LOG4J

APACHE LOG4J

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About the Tutorial

Log4j is a popular logging package written in Java. Log4J is ported to the C, C++, C#, Perl, Python, Ruby, and Eiffel languages.

Audience

This tutorial is prepared for beginners to help them understand the basic functionality of Log4J logging framework.

Prerequisites

As you are going to use Log4J logging framework in various Java-based application development, it is imperative that you should have a good understanding of Java programming language.

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1. Overview

Log4j is a reliable, fast, and flexible logging framework (APIs) written in Java, which is distributed under the Apache Software License.

Log4j has been ported to the C, C++, C#, Perl, Python, Ruby, and Eiffel languages.

Log4j is highly configurable through external configuration files at runtime. It views the logging process in terms of levels of priorities and offers mechanisms to direct logging information to a great variety of destinations, such as a database, file, console, UNIX Syslog, etc.

Log4j has three main components:

- **loggers:** Responsible for capturing logging information.
- **appenders:** Responsible for publishing logging information to various preferred destinations.
- **layouts:** Responsible for formatting logging information in different styles.

History of log4j

- Started in early 1996 as tracing API for the E.U. SEMPER (Secure Electronic Marketplace for Europe) project.
- After countless enhancements and several incarnations, the initial API has evolved to become log4j, a popular logging package for Java.
- The package is distributed under the Apache Software License, a full-fledged open source license certified by the open source initiative.
- The latest log4j version, including its full-source code, class files, and documentation can be found at http://logging.apache.org/log4j/.

log4j Features

- It is thread-safe.
- It is optimized for speed.
- It is based on a named logger hierarchy.
- It supports multiple output appenders per logger.
- It supports internationalization.
- It is not restricted to a predefined set of facilities.
- Logging behavior can be set at runtime using a configuration file.
- It is designed to handle Java Exceptions from the start.

- It uses multiple levels, namely ALL, TRACE, DEBUG, INFO, WARN, ERROR, and FATAL.
- The format of the log output can be easily changed by extending the *Layout* class.
- The target of the log output as well as the writing strategy can be altered by implementations of the Appender interface.
- It is fail-stop. However, although it certainly strives to ensure delivery, log4j does not guarantee that each log statement will be delivered to its destination.

Pros and Cons of Logging

Logging is an important component of the software development. A well-written logging code offers quick debugging, easy maintenance, and structured storage of an application's runtime information.

Logging does have its drawbacks also. It can slow down an application. If too verbose, it can cause scrolling blindness. To alleviate these concerns, log4j is designed to be reliable, fast, and extensible.

Since logging is rarely the main focus of an application, the log4j API strives to be simple to understand and to use.

2. Installation

Log4j API package is distributed under the Apache Software License, a full-fledged open source license certified by the open source initiative.

The latest log4j version, including its full-source code, class files, and documentation can be found at http://logging.apache.org/log4j/.

To install log4j on your system, download apache-log4j-x.x.x.tar.gz from the specified URL and follow the steps given below.

Step 1

Unzip and untar the downloaded file in /usr/local/ directory as follows:

```
$ gunzip apache-log4j-1.2.15.tar.gz
$ tar -xvf apache-log4j-1.2.15.tar
apache-log4j-1.2.15/tests/input/
apache-log4j-1.2.15/tests/input/xml/
apache-log4j-1.2.15/tests/src/
apache-log4j-1.2.15/tests/src/java/
apache-log4j-1.2.15/tests/src/java/org/
.......................................
```

While untarring, it would create a directory hierarchy with a name apache-log4j-x.x.x as follows:

```
-rw-r--r--  1 root root   3565 2007-08-25 00:09 BUILD-INFO.txt
-rw-r--r--  1 root root   2607 2007-08-25 00:09 build.properties.sample
-rw-r--r--  1 root root  32619 2007-08-25 00:09 build.xml
drwxr-xr-x 14 root root   4096 2010-02-04 14:09 contribs
drwxr-xr-x  5 root root   4096 2010-02-04 14:09 examples
-rw-r--r--  1 root root   2752 2007-08-25 00:09 INSTALL
-rw-r--r--  1 root root   4787 2007-08-25 00:09 KEYS
-rw-r--r--  1 root root  11366 2007-08-25 00:09 LICENSE
-rw-r--r--  1 root root 391834 2007-08-25 00:29 log4j-1.2.15.jar
-rw-r--r--  1 root root    160 2007-08-25 00:09 NOTICE
-rwxr-xr-x  1 root root  10240 2007-08-25 00:27 NTEventLogAppender.dll
-rw-r--r--  1 root root  17780 2007-08-25 00:09 pom.xml
drwxr-xr-x  7 root root   4096 2007-08-25 00:13 site
```

```
drwxr-xr-x  8 root root   4096 2010-02-04 14:08 src
drwxr-xr-x  6 root root   4096 2010-02-04 14:09 tests
```

Step 2

This step is optional and depends on what features you are going to use from log4j framework. If you already have following packages installed on your machine then it is fine, otherwise you need to install them to make log4j work.

- **JavaMail API:** The e-mail based logging feature in log4j requires the Java Mail API (mail.jar) to be installed on your machine from https://glassfish.dev.java.net/javaee5/mail/.
- **JavaBeans Activation Framework:** The Java Mail API will also require that the JavaBeans Activation Framework (activation.jar) be installed on your machine from http://java.sun.com/products/javabeans/jaf/index.jsp.
- **Java Message Service:** The JMS-compatible features of log4j will require that both JMS and Java Naming and Directory Interface (JNDI) be installed on your machine from http://java.sun.com/products/jms.
- **XML Parser:** You need a JAXP-compatible XML parser to use log4j. Make sure you have Xerces.jar installed on your machine from http://xerces.apache.org/xerces-j/install.html.

Step 3

Now you need to set up the CLASSPATH and PATH variables appropriately. Here we are going to set it just for the log4j.x.x.x.jar file.

```
$ pwd
/usr/local/apache-log4j-1.2.15
$ export CLASSPATH= \
      $CLASSPATH:/usr/local/apache-log4j-1.2.15/log4j-1.2.15.jar
$ export PATH=$PATH:/usr/local/apache-log4j-1.2.15/
```

3. Architecture

Log4j API follows a layered architecture where each layer provides different objects to perform different tasks. This layered architecture makes the design flexible and easy to extend in future.

There are two types of objects available with Log4j framework:

- **Core Objects:** These are mandatory objects of the framework. They are required to use the framework.

- **Support Objects:** These are optional objects of the framework. They support core objects to perform additional but important tasks.

Core Objects

Core objects include the following types of objects:

Logger Object

The top-level layer is the Logger which provides the Logger object. The Logger object is responsible for capturing logging information and they are stored in a namespace hierarchy.

Layout Object

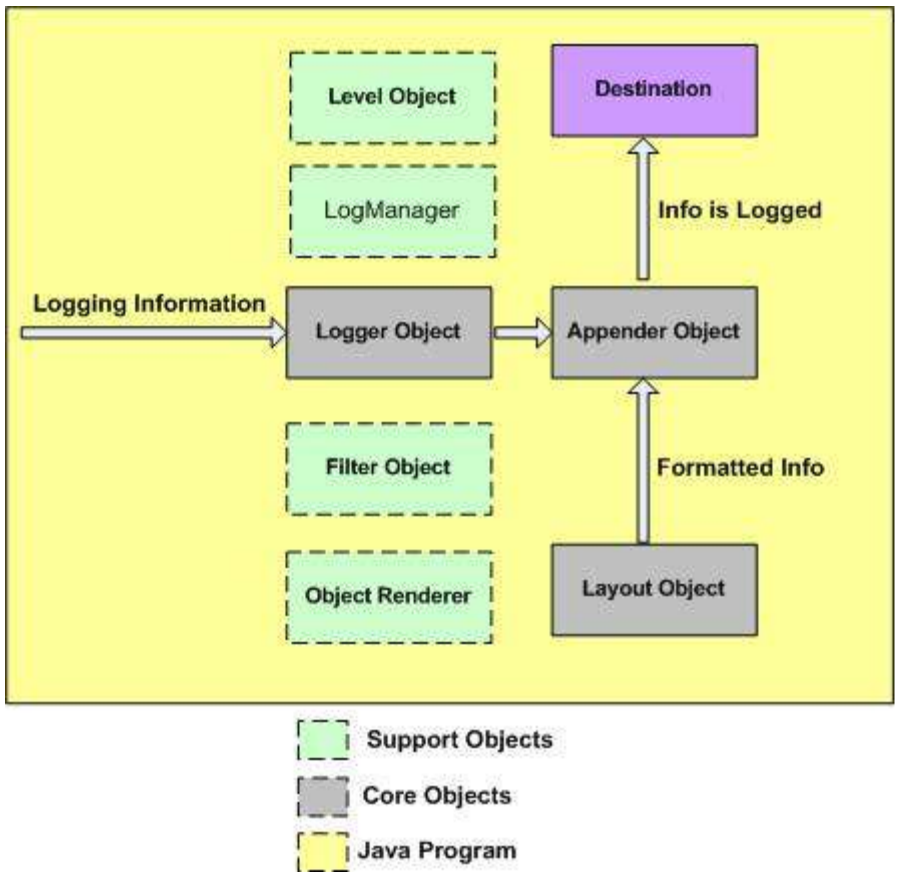
The Layout layer provides objects which are used to format logging information in different styles. It provides support to appender objects before publishing logging information.

Layout objects play an important role in publishing logging information in a way that is human-readable and reusable.

Appender Object

This is a lower-level layer which provides Appender objects. The Appender object is responsible for publishing logging information to various preferred destinations such as a database, file, console, UNIX Syslog, etc.

The following virtual diagram shows the components of a log4j framework:



Support Objects

There are other important objects in the log4j framework that play a vital role in the logging framework:

Level Object

The Level object defines the granularity and priority of any logging information. There are seven levels of logging defined within the API: OFF, DEBUG, INFO, ERROR, WARN, FATAL, and ALL.

Filter Object

The Filter object is used to analyze logging information and make further decisions on whether that information should be logged or not.

An Appender objects can have several Filter objects associated with them. If logging information is passed to a particular Appender object, all the Filter objects associated with that Appender need to approve the logging information before it can be published to the attached destination.

ObjectRenderer

The ObjectRenderer object is specialized in providing a String representation of different objects passed to the logging framework. This object is used by Layout objects to prepare the final logging information.

LogManager

The LogManager object manages the logging framework. It is responsible for reading the initial configuration parameters from a system-wide configuration file or a configuration class.

4. Configuration

The previous chapter explained the core components of log4j. This chapter explains how you can configure the core components using a configuration file. Configuring log4j involves assigning the Level, defining Appender, and specifying Layout objects in a configuration file.

The *log4j.properties* file is a log4j configuration file which keeps properties in key-value pairs. By default, the LogManager looks for a file named *log4j.properties* in the CLASSPATH.

- The level of the root logger is defined as DEBUG. The DEBUG attaches the appender named X to it.
- Set the appender named X to be a valid appender.
- Set the layout for the appender X.

log4j.properties Syntax

Following is the syntax of *log4j.properties* file for an appender X:

```
# Define the root logger with appender X
log4j.rootLogger = DEBUG, X

# Set the appender named X to be a File appender
log4j.appender.X=org.apache.log4j.FileAppender

# Define the layout for X appender
log4j.appender.X.layout=org.apache.log4j.PatternLayout
log4j.appender.X.layout.conversionPattern=%m%n
```

log4j.properties Example

Using the above syntax, we define the following in *log4j.properties* file:

- The level of the root logger is defined as DEBUG. The DEBUG the appender named FILE to it.
- The appender FILE is defined as *org.apache.log4j.FileAppender*. It writes to a file named "log.out" located in the log directory.
- The layout pattern defined is *%m%n,* which means the printed logging message will be followed by a newline character.

```
# Define the root logger with appender file
log4j.rootLogger = DEBUG, FILE
```

```
# Define the file appender
log4j.appender.FILE=org.apache.log4j.FileAppender
log4j.appender.FILE.File=${log}/log.out

# Define the layout for file appender
log4j.appender.FILE.layout=org.apache.log4j.PatternLayout
log4j.appender.FILE.layout.conversionPattern=%m%n
```

It is important to note that log4j supports UNIX-style variable substitution such as ${variableName}.

Debug Level

We have used DEBUG with both the appenders. All the possible options are:

- TRACE
- DEBUG
- INFO
- WARN
- ERROR
- FATAL
- ALL

These levels would be explained in Log4j Logging Levels.

Appenders

Apache log4j provides Appender objects which are primarily responsible for printing logging messages to different destinations such as consoles, files, sockets, NT event logs, etc.

Each Appender object has different properties associated with it, and these properties indicate the behavior of that object.

Property	**Description**
layout	Appender uses the Layout objects and the conversion pattern associated with them to format the logging information.
target	The target may be a console, a file, or another item depending on the appender.

level	The level is required to control the filtration of the log messages.
threshold	Appender can have a threshold level associated with it independent of the logger level. The Appender ignores any logging messages that have a level lower than the threshold level.
filter	The Filter objects can analyze logging information beyond level matching and decide whether logging requests should be handled by a particular Appender or ignored.

We can add an Appender object to a Logger by including the following setting in the configuration file with the following method:

```
log4j.logger.[logger-name]=level, appender1,appender..n
```

You can write same configuration in XML format as follows:

```
<logger name="com.apress.logging.log4j" additivity="false">
   <appender-ref ref="appender1"/>
   <appender-ref ref="appender2"/>
</logger>
```

If you are willing to add Appender object inside your program then you can use following method:

```
public void addAppender(Appender appender);
```

The addAppender() method adds an Appender to the Logger object. As the example configuration demonstrates, it is possible to add many Appender objects to a logger in a comma-separated list, each printing logging information to separate destinations.

We have used only one appender *FileAppender* in our example above. All the possible appender options are:

- AppenderSkeleton
- AsyncAppender
- ConsoleAppender
- DailyRollingFileAppender
- ExternallyRolledFileAppender
- FileAppender
- JDBCAppender
- JMSAppender
- LF5Appender
- NTEventLogAppender

- NullAppender
- RollingFileAppender
- SMTPAppender
- SocketAppender
- SocketHubAppender
- SyslogAppender
- TelnetAppender
- WriterAppender

We would cover FileAppender in Logging in Files and JDBC Appender would be covered in Logging in Database.

Layout

We have used PatternLayout with our appender. All the possible options are:

- DateLayout
- HTMLLayout
- PatternLayout
- SimpleLayout
- XMLLayout

Using HTMLLayout and XMLLayout, you can generate log in HTML and in XML format as well.

Layout Formatting

You would learn how to format a log message in chapter: Log Formatting.

5. Sample Program

We have seen how to create a configuration file. This chapter describes how to generate debug messages and log them in a simple text file.

Following is a simple configuration file created for our example. Let us revise it once again:

- The level of the root logger is defined as DEBUG and attaches appender named FILE to it.
- The appender FILE is defined as org.apache.log4j.FileAppender and writes to a file named "log.out" located in the **log** directory.
- The layout pattern defined is %m%n, which means the printed logging message will be followed by a newline character.

The contents of *log4j.properties* file are as follows:

```
# Define the root logger with appender file
log = /usr/home/log4j
log4j.rootLogger = DEBUG, FILE

# Define the file appender
log4j.appender.FILE=org.apache.log4j.FileAppender
log4j.appender.FILE.File=${log}/log.out

# Define the layout for file appender
log4j.appender.FILE.layout=org.apache.log4j.PatternLayout
log4j.appender.FILE.layout.conversionPattern=%m%n
```

Using log4j in Java Program

The following Java class is a very simple example that initializes and then uses the Log4J logging library for Java applications.

```
import org.apache.log4j.Logger;

import java.io.*;
import java.sql.SQLException;
import java.util.*;

```

```
public class log4jExample{
  /* Get actual class name to be printed on */
  static Logger log = Logger.getLogger(log4jExample.class.getName());

  public static void main(String[] args)
                throws IOException,SQLException{

     log.debug("Hello this is  a debug message");
     log.info("Hello this is an info message");
  }
}
```

Compile and Execute

Here are the steps to compile and run the above-mentioned program. Make sure you have set PATH and CLASSPATH appropriately before proceeding for the compilation and execution.

All the libraries should be available in CLASSPATH and your *log4j.properties* file should be available in PATH. Follow the steps given below:

- Create log4j.properties as shown above.
- Create log4jExample.java as shown above and compile it.
- Execute log4jExample binary to run the program.

You would get the following result inside /usr/home/log4j/log.out file:

```
Hello this is a debug message
Hello this is an info message
```

6. Logging Methods

Logger class provides a variety of methods to handle logging activities. The Logger class does not allow us to instantiate a new Logger instance but it provides two static methods for obtaining a Logger object:

- public static Logger getRootLogger();
- public static Logger getLogger(String name);

The first of the two methods returns the application instance's root logger and it does not have a name.

Any other named Logger object instance is obtained through the second method by passing the name of the logger. The name of the logger can be any string you can pass, usually a class or a package name as we have used in the last chapter and it is mentioned below:

```
static Logger log = Logger.getLogger(log4jExample.class.getName());
```

Logging Methods

Once we obtain an instance of a named logger, we can use several methods of the logger to log messages. The Logger class has the following methods for printing the logging information.

Sr. No.	Methods and Description
1	public void debug(Object message) It prints messages with the level Level.DEBUG.
2	public void error(Object message) It prints messages with the level Level.ERROR.
3	public void fatal(Object message); It prints messages with the level Level.FATAL.
4	public void info(Object message); It prints messages with the level Level.INFO.
5	public void warn(Object message); It prints messages with the level Level.WARN.

6	public void trace(Object message); It prints messages with the level Level.TRACE.

All the levels are defined in the org.apache.log4j.Level class and any of the above-mentioned methods can be called as follows:

```
import org.apache.log4j.Logger;


public class LogClass {
   private static org.apache.log4j.Logger log = Logger
                                  .getLogger(LogClass.class);
   public static void main(String[] args) {
      log.trace("Trace Message!");
      log.debug("Debug Message!");
      log.info("Info Message!");
      log.warn("Warn Message!");
      log.error("Error Message!");
      log.fatal("Fatal Message!");
   }
}
```

When you compile and run LogClass program, it would generate the following result:

```
Debug Message!
Info Message!
Warn Message!
Error Message!
Fatal Message!
```

All the debug messages make more sense when they are used in combination with levels. We will cover levels in the next chapter and then, you would have a good understanding of how to use these methods in combination with different levels of debugging.

7. Logging Levels

The org.apache.log4j.Level class provides the following levels. You can also define your custom levels by sub-classing the Level class.

Level	Description
ALL	All levels including custom levels.
DEBUG	Designates fine-grained informational events that are most useful to debug an application.
ERROR	Designates error events that might still allow the application to continue running.
FATAL	Designates very severe error events that will presumably lead the application to abort.
INFO	Designates informational messages that highlight the progress of the application at coarse-grained level.
OFF	The highest possible rank and is intended to turn off logging.
TRACE	Designates finer-grained informational events than the DEBUG.
WARN	Designates potentially harmful situations.

How do Levels Work?

A log request of level **p** in a logger with level **q** is enabled if p >= q. This rule is at the heart of log4j. It assumes that levels are ordered. For the standard levels, we have ALL < DEBUG < INFO < WARN < ERROR < FATAL < OFF.

The following example shows how we can filter all our DEBUG and INFO messages. This program uses the logger method setLevel (Level.X) to set a desired logging level:

This example would print all the messages except Debug and Info:

```
import org.apache.log4j.*;


public class LogClass {
   private static org.apache.log4j.Logger log = Logger.getLogger(LogClass.class);
   public static void main(String[] args) {
      log.setLevel(Level.WARN);

      log.trace("Trace Message!");
      log.debug("Debug Message!");
      log.info("Info Message!");
      log.warn("Warn Message!");
      log.error("Error Message!");
      log.fatal("Fatal Message!");
   }
}
```

When you compile and run the LogClass program, it would generate the following result:

```
Warn Message!
Error Message!
Fatal Message!
```

Setting Levels using Configuration File

Log4j provides you configuration file based level setting which sets you free from changing the source code when you want to change the debugging level.

Following is an example configuration file which would perform the same task as we did using the *log.setLevel(Level.WARN)* method in the above example.

```
# Define the root logger with appender file
log = /usr/home/log4j
log4j.rootLogger = WARN, FILE

# Define the file appender
log4j.appender.FILE=org.apache.log4j.FileAppender
log4j.appender.FILE.File=${log}/log.out

# Define the layout for file appender
log4j.appender.FILE.layout=org.apache.log4j.PatternLayout
log4j.appender.FILE.layout.conversionPattern=%m%n
```

Let us now use our following program:

```
import org.apache.log4j.*;

public class LogClass {
   private static org.apache.log4j.Logger log = Logger.getLogger(LogClass.class);
   public static void main(String[] args) {
      log.trace("Trace Message!");
      log.debug("Debug Message!");
      log.info("Info Message!");
      log.warn("Warn Message!");
      log.error("Error Message!");
      log.fatal("Fatal Message!");
   }
}
```

Now compile and run the above program and you would get following result in /usr/home/log4j/log.out file:

```
Warn Message!
Error Message!
Fatal Message!
```

8. Log Formatting

Apache log4j provides various Layout objects, each of which can format logging data according to various layouts. It is also possible to create a Layout object that formats logging data in an application-specific way.

All Layout objects receive a LoggingEvent object from the Appender objects. The Layout objects then retrieve the message argument from the LoggingEvent and apply the appropriate ObjectRenderer to obtain the String representation of the message.

The Layout Types

The top-level class in the hierarchy is the abstract class org.apache.log4j.Layout. This is the base class for all other Layout classes in the log4j API.

The Layout class is defined as abstract within an application, we never use this class directly; instead, we work with its subclasses which are as follows:

- DateLayout
- HTMLLayout
- PatternLayout
- SimpleLayout
- XMLLayout

HTMLLayout

If you want to generate your logging information in an HTML-formatted file, then you can use org.apache.log4j.HTMLLayout to format your logging information.

The HTMLLayout class extends the abstract org.apache.log4j.Layout class and overrides the format() method from its base class to provide HTML-style formatting.

It provides the following information to be displayed:

- The time elapsed from the start of the application before a particular logging event was generated.
- The name of the thread that invoked the logging request.
- The level associated with this logging request.
- The name of the logger and logging message.
- The optional location information for the program file and the line number from which this logging was invoked.

HTMLLayout is a very simple Layout object that provides the following methods:

S.N.	Method & Description
1	**setContentType(String)** Sets the content type of the text/html HTML content. Default is text/html.
2	**setLocationInfo(String)** Sets the location information for the logging event. Default is false.
3	**setTitle(String)** Sets the title for the HTML file. Default is Log4j Log Messages.

HTMLLayout Example

Following is a simple configuration file for HTMLLayout:

```
# Define the root logger with appender file
log = /usr/home/log4j
log4j.rootLogger = DEBUG, FILE

# Define the file appender
log4j.appender.FILE=org.apache.log4j.FileAppender
log4j.appender.FILE.File=${log}/htmlLayout.html

# Define the layout for file appender
log4j.appender.FILE.layout=org.apache.log4j.HTMLLayout
log4j.appender.FILE.layout.Title=HTML Layout Example
log4j.appender.FILE.layout.LocationInfo=true
```

Now consider the following Java Example which would generate logging information:

```
import org.apache.log4j.Logger;


import java.io.*;
import java.sql.SQLException;
import java.util.*;


public class log4jExample{
  /* Get actual class name to be printed on */
  static Logger log = Logger.getLogger(
                      log4jExample.class.getName());

  public static void main(String[] args)
                throws IOException,SQLException{

     log.debug("Hello this is a debug message");
     log.info("Hello this is an info message");
  }
}
```

Compile and run the above program. It would create an htmlLayout.html file in /usr/home/log4j directory which would have the following log information:

Log session start time Mon Mar 22 13:30:24 AST 2010

Time	Thread	Level	Category	File:Line	Message
0	main	DEBUG	log4jExample	log4jExample.java:15	Hello this is a debug message
6	main	INFO	log4jExample	log4jExample.java:16	Hello this is an info message

You would use a web browser to open htmlLayout.html file. It is also important to note that the footer for the </html> and </body> tags is completely missing.

One of the big advantages of having the log file in HTML format is that it can be published as a web page for remote viewing.

PatternLayout

If you want to generate your logging information in a particular format based on a pattern, then you can use org.apache.log4j.PatternLayout to format your logging information.

The PatternLayout class extends the abstract org.apache.log4j.Layout class and overrides the format() method to structure the logging information according to a supplied pattern.

PatternLayout is also a simple Layout object that provides the following *Bean Property* which can be set using the configuration file:

S.N.	Property & Description
1	**conversionPattern** Sets the conversion pattern. Default is %r [%t] %p %c %x - %m%n

Pattern Conversion Characters

The following table explains the characters used in the above pattern and all other characters that you can use in your custom pattern:

Conversion Character	Meaning
c	Used to output the category of the logging event. For example, for the category name "a.b.c" the pattern %c{2} will output "b.c".
C	Used to output the fully qualified class name of the caller issuing the logging request. For example, for the class name "org.apache.xyz.SomeClass", the pattern %C{1} will output "SomeClass".
d	Used to output the date of the logging event. For example, %d{HH:mm:ss,SSS} or %d{dd MMM yyyy HH:mm:ss,SSS}.
F	Used to output the file name where the logging request was issued.
l	Used to output location information of the caller which generated the logging event.
L	Used to output the line number from where the logging request was issued.
m	Used to output the application supplied message associated with the logging event.
M	Used to output the method name where the logging request was issued.
n	Outputs the platform dependent line separator character or characters.
p	Used to output the priority of the logging event.
r	Used to output the number of milliseconds elapsed from the construction of the layout until the creation of the logging event.
t	Used to output the name of the thread that generated the logging event.
x	Used to output the NDC (nested diagnostic context) associated with the thread that generated the logging event.
X	The X conversion character is followed by the key for the MDC. For example, X{clientIP} will print the information stored in the MDC against the key clientIP.
%	The literal percent sign. %% will print a % sign.

Format Modifiers

By default, the relevant information is displayed as output as is. However, with the aid of format modifiers, it is possible to change the minimum field width, the maximum field width, and justification.

Following table covers various modifiers scenarios:

Format modifier	left justify	minimum width	maximum width	comment
%20c	false	20	none	Left pad with spaces if the category name is less than 20 characters long.
%-20c	true	20	none	Right pad with spaces if the category name is less than 20 characters long.
%.30c	NA	none	30	Truncate from the beginning if the category name is longer than 30 characters.
%20.30c	false	20	30	Left pad with spaces if the category name is shorter than 20 characters. However, if the category name is longer than 30 characters, then truncate from the beginning.
%-20.30c	true	20	30	Right pad with spaces if the category name is shorter than 20 characters. However, if category name is longer than 30 characters, then truncate from the beginning.

PatternLayout Example

Following is a simple configuration file for PatternLayout:

```
# Define the root logger with appender file
log = /usr/home/log4j
log4j.rootLogger = DEBUG, FILE
```

```
# Define the file appender
log4j.appender.FILE=org.apache.log4j.FileAppender
log4j.appender.FILE.File=${log}/log.out

# Define the layout for file appender
log4j.appender.FILE.layout=org.apache.log4j.PatternLayout
log4j.appender.FILE.layout.ConversionPattern=
      %d{yyyy-MM-dd}-%t-%x-%-5p-%-10c:%m%n
```

Now consider the following Java Example which would generate logging information:

```
import org.apache.log4j.Logger;

import java.io.*;
import java.sql.SQLException;
import java.util.*;

public class log4jExample{
  /* Get actual class name to be printed on */
  static Logger log = Logger.getLogger(log4jExample.class.getName());

  public static void main(String[] args)
                throws IOException,SQLException{

     log.debug("Hello this is a debug message");
     log.info("Hello this is an info message");
  }
}
```

Compile and run the above program. It would create a log.out file in /usr/home/log4j directory which would have the following log information:

```
2010-03-23-main--DEBUG-log4jExample:Hello this is a debug message
2010-03-23-main--INFO -log4jExample:Hello this is an info message
```

The Layout Methods

This class provides a skeleton implementation of all the common operations across all other Layout objects and declares two abstract methods.

Sr. No.	Methods and Description
1	**public abstract boolean ignoresThrowable()** It indicates whether the logging information handles any java.lang.Throwable object passed to it as a part of the logging event. If the Layout object handles the Throwable object, then the Layout object does not ignore it, and returns false.
2	**public abstract String format(LoggingEvent event)** Individual layout subclasses implement this method for layout specific formatting.

Apart from these abstract methods, the Layout class provides concrete implementation for the methods listed below:

Sr. No.	Methods and Description
1	**public String getContentType()** It returns the content type used by the Layout objects. The base class returns text/plain as the default content type.
2	**public String getFooter()** It specifies the footer information of the logging message.
3	**public String getHeader()** It specifies the header information of the logging message.

Each subclass can return class-specific information by overriding the concrete implementation of these methods.

9. Logging in Files

To write your logging information into a file, you would have to use *org.apache.log4j.FileAppender*.

FileAppender Configuration

FileAppender has the following configurable parameters:

Property	Description
immediateFlush	This flag is by default set to true, which means the output stream to the file being flushed with each append operation.
encoding	It is possible to use any character-encoding. By default, it is the platform-specific encoding scheme.
threshold	The threshold level for this appender.
Filename	The name of the log file.
fileAppend	This is by default set to true, which means the logging information being appended to the end of the same file.
bufferedIO	This flag indicates whether we need buffered writing enabled. By default, it is set to false.
bufferSize	If buffered I/O is enabled, it indicates the buffer size. By default, it is set to 8 kb.

Following is a sample configuration file *log4j.properties* for FileAppender.

```
# Define the root logger with appender file
log4j.rootLogger = DEBUG, FILE


# Define the file appender
log4j.appender.FILE=org.apache.log4j.FileAppender
# Set the name of the file
```

```
log4j.appender.FILE.File=${log}/log.out

# Set the immediate flush to true (default)
log4j.appender.FILE.ImmediateFlush=true

# Set the threshold to debug mode
log4j.appender.FILE.Threshold=debug

# Set the append to false, overwrite
log4j.appender.FILE.Append=false

# Define the layout for file appender
log4j.appender.FILE.layout=org.apache.log4j.PatternLayout
log4j.appender.FILE.layout.conversionPattern=%m%n
```

If you wish to have an XML configuration file equivalent to the above *log4j.properties* file, then here is the content:

```
<?xml version="1.0" encoding="UTF-8" ?>
<!DOCTYPE log4j:configuration SYSTEM "log4j.dtd">
<log4j:configuration>

<appender name="FILE" class="org.apache.log4j.FileAppender">
   <param name="file" value="${log}/log.out"/>
   <param name="immediateFlush" value="true"/>
   <param name="threshold" value="debug"/>
   <param name="append" value="false"/>
   <layout class="org.apache.log4j.PatternLayout">
      <param name="conversionPattern" value="%m%n"/>
   </layout>
</appender>

<logger name="log4j.rootLogger" additivity="false">
   <level value="DEBUG"/>
   <appender-ref ref="FILE"/>
</logger>
```

```
</log4j:configuration>
```

You can try log4j - Sample Program with the above configuration.

Logging in Multiple Files

You may want to write your log messages into multiple files for certain reasons, for example, if the file size reached to a certain threshold.

To write your logging information into multiple files, you would have to use *org.apache.log4j.RollingFileAppender* class which extends the *FileAppender* class and inherits all its properties.

We have the following configurable parameters in addition to the ones mentioned above for FileAppender:

Property	Description
maxFileSize	This is the critical size of the file above which the file will be rolled. Default value is 10 MB.
maxBackupIndex	This property denotes the number of backup files to be created. Default value is 1.

Following is a sample configuration file *log4j.properties* for RollingFileAppender.

```
# Define the root logger with appender file
log4j.rootLogger = DEBUG, FILE

# Define the file appender
log4j.appender.FILE=org.apache.log4j.RollingFileAppender
# Set the name of the file
log4j.appender.FILE.File=${log}/log.out

# Set the immediate flush to true (default)
log4j.appender.FILE.ImmediateFlush=true

# Set the threshold to debug mode
log4j.appender.FILE.Threshold=debug

# Set the append to false, should not overwrite
log4j.appender.FILE.Append=true
```

```
# Set the maximum file size before rollover
log4j.appender.FILE.MaxFileSize=5KB

# Set the the backup index
log4j.appender.FILE.MaxBackupIndex=2

# Define the layout for file appender
log4j.appender.FILE.layout=org.apache.log4j.PatternLayout
log4j.appender.FILE.layout.conversionPattern=%m%n
```

If you wish to have an XML configuration file, you can generate the same as mentioned in the initial section and add only additional parameters related to *RollingFileAppender*.

This example configuration demonstrates that the maximum permissible size of each log file is 5 MB. Upon exceeding the maximum size, a new log file will be created. Since *maxBackupIndex* is defined as 2, once the second log file reaches the maximum size, the first log file will be erased and thereafter, all the logging information will be rolled back to the first log file.

You can try log4j - Sample Program with the above configuration.

Daily Log File Generation

There may be a requirement to generate your log files on a daily basis to keep a clean record of your logging information.

To write your logging information into files on a daily basis, you would have to use *org.apache.log4j.DailyRollingFileAppender* class which extends the *FileAppender* class and inherits all its properties.

There is only one important configurable parameter in addition to the ones mentioned above for FileAppender:

Property	Description
DatePattern	This indicates when to roll over the file and the naming convention to be followed. By default, roll over is performed at midnight each day.

DatePattern controls the rollover schedule using one of the following patterns:

DatePattern	Description
'.' yyyy-MM	Roll over at the end of each month and at the beginning of the next month.
'.' yyyy-MM-dd	Roll over at midnight each day. This is the default value.
'.' yyyy-MM-dd-a	Roll over at midday and midnight of each day.
'.' yyyy-MM-dd-HH	Roll over at the top of every hour.
'.' yyyy-MM-dd-HH-mm	Roll over every minute.
'.' yyyy-ww	Roll over on the first day of each week depending upon the locale.

Following is a sample configuration file *log4j.properties* to generate log files rolling over at midday and midnight of each day.

```
# Define the root logger with appender file
log4j.rootLogger = DEBUG, FILE

# Define the file appender
log4j.appender.FILE=org.apache.log4j.DailyRollingFileAppender
# Set the name of the file
log4j.appender.FILE.File=${log}/log.out

# Set the immediate flush to true (default)
log4j.appender.FILE.ImmediateFlush=true

# Set the threshold to debug mode
log4j.appender.FILE.Threshold=debug

# Set the append to false, should not overwrite
log4j.appender.FILE.Append=true

# Set the DatePattern
```

```
log4j.appender.FILE.DatePattern='.' yyyy-MM-dd-a


# Define the layout for file appender
log4j.appender.FILE.layout=org.apache.log4j.PatternLayout
log4j.appender.FILE.layout.conversionPattern=%m%n
```

If you wish to have an XML configuration file, you can generate the same as mentioned in the initial section and add only additional parameters related to *DailyRollingFileAppender*.

You can try log4j - Sample Program with the above configuration.

10. Logging in Database

The log4j API provides the *org.apache.log4j.jdbc.JDBCAppender* object, which can put logging information in a specified database.

JDBCAppender Configuration

Property	Description
bufferSize	Sets the buffer size. Default size is 1.
driver	Sets the driver class to the specified string. If no driver class is specified, it defaults to sun.jdbc.odbc.JdbcOdbcDriver.
layout	Sets the layout to be used. Default layout is org.apache.log4j.PatternLayout.
password	Sets the database password.
sql	Specifies the SQL statement to be executed every time a logging event occurs. This could be INSERT, UPDATE, or DELETE.
URL	Sets the JDBC URL.
user	Sets the database user name.

Log Table Configuration

Before you start using JDBC based logging, you should create a table to maintain all the log information. Following is the SQL Statement for creating the LOGS table:

```
CREATE TABLE LOGS
   (USER_ID VARCHAR(20) NOT NULL,
    DATED   DATE NOT NULL,
    LOGGER  VARCHAR(50) NOT NULL,
    LEVEL   VARCHAR(10) NOT NULL,
    MESSAGE VARCHAR(1000) NOT NULL
   );
```

Sample Configuration File

Following is a sample configuration file *log4j.properties* for JDBCAppender which is used to log messages to a LOGS table.

```
# Define the root logger with appender file
log4j.rootLogger = DEBUG, DB

# Define the DB appender
log4j.appender.DB=org.apache.log4j.jdbc.JDBCAppender

# Set JDBC URL
log4j.appender.DB.URL=jdbc:mysql://localhost/DBNAME

# Set Database Driver
log4j.appender.DB.driver=com.mysql.jdbc.Driver

# Set database user name and password
log4j.appender.DB.user=user_name
log4j.appender.DB.password=password

# Set the SQL statement to be executed.
log4j.appender.DB.sql=INSERT INTO LOGS
                      VALUES('%x','%d','%C','%p','%m')

# Define the layout for file appender
log4j.appender.DB.layout=org.apache.log4j.PatternLayout
```

For MySQL database, you would have to use the actual DBNAME, user ID, and password, where you have created LOGS table. The SQL statement is to execute an INSERT statement with the table name LOGS and the values to be entered into the table.

JDBCAppender does not need a layout to be defined explicitly. Instead, the SQL statement passed to it uses a PatternLayout.

If you wish to have an XML configuration file equivalent to the above *log4j.properties* file, then here is the content:

```
<?xml version="1.0" encoding="UTF-8" ?>
<!DOCTYPE log4j:configuration SYSTEM "log4j.dtd">
<log4j:configuration>
```

```
<appender name="DB" class="org.apache.log4j.jdbc.JDBCAppender">
   <param name="url" value="jdbc:mysql://localhost/DBNAME"/>
   <param name="driver" value="com.mysql.jdbc.Driver"/>
   <param name="user" value="user_id"/>
   <param name="password" value="password"/>
   <param name="sql" value="INSERT INTO LOGS VALUES('%x',
                             '%d','%C','%p','%m')"/>
   <layout class="org.apache.log4j.PatternLayout">
   </layout>

</appender>


<logger name="log4j.rootLogger" additivity="false">
   <level value="DEBUG"/>
   <appender-ref ref="DB"/>
</logger>


</log4j:configuration>
```

Sample Program

The following Java class is a very simple example that initializes and then uses the Log4J logging library for Java applications.

```
import org.apache.log4j.Logger;
import java.sql.*;
import java.io.*;
import java.util.*;


public class log4jExample{
  /* Get actual class name to be printed on */
  static Logger log = Logger.getLogger(log4jExample.class.getName());


  public static void main(String[] args)
                throws IOException,SQLException{
```

```
      log.debug("Debug");
      log.info("Info");
   }
}
```

Compile and Execute

Here are the steps to compile and run the above-mentioned program. Make sure you have set PATH and CLASSPATH appropriately before proceeding for compilation and execution.

All the libraries should be available in CLASSPATH and your *log4j.properties* file should be available in PATH. Follow the given steps:

- Create log4j.properties as shown above.
- Create log4jExample.java as shown above and compile it.
- Execute log4jExample binary to run the program.

Now check your LOGS table inside DBNAME database and you would find the following entries:

```
mysql >  select * from LOGS;
+---------+------------+-------------+-------+---------+
| USER_ID | DATED      | LOGGER      | LEVEL | MESSAGE |
+---------+------------+-------------+-------+---------+
|         | 2010-05-13 | log4jExample | DEBUG | Debug   |
|         | 2010-05-13 | log4jExample | INFO  | Info    |
+---------+------------+-------------+-------+---------+
2 rows in set (0.00 sec)
```

Note: Here **x** is used to output the Nested Diagnostic Context (NDC) associated with the thread that generated the logging event. We use NDC to distinguish clients in server-side components handling multiple clients. Check Log4J Manual for more information on this.