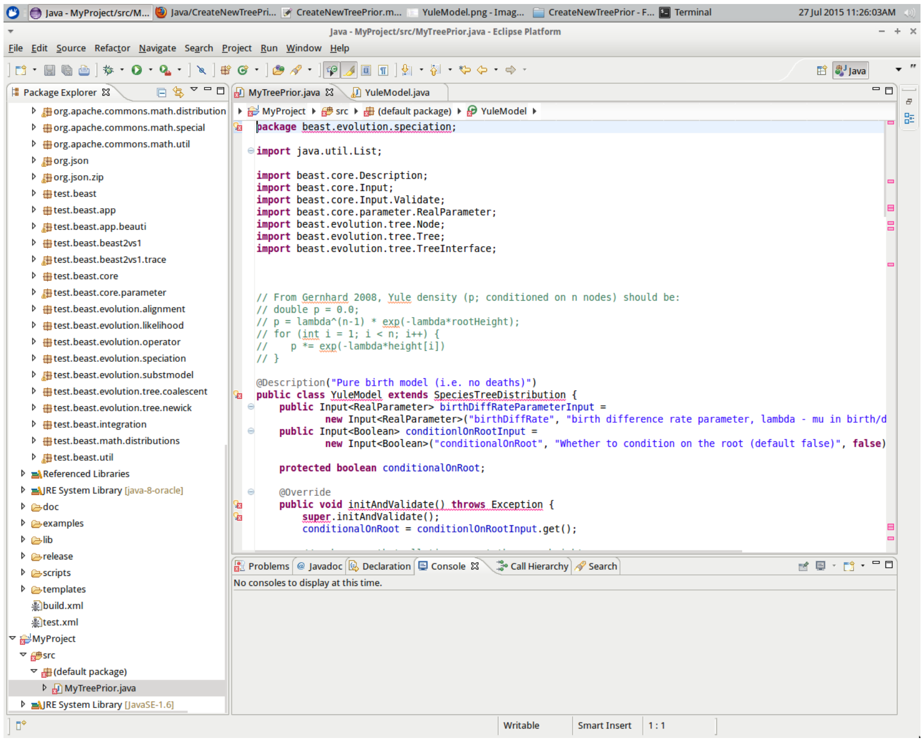

Java - beast2/src/b...
EclipseAddedBeas...
Java/CreateNewTr...
CreateNewTreePri...
EclipseMyProjectP...
CreateNewTreePri...
Terminal
27 Jul 2015 11:15:12AM
Java - beast2/src/beast/evolution/speciation/YuleModel.java - Eclipse Platform
File Edit Source Refactor Navigate Search Project Run Window Help
Java
Package Explorer
beast2
src
beast.app
beast.app.beastapp
beast.app.beastapp.images
beast.app.beauti
beast.app.draw
beast.app.draw.icons
beast.app.seqgen
beast.app.tools
beast.app.tools.images
beast.app.util
beast.core
beast.core.parameter
beast.core.util
beast.evolution.alignment
beast.evolution.alignment.distance
beast.evolution.branchratemodel
beast.evolution.datatype
beast.evolution.likelihood
beast.evolution.operators
beast.evolution.sitemodel
beast.evolution.speciation
BirthDeathGernhard08Model.java
CalibratedYuleInitialTree.java
CalibratedYuleModel.java
CalibrationLineagesIterator.java
CalibrationPoint.java
GeneTreeForSpeciesTreeDistribution.ja
RandomGeneTree.java
SpeciesTreeDistribution.java
SpeciesTreeLogger.java
SpeciesTreePrior.java
StarBeastStartState.java
TreeTopFinder.java
YuleModel.java
beast.evolution.substitutionmodel
YuleModel.java
beast2 › src › beast.evolution.speciation › YuleModel ›
Problems
Javadoc
Declaration
Console
Call Hierarchy
Search
beast.evolution.speciation.YuleModel.java - beast2/src

```java
package beast.evolution.speciation;

import java.util.List;



// From Gernhard 2008, Yule density (p; conditioned on n nodes) should be:
// double p = 0.0;
// p = lambda^(n-1) * exp(-lambda*rootHeight);
// for (int i = 1; i < n; i++) {
//     p *= exp(-lambda*height[i])
// }

@Description("Pure birth model (i.e. no deaths)")
public class YuleModel extends SpeciesTreeDistribution {
    public Input<RealParameter> birthDiffRateParameterInput =
            new Input<RealParameter>("birthDiffRate", "birth difference rate parameter, lambda - mu in birth/d
    public Input<Boolean> conditionlOnRootInput =
            new Input<Boolean>("conditionalOnRoot", "Whether to condition on the root (default false)", false)

    protected boolean conditionalOnRoot;

    @Override
    public void initAndValidate() throws Exception {
        super.initAndValidate();
        conditionalOnRoot = conditionlOnRootInput.get();

        // make sure that all tips are at the same height,
        // otherwise this Yule Model is not appropriate
        TreeInterface tree = treeInput.get();
        if (tree == null) {
            tree = treeIntervalsInput.get().treeInput.get();
        }
        List<Node> leafs = tree.getExternalNodes();
        double height = leafs.get(0).getHeight();
```

```
No consoles to display at this time.
```

Figure 19: Yule model code

Copy-paste the source code into the `MyTreePrior` code. A lot of errors pop up that we'll fix now.



Java - MyProject/src/MyTreePrior.java - Eclipse Platform
File Edit Source Refactor Navigate Search Project Run Window Help
Package Explorer
MyTreePrior.java
YuleModel.java
MyProject ▸ src ▸ (default package) ▸ YuleModel
Problems
Javadoc
Declaration
Console
Call Hierarchy
Search
Writable
Smart Insert
1 : 1

```
package beast.evolution.speciation;

import java.util.List;

import beast.core.Description;
import beast.core.Input;
import beast.core.Input.Validate;
import beast.core.parameter.RealParameter;
import beast.evolution.tree.Node;
import beast.evolution.tree.Tree;
import beast.evolution.tree.TreeInterface;



// From Gernhard 2008, Yule density (p; conditioned on n nodes) should be:
// double p = 0.0;
// p = lambda^(n-1) * exp(-lambda*rootHeight);
// for (int i = 1; i < n; i++) {
//    p *= exp(-lambda*height[i])
// }

@Description("Pure birth model (i.e. no deaths)")
public class YuleModel extends SpeciesTreeDistribution {
    public Input<RealParameter> birthDiffRateParameterInput =
            new Input<RealParameter>("birthDiffRate", "birth difference rate parameter, lambda - mu in birth/d
    public Input<Boolean> conditionlOnRootInput =
            new Input<Boolean>("conditionalOnRoot", "Whether to condition on the root (default false)", false)

    protected boolean conditionalOnRoot;

    @Override
    public void initAndValidate() throws Exception {
        super.initAndValidate();
        conditionalOnRoot = conditionlOnRootInput.get();
```

No consoles to display at this time.

Figure 20: Copied Yule model code

The first error suggests to put the class in the appropriate package.

Double-click this fix.

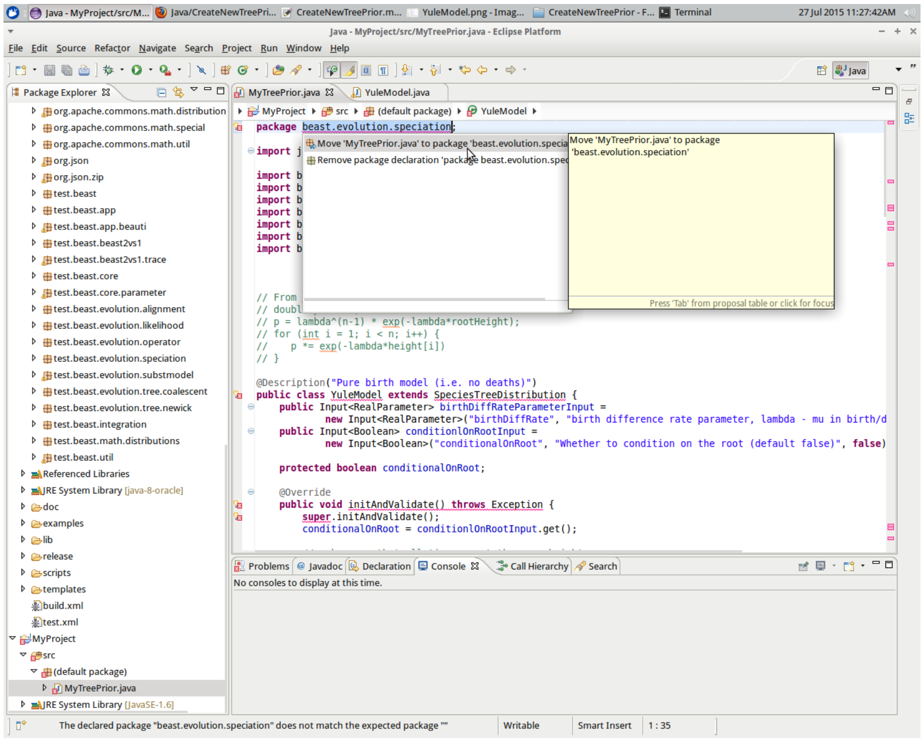
The next error is that `YuleModel` is not the correct type and Eclipse suggest to rename it to `MyTreePrior` instead.

Double-click this fix. Our class now has the correct (new) class name.

Add the tree prior to BEAUti

To allow BEAUti to find the new tree prior, a template XML files needs to be created. Because `MyTreePrior` is a copy of `YuleModel`, we will use the XML code of that model as a starting point.

In the `MyProject` folder, you will need to create a `templates` folder. I just copied `~/GitHubs/Java/beast2/templates` to `~/GitHubs/Java/MyProject/templates`.


Java - MyProject/src/MyTreePrior.java - Eclipse Platform
File Edit Source Refactor Navigate Search Project Run Window Help
Package Explorer
MyTreePrior.java
YuleModel.java
MyProject ▸ src ▸ (default package) ▸ YuleModel
Problems
Javadoc
Declaration
Console
Call Hierarchy
Search
Writable
Smart Insert
1 : 35

```
package beast.evolution.speciation;

import j

import b
import b
import b
import b
import b
import b
import b



// From
// doubl
// p = lambda^(n-1) * exp(-lambda*rootHeight);
// for (int i = 1; i < n; i++) {
//    p *= exp(-lambda*height[i])
// }

@Description("Pure birth model (i.e. no deaths)")
public class YuleModel extends SpeciesTreeDistribution {
    public Input<RealParameter> birthDiffRateParameterInput =
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    public Input<Boolean> conditionlOnRootInput =
            new Input<Boolean>("conditionalOnRoot", "Whether to condition on the root (default false)", false)

    protected boolean conditionalOnRoot;

    @Override
    public void initAndValidate() throws Exception {
        super.initAndValidate();
        conditionalOnRoot = conditionlOnRootInput.get();
```

Move 'MyTreePrior.java' to package 'beast.evolution.specia

Remove package declaration 'package beast.evolution.spec

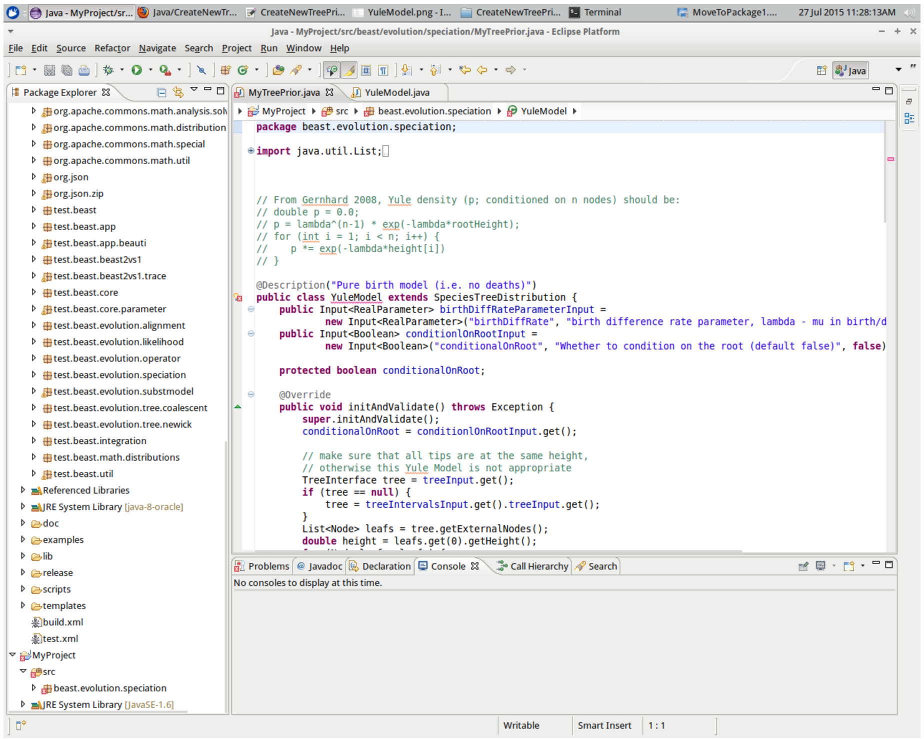
Move 'MyTreePrior.java' to package 'beast.evolution.speciation'

Press 'Tab' from proposal table or click for focus

No consoles to display at this time.

The declared package "beast.evolution.speciation" does not match the expected package ""

Figure 21: Suggest to move to package


Java - MyProject/src/beast/evolution/speciation/MyTreePrior.java - Eclipse Platform
File Edit Source Refactor Navigate Search Project Run Window Help
Package Explorer
MyTreePrior.java
YuleModel.java
MyProject ▸ src ▸ beast.evolution.speciation ▸ YuleModel ▸
Problems
Javadoc
Declaration
Console
Call Hierarchy
Search
Writable
Smart Insert
1 : 1

```
package beast.evolution.speciation;

import java.util.List;


// From Gernhard 2008, Yule density (p; conditioned on n nodes) should be:
// double p = 0.0;
// p = lambda^(n-1) * exp(-lambda*rootHeight);
// for (int i = 1; i < n; i++) {
//     p *= exp(-lambda*height[i])
// }

@Description("Pure birth model (i.e. no deaths)")
public class YuleModel extends SpeciesTreeDistribution {
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    public Input<Boolean> conditionlOnRootInput =
            new Input<Boolean>("conditionalOnRoot", "Whether to condition on the root (default false)", false)

    protected boolean conditionalOnRoot;

    @Override
    public void initAndValidate() throws Exception {
        super.initAndValidate();
        conditionalOnRoot = conditionlOnRootInput.get();

        // make sure that all tips are at the same height,
        // otherwise this Yule Model is not appropriate
        TreeInterface tree = treeInput.get();
        if (tree == null) {
            tree = treeIntervalsInput.get().treeInput.get();
        }
        List<Node> leafs = tree.getExternalNodes();
        double height = leafs.get(0).getHeight();
```
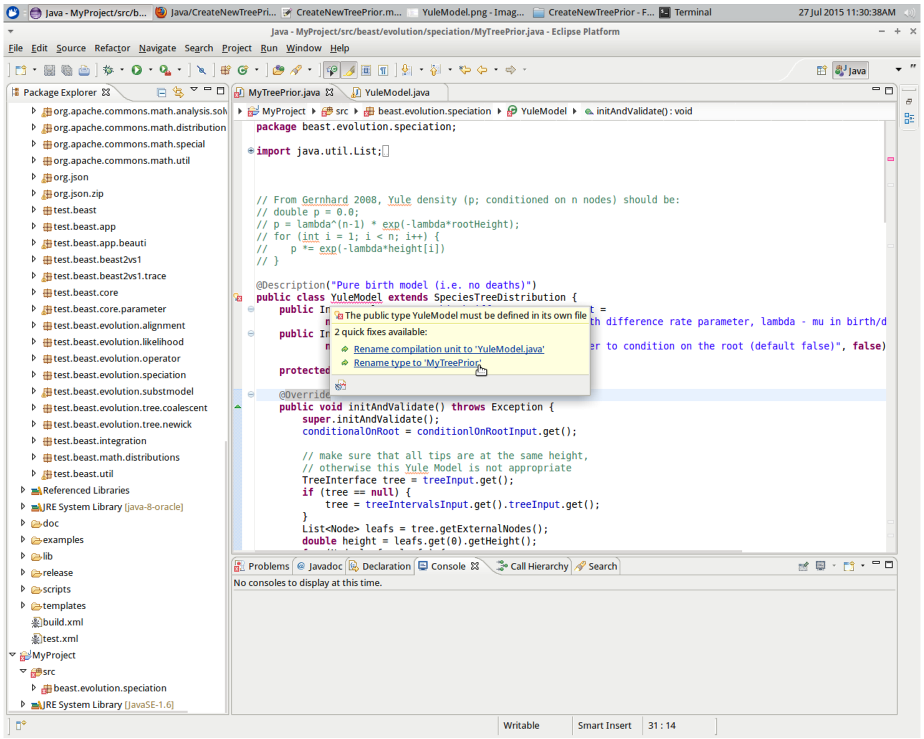

```
No consoles to display at this time.
```

Figure 22: Yule model copy in correct package


Java - MyProject/src/b...
Java/CreateNewTreePri...
CreateNewTreePrior.m...
YuleModel.png - Imag...
CreateNewTreePrior - F...
Terminal
27 Jul 2015 11:30:38AM
Java - MyProject/src/beast/evolution/speciation/MyTreePrior.java - Eclipse Platform
File Edit Source Refactor Navigate Search Project Run Window Help
Java
Package Explorer
org.apache.commons.math.analysis.solv
org.apache.commons.math.distribution
org.apache.commons.math.special
org.apache.commons.math.util
org.json
org.json.zip
test.beast
test.beast.app
test.beast.app.beauti
test.beast.beast2vs1
test.beast.beast2vs1.trace
test.beast.core
test.beast.core.parameter
test.beast.evolution.alignment
test.beast.evolution.likelihood
test.beast.evolution.operator
test.beast.evolution.speciation
test.beast.evolution.substmodel
test.beast.evolution.tree.coalescent
test.beast.evolution.tree.newick
test.beast.integration
test.beast.math.distributions
test.beast.util
Referenced Libraries
JRE System Library [java-8-oracle]
doc
examples
lib
release
scripts
templates
build.xml
test.xml
MyProject
src
beast.evolution.speciation
JRE System Library [JavaSE-1.6]
MyTreePrior.java
YuleModel.java
MyProject ▸ src ▸ beast.evolution.speciation ▸ YuleModel ▸ initAndValidate() : void
Problems
Javadoc
Declaration
Console
Call Hierarchy
Search
Writable
Smart Insert
31 : 14

```
package beast.evolution.speciation;

import java.util.List;


// From Gernhard 2008, Yule density (p; conditioned on n nodes) should be:
// double p = 0.0;
// p = lambda^(n-1) * exp(-lambda*rootHeight);
// for (int i = 1; i < n; i++) {
//    p *= exp(-lambda*height[i])
// }

@Description("Pure birth model (i.e. no deaths)")
public class YuleModel extends SpeciesTreeDistribution {
    public In                                          t =
            n                                          th difference rate parameter, lambda - mu in birth/d
    public In
            n                                          er to condition on the root (default false)", false)

    protected

    @Override
    public void initAndValidate() throws Exception {
        super.initAndValidate();
        conditionalOnRoot = conditionlOnRootInput.get();

        // make sure that all tips are at the same height,
        // otherwise this Yule Model is not appropriate
        TreeInterface tree = treeInput.get();
        if (tree == null) {
            tree = treeIntervalsInput.get().treeInput.get();
        }
        List<Node> leafs = tree.getExternalNodes();
        double height = leafs.get(0).getHeight();
```

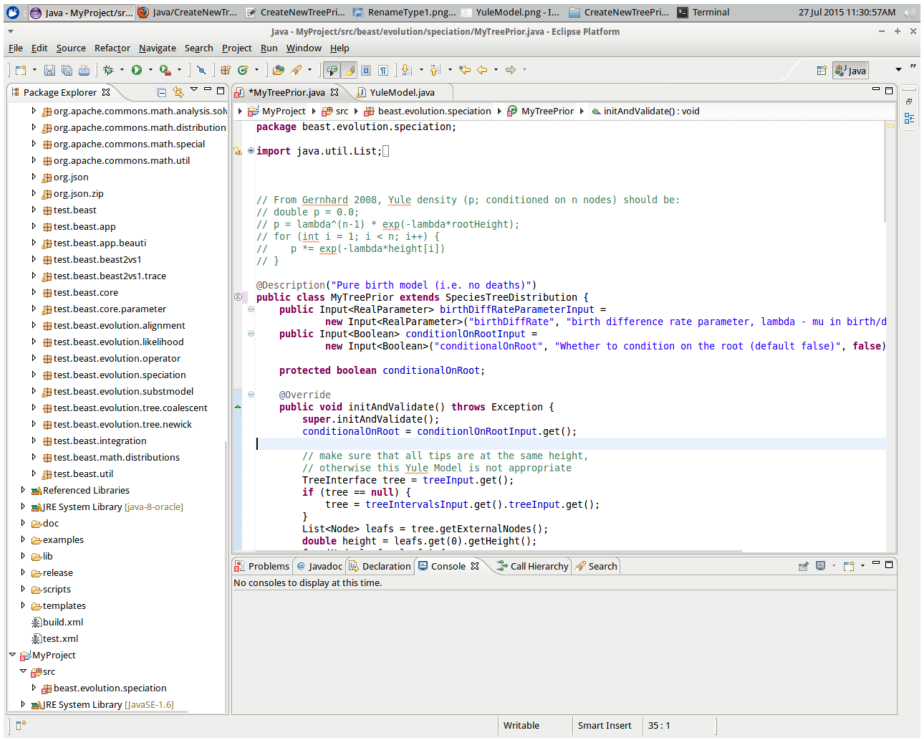
The public type YuleModel must be defined in its own file

2 quick fixes available:

- Rename compilation unit to 'YuleModel.java'
- Rename type to 'MyTreePrior'

No consoles to display at this time.

Figure 23: Eclipse suggests to rename the type

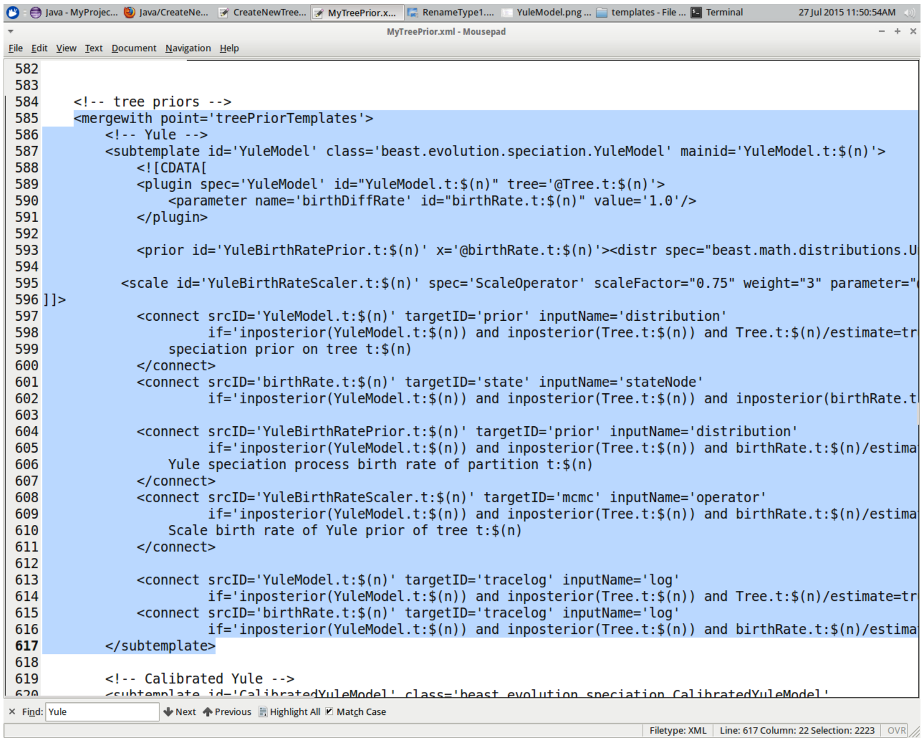

Java - MyProject/src/beast/evolution/speciation/MyTreePrior.java - Eclipse Platform
File Edit Source Refactor Navigate Search Project Run Window Help
Package Explorer
*MyTreePrior.java
YuleModel.java
MyProject ▸ src ▸ beast.evolution.speciation ▸ MyTreePrior ▸ initAndValidate() : void
org.apache.commons.math.analysis.solv
org.apache.commons.math.distribution
org.apache.commons.math.special
org.apache.commons.math.util
org.json
org.json.zip
test.beast
test.beast.app
test.beast.app.beauti
test.beast.beast2vs1
test.beast.beast2vs1.trace
test.beast.core
test.beast.core.parameter
test.beast.evolution.alignment
test.beast.evolution.likelihood
test.beast.evolution.operator
test.beast.evolution.speciation
test.beast.evolution.substmodel
test.beast.evolution.tree.coalescent
test.beast.evolution.tree.newick
test.beast.integration
test.beast.math.distributions
test.beast.util
Referenced Libraries
JRE System Library [java-8-oracle]
doc
examples
lib
release
scripts
templates
build.xml
test.xml
MyProject
src
beast.evolution.speciation
JRE System Library [JavaSE-1.6]
Problems
Javadoc
Declaration
Console
Call Hierarchy
Search
Writable
Smart Insert
35 : 1
Java
Terminal
27 Jul 2015 11:30:57AM

```
package beast.evolution.speciation;

import java.util.List;



// From Gernhard 2008, Yule density (p; conditioned on n nodes) should be:
// double p = 0.0;
// p = lambda^(n-1) * exp(-lambda*rootHeight);
// for (int i = 1; i < n; i++) {
//    p *= exp(-lambda*height[i])
// }

@Description("Pure birth model (i.e. no deaths)")
public class MyTreePrior extends SpeciesTreeDistribution {
    public Input<RealParameter> birthDiffRateParameterInput =
            new Input<RealParameter>("birthDiffRate", "birth difference rate parameter, lambda - mu in birth/d
    public Input<Boolean> conditionlOnRootInput =
            new Input<Boolean>("conditionalOnRoot", "Whether to condition on the root (default false)", false)

    protected boolean conditionalOnRoot;

    @Override
    public void initAndValidate() throws Exception {
        super.initAndValidate();
        conditionalOnRoot = conditionlOnRootInput.get();

        // make sure that all tips are at the same height,
        // otherwise this Yule Model is not appropriate
        TreeInterface tree = treeInput.get();
        if (tree == null) {
            tree = treeIntervalsInput.get().treeInput.get();
        }
        List<Node> leafs = tree.getExternalNodes();
        double height = leafs.get(0).getHeight();
```

No consoles to display at this time.

Figure 24: Eclipse renamed the type

In that folder, only keep SubstModels.xml and rename it to MyTreePrior.xml. Then edit MyTreePrior.xml. You can find YuleModel somewhere in that file. It will be the only one to keep.



```


    <!-- tree priors -->
    <mergewith point='treePriorTemplates'>
        <!-- Yule -->
        <subtemplate id='YuleModel' class='beast.evolution.speciation.YuleModel' mainid='YuleModel.t:$(n)'>
            <![CDATA[
            <plugin spec='YuleModel' id="YuleModel.t:$(n)" tree='@Tree.t:$(n)'>
                <parameter name='birthDiffRate' id="birthRate.t:$(n)" value='1.0'/>
            </plugin>

            <prior id='YuleBirthRatePrior.t:$(n)' x='@birthRate.t:$(n)'><distr spec="beast.math.distributions.U

          <scale id='YuleBirthRateScaler.t:$(n)' spec='ScaleOperator' scaleFactor="0.75" weight="3" parameter="
]]>
            <connect srcID='YuleModel.t:$(n)' targetID='prior' inputName='distribution'
                     if='inposterior(YuleModel.t:$(n)) and inposterior(Tree.t:$(n)) and Tree.t:$(n)/estimate=tr
                speciation prior on tree t:$(n)
            </connect>
            <connect srcID='birthRate.t:$(n)' targetID='state' inputName='stateNode'
                     if='inposterior(YuleModel.t:$(n)) and inposterior(Tree.t:$(n)) and inposterior(birthRate.t

            <connect srcID='YuleBirthRatePrior.t:$(n)' targetID='prior' inputName='distribution'
                     if='inposterior(YuleModel.t:$(n)) and inposterior(Tree.t:$(n)) and birthRate.t:$(n)/estima
                Yule speciation process birth rate of partition t:$(n)
            </connect>
            <connect srcID='YuleBirthRateScaler.t:$(n)' targetID='mcmc' inputName='operator'
                     if='inposterior(YuleModel.t:$(n)) and inposterior(Tree.t:$(n)) and birthRate.t:$(n)/estima
                Scale birth rate of Yule prior of tree t:$(n)
            </connect>

            <connect srcID='YuleModel.t:$(n)' targetID='tracelog' inputName='log'
                     if='inposterior(YuleModel.t:$(n)) and inposterior(Tree.t:$(n)) and Tree.t:$(n)/estimate=tr
            <connect srcID='birthRate.t:$(n)' targetID='tracelog' inputName='log'
                     if='inposterior(YuleModel.t:$(n)) and inposterior(Tree.t:$(n)) and birthRate.t:$(n)/estima
        </subtemplate>

        <!-- Calibrated Yule -->
        <subtemplate id='CalibratedYuleModel' class='beast.evolution.speciation.CalibratedYuleModel'
```

Figure 25: MyTreePrior.xml before edit

Remove all other things, except for YuleModel. Be sure to keep the closing XML tags. Or just copy paste this code:

```
<beast version='2.0'
       namespace='beast.app.beauti:beast.core:beast.evolution.branchratemodel:beast.evolutic

    <!-- tree priors -->
    <mergewith point='treePriorTemplates'>
        <!-- Yule -->
        <subtemplate id='YuleModel' class='beast.evolution.speciation.YuleModel' mainid='Yul
            <![CDATA[
            <plugin spec='YuleModel' id="YuleModel.t:$(n)" tree='@Tree.t:$(n)'>
                <parameter name='birthDiffRate' id="birthRate.t:$(n)" value='1.0'/>
            </plugin>

            <prior id='YuleBirthRatePrior.t:$(n)' x='@birthRate.t:$(n)'><distr spec="beast.r
            <scale id='YuleBirthRateScaler.t:$(n)' spec='ScaleOperator' scaleFactor="0.75" w
]]>
            <connect srcID='YuleModel.t:$(n)' targetID='prior' inputName='distribution'
                     if='inposterior(YuleModel.t:$(n)) and inposterior(Tree.t:$(n)) and Tree
                speciation prior on tree t:$(n)
            </connect>
            <connect srcID='birthRate.t:$(n)' targetID='state' inputName='stateNode'
                     if='inposterior(YuleModel.t:$(n)) and inposterior(Tree.t:$(n)) and inpo

            <connect srcID='YuleBirthRatePrior.t:$(n)' targetID='prior' inputName='distribut
                     if='inposterior(YuleModel.t:$(n)) and inposterior(Tree.t:$(n)) and birt
                Yule speciation process birth rate of partition t:$(n)
            </connect>
            <connect srcID='YuleBirthRateScaler.t:$(n)' targetID='mcmc' inputName='operator'
                     if='inposterior(YuleModel.t:$(n)) and inposterior(Tree.t:$(n)) and birt
                Scale birth rate of Yule prior of tree t:$(n)
            </connect>

            <connect srcID='YuleModel.t:$(n)' targetID='tracelog' inputName='log'
                     if='inposterior(YuleModel.t:$(n)) and inposterior(Tree.t:$(n)) and Tree
            <connect srcID='birthRate.t:$(n)' targetID='tracelog' inputName='log'
                     if='inposterior(YuleModel.t:$(n)) and inposterior(Tree.t:$(n)) and birt
        </subtemplate>

    </mergewith>

</beast>
```

Some YuleModel occurrances must be replaced by MyTreePrior.

```
<beast version='2.0'
       namespace='beast.app.beauti:beast.core:beast.evolution.branchratemodel:beast.evolutio

    <!-- tree priors -->
    <mergewith point='treePriorTemplates'>
        <!-- Yule -->
        <subtemplate id='MyTreePrior' class='beast.evolution.speciation.MyTreePrior' mainid=
            <![CDATA[
            <plugin spec='MyTreePrior' id="MyTreePrior.t:$(n)" tree='@Tree.t:$(n)'>
                <parameter name='birthDiffRate' id="birthRate.t:$(n)" value='1.0'/>
            </plugin>

            <prior id='YuleBirthRatePrior.t:$(n)' x='@birthRate.t:$(n)'><distr spec="beast.m
            <scale id='YuleBirthRateScaler.t:$(n)' spec='ScaleOperator' scaleFactor="0.75" w
]]>
            <connect srcID='MyTreePrior.t:$(n)' targetID='prior' inputName='distribution'
                     if='inposterior(MyTreePrior.t:$(n)) and inposterior(Tree.t:$(n)) and Tr
            </connect>
            <connect srcID='birthRate.t:$(n)' targetID='state' inputName='stateNode'
                     if='inposterior(MyTreePrior.t:$(n)) and inposterior(Tree.t:$(n)) and in

            <connect srcID='YuleBirthRatePrior.t:$(n)' targetID='prior' inputName='distribut
                     if='inposterior(MyTreePrior.t:$(n)) and inposterior(Tree.t:$(n)) and bi
                Yule speciation process birth rate of partition t:$(n)
            </connect>
            <connect srcID='YuleBirthRateScaler.t:$(n)' targetID='mcmc' inputName='operator'
                     if='inposterior(MyTreePrior.t:$(n)) and inposterior(Tree.t:$(n)) and bi
                Scale birth rate of Yule prior of tree t:$(n)
            </connect>

            <connect srcID='MyTreePrior.t:$(n)' targetID='tracelog' inputName='log'
                     if='inposterior(MyTreePrior.t:$(n)) and inposterior(Tree.t:$(n)) and Tr
            <connect srcID='birthRate.t:$(n)' targetID='tracelog' inputName='log'
                     if='inposterior(MyTreePrior.t:$(n)) and inposterior(Tree.t:$(n)) and bi
        </subtemplate>

    </mergewith>

</beast>
```

Run BEAUti

To create a debug configuration that runs BEAUti, choose `Run | Debug Configurations`.

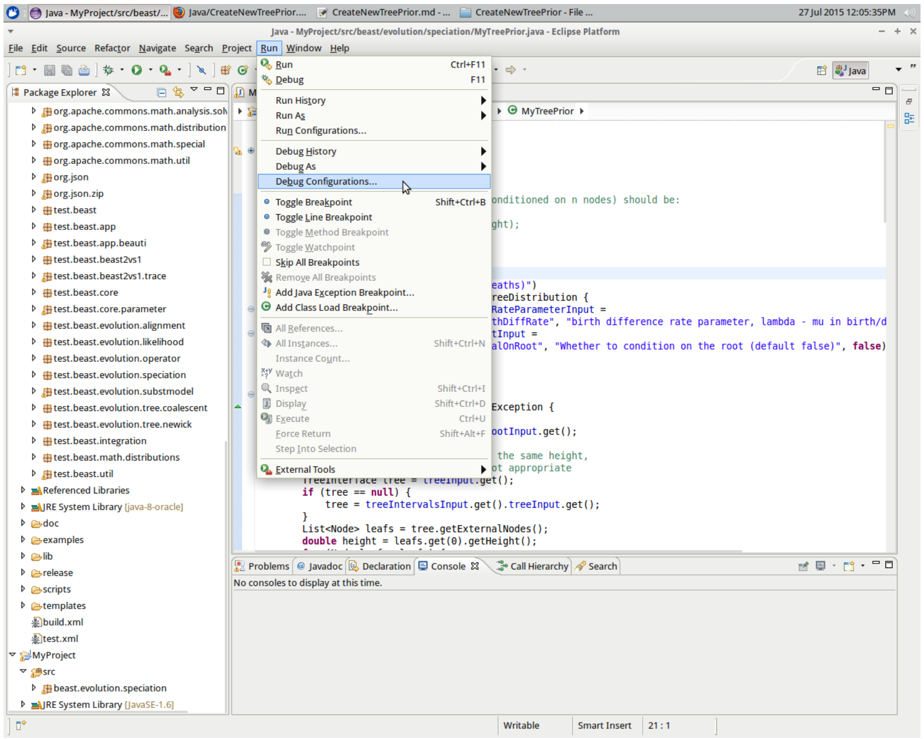
In the Debug Configurations dialog, select `Java Application`, right-click, then click `New`.

- In the `Name` field at the top of the dialog box, type `BEAUti`
- In the Project field of the Main tab, type `MyProject`
- For the Main class, type `beast.app.beauti.Beauti`

Click `Apply`.

Click `Debug` to start BEAUti.

Use `File | Import Alignment` or click the `+` button at the lower left, then navigate to the `~/GitHubs/Java/beast2/examples/nexus` folder and select the `anolis.nex` file. Note: you can avoid doing this step if you specify `-nex`


Java - MyProject/src/beast/...
Java/CreateNewTreePrior....
CreateNewTreePrior.md - ...
CreateNewTreePrior - File ...
27 Jul 2015 12:05:35PM
Java - MyProject/src/beast/evolution/speciation/MyTreePrior.java - Eclipse Platform
File
Edit
Source
Refactor
Navigate
Search
Project
Run
Window
Help
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org.apache.commons.math.analysis.solv
org.apache.commons.math.distribution
org.apache.commons.math.special
org.apache.commons.math.util
org.json
org.json.zip
test.beast
test.beast.app
test.beast.app.beauti
test.beast.beast2vs1
test.beast.beast2vs1.trace
test.beast.core
test.beast.core.parameter
test.beast.evolution.alignment
test.beast.evolution.likelihood
test.beast.evolution.operator
test.beast.evolution.speciation
test.beast.evolution.substmodel
test.beast.evolution.tree.coalescent
test.beast.evolution.tree.newick
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test.beast.math.distributions
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release
scripts
templates
build.xml
test.xml
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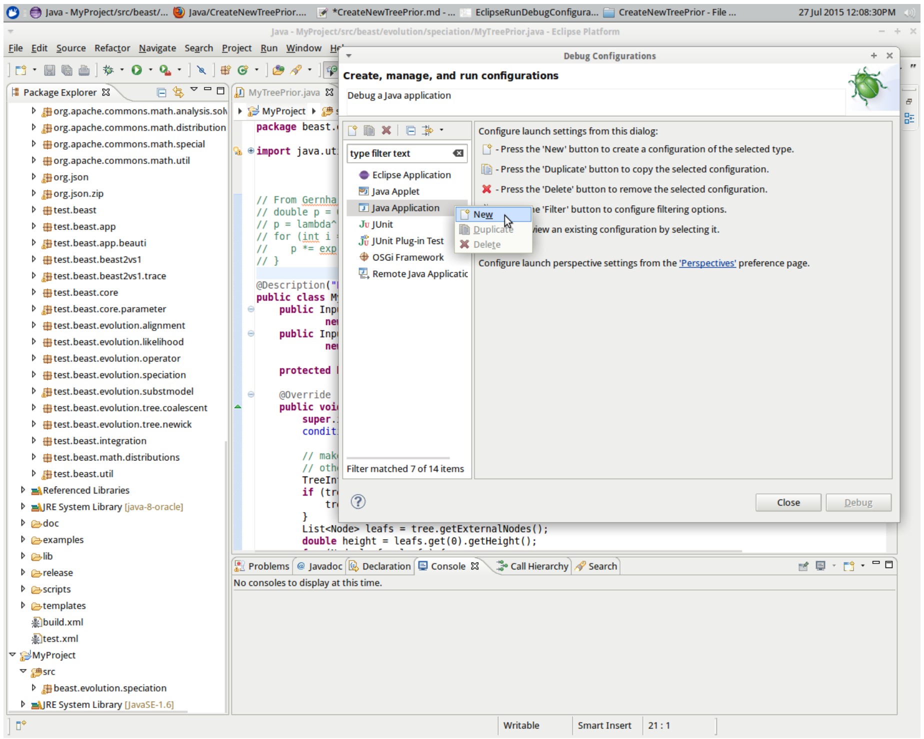
beast.evolution.speciation
JRE System Library [JavaSE-1.6]
Run Ctrl+F11
Debug F11
Run History
Run As
Run Configurations...
Debug History
Debug As
Debug Configurations...
Toggle Breakpoint Shift+Ctrl+B
Toggle Line Breakpoint
Toggle Method Breakpoint
Toggle Watchpoint
Skip All Breakpoints
Remove All Breakpoints
Add Java Exception Breakpoint...
Add Class Load Breakpoint...
All References...
All Instances... Shift+Ctrl+N
Instance Count...
Watch
Inspect Shift+Ctrl+I
Display Shift+Ctrl+D
Execute Ctrl+U
Force Return Shift+Alt+F
Step Into Selection
External Tools
MyTreePrior
Problems
Javadoc
Declaration
Console
Call Hierarchy
Search
Writable
Smart Insert
21 : 1

```
onditioned on n nodes) should be:

ght);

eaths)")
reeDistribution {
RateParameterInput =
thDiffRate", "birth difference rate parameter, lambda - mu in birth/d
tInput =
alOnRoot", "Whether to condition on the root (default false)", false)

Exception {

ootInput.get();

 the same height,
ot appropriate
        TreeInterface tree = treeInput.get();
        if (tree == null) {
            tree = treeIntervalsInput.get().treeInput.get();
        }
        List<Node> leafs = tree.getExternalNodes();
        double height = leafs.get(0).getHeight();
```

No consoles to display at this time.

Figure 26: Debug configurations



Java - MyProject/src/beast/...
Java/CreateNewTreePrior....
*CreateNewTreePrior.md - ...
EclipseRunDebugConfigura...
CreateNewTreePrior - File ...
27 Jul 2015 12:08:30PM
Java - MyProject/src/beast/evolution/speciation/MyTreePrior.java - Eclipse Platform
File
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Refactor
Navigate
Search
Project
Run
Window
Package Explorer
org.apache.commons.math.analysis.solv
org.apache.commons.math.distribution
org.apache.commons.math.special
org.apache.commons.math.util
org.json
org.json.zip
test.beast
test.beast.app
test.beast.app.beauti
test.beast.beast2vs1
test.beast.beast2vs1.trace
test.beast.core
test.beast.core.parameter
test.beast.evolution.alignment
test.beast.evolution.likelihood
test.beast.evolution.operator
test.beast.evolution.speciation
test.beast.evolution.substmodel
test.beast.evolution.tree.coalescent
test.beast.evolution.tree.newick
test.beast.integration
test.beast.math.distributions
test.beast.util
Referenced Libraries
JRE System Library [java-8-oracle]
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release
scripts
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build.xml
test.xml
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beast.evolution.speciation
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MyTreePrior.java
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Java Applet
Java Application
JUnit
JUnit Plug-in Test
OSGi Framework
Remote Java Applicatic
New
Duplicate
Delete
Close
Debug
Problems
Javadoc
Declaration
Console
Call Hierarchy
Search
Writable
Smart Insert
21 : 1

```
package beast.
import java.ut
// From Gernha
// double p = 
// p = lambda^
// for (int i 
//     p *= exp
// }
@Description("
public class M
    public Inp
            ne
    public Inp
            ne
    protected 
    @Override
    public voi
        super.
        condit
        // mak
        // oth
        TreeIn
        if (tr
            tr
        }
        List<Node> leafs = tree.getExternalNodes();
        double height = leafs.get(0).getHeight();
```

Create, manage, and run configurations

Debug a Java application

Configure launch settings from this dialog:

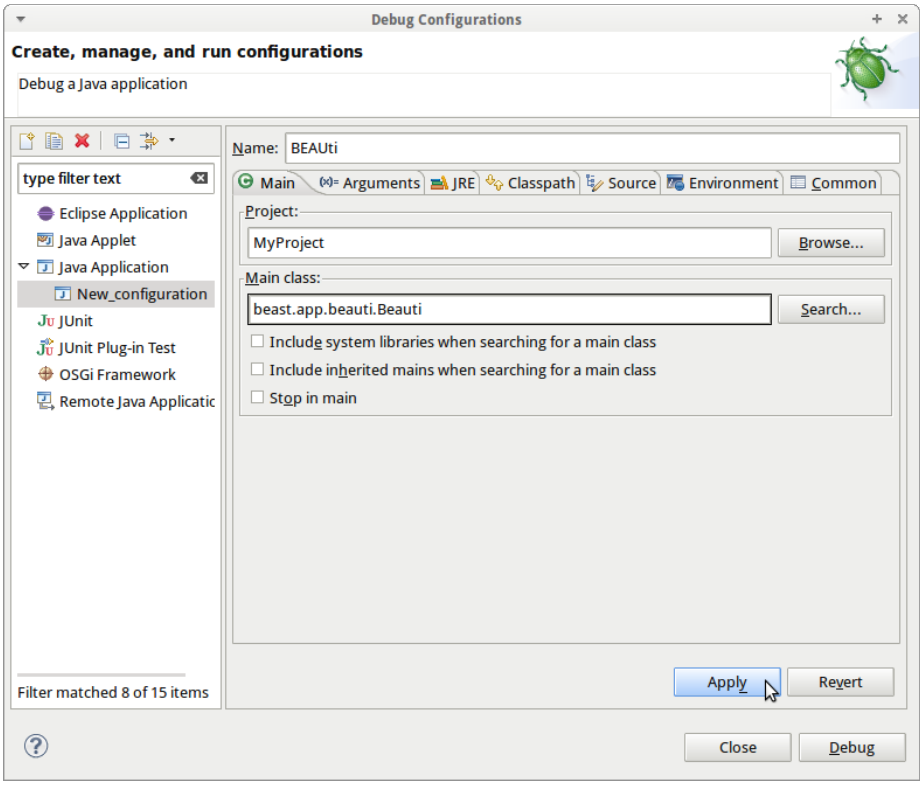
- Press the 'New' button to create a configuration of the selected type.
- Press the 'Duplicate' button to copy the selected configuration.
- Press the 'Delete' button to remove the selected configuration.
- e 'Filter' button to configure filtering options.
- iew an existing configuration by selecting it.

Configure launch perspective settings from the 'Perspectives' preference page.

Filter matched 7 of 14 items

No consoles to display at this time.

Figure 27: Debug configuration: add new java application



Debug Configurations

Create, manage, and run configurations

Debug a Java application

type filter text

- Eclipse Application
- Java Applet
- Java Application
  - New_configuration
- JUnit
- JUnit Plug-in Test
- OSGi Framework
- Remote Java Applicatic

Filter matched 8 of 15 items

Name: BEAUti

Project: MyProject

Main class: beast.app.beauti.Beauti

□ Include system libraries when searching for a main class

□ Include inherited mains when searching for a main class

□ Stop in main

Figure 28: Debug configuration done

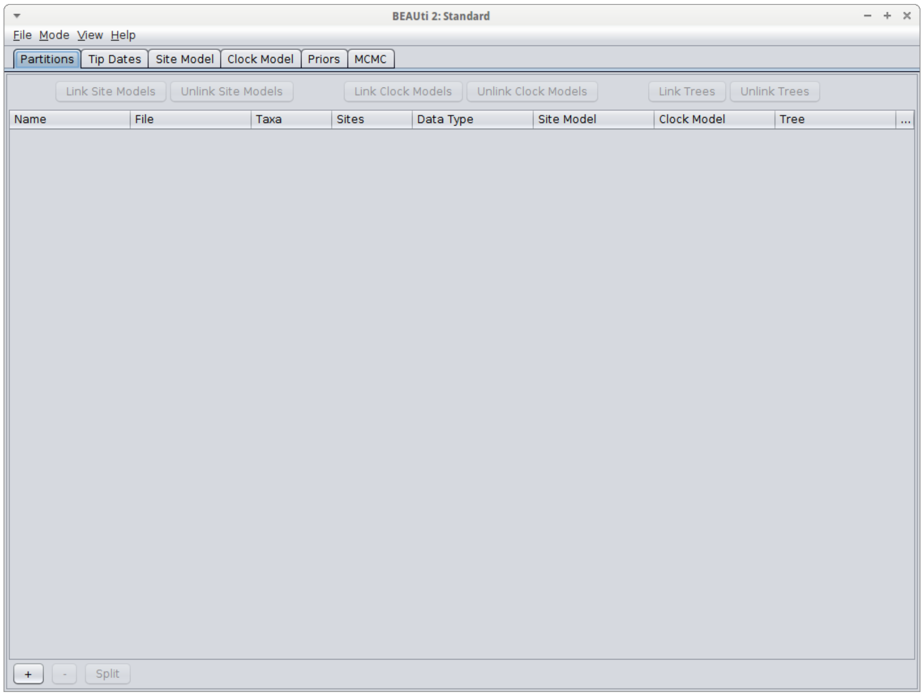
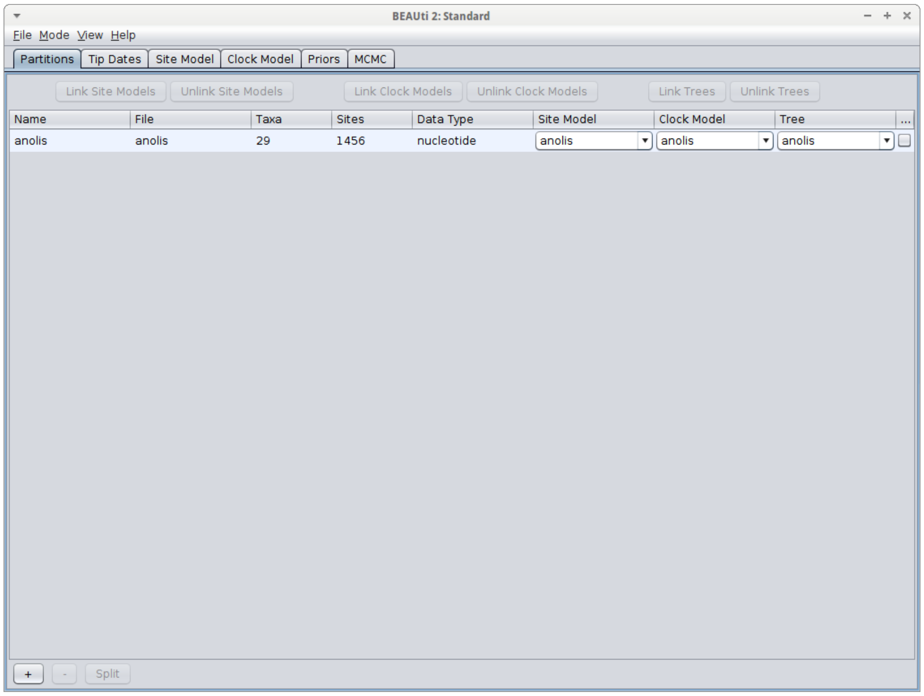


Figure 29: BEAUti2 still empty

`../beast2/examples/nexus/anolis.nex` in the `Program arguments` field of the `Arguments` tab in the BEAUti debug configuration.

Now the alignment is used in BEAUti.



Name	File	Taxa	Sites	Data Type	Site Model	Clock Model	Tree	...
anolis	anolis	29	1456	nucleotide	anolis	anolis	anolis	□

Figure 30: BEAUti2 Anolis

Under the tab `Priors` you can select the `My Tree Prior`.

And there it is!

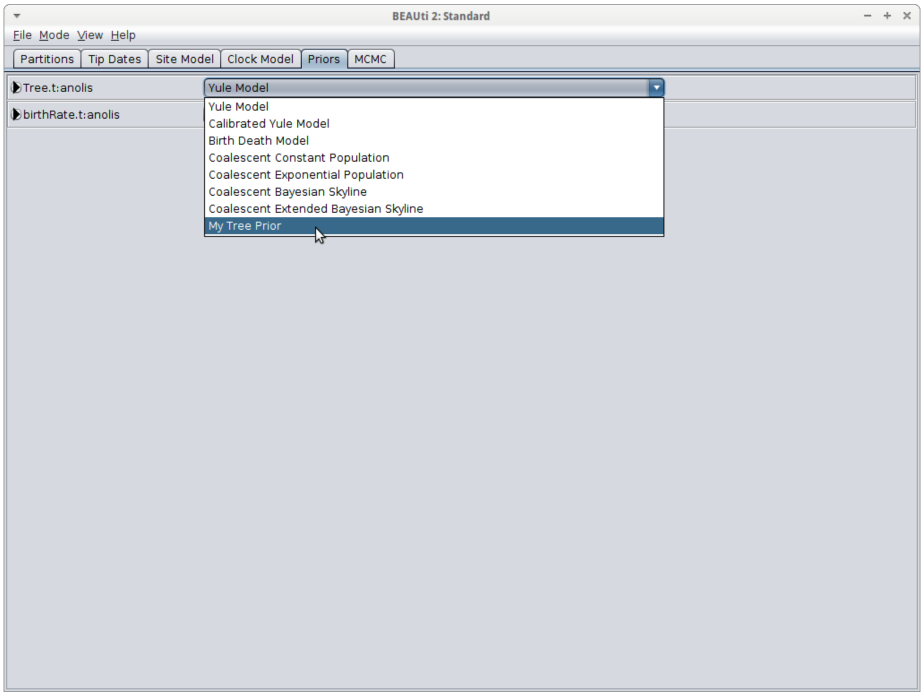
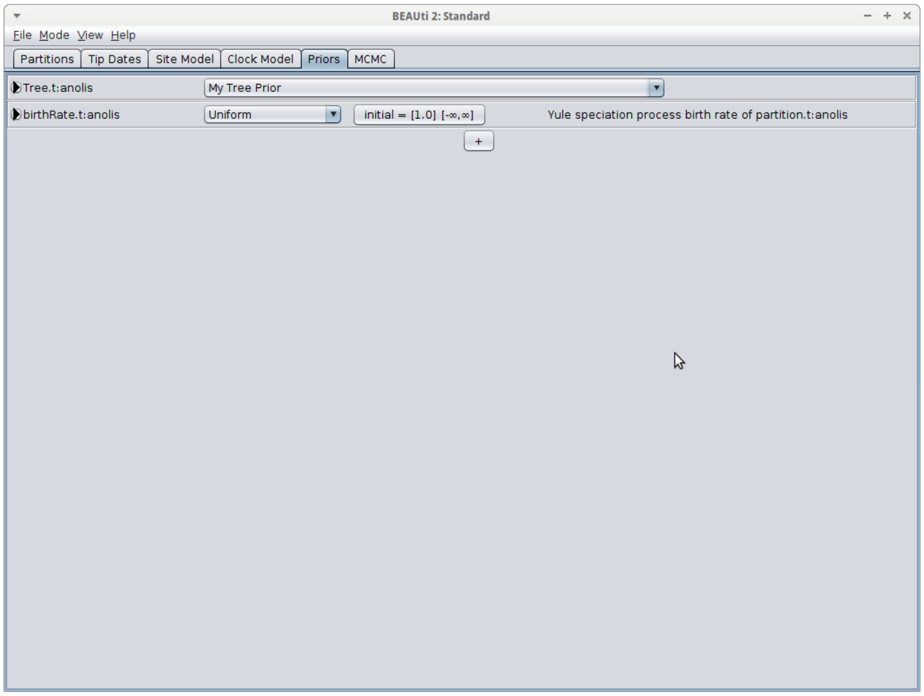


Figure 31: BEAUti2 Anolis and new tree prior is present



Tree.t:anolis My Tree Prior

birthRate.t:anolis Uniform initial = [1.0] [-∞,∞] Yule speciation process birth rate of partition.t:anolis

Figure 32: BEAUti2 Anolis and new tree prior is present