Tutorial

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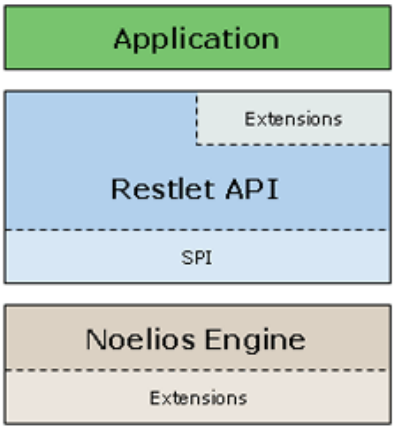
1. Registering an implementation

The Restlet framework is composed of two main parts. First, there is the "Restlet API", a neutral API supporting the concepts of REST and a mechanism called Restlet facilitating the handling of REST uniform calls. This API must be supported by a "Restlet Implementation" before it can effectively be used. Multiple implementations could be provided (open source projects or commercial products).



This separation between the API and the implementation is similar to the one between the Servlet API and Web containers like Jetty or Tomcat, or between the JDBC API and actual JDBC drivers. Currently, the "Noelios Restlet Engine" (NRE) is available and acts as the reference implementation. When you download the Restlet framework, the API and the NRE come bundled together, ready to be used. If you need to use a different implementation just add the implementation JAR file to the classpath and remove the NRE JAR file named com.noelios.restlet.jar by default.

The registration is done automatically. See the JAR specification for details. When an implementation is loaded, it automatically calls back the `org.restlet.Factory.setInstance()` method.

2. Retrieving the content of a Web page

As we mentioned in the introduction paper, the Restlet framework is at the same time a client and a server framework. For example, NRE can easily work with remote resources using its HTTP client connector. A connector in REST is a software element that enables the communication between components, typically by implementing one side of a network protocol. Here we will get the representation of an existing resource and output it in the JVM console:

```
// Outputting the content of a Web page
```

```
Client client = new Client(Protocol.HTTP);
client.get("http://www.restlet.org").getEntity().write(System.out);
```

Note that the example above uses a simplified way to issue calls via the generic Client class. A more flexible way is to create a new Request object and to ask the Client to handle it. The example below illustrate how to set some preferences in your call, like a referrer URI or the languages and media types you prefer to receive as a response:

```
// Prepare the request
Request request = new Request(Method.GET, "http://www.restlet.org");
request.setReferrerRef("http://www.mysite.org");

// Handle it using an HTTP client connector
Client client = new Client(Protocol.HTTP);
Response response = client.handle(request);

// Write the response entity on the console
Representation output = response.getEntity();
output.write(System.out);
```

3. Listening to Web browsers

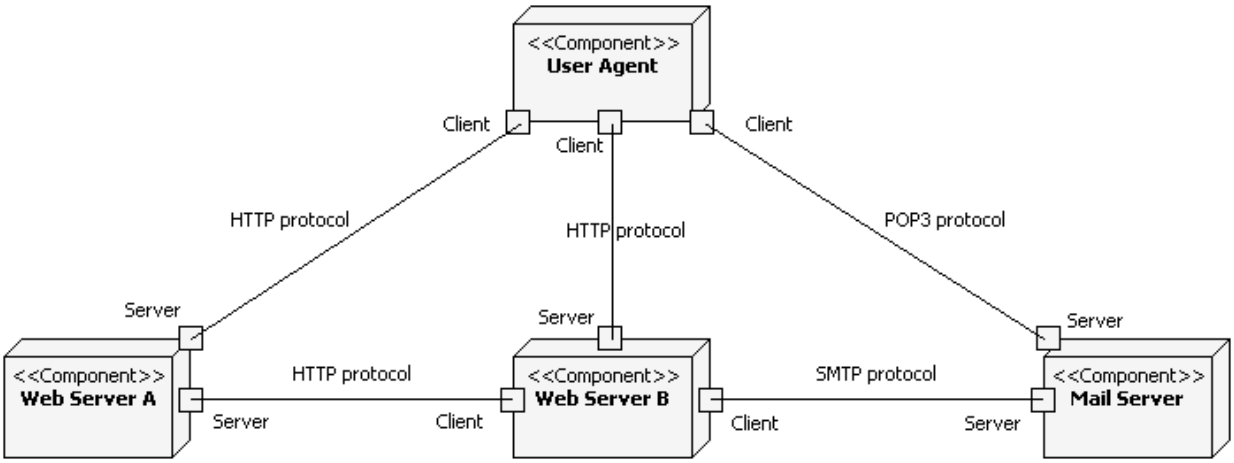
Now, we want to see how the Restlet framework can listen to client requests and reply to them. We will use one of the NRE HTTP server connectors (supported by Mortbay's Jetty HTTP listener) and return a simple string representation "Hello World!" as plain text. Note that in a more realistic application, we would probably create a separate class extending the Restlet instead of relying on an anonymous inner class. Also, if you need to handle only a specific method, you should use Handler as your base class.

```
// Creating a minimal Restlet returning "Hello World"
Restlet restlet = new Restlet() {
    @Override
    public void handle(Request request, Response response) {
        response.setEntity("Hello World!", MediaType.TEXT_PLAIN);
    }
};

// Create the HTTP server and listen on port 8182
new Server(Protocol.HTTP, 8182, restlet).start();
```

If you run this code and launch your server, you can open a Web browser and hit the http://localhost:8182. Actually, any URI will work, try also http://localhost:8182/test/tutorial. Note that if you test your server from a different machine, you need to replace "localhost" by either the IP address of your server or its domain name. The handler that we created is very primitive. We will see later how to take more advantage of the Restlet framework.

4. Overview of a REST architecture

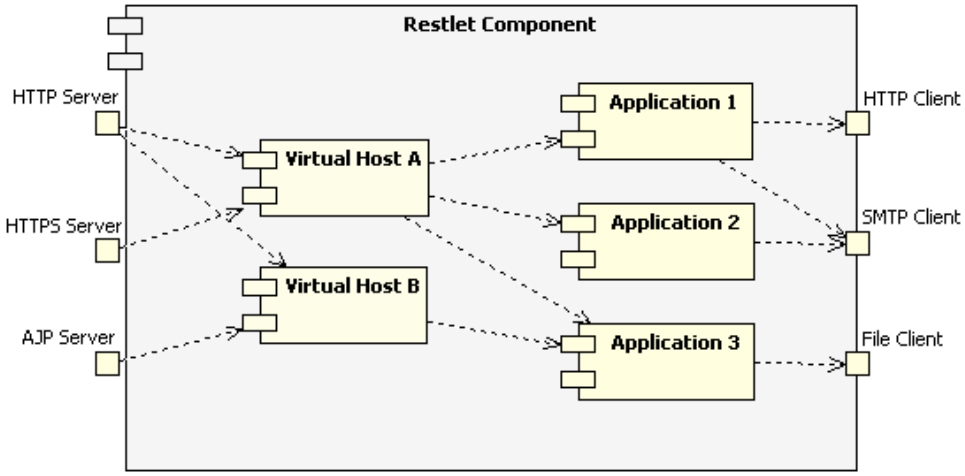
Let's step back a little bit and consider typical web architectures from a REST point of view. In the diagram below, ports represent the connector that enables the communication between components which are represented by the larger boxes. The links represents the particular protocol (HTTP, SMTP, etc.) used for the actual communication.



Note that the same component can have any number of client and server connectors attached to it. Web Server B, for example, has both a server connector to respond to requests from the User Agent component, and client connectors to send requests to the Database Server, the Mail Server and the Web Server A.

5. Components and Virtual Hosts

In addition to supporting the standard REST software architecture elements as presented before, the Restlet framework also provides a set of classes that greatly simplify the hosting of complex applications within a single JVM. The goal is to provide a RESTful, portable and more flexible alternative to existing Servlet API. In the diagram below, we can see the three types of Restlets that are provided in order to manage these complex cases. Components can manage several Virtual Hosts and Applications. Virtual Hosts support flexible configuration where, for example, the same IP address is shared by several domain names, or where the same domain name is load-balanced across several IP addresses. Finally, we use Applications to manage a set of related Restlets, Resources and Representations. In addition, Applications are ensured to be portable and reconfigurable over different Restlet implementations and with different virtual hosts, and they provide important services such as access logging and status page setting.



In order to illustrate these classes, let's examine a simple example. Here we create a Component, then add an HTTP server to it, listening on port 8182. Then we create a simple trace Restlet and attach it to the defaut VirtualHost of the Component. This default host is catching any request that wasn't already routed to a declared VirtualHost (see the "hosts" property on Component for details). In a later example, we will also introduce the usage of the Application class. Note that for now you don't see any access log displayed in the console.

```
// Create a new Restlet component and add a HTTP server connector to it
Component component = new Component();
component.getServers().add(Protocol.HTTP, 8182);

// Create a new Restlet that will display some path information.
Restlet restlet = new Restlet() {
    @Override
```

```
        public void handle(Request request, Response response) {
            // Print the requested URI path
            String message = "Resource URI:   " + request.getResourceRef()
                    + '\n' + "Routed part:    "
                    + request.getResourceRef().getBaseRef() + '\n'
                    + "Remaining part: "
                    + request.getResourceRef().getRemainingPart();
            response.setEntity(message, MediaType.TEXT_PLAIN);
        }
    };

    // Then attach it to the local host
    component.getDefaultHost().attach("/trace", restlet);

    // Now, let's start the component!
    // Note that the HTTP server connector is also automatically started.
    component.start();
```

Now let's test it by entering http://localhost:8182/trace/abc/def?param=123 in a Web browser. Here is the result that you will get:

```
Resource URI:   http://localhost:8182/trace/abc/def?param=123
Routed part:    http://localhost:8182/trace
Remaining part: /abc/def?param=123
```

6. Serving static files

Do you have a part of your web application that serves static pages like Javadocs? Well, no need to setup an Apache server just for that, the Noelios Restlet Engine provides a dedicated Restlet called DirectoryRestlet. See how simple it is to use it:

```
    // Create a component
    Component component = new Component();
    component.getServers().add(Protocol.HTTP, 8182);
    component.getClients().add(Protocol.FILE);

    // Create an application
    Application application = new Application(component.getContext()) {
        @Override
        public Restlet createRoot() {
            return new Directory(getContext(), ROOT_URI);
        }
    };

    // Attach the application to the component and start it
    component.getDefaultHost().attach("", application);
    component.start();
```

In order to run this example, you need to specify a valid value for ROOT_URI, depending on the location of your Restlet installation. By default, it is set to "file:///D:/Restlet/www/docs/api/". Note that no additional configuration is needed. If you want to customize the mapping between file extensions and metadata (media type, language or encoding) or if you want to specify a different index name, you can use the Application's "metadataService" property.

7. Access logging

Being able to properly log the activity of a Web application is a common requirement. Restlet Applications and Containers have built-in support for logging that knows how to generate Apache-like logs. By taking advantage of the logging facility built in the JDK, the logger can be configured like any standard JDK log to filter messages, reformat them and specify where to send them. Rotation of logs is also supported; see the java.util.logging package for details.

Note that you can customize the logger name given to the java.util.logging framework by modifying the Application's "logService" property. In order to fully configure the logging, you need to declare a configuration file by setting a system property like:

```
    System.setProperty("java.util.logging.config.file", "/your/path/logging.config");
```

For details on the configuration file format, please check the JDK's LogManager class.

8. Displaying error pages

Another common requirement is the ability to customize the status pages returned when something didn't go as expected during the call handling. Maybe a resource was not found or an acceptable representation isn't available? In this case, or when any unhandled exception must be intercepted, the Application or the Container will automatically provide a default status page for you. This service is associated to the org.restlet.util.StatusService class, which is accessible as an Application and Container property called "statusService".

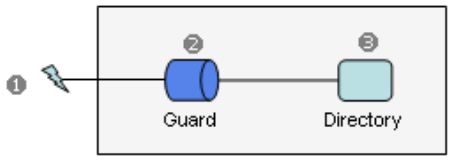
In order to customize the default messages, you will simply need to create a subclass of StatusService and override the getRepresentation(Status, Request, Response) method. Then just set an instance of your custom service to the appropriate "statusService" property.

9. Guarding access to sensitive resources

When you need to secure the access to some Restlets, several options are available. The most common way is to rely on cookies to identify clients (or client sessions) and to check a given user ID or session ID against your application state to determine if access should be granted. Restlets natively support cookies via the Cookie and CookieSetting objects accessible from a Request or a Response.

Also, there is another way based on the standard HTTP authentication mechanism. The Restlet framework currently supports the basic HTTP authentication scheme via the GuardFilter. Filters are specialized Restlets that filter calls passed to them, without modifying the requested resource URI. If you are familiar with the Servlet API, the concept is similar to the Filter interface. See below how we would modify the previous example to secure the access to the DirectoryHandler:

```
// Create a Guard
Guard guard = new Guard(getContext(),
        ChallengeScheme.HTTP_BASIC, "Tutorial");
guard.getAuthorizations().put("scott", "tiger");

// Create a Directory able to return a deep hierarchy of files
Directory directory = new Directory(getContext(), ROOT_URI);
guard.setNext(directory);
```



Note that the authorization decision is fully customizable via the authorize method. Any mechanism can be used to check whether the given credentials are valid. Here we simply hard-coded the only valid user and password. In order to test this authentication mechanism, let's use the client-side Restlet API:

```
// Prepare the request
Request request = new Request(Method.GET, "http://localhost:8182/");

// Add the client authentication to the call
ChallengeScheme scheme = ChallengeScheme.HTTP_BASIC;
ChallengeResponse authentication = new ChallengeResponse(scheme,
        "scott", "tiger");
request.setChallengeResponse(authentication);

// Ask to the HTTP client connector to handle the call
Client client = new Client(Protocol.HTTP);
Response response = client.handle(request);

if (response.getStatus().isSuccess()) {
    // Output the response entity on the JVM console
    response.getEntity().write(System.out);
} else if (response.getStatus()
        .equals(Status.CLIENT_ERROR_UNAUTHORIZED)) {
    // Unauthorized access
    System.out
```

```
                .println("Access authorized by the server, check your credentials");
        } else {
            // Unexpected status
            System.out.println("An unexpected status was returned: "
                    + response.getStatus());
        }
```

You can change the user ID or password sent by this test client in order to check the response returned by the server. Remember to launch the previous Restlet server before starting your client. Note that if you test your server from a different machine, you need to replace "localhost" by either the IP address of your server or its domain name when typing the URI in the browser. The server won't need any adjustment due to the usage of the HostRouter which accepts all types of URI by default.

10. URI rewriting and redirection

One of the advantages of the Restlet framework is the built-in support for cool URIs. Another good description of the importance of proper URI design is given by Jacob Nielsen in his AlertBox. The first tool available is the Redirector, which allows the rewriting of a cool URI to another URI, followed by an automatic redirection. Several types of redirection are supported, the external redirection via the client/browser, the internal redirection at the container level and the connector redirection for proxy-like behavior. In the example below, we will define a search service for our web site (named "mysite.org") based on Google. The "/search" relative URI identifies the search service, accepting some keywords via the "kwd" parameter:

```
        // Create an application
        Application application = new Application(component.getContext()) {
            @Override
            public Restlet createRoot() {
                // Create a Redirector to Google search service
                String target = "http://www.google.com/search?q=site:mysite.org+{keywords}";
                return new Redirector(getContext(), target,
                        Redirector.MODE_CLIENT_TEMPORARY);
            }
        };

        // Attach the application to the component's default host
        Route route = component.getDefaultHost().attach("/search", application);

        // While routing requests to the application, extract a query parameter
        // For instance :
        // http://localhost:8182/search?kwd=myKeyword1+myKeyword2
        // will be routed to
        // http://www.google.com/search?q=site:mysite.org+myKeyword1%20myKeyword2
        route.extractQuery("keywords", "kwd", true);
```

Note that the Redirector needs three parameters only. The first is the parent context, the second one defines how the URI rewriting should be done, based on a URI template. This template will be processed by the Template class. The second parameter defines the type of redirection; here we chose the client redirection, for simplicity purpose.

Also, we are relying on the Route class to extract the query parameter "kwd" from the initial request while the call is routed to the application. If the parameter is found, it is copied into the request attribute named "keywords", ready to be used by the Redirector when formatting its target URIs.

11. Routers and hierarchical URIs

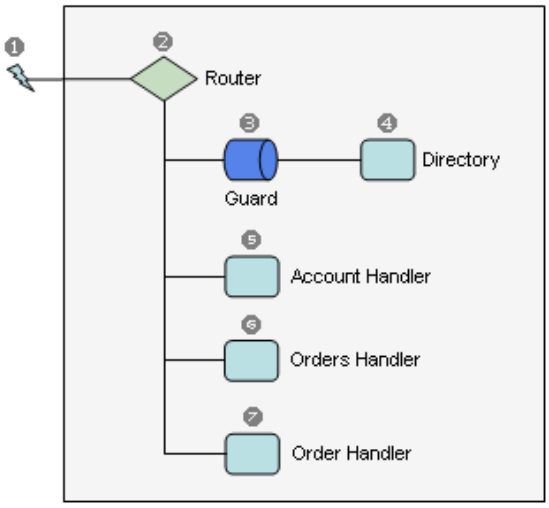
In addition to the Redirector, we have another tool to manage cool URIs: Routers. They are specialized Restlets that can have other Restlets (Handlers and Filters for example) attached to them and that can automatically delegate calls based on a URI template. In general, you will set a Router as the root of your Application.

Here we want to explain how to handle the following URI patterns:

1. /docs/ to display static files
2. /users/{user} to display a user account
3. /users/{user}/orders to display the orders of a particular user
4. /users/{user}/orders/{order} to display a specific order

The fact that these URIs contain some dynamic parts (variables between accolades) and that no file extension is used makes it harder to handle them

in a typical Web container. With Restlets, you just need to attach target Restlets to a Router using the URI template. At runtime, the route that best matches the request URI will received the call and be able to invoke its attached Restlet. At the same time, the request's attributes map will be automatically updated with the value of the URI template variables!



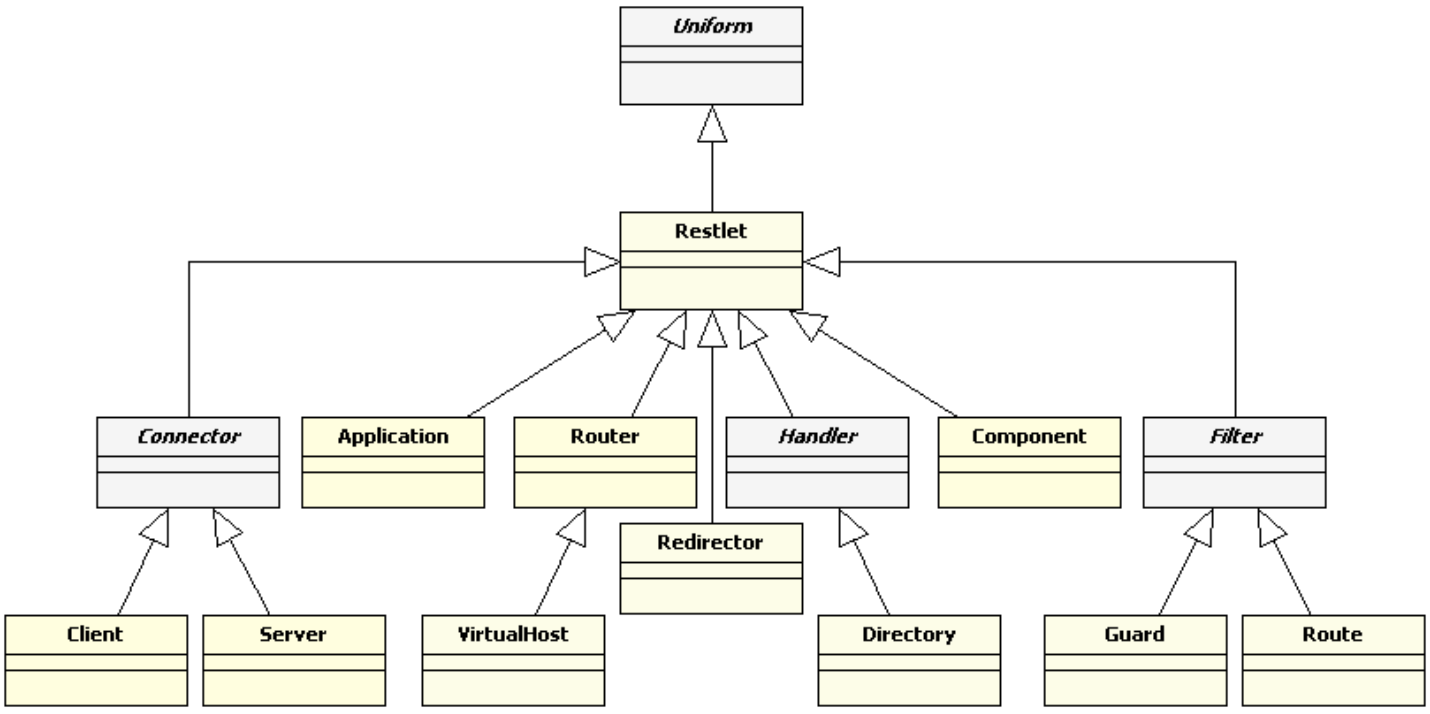
See the implementation code below. In a real application, you will probably want to create separate subclasses instead of the anonymous ones we use here:

```
// Create a component
Component component = new Component();
component.getServers().add(Protocol.HTTP, 8182);
component.getClients().add(Protocol.FILE);

// Create an application
Application application = new Application(component.getContext()) {
    @Override
    public Restlet createRoot() {
        // Create a root Router
        Router router = new Router(getContext());

        // Attach a Guard to secure access to the chained directory
        // handler
        Guard guard = new Guard(getContext(),
                ChallengeScheme.HTTP_BASIC, "Restlet tutorial");
        guard.getAuthorizations().put("scott", "tiger");
        router.attach("/docs/", guard);

        // Create a Directory able to return a deep hierarchy of Web
        // files
        Directory directory = new Directory(getContext(), ROOT_URI);
        guard.setNext(directory);

        // Create the Account Handler
        Restlet account = new Restlet() {
            @Override
            public void handle(Request request, Response response) {
                // Print the requested URI path
                String message = "Account of user \""
                        + request.getAttributes().get("user") + "\"";
                response.setEntity(message, MediaType.TEXT_PLAIN);
            }
        };

        // Create the Orders Handler
        Restlet orders = new Restlet(getContext()) {
            @Override
            public void handle(Request request, Response response) {
```

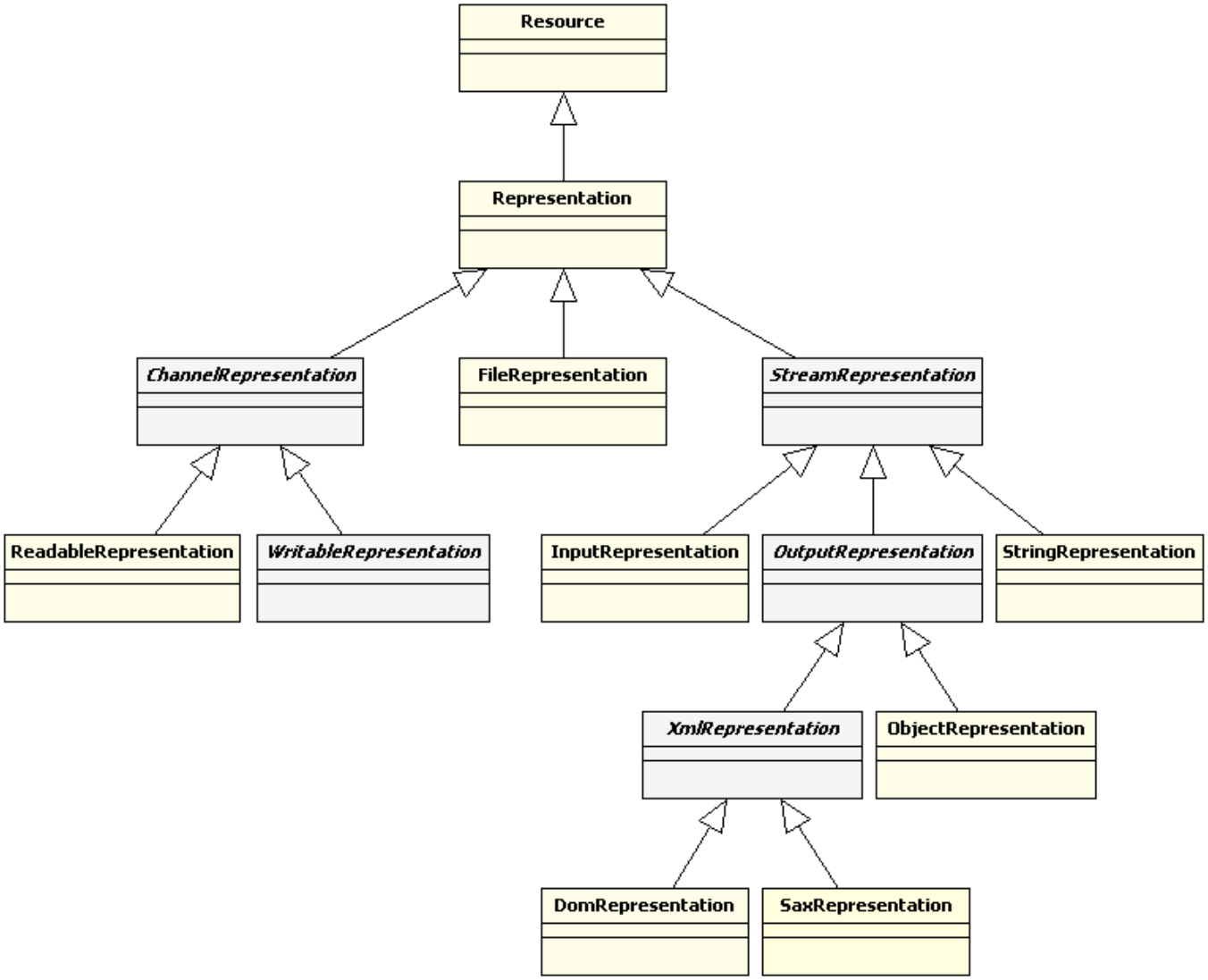
```
                // Print the user name of the requested orders
                String message = "Orders of user \""
                        + request.getAttributes().get("user") + "\"";
                response.setEntity(message, MediaType.TEXT_PLAIN);
            }
        };

        // Create the Order Handler
        Restlet order = new Restlet(getContext()) {
            @Override
            public void handle(Request request, Response response) {
                // Print the user name of the requested orders
                String message = "Order \""
                        + request.getAttributes().get("order")
                        + "\" for user \""
                        + request.getAttributes().get("user") + "\"";
                response.setEntity(message, MediaType.TEXT_PLAIN);
            }
        };

        // Attach the Handlers to the Router
        router.attach("/users/{user}", account);
        router.attach("/users/{user}/orders", orders);
        router.attach("/users/{user}/orders/{order}", order);

        // Return the root router
        return router;
    }
};

// Attach the application to the component and start it
component.getDefaultHost().attach("", application);
component.start();
```

Conclusion

We already covered many aspects of the framework. Before you move on by yourself, let's take a step back and look at two hierarchy diagrams showing the main concepts covered in this tutorial and their relationships:



Now, here is the Resource hierarchy, including of the core Representation classes:



Beside this tutorial, your best source of information will be the Javadocs available for the Restlet API, the Restlet Extensions and the NRE. You can also post your questions and help others in our discussion list.

Jérôme Louvel (blog)

Notes

- I encourage you to run the examples. The full source code is available in the latest release.
- Thanks to Jean-Paul Figer, Christian Jensen, Jim Ancona, Roger Menday, John D. Mitchell, Jérôme Bernard, Dave Pawson and Peter Murray for the feed-back on this tutorial.