

# Apache FOP: Embedding

## How to Embed FOP in a Java application

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## 1. Overview

Review [Running FOP](#) for important information that applies to embedded applications as well as command-line use, such as options and performance.

To embed Apache FOP in your application, instantiate `org.apache.fop.apps.Fop`. You'll tell FOP in the constructor which output format (i.e. `Renderer`) to use. Afterwards, you'll set the `OutputStream` to use to output the results of the rendering (where applicable). You can customize FOP's behaviour by supplying your own `FOUserAgent` instance. The `FOUserAgent` can, for example, be used to set your own `Renderer` instance (details below). Finally, you retrieve a `SAX DefaultHandler` instance from the `Fop` instance to which you can send your FO file.

## 2. Basic Usage Pattern

Apache FOP relies heavily on JAXP. It uses SAX events exclusively to receive the XSL-FO input document. It is therefore a good idea that you know a few things about JAXP (which is a good skill anyway). Let's look at the basic usage pattern for FOP...

Here is the basic pattern to render an XSL-FO file to PDF:

```
import org.apache.fop.apps.Fop;
import org.apache.fop.apps.MimeConstants;

/*...*/

// Step 1: Construct fop with desired output format
Fop fop = new Fop(MimeConstants.MIME_PDF);

// Step 2: Setup output stream.
// Note: Using BufferedOutputStream for performance reasons (helpful with
// FileOutputStreams).
OutputStream out = new BufferedOutputStream(new FileOutputStream(new
File("C:/Temp/myfile.pdf")));
try {
    fop.setOutputStream(out);

    // Step 3: Setup JAXP using identity transformer
    TransformerFactory factory = TransformerFactory.newInstance();
    Transformer transformer = factory.newTransformer(); // identity transformer

    // Step 4: Setup input and output for XSLT transformation
    // Setup input stream
    Source src = new StreamSource(new File("C:/Temp/myfile.fo"));

    // Resulting SAX events (the generated FO) must be piped through to FOP
```

```

Result res = new SAXResult(fop.getDefaultHandler());

// Step 5: Start XSLT transformation and FOP processing
transformer.transform(src, res);

} finally {
    //Clean-up
    out.close();
}

```

Let's discuss these 5 steps in detail:

- **Step 1:** You create a new Fop instance and set it up for PDF output.
- **Step 2:** You tell FOP where to save the generated PDF file later. It's a good idea to buffer the OutputStream as demonstrated to improve performance.
- **Step 3:** We recommend that you use JAXP Transformers even if you don't do XSLT transformations to generate the XSL-FO file. This way you can always use the same basic pattern. The example here sets up an "identity transformer" which just passes the input (Source) unchanged to the output (Result). You don't have to work with a SAXParser if you don't do any XSLT transformations.
- **Step 4:** Here you set up the input and output for the XSLT transformation. The Source object is set up to load the "myfile.fo" file. The Result is set up so the output of the XSLT transformation is sent to FOP. The FO file is sent to FOP in the form of SAX events which is the most efficient way. Please always avoid saving intermediate results to a file or a memory buffer because that affects performance negatively.
- **Step 5:** Finally, we start the XSLT transformation by starting the JAXP Transformer. As soon as the JAXP Transformer starts to send its output to FOP, FOP itself starts its processing in the background. When the `transform( )` method returns FOP will also have finished converting the FO file to a PDF file and you can close the OutputStream.

#### Tip!

It's a good idea to enclose the whole conversion in a try..finally statement. If you close the OutputStream in the finally section, this will make sure that the OutputStream is properly closed even if an exception occurs during the conversion.

If you're not totally familiar with JAXP Transformers, please have a look at the [Embedding examples](#) below. The section contains examples for all sorts of use cases. If you look at all of them in turn you should be able to see the patterns in use and the flexibility this approach offers without adding too much complexity.

This may look complicated at first, but it's really just the combination of an XSL transformation and a FOP run. It's also easy to comment out the FOP part for debugging purposes, for example when you're tracking down a bug in your stylesheet. You can easily write the XSL-FO output from the XSL transformation to a file to check if that part generates the expected output. An example for that can be found in the [Embedding examples](#) (See "ExampleXML2FO").

**Note:**

Please be aware that you should not reuse a Fop instance for additional rendering runs. Recreate a new instance for each rendering run. This is a relatively inexpensive operation and will be further optimized shortly.

## 2.1. Logging

Logging is now a little different than it was in FOP 0.20.5. We've switched from Avalon Logging to [Jakarta Commons Logging](#). While with Avalon Logging the loggers were directly given to FOP, FOP now retrieves its logger(s) through a statically available LogFactory. This is similar to the general pattern that you use when you work with Apache Log4J directly, for example. We call this "static logging" (Commons Logging, Log4J) as opposed to "instance logging" (Avalon Logging). This has a consequence: You can't give FOP a logger for each processing run anymore. The log output of multiple, simultaneously running FOP instances is sent to the same logger.

**Note:**

We know this may be an issue in multi-threaded server environments if you'd like to know what's going on in every single FOP processing run. We're planning to add an additional feedback facility to FOP which can be used to obtain all sorts of specific feedback (validation messages, layout problems etc.). "Static logging" is mainly interesting for a developer working on FOP and for advanced users who are debugging FOP. We don't consider the logging output to be useful to normal FOP users. Please have some patience until we can add this feature or jump in and help us build it. We've set up a [Wiki page](#) which documents what we're going to build.

By default, [Jakarta Commons Logging](#) uses JDK logging (available in JDKs 1.4 or higher) as its backend. You can configure Commons Logging to use an alternative backend, for example Log4J. Please consult the [documentation for Jakarta Commons Logging](#) on how to configure alternative backends.

## 2.2. Processing XSL-FO

Once the Fop instance is set up, call `getDefaultHandler()` to obtain a SAX DefaultHandler instance to which you can send the SAX events making up the XSL-FO document you'd like to render. FOP processing starts as soon as the DefaultHandler's `startDocument()` method is called. Processing stops again when the DefaultHandler's `endDocument()` method is called. Please refer to the basic usage pattern shown above to render a simply XSL-FO document.

## 2.3. Processing XSL-FO generated from XML+XSLT

If you want to process XSL-FO generated from XML using XSLT we recommend again using

standard JAXP to do the XSLT part and piping the generated SAX events directly through to FOP. The only thing you'd change to do that on the basic usage pattern above is to set up the Transformer differently:

```
//before (without XSLT):
//Transformer transformer = factory.newTransformer(); // identity
transformer

//after (with XSLT):
Source xslt = new StreamSource(new File("mystylesheet.xsl"));
Transformer transformer = factory.newTransformer(xslt);
```

### 3. Input Sources

The input XSL-FO document is always handled internally as SAX (see the [Parsing Design Document](#) for the rationale).

However, you may not always have your input document available as a SAX stream. But with JAXP it's easy to convert different input sources to a SAX stream so you can pipe it into FOP. That sounds more difficult than it is. You simply have to set up the right Source instance as input for the JAXP transformation. A few examples:

- **URL:** Source src = new StreamSource("http://localhost:8080/testfile.xml");
- **File:** Source src = new StreamSource(new File("C:/Temp/myinputfile.xml"));
- **String:** Source src = new StreamSource(new StringReader(myString)); //myString is a String
- **InputStream:** Source src = new StreamSource(new MyInputStream(something));
- **Byte Array:** Source src = new StreamSource(new ByteArrayInputStream(myBuffer)); //myBuffer is a byte[] here
- **DOM:** Source src = new DOMSource(myDocument); //myDocument is a Document or a Node
- **Java Objects:** Please have a look at the [Embedding examples](#) which contains an example for this.

There are a variety of upstream data manipulations possible. For example, you may have a DOM and an XSL stylesheet; or you may want to set variables in the stylesheet. Interface documentation and some cookbook solutions to these situations are provided in [Xalan Basic Usage Patterns](#).

## 4. Configuring Apache FOP Programmatically

Apache FOP provides a class called `FOUserAgent` which is used to customize FOP's behaviour. If you wish to do that, the first step is to create your own instance of `FOUserAgent` and pass that to the `Fop` constructor:

```
FOUserAgent userAgent = new FOUserAgent();  
Fop fop = new Fop(MimeConstants.MIME_POSTSCRIPT, userAgent);
```

You can do all sorts of things on the user agent:

- The **base URL** to use when resolving relative URLs. Example:  

```
userAgent.setBaseURL("file:///C:/Temp/");
```
- Disable **strict validation**. When disabled FOP is less strict about the rules established by the XSL-FO specification. Example:  

```
userAgent.setStrictValidation(false);
```
- Set the **producer** of the document. This is metadata information that can be used for certain output formats such as PDF. The default producer is "Apache FOP". Example:  

```
userAgent.setProducer("MyKillerApplication");
```
- Set the **creating user** of the document. This is metadata information that can be used for certain output formats such as PDF. Example:  

```
userAgent.setCreator("John Doe");
```
- Set the **author** of the document. This is metadata information that can be used for certain output formats such as PDF. Example:  

```
userAgent.setAuthor("John Doe");
```
- Override the **creation date and time** of the document. This is metadata information that can be used for certain output formats such as PDF. Example:  

```
userAgent.setCreationDate(new Date());
```
- Set the **title** of the document. This is metadata information that can be used for certain output formats such as PDF. Example:  

```
userAgent.setTitle("Invoice No 138716847");
```
- Set the **keywords** of the document. This is metadata information that can be used for certain output formats such as PDF. Example:  

```
userAgent.setKeywords("XML XSL-FO");
```
- Set the **internal resolution** for the document. This is used when creating bitmap images, for example. Example:  

```
userAgent.setResolution(300); // = 300dpi (dots/pixels per Inch)
```
- Set **your own Renderer instance**. If you want to supply your own renderer or configure a `Renderer` in a special way you can give the instance to the `FOUserAgent`. Normally, the `Renderer` instance is created by FOP. Example:

```
userAgent.setRendererOverride(myRenderer); //myRenderer is an
org.apache.fop.render.Renderer
```

- Set **your own FOEventHandler instance**. If you want to supply your own FOEventHandler or configure an FOEventHandler subclass in a special way you can give the instance to the FOUUserAgent. Normally, the FOEventHandler instance is created by FOP. Example:

```
userAgent.setFOEventHandlerOverride(myFOEventHandler); //myFOEventHandler
is an org.apache.fop.fo.FOEventHandler
```

- Manually add a **ElementMapping instance**. If you want to supply a special FOP extension you can give the instance to the FOUUserAgent. Normally, the FOP extensions can be automatically detected (see the documentation on extension for more info).

```
userAgent.addElementMapping(myElementMapping); //myElementMapping is a
org.apache.fop.fo.ElementMapping
```

- Set a **URIResolver** for custom URI resolution. By supplying a JAXP URIResolver you can add custom URI resolution functionality to FOP. For example, you can use [Apache XML Commons Resolver](#) to make use of XCatalogs.

```
userAgent.setURIResolver(myResolver); //myResolver is a
javax.xml.transform.URIResolver
```

- Set the **parameters for PDF encryption** for the document. If you create PDF files you can instantiate and set an org.apache.fop.pdf.PDFEncryptionParams object. Example:

```
userAgent.setPDFEncryptionParams(new PDFEncryptionParams(null, "owner",
false, false, true, true));
```

#### Note:

You should not reuse an FOUUserAgent instance between FOP rendering runs although you can. Especially in multi-threaded environment, this is a bad idea.

## 5. Using a Configuration File

Instead of setting the parameters manually in code as shown above you can also set many values from an XML configuration file:

```
import org.apache.avalon.framework.configuration.Configuration;
import org.apache.avalon.framework.configuration.DefaultConfigurationBuilder;

/*...*/

DefaultConfigurationBuilder cfgBuilder = new DefaultConfigurationBuilder();
Configuration cfg = cfgBuilder.buildFromFile(new File("C:/Temp/mycfg.xml"));
userAgent.setUserConfig(cfg);
```

The layout of the configuration file is described on the [Configuration page](#).

## 6. Hints



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## 6.1. Object reuse

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At the moment, the Fop instances shouldn't be reused. Please recreate Fop and FOUserAgent instances for each rendering run until further notice. We will likely add an additional object which will carry information and configuration which can be reused between rendering runs to further optimize this.

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## 6.2. AWT issues

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If your XSL-FO files contain SVG then Apache Batik will be used. When Batik is initialised it uses certain classes in `java.awt` that initialise the Java AWT classes. This means that a daemon thread is created by the JVM and on Unix it will need to connect to a DISPLAY.

The thread means that the Java application may not automatically quit when finished, you will need to call `System.exit()`. These issues should be fixed in the JDK 1.4.

If you run into trouble running FOP on a head-less server, please see the [notes on Batik](#).

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## 6.3. Getting information on the rendering process

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To get the number of pages that were rendered by FOP you can call `Fop.getResults()`. This returns a `FormattingResults` object where you can lookup the number of pages produced. It also gives you the page-sequences that were produced along with their id attribute and their number of pages. This is particularly useful if you render multiple documents (each enclosed by a page-sequence) and have to know the number of pages of each document.

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## 7. Improving performance

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There are several options to consider:

- Whenever possible, try to use SAX to couple the individual components involved (parser, XSL transformer, SQL datasource etc.).
- Depending on the target OutputStream (in case of an `FileOutputStream`, but not for a `ByteArrayOutputStream`, for example) it may improve performance considerably if you buffer the OutputStream using a `BufferedOutputStream`: `fop.setOutputStream(new java.io.BufferedOutputStream(out))`;  
Make sure you properly close the OutputStream when FOP is finished.
- Cache the stylesheet. If you use the same stylesheet multiple times you can setup a JAXP `Templates` object and reuse it each time you do the XSL transformation. (More

information can be found [here](#).)

- Use an XSLT compiler like [XSLTC](#) that comes with Xalan-J.

## 8. Multithreading FOP

Apache FOP may currently not be completely thread safe. FOP uses some static variables (for example for the image cache). This code has not been fully tested for multi-threading issues, yet.

There is also a known issue with fonts being jumbled between threads when using the Java2D/AWT renderer (which is used by the -awt and -print output options). In general, you cannot safely run multiple threads through the AWT renderer.

## 9. Examples

The directory "{fop-dir}/examples/embedding" contains several working examples. In contrast to the examples above the examples here primarily use JAXP for XML access. This may be easier to understand for people familiar with JAXP.

### 9.1. ExampleFO2PDF.java

This [example](#) demonstrates the basic usage pattern to transform an XSL-FO file to PDF using FOP.

Example XSL-FO to PDF

### 9.2. ExampleXML2FO.java

This [example](#) has nothing to do with FOP. It is there to show you how an XML file can be converted to XSL-FO using XSLT. The JAXP API is used to do the transformation. Make sure you've got a JAXP-compliant XSLT processor in your classpath (ex. [Xalan](#)).

Example XML to XSL-FO

### 9.3. ExampleXML2PDF.java

This [example](#) demonstrates how you can convert an arbitrary XML file to PDF using XSLT and XSL-FO/FOP. It is a combination of the first two examples above. The example uses JAXP to transform the XML file to XSL-FO and FOP to transform the XSL-FO to PDF.

Example XML to PDF (via XSL-FO)

The output (XSL-FO) from the XSL transformation is piped through to FOP using SAX events. This is the most efficient way to do this because the intermediate result doesn't have to be saved somewhere. Often, novice users save the intermediate result in a file, a byte array or a DOM tree. We strongly discourage you to do this if it isn't absolutely necessary. The performance is significantly higher with SAX.

## 9.4. ExampleObj2XML.java

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This [example](#) is a preparatory example for the next one. It's an example that shows how an arbitrary Java object can be converted to XML. It's an often needed task to do this. Often people create a DOM tree from a Java object and use that. This is pretty straightforward. The example here however shows how to do this using SAX which will probably be faster and not even more complicated once you know how this works.

### Example Java object to XML

For this example we've created two classes: ProjectTeam and ProjectMember (found in `xml-fop/examples/embedding/java/embedding/model`). They represent the same data structure found in `xml-fop/examples/embedding/xml/xml/projectteam.xml`. We want to serialize a project team with several members which exist as Java objects to XML. Therefore we created the two classes: ProjectTeamInputSource and ProjectTeamXMLReader (in the same place as ProjectTeam above).

The XMLReader implementation (regard it as a special kind of XML parser) is responsible for creating SAX events from the Java object. The InputSource class is only used to hold the ProjectTeam object to be used.

Have a look at the source of ExampleObj2XML.java to find out how this is used. For more detailed information see other resources on JAXP (ex. [An older JAXP tutorial](#)).

## 9.5. ExampleObj2PDF.java

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This [example](#) combines the previous and the third to demonstrate how you can transform a Java object to a PDF directly in one smooth run by generating SAX events from the Java object that get fed to an XSL transformation. The result of the transformation is then converted to PDF using FOP as before.

### Example Java object to PDF (via XML and XSL-FO)

## 9.6. ExampleDOM2PDF.java

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This [example](#) has FOP use a DOMSource instead of a StreamSource in order to use a DOM tree

as input for an XSL transformation.

### 9.7. ExampleSVG2PDF.java (PDF Transcoder example)

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This [example](#) shows use of the PDF Transcoder, a sub-application within FOP. It is used to generate a PDF document from an SVG file.

### 9.8. Final notes

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These examples should give you an idea of what's possible. It should be easy to adjust these examples to your needs. Also, if you have other examples that you think should be added here, please let us know via either the fop-users or fop-dev mailing lists. Finally, for more help please send your questions to the fop-users mailing list.