

# Maven

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March 17, 2013

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## 1 Why Maven?

### Maven

Another Apache project, *Maven* came well after **Ant** had come to dominate the Java open source landscape.

- Initially seen as a competitor or replacement for Ant
- Maven addresses both
  - build management (as does Ant)
  - and configuration management (which Ant does not)
    - \* Later, we'll talk about Ivy, which adds configuration mgmt to Ant

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### Motivations for Maven

Grew out of an observation that many supposedly cooperative, related Apache projects had inconsistent and incompatible **ant** build structures.

Stated goals are

- Making the build process easy
- Providing a uniform build system
- Providing quality project information
- Providing guidelines for best practices development
- Allowing transparent migration to new features

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### Uniform Build System

- Maven supports *archetype* projects that standardize
  - directory structure
    - \* Source code kept in separate directory tree from both intermediate and final build products
    - \* Tests occupy separate subtrees of the source and product trees
  - “Life Cycle”
    - \* Really, a presumptuous name on their part for a build process

\* A sequence of *goals*

- Archetypes can be obtained from the Maven project or tailored for an organization.

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### Providing quality project information

- Provides easy access to report tools
- Aids in building & maintaining project web sites (e.g.)

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### Providing guidelines for best practices development

- Directory structures (already discussed)
- Unit testing
- Encourage familiarity with approved archetypes

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## 2 Maven as a Build Manager

### Maven as a Build Manager

Perhaps the best way to illustrate this is to follow the steps in Maven in 5 Minutes

- Start with the command

```
mvn archetype:generate -DgroupId=edu.odu.cs \
-DartifactId=codeAnnotation \
-DarchetypeArtifactId=maven-archetype-quickstart \
-DinteractiveMode=false
```

- Lots of libraries (mainly comprising the latest version of Maven system itself) will be downloaded into your `~/m2` directory.
- A directory, `codeAnnotation`, will be created.

- **cd** into the new directory and explore
  - `src` directory structure
  - `pom.xml` is the *build file* for this project

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### Building with the Sample Source

- Run

```
mvn package
```

  - Sample source code is compiled
  - Sample unit test is run and executed.
  - A jar file is created with the sample source code
- Explore the target directory to see what has been placed there

.....

### OK, that was fun...

Let's try this with some real source code.

- Delete the target directory (or run `mvn clean`)
- Replace the contents of `src/main/java` and `src/test/java` by the corresponding contents from my code Annotation project.
  - Also, copy `src/main/jflex` while we're at it, though we won't use this right away.
- Try `mvn package` again.

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### What Went Wrong?

- A glance at the code with the error messages won't show anything obvious.
  - But I happen to know that Maven defaults to running the Java compiler in Java 5 compatibility mode
  - This code uses Java 6 features
- Edit the `pom.xml` file and, just above the `<dependencies>` section, add

```
<properties>
  <project.build.sourceEncoding>UTF-8</project.build.sourceEncoding>
  <maven.compiler.source>1.6</maven.compiler.source>
  <maven.compiler.target>1.6</maven.compiler.target>
</properties>
```

- Then try `mvn package` again

.....

### That was a little better

- The main source code compiled successfully.
- The error was in the compilation of the unit tests
  - The first error message says  
[ERROR] /home/zeil/cs795SD/Build/lib/codeAnnotation/src/test/java/edu/odu/cs/codeAnnotation/package org.junit does not exist
- Looks to be a problem with the JUnit library
- In the original project, I was keeping a copy of `junit4.jar` in the project directory.
  - A clumsy solution
  - Which brings us to ...

.....

## 3 Maven as a Configuration Manager

### 3.1 Dependencies

#### Maven as a Configuration Manager

- Edit the `pom.xml` file and look for the dependencies section.

You should see something like

```
<dependencies>
  <dependency>
    <groupId>junit </groupId>
    <artifactId>junit </artifactId>
    <version>3.8.1 </version>
    <scope>test </scope>
  </dependency>
</dependencies>
```

- This indicates that our project requires the `junit` package.
  - \* But it's an old version. JUnit changed a *lot* in version 4.

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### Updating the Dependency

- Change the version number to

```
<dependencies>
  <groupId>junit </groupId>
  <artifactId>junit </artifactId >
  <version>4.10</version>
  <scope>test </scope>
</dependencies>
```

- Could also say [4.10, ) to get versions 4.10 or greater

- Try `mvn package` again.

.....

### Fetching Dependencies

- Maven does a transitive search over the dependencies for a project
  - Tries to find a mutually compatible set of versions
    - \* Helps if you give it some flexibility
- Maven then downloads the required libraries automatically
  - Downloaded libraries are cached (e.g., `~/ .m2`)

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### Version Ranges

- Version ranges can be specified as [*low*, *high*]  
and are inclusive. Use ( and ) for exclusive
  - If *low* or *high* are omitted, taken as  $\pm\infty$
- Examples
  - [4.0, 4.10] inclusive range
  - [4.10, ) 4.10 or anything more recent
  - [4.10] 4.10 and nothing else
  - 4.10 with no brackets means “any version, but prefer 4.10”

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### Maven Repositories

- By default, Maven searches the ibiblio repository, which can be human-searched here.
- Try searching for junit
  - Notice range of versions available
    - \* Select one (e.g., 4.10)
  - The “Maven” tab shows what to put into your <dependencies> section to request this version.

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### Transitive Dependencies

How does Maven know whether junit itself depends on other libraries?

- Near the top of the junit 4.10 page, click to “View” the POM file:

Near the bottom, you will see

```
<dependencies>
  <groupId>org.hamcrest</groupId>
  <artifactId>hamcrest-core</artifactId>
  <version>1.3</version>
  <scope>compile</scope>
</dependencies>
```

- This is the same kind of info that we put into our own pom.xml file
  - And is, presumably, taken from the pom.xml that the JUnit team used to maintain their builds.
  - Publishing the dependency information along with the libraries leads to an accumulated base of information on library dependencies.

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### Choosing Repositories

- Technically, our project has two repositories
  - a *remote repository*, at ibiblio
  - a *local repository* holding my cache
- Team projects will often employ an intermediate *shared repository*

- reduce cache duplication
- provide a mechanism for managing subproject modules
- provide a common storage area for libraries not available on ibiblio
- preserve older versions needed for a project baseline

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### Example: the Forge350 Repository

A basic shared repository can be found here.

To add access to it, we add this to our pom.xml:

```
<repositories>
  <repository>
    <snapshots>
      <enabled>>false </enabled>
    </snapshots>
    <id>forge350</id>
    <name>ODU CS Forge350 Repository</name>
    <url>http://forge350.cs.odu.edu/www/mavenrepo1/repo</url>
  </repository>
</repositories>
```

- We could then, for example, import early versions of zipdiff and trilead-ssh that were part of the baseline for the Extract project
  - At the time they were added to the project baseline, they were not in the remote Maven repository
  - As time has passed, those libraries were added, but have started with versions later than the project baseline

.....

### Publishing to a Repository

Suppose that we want to publish our jar to a repository.

- “Output” repositories are listed similarly to, but separately from, input repositories
  - Necessary because the network protocol may be different



```
<repositories>
  :
  </repository>
</repositories>
<distributionManagement>
  <repository>
    <id>forge350Scp</id>
    <name>ODU CS Forge350 Repository (scp)</name>
    <url>scp://forge350.cs.odu.edu/var/lib/gforge/chroot/home/groups/mavenrepo1/htdocs/repo</url>
  </repository>
</distributionManagement>
```

.....

### Connection Info

In addition to adding the output repository to the POM, you need to provide your authentication info for the servers that you use in `~/.m2/settings.xml`:

```
<settings>
  <servers>
    <server>
      <id>forge350Scp</id>
      <username>yourLogin</username>
      <password>yourPassword</password>
      <!-- privateKey>/path/to/your/private/key</privateKey -->
      <filePermissions>664</filePermissions>
      <directoryPermissions>775</directoryPermissions>
      <configuration>
      </configuration>
    </server>
  </servers>
</settings>
```

- ❶ This ID provides a handle for the `distributionManagement` tag in your POM to use identifying where you want to publish to.
- ❷ This is a clear security issue.
  - Only very recently has an option been added that allows you to use encrypted passwords instead of plain text.
    - \* I'm still not sure how secure that really is.
- ❸ Probably a better idea is to use public/private key access.



- The `privateKey` tag might not even be required if you are using a key agent.

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### We're Not Done Yet

Our repository can be accessed by **scp**

- Of course, you can't actually do something like **scp** without a library that supports it.
  - Unlike the libraries we list in the dependencies, we need something that would become part of the maven process, not simply passed to the compiler or to the

.....

## 3.2 Extending Maven

### Extending Maven

- Maven is usually extended by adding *plugins*
  - Each plugin is a collection of related *MOJOs*, a Maven plain Old Java Object
    - \* Each MOJO provides a specific function
    - \* which can be bound to a specific goal of the life cycle for our selected project archetype

.....

### Circling the Wagons

However, for whatever reason, communication with repositories has a separate extension mechanism, called *wagons*.

- 'Cause they ship things from one place to another, get it?

```
</dependencies>
<build>
  <extensions>
    <extension>
      <groupId>org.apache.maven.wagon</groupId>
      <artifactId>wagon-ssh</artifactId>
      <version>2.2</version>
    </extension>
  </extensions>
</build>
```

.....

**If all is well...**

- mvn deploy should then publish your project to the designated repository.

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**Modification via Plugin**

- Much of the source code in this project is generated by **jflex**
- Currently, we have relied on that generated code already being in our src/main/java
- Let's fix that.
  - First, delete the \*Scanner.java files
- Maven has a jflex plugin that will convert jflex inputs in src/main/jflex to Java source code in the target directory and will include that generated code in the normal compilation.

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**Adding the JFlex Plugin**

- Search the Maven ibiblio for the plugin
  - “jflex-plugin”, not the “jflex” library
    - \* the library will be obtained as well, but as a transitive dependency
- Modify the POM:

```
<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema
xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/maven-v4_0_0
<modelVersion>4.0.0</modelVersion>
<groupId>edu.odu.cs</groupId>
<artifactId>codeAnnotation</artifactId>
<packaging>jar</packaging>
<version>1.0</version>
<name>codeAnnotation</name>

<!-- site generation:
    mvn test
    mvn jxr:jxr surefire-report:report
```

```
    mvn site
-->

<repositories>
  <repository>
    <snapshots>
      <enabled>false</enabled>
    </snapshots>
    <id>forge350</id>
    <name>ODU CS Forge350 Repository</name>
    <url>http://forge350.cs.odu.edu/www/mavenrepo1/repo</url>
  </repository>
</repositories>
<distributionManagement>
  <repository>
    <id>forge350Scp</id>
    <name>ODU CS Forge350 Repository (scp)</name>
    <url>scp://forge350.cs.odu.edu/var/lib/gforge/chroot/home/groups/mavenrepo1/htdocs/rep
  </repository>
</distributionManagement>

<dependencies>
  <dependency>
    <groupId>junit</groupId>
    <artifactId>junit</artifactId>
    <version>4.10</version>
    <scope>test</scope>
  </dependency>
</dependencies>
<build>
  <extensions>
    <extension>
      <groupId>org.apache.maven.wagon</groupId>
      <artifactId>wagon-ssh</artifactId>
      <version>2.2</version>
    </extension>
  </extensions>
</build>
```

```
<plugins>
  <plugin>
    <groupId>de.jflex</groupId>
    <artifactId>maven-jflex-plugin</artifactId>
    <version>1.4.3</version>
    <executions>
      <execution>
        <goals>
          <goal>generate</goal>
        </goals>
      </execution>
    </executions>
  </plugin>
</plugins>

</build>
<properties>
  <project.build.sourceEncoding>UTF-8</project.build.sourceEncoding>
  <maven.compiler.source>1.6</maven.compiler.source>
  <maven.compiler.target>1.6</maven.compiler.target>
</properties>
</project>
```

.....

## 4 Maven Report Generation

### Maven Report Generation

- Report generation is considered a key feature of Maven

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### Generating a Website

`mvn site` will generate a project website.

- Most of the content will be highly generic, however.
- The missing details have to be added to the POM

```
<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema
  xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/maven-v4_0_0
  <modelVersion>4.0.0</modelVersion>
  <groupId>edu.odu.cs</groupId>
  <artifactId>codeAnnotation</artifactId>
  <packaging>jar</packaging>
  <version>1.0</version>
  <name>codeAnnotation</name>
  <url>https://secweb.cs.odu.edu/~zeil/cs795SD/s13/Directory/topics.html</url>
  <description>
    This is a tool used to parse code listings and to
    generate syntax-highlighted C++/Java listings in both
    HTML and LaTeX.

    Markup can be added in the form of special comments that will
    be recognized as instructions to highlight blocks of code, to
    add callout symbols, or to insert vertical ellipses.
  </description>

  <!-- site generation:
    mvn test
    mvn jxr:jxr surefire-report:report
    mvn site
  -->

  <repositories>
    <repository>
      <snapshots>
        <enabled>>false</enabled>
      </snapshots>
      <id>forge350</id>
      <name>ODU CS Forge350 Repository</name>
      <url>http://forge350.cs.odu.edu/www/mavenrepo1/repo</url>
    </repository>
  </repositories>
  <distributionManagement>
    <repository>
      <id>forge350Scp</id>
```

```
    <name>ODU CS Forge350 Repository (scp)</name>
    <url>scp://forge350.cs.odu.edu/var/lib/gforge/chroot/home/groups/mavenrepo1/htdocs/rep
  </repository>
</distributionManagement>
```

```
<issueManagement>
  <system>Bugzilla</system>
  <url>https://www.cs.odu.edu/~zeil/bugzilla/</url>
</issueManagement>
```

```
<ciManagement>
  <system>Continuum</system>
  <url>http://www.cs.odu.edu/~zeil/continuum</url>
  <notifiers>
    <notifier>
      <type>mail</type>
      <address>zeil@cs.odu.edu</address>
    </notifier>
  </notifiers>
</ciManagement>
```

```
<developers>
  <developer>
    <id>szeil</id>
    <name>Steven Zeil</name>
    <email>zeil@cs.odu.edu</email>
    <roles>
      <role>Project Manager</role>
      <role>Programmer</role>
    </roles>
    <organization>ODU CS</organization>
  </developer>
</developers>
```

```
<scm>
```

```
<connection>scm:svn:svn://scm.forge350.cs.odu.edu/var/lib/gforge/chroot/scmrepos/svn/jst
<developerConnection>scm:svn:svn+ssh://sjzeil@scm.forge350.cs.odu.edu/var/lib/gforge/ch
<url>https://forge350.cs.odu.edu/scm/?group_id=97</url>
</scm>

<dependencies>
  <dependency>
    <groupId>junit</groupId>
    <artifactId>junit</artifactId>
    <version>4.10</version>
    <scope>test</scope>
  </dependency>
</dependencies>
<build>
  <extensions>
    <extension>
      <groupId>org.apache.maven.wagon</groupId>
      <artifactId>wagon-ssh</artifactId>
      <version>2.2</version>
    </extension>
  </extensions>
  <plugins>
    <plugin>
      <groupId>de.jflex</groupId>
      <artifactId>maven-jflex-plugin</artifactId>
      <version>1.4.3</version>
      <executions>
        <execution>
          <goals>
            <goal>generate</goal>
          </goals>
        </execution>
      </executions>
    </plugin>
  </plugins>
</build>
<properties>
  <project.build.sourceEncoding>UTF-8</project.build.sourceEncoding>
```



```
<maven.compiler.source>1.6</maven.compiler.source>
<maven.compiler.target>1.6</maven.compiler.target>
</properties>
</project>
```

.....

### Adding Reports

- A variety of report generators can then be run and have their reports linked in to the generated site

```
<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema
xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/maven-v4_0_0
<modelVersion>4.0.0</modelVersion>
<groupId>edu.odu.cs</groupId>
<artifactId>codeAnnotation</artifactId>
<packaging>jar</packaging>
<version>1.0</version>
<name>codeAnnotation</name>
<url>https://secweb.cs.odu.edu/~zeil/cs795SD/s13/Directory/topics.html</url>
<description>
  This is a tool used to parse code listings and to
  generate syntax-highlighted C++/Java listings in both
  HTML and LaTeX.

  Markup can be added in the form of special comments that will
  be recognized as instructions to highlight blocks of code, to
  add callout symbols, or to insert vertical ellipses.
</description>

<!-- site generation:
  mvn test
  mvn jxr:jxr surefire-report:report
  mvn site
-->

<repositories>
  <repository>
    <snapshots>
```

```
        <enabled>false</enabled>
    </snapshots>
    <id>forge350</id>
    <name>ODU CS Forge350 Repository</name>
    <url>http://forge350.cs.odu.edu/www/mavenrepo1/repo</url>
</repository>
</repositories>
<distributionManagement>
  <repository>
    <id>forge350Scp</id>
    <name>ODU CS Forge350 Repository (scp)</name>
    <url>scp://forge350.cs.odu.edu/var/lib/gforge/chroot/home/groups/mavenrepo1/htdocs/rep
  </repository>
</distributionManagement>

<issueManagement>
  <system>Bugzilla</system>
  <url>https://www.cs.odu.edu/~zeil/bugzilla/</url>
</issueManagement>

<ciManagement>
  <system>Continuum</system>
  <url>http://www.cs.odu.edu/~zeil/continuum</url>
  <notifiers>
    <notifier>
      <type>mail</type>
      <address>zeil@cs.odu.edu</address>
    </notifier>
  </notifiers>
</ciManagement>

<developers>
  <developer>
    <id>szeil</id>
    <name>Steven Zeil</name>
    <email>zeil@cs.odu.edu</email>
    <roles>
      <role>Project Manager</role>
    </roles>
  </developer>
</developers>
```

```
<role>Programmer</role>
  </roles>
  <organization>ODU CS</organization>
</developer>
</developers>

<scm>
  <connection>scm:svn:svn://scm.forge350.cs.odu.edu/var/lib/gforge/chroot/scmrepos/svn/jsh
  <developerConnection>scm:svn:svn+ssh://sjzeil@scm.forge350.cs.odu.edu/var/lib/gforge/chr
  <url>https://forge350.cs.odu.edu/scm/?group_id=97</url>
</scm>

<dependencies>
  <dependency>
    <groupId>junit</groupId>
    <artifactId>junit</artifactId>
    <version>4.10</version>
    <scope>test</scope>
  </dependency>
</dependencies>
<build>
  <extensions>
    <extension>
      <groupId>org.apache.maven.wagon</groupId>
      <artifactId>wagon-ssh</artifactId>
      <version>2.2</version>
    </extension>
  </extensions>
  <plugins>
    <plugin>
      <groupId>de.jflex</groupId>
      <artifactId>maven-jflex-plugin</artifactId>
      <version>1.4.3</version>
      <executions>
        <execution>
          <goals>
            <goal>generate</goal>
          </goals>
        </execution>
      </executions>
    </plugin>
  </plugins>
</build>
```

```
    </plugin>
    <plugin> ❶
<groupId>org.apache.maven.plugins</groupId>
<artifactId>maven-site-plugin</artifactId>
    </plugin>
    <!--
    <plugin> ❷
<groupId>com.atlassian.maven.plugins</groupId>
<artifactId>maven-clover2-plugin</artifactId>
<version>2.4</version>
    </plugin>
    -->
</plugins>

</build>
<properties>
  <project.build.sourceEncoding>UTF-8</project.build.sourceEncoding>
  <maven.compiler.source>1.6</maven.compiler.source>
  <maven.compiler.target>1.6</maven.compiler.target>
</properties>
<reporting> ❸
  <plugins>
    <plugin>
<artifactId>maven-javadoc-plugin</artifactId> ❹
      <version>2.9</version>
    </plugin>
    <plugin>
      <groupId>org.apache.maven.plugins</groupId>
      <artifactId>maven-jxr-plugin</artifactId> ❺
      <version>2.3</version>
    </plugin>

    <plugin>
<groupId>org.apache.maven.plugins</groupId>
<artifactId>maven-surefire-report-plugin</artifactId> ❻
      <version>2.13</version>
    </plugin>

    <plugin>
<groupId>org.apache.maven.plugins</groupId>
```

```
<artifactId>maven-pmd-plugin</artifactId> ⑦
<configuration>
  <targetjdk>1.6</targetjdk>
  <rulesets>
    <ruleset>rulesets/java/basic.xml</ruleset>
    <ruleset>rulesets/java/braces.xml</ruleset>
    <ruleset>rulesets/java/clone.xml</ruleset>
    <ruleset>rulesets/java/codesize.xml</ruleset>
    <ruleset>rulesets/java/comments.xml</ruleset>
    <ruleset>rulesets/java/controversial.xml</ruleset>
    <ruleset>rulesets/java/coupling.xml</ruleset>
    <ruleset>rulesets/java/design.xml</ruleset>
    <ruleset>rulesets/java/empty.xml</ruleset>
    <ruleset>rulesets/java/finalizers.xml</ruleset>
    <ruleset>rulesets/java/imports.xml</ruleset>
    <ruleset>rulesets/java/naming.xml</ruleset>
    <ruleset>rulesets/java/strictexception.xml</ruleset>
    <ruleset>rulesets/java/strings.xml</ruleset>
    <ruleset>rulesets/java/typeresolution.xml</ruleset>
    <ruleset>rulesets/java/unusedcode.xml</ruleset>
  </rulesets>
  <format>xml</format>
  <linkXref>true</linkXref>
  <sourceEncoding>utf-8</sourceEncoding>
  <minimumTokens>100</minimumTokens>
</configuration>
</plugin>

<!--
<plugin>
  <artifactId>maven-clover-plugin</artifactId> ⑧
</plugin>
-->

<plugin>
<groupId>org.apache.maven.plugins</groupId>
<artifactId>maven-project-info-reports-plugin</artifactId> ⑨
<version>2.6</version>
</plugin>
```

```
</plugins>
</reporting>
</project>
```

- Some tools need to have plugins loaded to run the tool itself at the appropriate point in the build process. ❶
  - \* E.g., Test coverage tools ❷ typically need to modify the compilation settings.
- Most are simply listed as plugins in a new reporting section ❸
  - ❹ Javadoc
  - ❺ Syntax-highlighted source listings
  - ❻ Unit test reports
  - ❼ PMD static analysis/style check
  - ❽ Test coverage
  - ❾ General report handling

.....

## 5 Further Modifying Maven Projects

### Further Modifying Maven Projects

Maven is wonderful when your project matches the archetype.  
When it doesn't...

- Look for a plug-in
  - Plugging it in to the build model requires familiarity with both the mojos provided by the plugin and the archetype's life cycle model

```
<plugin>
  <groupId>de.jflex</groupId>
  <artifactId>maven-jflex-plugin</artifactId>
  <version>1.4.3</version>
  <executions>
    <execution>
      <goals>
        <goal>generate</goal>
      </goals>
    </execution>
  </executions>
</plugin>
```

- How did I even know that “generate” was available as a goal?
- Maven plugin documentation is often atrocious

.....

### Sometimes Doing the Easiest Things

... will be the hardest thing to accomplish in Maven

- Example  
Basically, Maven is wonderful when your projects matches an archetype, and tortuous when it does not.

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## 5.1 Maven and Ant

### Maven and Ant

One of the more popular ways to “escape” when Maven is getting in the way of a simple step is the ant run plugin

- For example, Maven’s built-in process for deciding what goes into a .jar file is to include the compiled classes and anything provided in src/main/resources
- But what if I want to include some data files that were constructed during the build process?
  - First, I need to run the programs to build those files.
    - \* This definitely requires escaping from the normal life cycle
  - Then I need to get them included into the Jar file
    - \* The built-in mechanism for this is incredibly cumbersome
- Easiest to handle both via a couple of embedded **ant** tasks

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## 5.2 Maven and Eclipse

### Maven and Eclipse

- Integrating Maven into **eclipse** is more than just allowing you run **mvn** as the build command
- The Eclipse built-in compiler also needs to know what libraries Maven has pulled into your configuration

## Maven

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- Otherwise it will issue bogus error messages and inappropriate help suggestions
- Can also hope for convenience functions
  - In particular, POM editors
- Two plugins currently
  - m2eclipse, older plugin
  - Eclipse IAM

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