



WHITEMAGIC
SOFTWARE

CLASS ANALYZER
TECHNICAL OVERVIEW

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1 INTRODUCTION

This document provides technical details for the Class Analyzer software suite. The Class Analyzer software suite provides:

- A graphical application to interactively create class hierarchy diagrams.
- A command-line application to generate class hierarchy diagrams.
- A dependency analysis API for compiled Java classes.

1.1 PURPOSE

Class Analyzer provides software developers with a simple interface to traverse Java class hierarchies.

1.2 AUDIENCE

This document is written for a technical audience. Readers should be familiar with the Java programming language, package name spaces, class files, Java archive files, and recursion.

1.3 SOFTWARE REQUIREMENTS

The software used by Class Analyzer is listed in Table 1.1.

Software Package	Version	Notes
Java SE Runtime Environment	1.6.0	Runs the Class Analyzer.
BCEL	5.2.0	Java class file analysis.
JOpt Simple	3.1.0	Parses program arguments.
Prefuse	1.0.0	Graphics engine.
Lucene	1.4.3	Search engine.
RegExp	1.2.0	Parses regular expressions.

Table 1.1: Class Analyzer Application Dependencies

Except for Java, these software packages are distributed with Class Analyzer. See Table 4.1 on page 7 for build environment software requirements.

2 SYSTEM ARCHITECTURE

This section describes the architecture of the dependency analysis components.

2.1 COMPONENT OVERVIEW

How the major components interact is illustrated in Figure 2.1.

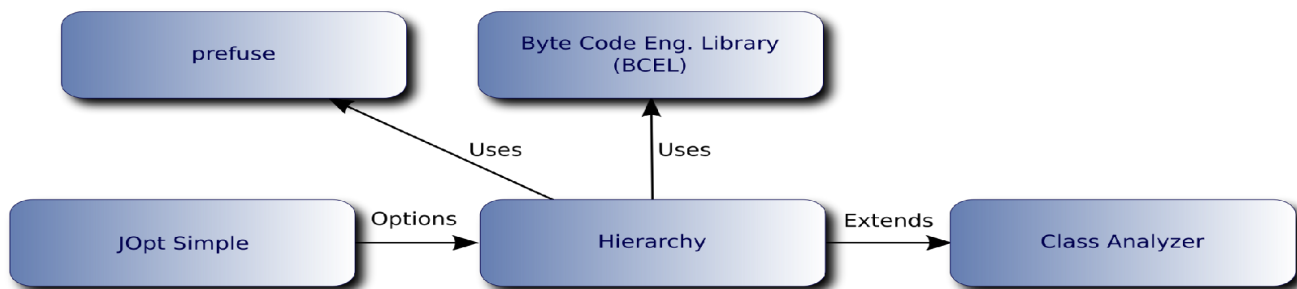


Figure 2.1: System Architecture

When the application is run, JOpt Simple is used to parse the command line arguments. These arguments are used to set various configuration parameters when running Hierarchy (such as the classes to analyze, which directories to search, graphing quality, and so forth). Hierarchy itself inherits from one of the Class Analyzer subclasses. All Class Analyzer subclasses use the Byte Code Engineering Library to parse Java files. The Prefuse Class Analyzer subclass creates an interactive graph.

2.1.1 JOPT SIMPLE

JOpt Simple is used to parse the command line arguments. The major classes used from this library include OptionParser and OptionSet.

2.1.2 BYTE CODE ENGINEERING LIBRARY

The Byte Code Engineering Library (BCEL) is used to determine the relationship of two classes. The major classes used from this library include JavaClass and ClassParser.

2.1.3 PREFUSE

Prefuse is the graphing library used to create the interactive hierarchical view of Java classes.

2.1.4 HIERARCHY

An application that uses Class Analyzer to display a graphical representation of a Java class hierarchy. This class is the hub for all the other architectural components shown in Figure 2.1. It performs command line argument parsing, creates a graphical user interface, transforms the Java class hierarchy into a tree compatible with the graphing package, and then displays the graph.

2.1.5 CLASS ANALYZER

This component is the abstract superclass for all the different types of hierarchical analysis classes. Section 3 describes this part of the suite in depth.

2.2 CACHING

The application heavily employs caching to achieve high speeds for its analysis. These main caches are described in the following sections.

2.2.1 CLASSWALKER

The ClassWalker is responsible for traversing files and directories in search of Java class files (any file whose name ends with `.class`). The ClassWalker maintains a list of classes that it has found. If that list is not empty, it means that the ClassWalker has already traversed all the classes available, and need not re-traverse the directory (and Java archive) structure again.

This optimization means that any Java class file that has been added after the first time ClassWalker has performed its walk will not be analyzed on subsequent passes. There are a few ways to work around the issue of new classes being added:

- Restart any application that uses ClassWalker.
- Code the application to re-walk the directory structure, rather than re-using ClassWalker's collection of class file names.

2.2.2 CLASSANALYZER

ClassAnalyzer retains a list of file names mapped to `JavaClass` instances. This prevents the applications from having to invoke BCEL to re-analyze each Java class file.

2.3 GRAPH

The graph produced by Hierarchy is not a true Manhattan layout (there is no Manhattan distance). The graph uses a `NodeLinkTreeLayout`, which is an orthogonal tree layout suitable for displaying hierarchical data. The graph is configured, controlled, and drawn using the following classes:

- `TreeView`
- `OrthogonalEdgeRenderer`

2.3.1 TREEVIEW

This class configures and controls the user interface. It configures the graphing library, setting up the graph layout, colours, fonts, canvas size, and user interface controls (such as keyboard short-cuts, mouse movements).

This class also controls the graph's animated zooming behaviour.

2.3.2 ORTHOGONALEDGE RENDERER

This class is responsible for creating the lines and arrows between two nodes in the graph. The algorithm it uses is straightforward, but involves a number of steps to avoid overlapping line segments and arrow heads.

The edge rendering algorithm follows:

1. Get the co-ordinates of the source node (sx, sy) and the target node (tx, ty).
2. Calculate the middle point along the y-axis between the source node and target node.
3. If the source node was not previously visited, draw the arrow head and line to the bus.
4. Create a new line segment that represents the line for the bus.
5. Before drawing the new segment, check for previous segment overlaps along the same y-axis.
 - a) If the previous line segment is longer than the new segment, then draw nothing.
 - b) If the previous line segment is shorter than the new segment, then draw the difference.
 - c) If no previous line segment would overlap the new one, then draw the new line.
6. If the source and target nodes are exactly vertically aligned, draw one line between them.

For further implementation details review the source code for `OrthogonalEdgeRenderer`.

3 CLASS ANALYZER

ClassAnalyzer is an abstract class that implements the `java.lang.Runnable` interface. The class has the following behaviours:

- Modifies the `java.class.path` System property during execution.
- Restores the `java.class.path` System property value upon completion.
- Uses `com.whitemagicsoftware.hierarchy.ClassWalker` to find class files.
- Uses BCEL to parse class files (without trying to instantiate them).

ClassAnalyzer can be used on its own to perform pure hierarchy analysis without dependency on a graphing library. Hierarchy requires a graphing library to produce diagrams, such as Figure 3.1.

3.1 INHERITANCE HIERARCHY

The full ClassAnalyzer inheritance hierarchy is shown in Figure 3.1.

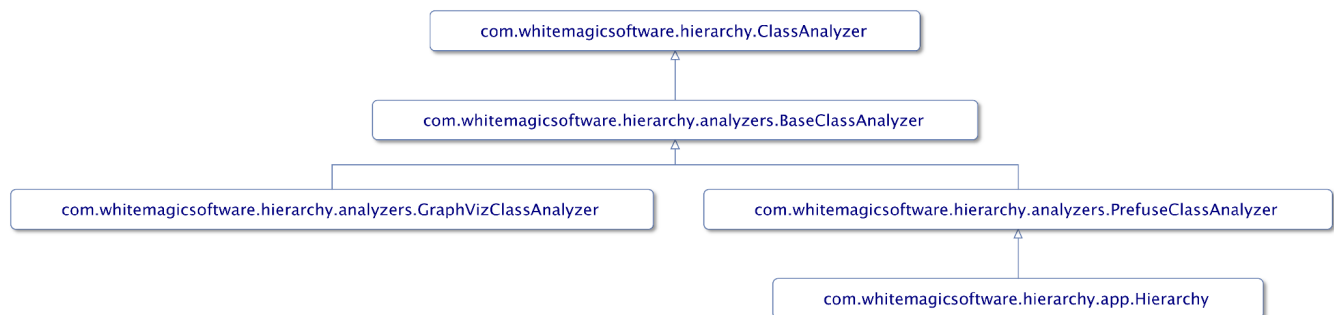


Figure 3.1: ClassAnalyzer Inheritance Hierarchy

The subsequent sections provide an overview of each ClassAnalyzer subclass.

3.1.1 BASECLASSANALYZER

This class abstracts configuring common command line options used by its subclasses. Its purpose is to decouple parsing of options from ClassAnalyzer.

3.1.2 GRAPHVIZCLASSANALYZER

This class writes a class hierarchy in a plain text format that is compatible with the GraphViz suite of

tools (to standard output). It shows an example usage of ClassAnalyzer performing a simple task.

This class is executable.

3.1.3 PREFUSECLASSANALYZER

This class writes a class hierarchy in an XML format that is compatible with the graphing library's TreeView example (to standard output). It provides a moderately complex example of how to use ClassAnalyzer to perform a non-trivial task. This class also serves as the base class for Hierarchy.

This class is executable.

3.1.4 HIERARCHY

This class draws an interactive, graphical representation of a Java class hierarchy. It provides software developers with a fast way of producing high-quality, high-resolution class hierarchies.

This class is executable.

3.2 EXTENDING CLASS ANALYZER

Methods developers must implement, or are of critical importance, are listed in Table 3.1. Full documentation can be found in the Javadocs.

Method	Usage
doAnalysis()	Called when the thread is run; this method must call <code>analyze()</code> .
visitSubclass(...)	Called for each unique parent-child subclass relationship found.
visitSuperclass(...)	Called for each unique parent-child superclass relationship found.
addClass(...)	Sets the path to a Java class file to be analyzed.
analyze()	Performs analysis of all Java class files that can be found.
setExcludeRegex(...)	Indicates which class files should be excluded from analysis.
updateClassPath(...)	Appends a new path for scanning onto the class path.

Table 3.1: ClassAnalyzer Methods

4 BUILDING CLASS ANALYZER

The Class Analyzer project can be built using any of the build tools listed in Table 4.1.

Application	Version
Apache Ant	1.7.1
Oracle JDeveloper 11g	11.1.1.1.0

Table 4.1: Build Environments

These tools are described in subsequent sections.

4.1 APACHE ANT

Apache's Ant can be used for all the tasks listed in Table 4.2.

Task	Usage	Effect
Build Hierarchy	<code>ant</code>	Compiles classes into classes directory and creates executable Java archive.
Delete classes and Javadocs	<code>ant clean</code>	Deletes classes , doc , and dist directories. Deletes executable Java archive.
Compile Hierarchy	<code>ant compile</code>	Compiles classes into classes directory and increases the build version.
Create distribution	<code>ant dist</code>	Writes zip archive into dist directory.
Generate Javadocs	<code>ant doc</code>	Writes Javadocs into doc directory.
Display version information.	<code>ant version</code>	Shows the version of Hierarchy to be created.

Table 4.2: Ant Tasks

4.2 ORACLE JDEVELOPER

To compile Class Analyzer using JDeveloper, complete the following steps:

1. Open the workspace file (e.g., Hierarchy.jws).
2. Click **Build » Rebuild ClassAnalyzer.jpr** or press **Alt-F9**.

5 DIRECTORY STRUCTURE

This section describes the content of the directories in use by the software.

5.1 CLASSES

Contains compiled classes ready for bundling into a Java archive file.

5.2 DIST

Contains the distribution archive for the application.

5.3 DOC

Contains supporting documentation.

5.4 JAVADOC

Created using the Ant tool, this contains HTML documentation.

5.5 LIB

Contains Java archives of the third-party libraries, as well as a compiled version of the application.

5.6 LICENSES

Contains licenses for the third-party libraries.

5.7 SRC

Contains source code.

6 COPYRIGHT

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