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Getting Started with Apache Ant

By James Sugrue

ABOUT APACHE ANT

Apache Ant is an XML based tool for automating software build processes. Starting out as part of the Apache Tomcat codebase, Ant got its first standalone release in July 2000. Today it is the most widely used build tool for Java projects, enabling developers to adopt agile principles: most importantly test-driven development.

Hot Tip

Download Instructions

You can download the latest Ant distribution (1.8.1) as a standalone tool from http://Ant.apache.org/. Ant is also built into most Java development IDEs, such as Eclipse, and NetBeans which uses it as its internal build system.

The Anatomy of an Ant Script

A typical Ant script consists of a single build.xml file. The root element of the build script is the project tag. Within the project element there are one or more targets specified. A target contains a set of tasks to be executed.

The project element can specify a default target if no target is chosen during execution of the build script.

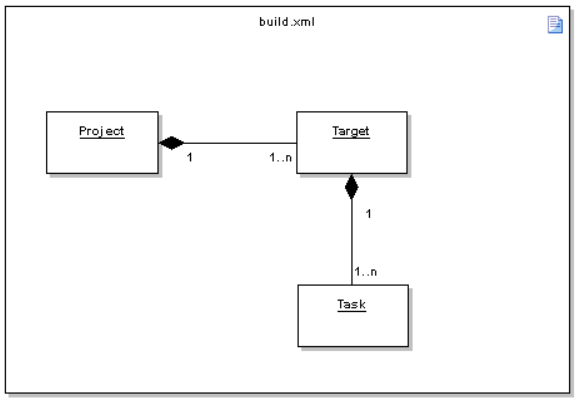

Figure 1: The basic structure of an Ant build script.

The most important concept in Ant is that of dependencies. Each target may depend on other targets. When running, Ant resolves these dependencies so that your script gets executed in the order you have specified.

Attribute	Description	Required
name	Name of the project.	No
basedir	Base directory from which all path calculations are done	No
default	The default target to run when no other target has been specified	No

Table 1: Project element attributes

Attribute	Description	Required
name	The name and identifier of this target	Yes
depends	Comma separated list of other targets that this target depends on	No
if	The name of a property which must be set for this target to run	No
unless	The name of a property which must not be set for this target to run	No
description	Description of this target	No
extensionOf	Add the target to the depends list of the named extension point	No

Table 2: Target element attributes

Hot Tip

Extension Points

Introduced in Ant 1.8.0 <extension-point> is similar to a <target> with its name and depends attributes. However, it does not contain any tasks and is used to collect targets that contribute to a state in the dependency relationships of the script.

Properties

Properties can be defined within the build script or in separate property files to provide more customizable build scripts.

Attribute	Description	Required
name	Name of the property	No
value	The value of the property	One of these when using name attribute
location	Set value to absolute filename. If the value passed through is not an absolute path it will be made relative to the project basedir	
refId	Reference to an object defined elsewhere	

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file	Location of the properties file	When not using the name attribute (i.e. loading external properties)
resource	Location in the classpath of the properties file	
url	URL pointing to properties file	
basedir	The basedir to calculate the relative path from	No. Default is project basedir
classpath / classpathref	The classpath to use when looking up a resource	No
environment	Prefix to use when accessing environment variables	No
prefix	Prefix to apply to properties loaded using file, resource or url	No

Table 3: Property element attributes

All system properties that can be accessed from the System. `getProperties()` methods in Java can be used in Ant. Additionally, the following built-in properties are available:

Property Name	Description
basedir	Absolute path of projects basedir
ant.core.lib	Absolute path of the ant.jar file
ant.file	Absolute path of buildfile
ant.home	Home directory of Ant
ant.java.version	Java version detected
ant.project.default-target	Name of the default target
ant.project.invoked-targets	List of targets specified in the command line when invoking this project
ant.project.name	Name of the project that is running
ant.version	Version of Ant

Table 4: Built-in properties

Path Structures

Path structures can be created using a series of `<pathelement>` tags. For example, a classpath can be created using:

```
<classpath>
   <pathelement location="/path/jarfile.jar"/>
   <pathelement path="/path/lib/jar1.jar;/path/lib/jar2.jar"/>
</classpath>
```

File Sets

In order to bundle files together, Ant provides the `<fileset>` tag:

Property Name	Description
casesensitive	Whether include/excludes patterns must be treated with case sensitivity. Default true
dir	Root of the directory tree of this fileset
defaultexcludes	If default excludes should be used (set of definitions that are always excluded)
erroronmissingdir	If true causes a build error, if false the fileset is ignored
excludes	List of patterns of files to exclude
excludesfile	Name of a file to exclude
file	Shortcut for specifying a fileset containing a single file
followsymlinks	Whether symbolic links should be followed. Default true

Table 5: Fileset attributes

Built-in Tasks

The following sections list out the most commonly used tasks in Ant build scripts. Required attributes are marked in bold.

Core Java Related Tasks

This section gives a complete reference of all taks and their attributes that are most commonly used by Java Developers.

Compiling Java Code

Compilation is achieved with the <javac> task.

Attribute	Description
srcdir	Location of java files to compile
bootclasspath/ boothclasspathref	Location of bootstrap class files or reference to a predefined path
classpath/ classpathref	Classpath to use for compilation or reference to a predefined path
compiler	Compiler implementation to use. Default is current VM
debug	Whether source should be compiled with debug information (-g parameter). Defaults to off
debuglevel	Can be lines, var or source. Used in the –g parameter for the compiler
depend	Enables dependency tracking on jikes and classic compilers
deprecation	Whether source should compile with deprecation information
destdir	Destination for compiled .class files
encoding	Encoding of source files
errorProperty	Property to set to true if compilation fails
excludes	Comma separated list of files that must be excluded from compilation. Wildcard patterns can be used
excludesFile	File that contains the exclusion list
executable	Path to javac executable to use when fork set to yes
extdirs	Location of installed extensions
fork	Whether to execute javac using the JDK compiler externally. Default no
failonerror	Whether compilation error fails the build. Default true
includes	Comma separated list of files that must be included in compilation. Wildcard patterns can be used
includeAntRuntime	Whether to include ANT runtime libraries in the classpath. Default yes
includeDestClasses	Whether classes compiled to the dest directory are included in the classpath. Default true. When false, causes recompilation of dependent classes
includesFile	File containing the exclusion list
includeJavaRuntime	Whether to include default libraries from VM. Default no
listfiles	Whether source files to be compiled will be listed. Default no
memoryInitialSize / memoryMaximumSize	Initial and maximum memory sizes for VM if run externally
nowarn	Whether –nowarn should be used with the compiler. Defaults to off
optimize	Whether to compile with optimization, ignored since JDK1.3
source	Value of the –source command line switch
sourcepath/ sourcepathref	Defaults to value of srcdir or reference to a predefined path
target	Generate class files for a particular VM version
tempdir	Temporary file location if fork set to yes
updatedProperty	Property to set for successful compilation
verbose	Use verbose output on the compiler

Table 6: javac tasks properties

Additional command line arguments can be passed through to the compiler using the `<compilerarg>` nested element.

Hot Tip

Compiler Choice

To use different compilers set the `build.compiler` property to classic (1.1, 1.2) modern (1.3-1.6) or choose a separate compiler such as jikes, jvc, kjc, gcj or sj.

Class file dependencies can be managed using the `<depend>` task.

Attribute	Description
srcdir	Location of Java files to compile. Will be examined to determine which files are out of date
cache	Directory where dependency information is stored and retrieved. No cache if not used
classpath	Classpath from which dependencies also need to be checked
closure	If true, all classes depending on an out-of-date class are deleted
destdir	Location of class file to be analyzed
dump	If true dependency info is written to the debug level log
warnOnRmiStubs	Disables warnings about files that look like rmic generated stubs but no .java source

Table 7: Depend task properties

Hot Tip

Ivy For Dependency Management

Ivy (http://ant.apache.org/ivy), a sub project of Ant, can also be used to manage dependencies.

Distributing Compiled Code

Jar files can be created using the `<jar>` task.

Attribute	Description
destfile	JAR file to create
basedir	The directory to build from
compress	Compress data in jar. Defaults true
createUnicodeExtraFields	Whether to create unicode extra fields to store file names a second time inside the entry's metadata
defaultexcludes	Whether default excludes should be used. Default true
duplicate	Behavior when a duplicate file is found – add (default), preserve, fail
keepcompression	For entries coming from other archives, keep its compression, overriding compress
encoding	Character encoding for filenames. Default UTF8
excludes	List of patterns of files to exclude
excludesfile	The name of a file that defines an exclude pattern
fallbacktoUTF8	If the specified encoding cannot be used, whether to fallback to UTF8
filesonly	Store only file entries. Default false
filesetmanifest	Behavior for when a manifest is found in a zipfileset. Can merge, mergewithoutmain or skip (default)
flattenAttributes	Merge attributes occurring more than once in a section into one single attribute
includes	List of patterns of files to include
includesfile	The name of a file that defines an include pattern
index	Whether to create an index list to speed up classloading. Default false
indexMetaInf	Whether to include META-INF in the index. Default false
level	Compression level for files from 0 (none) to 9 (maximum)
manifest	Location of manifest for jar
manifestencoding	Encoding to use for manifest. Default is platform encoding
mergeClassPathAttributes	Merge classpath attributes of different manifests when merging
preserve0permissions	If a file has permissions value of 0, it will preserve this instead of applying default values
roundup	Whether to round up file modification time to the next even number of seconds
strict	How to handle breaks of packaging version specification Fail, warn or ignore (default)
update	Whether to overwrite files that already exist. Default false
useLanguageEncodingFlag	Whether to set language encoding if encoding set to UTF8 only
whenmanifestonly	Behavior when no files match – fail, skip or create (default)

Table 8: Jar task properties

Hot Tip

War and Ear Archive Tasks

Both <war> and <ear> tasks have similar attributes to the <jar> task, adding in attributes for web.xml or application.xml respectively.

Additionally, you can sign jar archives using the `<signjar>` task.

Attribute	Description
alias	The alias to sign under
jar	The jar file to sign
storepass	The password for keystore integrity
executable	Specific jarsigner executable to use in place of default in JDK
force	Force signing if already signed or not out of date
internals	Whether to include the .SF file inside signature block. Default false
keypass	The password for the private key
keystore	Keystore location
lazy	Whether a signature file being present means the jar is signed
maxmemory	Maximum memory the VM will use when signing
preservelastmodified	Signed files keep the same modification time as original jar files
sectionsonly	Whether to compute the hash of entire manifest
sigfile	The name of the .SF or .DSA file
signedjar	The name of the signed jar file
storetype	The keystore type
tsacert	Alias in keystore for timestamp authority
tsaurl	URL for timestamp authority
verbose	Whether to use verbose output. Default false

Table 9: Signjar task properties

Manifests can be included using the `<manifest>` task.

Attribute	Description
file	Manifest file to create or update
encoding	Encoding to read existing manifest

flattenAttributes	Merge attributes occurring more than once in a section into one single attribute
mergeClassPathAttributes	Merge classpath attributes of different manifests when merging
mode	Either update or replace (default)

Table 10: Manifest task properties

Generating Documentation

JavaDoc generation is done through the `<javadoc>` task.

Attribute	Description
sourcepath sourcepathref sourcefiles	Location of the source files for the task. At least one of these attributes required for this specification
destdir	Destination directory required unless a doclet is specified
access	Access mode (public, private, protected, package)
additionalparam	Additional parameters to pass through
author	Include @author parts
bootclasspath / bootclasspathref	Location of class files loaded by bootstrap class loader
bottom	Bottom text for each page
breakiterator	Use new breakiterator algorithm
charset	Charset for cross platform viewing
classpath/classpathref	Location of classpath
defaultexcludes	Whether default excludes should be used
docencoding	Encoding of output file
docfilessubdirs	Deep copy of doc-file subdirectories
doclet/docletpathref	Classfile that starts to doclet used
doctitle	Title for the package index page
encoding	Source file encoding
excludepackagenames	Packages to exclude from javadoc
executable	Specify a javadoc executable instead of VM default
extdirs	Location of installed extensions
failonerror	Stops build process if command fails
footer	Footer text for each page
group	Group specified packages together in overview page
header	Header text for each page
helpfile	Specifies help file to include
includenosourcepackages	When true includes packages with no source
link	Create links to javadoc output at given url
linksource	Generate links to source files
locale	Locale to be used
maxmemory	Maximum amount of memory to allocate in VM
nodeprecated	Do not include @deprecated information
nodeprecatedlist	Do not generate deprecated list
notree	Do not generate class hierarchy
noindex	Do not generate index
nohelp	Do not generate help link
nonavbar	Do not generate naviation bar
noqualifier	Enables –noqualifier argument for a list of packages (or all)
overview	Read overview documentation from HTML file
packagenames	List of package files to use
packageList	File containing packages to use
public	Show only public classes and members
protected	Show only protected/public classes and members
package	Show only package/protected/public classes and members
private	Show all classes and members
serialwarn	Warn about @serial tag
source	Source level used for compilation
splitindex	Split index into one file per letter
stylesheetfile	Specifies CSS stylesheet
use	Create class and package usage pages
verbose	Output all messages of javadoc process
version	Include @version parts
windowtitle	Browser window title for documentation

Table 11: JavaDoc task properties

Executing Java Classes

Java classes can be executed from Ant using the `<java>` task.

Attribute	Description
classname jar	The jar file or classname to execute. If using jar, fork must be set to true
append	Whether output/error files should be appended or overwritten
args	Arguments for class. Better to use nested <arg> elements
classpath / classpathref	Classpath to use for execution
clonevm	Clones system properties and bootclasspath of forked VM to be the same as the Ant VM
dir	Directory to invoke VM in
error	File to write error (System.err) output to
errorproperty	Property to store error output from command
failonerror	Stops Ant build process if failure occurs
fork	Executes the class in another VM
input	File where standard input is taken from
inputstring	String where standard input is taken from
jvm	Command used to invoke JVM. Default is java
javmargs	Arguments for forked JVM. Better to use nested <jvmarg>
logError	Shows error output in Ant log
maxmemory	Maximum memory to allocate to the forked VM
newenvironment	When fork=true, do not propogate current environment variables
output	File to write output to
outputproperty	Property to store output of the command
resultproperty	Property where return code of command is stored
spawn	Need fork set to true. Will spawn a process independent of calling Ant process
timeout	Timeout for the command to execute within before being stopped

Table 12: Java task properties

Running Unit Tests

JUnit tests are executed from Ant through the `<junit>` task

Attribute	Description
clonevm	Clones system properties and bootclasspath of forked VM to be the same as the Ant VM
dir	Directory from which to invoke the VM
errorproperty	Property to set when errors occur

failureproperty	Property to set when failure occurs
filtertrace	Filter out JUnit or Ant stack frames from stack traces in errors or failures
fork	Run JUnit in a separate VM
forkmode	How many VMs to create when forking tests. (preTest, perBatch or once)
haltonerror	Stop build process if an error happens
haltonfailure	Stops build process if a test fails
includeAntruntime	Stops build process if a test fails
jvm	Command used to invoke VM, default java
logfailedtests	Log a FAILED message for each failed test to Ant's logging system
maxmemory	Maximum memory to allocate to forked VM
newenvironment	When fork=true, do not propogate current environment variables
outputformatters	Send output generated by tests to test formatters
printsummary	Print statistics for each test case. (on, off, withOutAndErr)
reloading	Whether a new classloader should be instAntiated for each test
showoutput	Send output to Ant log
tempdir	Location for temporary files
timeout	Cancel tests if not complete in specified time

Table 13: JUnit task properties

Tests are defined in nested elements within the `<junit>` task. Batch tests are defined using the `<batchtest>` tag:

Attribute	Description
name	Name of test class
errorproperty	Property to set when errors occur
failureproperty	Property to set when failure occurs
filtertrace	Filter out JUnit or Ant stack frames from stack traces in errors or failures
fork	Run tests in a separate VM, overriding the value set in the <junit> task
haltonerror	Stop build process if an error happens
haltonfailure	Stops build process if a test fails
if	Property condition to run test against, if set
todir	Directory to write reports to
unless	Property condition to run test against, if not set

Table 14: JUnit batch test definition

Hot Tip

Single Tests

If you just need to run a single test, the <test> tag can be used to specify the test. This contains similar attributes to the <batchtest> tag.

Test results can be written to different formats, using the `outputformatters` attribute in the `<junit>` task. The following table shows the options for formatter definition:

Attribute	Description
type	A predefined formatter type of either xml, plain, brief or failure
classname	If no type specified, use a customer formatter implementing `org.apache.tools.Ant.taskdefs.optional.junit.JUnitResultFormatter`
if	Use formatter if property is set
unless	Use formatter if property is not set
usefile	If output should be sent to a file. Default true

Table 15: JUnit formatter definition

Once tests are completed, reports can be generated for the tests using the `<junitreport>` task.

Attribute	Description
todir	The directory that will contain the results
tofile	The name of the XML file that will aggregate all previously generated results

Table 16: JUnitReport task properties

The `<junitreport>` task contains a fileset that collects all the reports from previous Junit tests.

To output to a report file, use the internal `<report>` tag.

Attribute	Description
format	Format of report (frames or noframes)
styledir	Directory containing stylesheets. Files must be junit-frames.xsl or junit-noframes.xsl
todir	The directory that files are written to. By default this is the current directory

Table 17: Report tag for <junitreport>

Infrastructure Tasks

There are a number of other core tasks related to file operations. The following is an overview of these tasks:

Task	Description
attrib /chmod	Changes permission of a file (attrib for Windows, chmod for Unix)
checksum	Generates a checksum for files
concat	Concatenates multiple files into one single file, or to the console
copy	Copies a file, or collection of files, to another location
delete	Deletes a file, directory or collection of files
exec	Executes a system command
ftp	Provides basic FTP functionality
get	Gets a file from a URL
import / include	Imports or includes another build file into the current Ant script
mail	Sends mail over SMTP
mkdir	Creates a new directory
move	Moves a file, or collection of files, to another location
record	Listens to the build process and outputs to a file
replace	Replaces occurances of a string in file or collection of files
replaceregexp	Replaces occurances of a string in file or collection of files using regular expressions
sql	Executes SQL statements to a database using JDBC
sync	Synchronizes a target directory with a list of files
zip / unzip tar / untar	Creates a zip file / unzips an existing zip. Also provides functionality for tar files

Table 18: Overview of basic infrastructure tasks

SCM Related Tasks

ANT provides a number of tasks for connecting with different source control management systems. The core support deals with CVS.

Task	Description
cvs	Handles commands to be run against CVS, defaulting with checkout
cvschangelog	Generates a report of change logs recorded in CVS
cvspass	Adds entries to a .cvspass file
cvstagdiff	Generates a report of the changes between two tags/dates from CVS
cvsversion	Retrieves CVS client and server version
patch	Applies a diff file to originals

Table 19: CVS task properties

There are also tasks available for interfacing with ClearCase, Visual Source Safe, Pvcs, Perforce and Continuus. Additional tasks can be found online for DCVS systems such as Git and Mercurial.

Property Tasks

Ant provides some tasks that deal with managing properties throughout your build process.

Task	Description
available	Sets property if file, directory or class in classpath is available at runtime
basename	Sets property to last element of specified path
buildnumber	Reads build number from a specified file
condition	Set property if a condition is true
dirname	Set property to the directory path of a specified file
echoproperties	Display all properties to file or console
loadfile	Loads a file into a property
loadproperties	Load a property file contents as Ant properties
makeurl	Converts filenames into URLs
pathconvert	Converts a file list or path structure to a separated string for the target platform
property	Set a property
propertyfile	Creation and modification of property files
uptodate	Set property if specified target file is newer than source files
whichresource	Find class or resource
xmlproperty	Loads properties from property file written in XML

Table 20: Ant Property Tasks

Hot Tip

Writing Your Own Tasks

If Ant doesn't provide you with the functionality that you need, you can write your own Ant tasks in Java by extending org.apache.tools.ant.Task.

ABOUT THE AUTHOR

James Sugrue has been editor at both Javalobby and EclipseZone for over two years, and loves every minute of it. By day, James is a software architect at Pilz Ireland, developing killer desktop software using Java and Eclipse all the way. While working on desktop technologies such as Eclipse RCP and Swing, James also likes meddling with up and coming technologies such as Eclipse e4. His current obsession is developing for the iPhone and iPad, having convinced himself that it's a turning point for the software industry.

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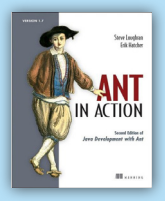

A single application of increasing complexity, followed throughout the book, shows how an application evolves and how to handle the problems of building and testing. Reviewers have praised the book's coverage of large-projects, Ant's advanced features, and the details and depth of the discussion-all unavailable elsewhere.

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