

# Creating new Resource Types

## Track II, Module 7

Fourth GATE Training Course

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# Outline

- 1** CREOLE Basics
  - CREOLE Recap
  - CREOLE Metadata
- 2** Creating CREOLE Resources
  - Your First Language Analyser
  - Best Practice
  - Your First Visual Resource
- 3** Advanced CREOLE
  - CREOLE Management
  - Corpus-level processing
  - Adding actions to the GUI

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# CREOLE

The GATE component model is called CREOLE (**C**ollection of **RE**usable **O**bjects for **L**anguage **E**ngineering).

CREOLE uses the following terminology:

- **CREOLE Plugins:** contain definitions for a set of resources.
- **CREOLE Resources:** Java objects with associated configuration.
- **CREOLE Configuration:** the metadata associated with Java classes that implement CREOLE resources.

# CREOLE Plugins

CREOLE is organised as a set of plugins.

Each CREOLE plugin:

- is a directory on disk (or on a web server);
- is specified as a URL pointing to the **directory**;
- contains a special file called `creole.xml`;
- may contain one or more `.jar` files with compiled Java classes.
  - alternatively, the required Java classes may simply be placed on the application classpath.
- contains the definitions for a set of CREOLE resources.

# CREOLE Resources

A CREOLE resource is a Java Bean with some additional metadata.

## A CREOLE resource:

- must implement the `gate.Resource` interface;
- must provide accessor methods for its parameters;
- must have associated CREOLE metadata.

## The CREOLE metadata associated with a resource:

- can be provided inside the `creole.xml` file for the plugin;
- can be provided as special Java annotations inside the source code (recommended).

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## Structure of a creole.xml File

```
1 <CREOLE-DIRECTORY>
2   <CREOLE>
3     <JAR>jarfile1.jar</JAR>
4     <JAR>jarfile2.jar</JAR>
5     ...
6     <RESOURCE>...</RESOURCE>
7     <RESOURCE>...</RESOURCE>
8     <RESOURCE>...</RESOURCE>
9     ...
10  </CREOLE>
11  <CREOLE>...</CREOLE>
12  <CREOLE>...</CREOLE>
13  ...
14 </CREOLE-DIRECTORY>
```

Each `creole.xml` file contains:



## Structure of a creole.xml File

```
1 <CREOLE-DIRECTORY>
2   <CREOLE>
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5     ...
6     <RESOURCE>...</RESOURCE>
7     <RESOURCE>...</RESOURCE>
8     <RESOURCE>...</RESOURCE>
9     ...
10  </CREOLE>
11  <CREOLE>...</CREOLE>
12  <CREOLE>...</CREOLE>
13  ...
14 </CREOLE-DIRECTORY>
```

Each `creole.xml` file contains:

- one **CREOLE-DIRECTORY** element, containing:

## Structure of a creole.xml File

```
1 <CREOLE-DIRECTORY>
2   <CREOLE>
3     <JAR>jarfile1.jar</JAR>
4     <JAR>jarfile2.jar</JAR>
5     ...
6     <RESOURCE>...</RESOURCE>
7     <RESOURCE>...</RESOURCE>
8     <RESOURCE>...</RESOURCE>
9     ...
10  </CREOLE>
11  <CREOLE>...</CREOLE>
12  <CREOLE>...</CREOLE>
13  ...
14 </CREOLE-DIRECTORY>
```

Each `creole.xml` file contains:

- one **CREOLE-DIRECTORY** element, containing:
  - optionally, zero or more **CREOLE** elements (used for grouping);

## Structure of a creole.xml File

```
1 <CREOLE-DIRECTORY>
2   <CREOLE>
3     <JAR>jarfile1.jar</JAR>
4     <JAR>jarfile2.jar</JAR>
5     ...
6     <RESOURCE>...</RESOURCE>
7     <RESOURCE>...</RESOURCE>
8     <RESOURCE>...</RESOURCE>
9     ...
10  </CREOLE>
11  <CREOLE>...</CREOLE>
12  <CREOLE>...</CREOLE>
13  ...
14 </CREOLE-DIRECTORY>
```

Each `creole.xml` file contains:

- one CREOLE-DIRECTORY element, containing:
  - optionally, zero or more CREOLE elements (used for grouping);
  - optionally, zero or more JAR elements;

## Structure of a creole.xml File

```
1 <CREOLE-DIRECTORY>
2   <CREOLE>
3     <JAR>jarfile1.jar</JAR>
4     <JAR>jarfile2.jar</JAR>
5     ...
6     <RESOURCE>...</RESOURCE>
7     <RESOURCE>...</RESOURCE>
8     <RESOURCE>...</RESOURCE>
9     ...
10  </CREOLE>
11  <CREOLE>...</CREOLE>
12  <CREOLE>...</CREOLE>
13  ...
14 </CREOLE-DIRECTORY>
```

Each `creole.xml` file contains:

- one CREOLE-DIRECTORY element, containing:
  - optionally, zero or more CREOLE elements (used for grouping);
  - optionally, zero or more JAR elements;
  - one or more RESOURCE elements.

## Structure of a creole.xml File

```
1 <CREOLE-DIRECTORY>
2   <CREOLE>
3     <JAR>jarfile1.jar</JAR>
4     <JAR>jarfile2.jar</JAR>
5     ...
6     <RESOURCE>...</RESOURCE>
7     <RESOURCE>...</RESOURCE>
8     <RESOURCE>...</RESOURCE>
9     ...
10  </CREOLE>
11  <CREOLE>...</CREOLE>
12  <CREOLE>...</CREOLE>
13  ...
14 </CREOLE-DIRECTORY>
```

Each `creole.xml` file contains:

- one **CREOLE-DIRECTORY** element, containing:
  - optionally, zero or more **CREOLE** elements (used for grouping);
  - optionally, zero or more **JAR** elements;
  - one or more **RESOURCE** elements.

## A creole.xml Example

```
1 ...
2 <RESOURCE>
3   <NAME>ANNIE VP Chunker</NAME>
4   <CLASS>gate.creole.VPChunker</CLASS>
5   <COMMENT>ANNIE VP Chunker component.</COMMENT>
6   <HELPURL>http://gate...sec:parsers:vgchunker</HELPURL>
7   <PARAMETER NAME="document" RUNTIME="true"
8     COMMENT="The document to be processed">
9     gate.Document</PARAMETER>
10  <PARAMETER NAME="inputASName" RUNTIME="true"
11    COMMENT=
12    "The annotation set to be used as input"
13    OPTIONAL="true">java.lang.String</PARAMETER>
14  <PARAMETER NAME="outputASName" RUNTIME="true"
15    COMMENT=
16    "The annotation set to be used as output"
17    OPTIONAL="true">java.lang.String</PARAMETER>
18  ...
19 </RESOURCE>
```

More info: <http://gate.ac.uk/userguide/sec:creole-model:config> 

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## A CREOLE Resource

To create a new CREOLE resource type, you need:

- A Java class that implements the **gate.Resource** interface, or one of its sub-interfaces:
  - **gate.LanguageResource**
  - **gate.ProcessingResource**
  - **gate.VisualResource**
  - **gate.Controller**
- a directory containing:
  - a creole.xml file.
  - a .jar file with the compiled Java class.



# Exercise 1: Create an Empty Processing Resource

## Create a Java class:

```
1 package module7;  
2 import gate.creole.AbstractLanguageAnalyser;  
3 public class DocStats extends AbstractLanguageAnalyser { }
```

- make sure it compiles;
- create a .jar file with the compiled class;
- **TIP:** see the `build.xml` file in your hands-on!

## Create a corresponding creole.xml file:

```
1 <CREOLE-DIRECTORY><CREOLE>  
2   <RESOURCE>  
3     <NAME>Document Statistics</NAME>  
4     <CLASS>module7.DocStats</CLASS>  
5   </RESOURCE>  
6 </CREOLE></CREOLE-DIRECTORY>
```

## Exercise 1 (part 2): Implementation

Implement:

```
1 public Resource init()  
2   throws ResourceInstantiationException { }
```

... to print out a message;

Implement:

```
1 public void execute() throws ExecutionException { }
```

... to count the number of Token annotations in the input document, and set the value as a feature on the document.

## Exercise 1: Solution

Try not to use this!

## Exercise 1: Solution

Try not to use this!

```
1 package module7;
2
3 import gate.Resource;
4 import gate.creole.AbstractLanguageAnalyser;
5 import gate.creole.ExecutionException;
6 import gate.creole.ResourceInstantiationException;
7
8 public class DocStats extends AbstractLanguageAnalyser {
9
10     @Override
11     public void execute() throws ExecutionException {
12         int tokens = document.getAnnotations().get("Token").size();
13         document.getFeatures().put("token_count", tokens);
14     }
15
16     @Override
17     public Resource init() throws ResourceInstantiationException {
18         System.out.println(getClass().getName() + " is initialising.");
19         return this;
20     }
21 }
```

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## Best Practice: Use Parameters!

- Do not hardcode values, specify them as parameters.
- Values that change internal data structures, built when the PR is created, should be `init-time` parameters. These cannot be changed once the PR was created.
- Values that can be changed between executions should be `run-time` parameters.
- Try to make as many parameters as possible into `run-time` parameters!
- Provide *sensible defaults* for most parameters.
- If you have too many `init-time` parameters, use a config file instead!
- If you have too many `run-time` parameters, provide a Visual Resource!
- Make sure the parameters are well documented in the `creole.xml` file!

## Best Practice: Input/Output

### Specify Input/Output!

- If your PR uses annotations, always specify input and output annotation sets:
- use a parameter `inputASName` for the input annotation set name;
- use a parameter `outputASName` for the output annotation set name;

### OR

- use a parameter named `annotationSetName` (if the PR only modifies existing annotations).

## Exercise 2: Develop/Test Cycle

### Apply Best Practice

Change the implementation from *Exercise 1* to:

- use a parameter for the input annotation set;
- use a parameter for the `Token` annotation type;
- make sure these parameters have good defaults, and documentation;

### Test it!

- Start GATE Developer, load a document, create an instance of the Unicode Tokeniser;
- load the `module7` CREOLE plugin, create an instance of your PR; create a Corpus Pipeline and add the two PRs to it;
- run the pipeline over the document and check it works.



## Best Practice: CREOLE Metadata as Java Annotations

Starting with GATE 5, the CREOLE metadata can also be added as Java 5 annotations directly in the source code. This is now the recommended way of creating CREOLE configuration because:

- it is easier to maintain;
- it makes it impossible to have a version mismatch between the implementation and its configuration data;
- takes advantage of IDE support (e.g. Eclipse).
- uses inheritance: parameters inherited from super classes and interfaces (e.g. `document` and `corpus` on `LanguageAnalyser`) need not be declared again.

## CREOLE Annotations: @CreoleResource

Used for Resource implementations. Main attributes:

- name** (String) the name of the resource.
- comment** (String) a descriptive comment about the resource
- helpURL** (String) a URL to a help document on the web for this resource.
- icon** (String) the icon to use to represent the resource in GATE Developer.

### Example

```
1 @CreoleResource (name = "Document Stats",  
2                 comment = "Calculates document statistics.")  
3 public class DocStats extends AbstractLanguageAnalyser {  
4     ...  
5 }
```

## CREOLE Annotations: @CreoleResource

### Attributes for Visual Resources

If the resource being configured is a Visual Resource, you can also use the following attributes:

**guiType** (GuiType enum) the type of GUI this resource defines.  
XML equivalent `<GUI TYPE="LARGE|SMALL">`.

**resourceDisplayed** (String) the class name of the resource type that this VR displays, e.g. "gate.Corpus".

**mainViewer** (boolean) is this VR the *most important* viewer for its displayed resource type?

## CREOLE Annotations: @CreoleParameter

Creole parameters are identified by `@CreoleParameter` annotations on their setter method. Main attributes include:

**comment** (String) an optional descriptive comment about the parameter.

**defaultValue** (String) the optional default value for this parameter.

**suffixes** (String) for URL-valued parameters, a semicolon-separated list of default file suffixes that this parameter accepts.

### Example

```
1
2 @CreoleParameter(defaultValue="",
3                   comment="The name for the input annotation set.")
4 public void setInputASName(String inputASName) {
5     this.inputASName = inputASName;
6 }
```

## CREOLE Annotations: Parameter Types

You can also use the following annotations to mark the type of a CREOLE parameter:

**@Optional** for parameters that are not required.

**@RunTime** for run-time parameters.

### Corrected Example

```
1  @Optional
2  @RunTime
3  @CreoleParameter(defaultValue="",
4      comment="The name for the input annotation set.")
5  public void setInputASName(String inputASName) {
6      this.inputASName = inputASName;
7  }
```

**TIP:** More info at <http://gate.ac.uk/userguide/sec:creole-model:config>

## Putting it All Together

- You still need a `creole.xml` file to define a CREOLE plugin!
- Your `<RESOURCE>` entries only need the `<CLASS>` element.

### Example:

```
1 <CREOLE-DIRECTORY><CREOLE>
2   <RESOURCE>
3     <CLASS>module7.DocStats</CLASS>
4   </RESOURCE>
5 </CREOLE></CREOLE-DIRECTORY>
```

- **OR**, if you have a `<JAR>` element, you can ask GATE to scan it for classes annotated with `@CreoleResource`.

### Example:

```
1 <CREOLE-DIRECTORY><CREOLE>
2 <JAR SCAN="true">module7.jar</JAR>
3 </CREOLE></CREOLE-DIRECTORY>
```

## Exercise 3: Switch to CREOLE Annotations

Change the implementation from *Exercise 2* to:

- use CREOLE annotations for the resource;
- use CREOLE annotations for the parameters;
- use the jar scanning technique for the creole.xml file.

### Test it!

Repeat the test procedure from *Exercise 2* and check it still works as expected.

## Exercise 4: Better Statistics

Change the implementation from *Exercise 3* to also calculate counts for all **words**, all **nouns**, all **verbs**.

### TIPs:

You will need to run a Sentence Splitter, and POS Tagger after the Tokeniser, in order to get the part-of-speech information.

Definitions:

```
word {Token.kind=="word" }
```

```
noun {Token.category.startsWith("NN") }
```

```
verb {Token.category.startsWith("VB") }
```

Test it!



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## Visual Resources

- Visual Resources provide UI elements (Swing components) for building user interfaces.
- They are classes that implement the `gate.VisualResource` interface.
- They are associated with a type of resource via CREOLE metadata (which is used as a model for the view represented by the VR).
- The abstract class `gate.creole.AbstractVisualResource` can be used a starting point.

# Visual Resource API

## Visual Resource API

Visual resources extend the `gate.Resource` interface, with :

```
1 /** set the object to be displayed */  
2 public void setTarget(Object target);
```

## AbstractVisualResource

- **extends** `javax.swing.JPanel`;
- **implements** all the methods required by `gate.Resource`;
- **extending classes** only need to implement:
  - **public** `Resource` `init()`: initialise the resource (i.e. build the required UI elements);
  - **public void** `setTarget(Object target)`: sets the model for this view.

## Visual Resource CREOLE Metadata

- A Visual Resource is associated with a given type of object that it can display (or edit, configure). This association is done via CREOLE metadata on the VR implementation.
- From the API, the VR is populated by calling `setTarget(Object target)`.
- In GATE Developer, the appropriate VR types are instantiated on demand when a resource is double-clicked in the tree. E.g., when a Document is double-clicked, all VR registered as capable of displaying `gate.Document` targets are instantiated.

## VR Metadata Example

### CREOLE Annotations:

```
1 @CreoleResource (name="Statistics Viewer",  
2     comment="Shows document statistics",  
3     resourceDisplayed="gate.Document",  
4     guiType=GuiType.LARGE,  
5     mainViewer=true)  
6 public class StatsViewer extends AbstractVisualResource
```

# VR Metadata Example

## XML:

```
1 <RESOURCE>
2   <NAME>Statistics Viewer</NAME>
3   <CLASS>module7.StatsViewer</CLASS>
4   <COMMENT>Shows document statistics</COMMENT>
5   <GUI TYPE="large"><MAIN_VIEWER />
6     <RESOURCE_DISPLAYED>gate.Document</RESOURCE_DISPLAYED>
7   </GUI>
8 </RESOURCE>
```

## Exercise 5: Show the Statistics

- Create a VR that, given a document, can show the statistics produced by the DocStats language analyser.
- add CREOLE metadata to associate the new VR with the interface `gate.Document`;

You can use a simple `JTextPane` to show a `.toString()` value for the document's features.

## Exercise 5: Solution

Try not to use this!



## Exercise 5: Solution

Try not to use this!

```
1 package module7;
2 import javax.swing.*;
3 import gate.*;
4 import gate.creole.*;
5 import gate.event.FeatureMapListener;
6 public class StatsViewer extends AbstractVisualResource
7     implements FeatureMapListener{
8     private JTextPane textPane;
9     private FeatureMap targetFeatures;
10    public Resource init() throws ResourceInstantiationException {
11        textPane = new JTextPane();
12        add(new JScrollPane(textPane));
13        return this;
14    }
15    public void setTarget(Object target) {
16        if(targetFeatures != null) targetFeatures.removeFeatureMapListener(this);
17        targetFeatures = ((Document)target).getFeatures();
18        targetFeatures.addFeatureMapListener(this);
19        featureMapUpdated();
20    }
21    public void featureMapUpdated() {
22        textPane.setText(targetFeatures.toString());
23    }
24 }
```

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# The CREOLE and DataStore Registers

## The CREOLE Register

- Stores all CREOLE data, including:
  - which plugins are loaded;
  - which types of CREOLE Resources have been defined;
  - loaded instances of each resource type;
  - which Visual Resources can display any resource type;
- fires events when resources are loaded and deleted;
- forwards all events from the DataStore Register (see below).

## The DataStore Register

- is a `java.util.Set` of DataStore objects.
- fires events when datastores are created, opened and closed.

## CREOLE Register and its Events

```
1 // Obtain a pointer to the CREOLE Register
2 CreoleRegister cReg = Gate.getCreoleRegister();
3 // listen to CREOLE events
4 cReg.addCreoleListener(new CreoleListener() {
5     public void resourceUnloaded(CreoleEvent e) { ... }
6     public void resourceRenamed(Resource resource,
7         String oldName, String newName) { ... }
8     public void resourceLoaded(CreoleEvent e) { ... }
9     public void datastoreOpened(CreoleEvent e) { ... }
10    public void datastoreCreated(CreoleEvent e) { ... }
11    public void datastoreClosed(CreoleEvent e) { ... }
12 });
13 // remove a registered listener
14 cReg.removeCreoleListener(aListener);
```

## Other CREOLE APIs

### Plugins Management

```
1 //load a new CREOLE plugin
2 try {
3     cReg.registerDirectories(new URL("..."));
4     // register a single resource class without using creole.xml
5     cReg.registerComponent(MyResource.class);
6 } catch (GateException e1) { ... }
7 //get all loaded plugins
8 cReg.getDirectories();
9 //remove a loaded plugin
10 cReg.removeDirectory(...);
```

## Other CREOLE APIs (continued)

### Find Loaded Resources

```
1 // find all resources of a given type
2 try {
3     cReg.getAllInstances("gate.LanguageAnalyser");
4 } catch (GateException e1) { ... }
```

### Resource Types

```
1 cReg.getPrTypes(); // get PR types (class names)
2 cReg.getLrTypes(); // get LR types (class names)
3 cReg.getVrTypes(); // get VR types (class names)
```

## Other CREOLE APIs (continued)

### CREOLE Metadata

```
1 // Obtain the Resource Data about a resource
2 ResourceData rData = cReg.get("resource.class.name");
3 // get the list of instances
4 List<Resource> instances = rData.getInstantiations();
5 // get the list of parameters
6 ParameterList pList = rData.getParameterList();
7 // get the Init-time / Run-time parameters
8 List<List<Parameter>> someParams;
9 someParams = pList.getRuntimeParameters();
10 someParams = pList.getInitimeParameters();
```

## Exercise 6: CREOLE Metadata

- load the ANNIE application;
- find out which plugins are loaded;
- find out which PR **instances** exist;
- find out which PR types are known to the system;
- find out what parameters they have.

You may find this useful:

```
1 public void main(String[] args) throws Exception{
2     Gate.init();
3     //load the ANNIE application
4     File annieGappFile = new File(
5         new File(Gate.getPluginsHome(), "ANNIE"),
6         "ANNIE_with_defaults.gapp");
7     PersistenceManager.loadObjectFromFile(annieGappFile);
8     // ...
9 }
```



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## Corpus-level processing

- When running a PR over a corpus of more than one document, you may want to do some additional pre- and post-processing before the first and after the last document.
- To do this, implement `gate.creole.ControllerAwarePR`
- Three callback methods called at key points in the execution of the *controller that contains the PR*:
  - `controllerExecutionStarted`
  - `controllerExecutionFinished`
  - `controllerExecutionAborted`
- Parameter is the `Controller`.
- “aborted” callback also receives the `Throwable` that caused the abort.

## Corpus-level processing

- So if the controller is a `CorpusController`, these correspond to:
  - before the first document
  - after the last document
  - when something goes wrong

## ControllerAwarePR example

```
1 public class ExampleAnalyser
2     extends AbstractLanguageAnalyser
3     implements ControllerAwarePR {
4     public void controllerExecutionStarted(Controller c) {
5         if(c instanceof CorpusController) {
6             System.out.println("Processing corpus " +
7                 ((CorpusController)c).getCorpus().getName());
8         }
9         else {
10            System.out.println(
11                "Running in a simple pipeline");
12        }
13    }
14
15    // controllerExecutionFinished is similar
16 }
```

## Exercise 7: Corpus statistics

Add corpus statistics to your DocStats PR:

- Add private fields to keep a running total count of words (and nouns/verbs).
- Implement `ControllerAwarePR`.
- In the “started” callback, initialize these totals to 0.
- In the “finished” callback
  - check whether you are running in `CorpusController`
  - if so, put the total counts into features on the controller’s `Corpus`.
- You can leave the “aborted” callback empty (or just print a message).

## Exercise 7: Solution

```
1 package module7;
2 // imports omitted for space reasons
3
4 @CreoleResource(name = "Corpus statistics")
5 public class CorpusStats extends AbstractLanguageAnalyser
6     implements ControllerAwarePR {
7     private int totalTokens;
8
9     public void execute() throws ExecutionException {
10         int tokens = document.getAnnotations().get("Token").size();
11         document.getFeatures().put("token_count", tokens);
12         totalTokens += tokens; // keep a running total
13     }
14
15     public void controllerExecutionStarted(Controller c) {
16         totalTokens = 0;
17     }
18
19     public void controllerExecutionFinished(Controller c) {
20         if(c instanceof CorpusController) {
21             ((CorpusController)c).getCorpus().getFeatures()
22                 .put("token_count", totalTokens);
23         }
24     }
25
26     // controllerExecutionAborted omitted
27 }
```

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## Adding actions to the GUI

- Any (language, processing or visual) resource can contribute *actions* to the GATE developer GUI.
- These appear as items on the resource's right-click menu. For example:
  - The “Run” option for controllers comes from the controller editor VR
  - The “Save as...” and “Delete ontology data” options for an ontology LR come from the LR itself.
- This is done by implementing the interface  
`gate.gui.ActionsPublisher`
- One method, returning a `List` of `javax.swing.Action` objects.



## Exercise 8: ActionsPublisher

Implement cumulative statistics for your DocStats PR:

- keep a running total as before, but rather than resetting it in `controllerExecutionStarted`, provide an action to reset it explicitly.
- provide another action to display the current total.

## Exercise 8: Solution

```
1 package module7;
2 // imports omitted for space reasons
3
4 @CreoleResource(name = "Cumulative statistics")
5 public class CumulativeStats extends AbstractLanguageAnalyser
6                               implements ActionsPublisher {
7     // totalTokens and execute() method exactly as in exercise 7
8
9     public List<Action> getActions() {
10         if(actions == null) {
11             actions.add(new AbstractAction("Reset counter") {
12                 public void actionPerformed(ActionEvent e) {
13                     totalTokens = 0;
14                 }
15             });
16
17             actions.add(new AbstractAction("Show current total") {
18                 public void actionPerformed(ActionEvent e) {
19                     JOptionPane.showMessageDialog(
20                         MainFrame.getInstance(), totalTokens + " token(s) since last reset.");
21                 }
22             });
23         }
24         return actions;
25     }
26
27     private List<Action> actions;
28 }
```

# Thank you!

## Questions?

More answers at:

- <http://gate.ac.uk> (Our website)
- <http://gate.ac.uk/mail/> (Our mailing list)