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Logging

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Objectives

After completing this lesson, you should be able to:

- Add a logging mechanism to your Java application
- Log messages to a file at an appropriate level
- Configure your logger
- Configure logging formatters and handlers

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Topics

- Logging API overview
- Logging configuration
- Logging examples
- Configuration files and custom handlers

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Logging Overview

For software applications, logging systems provide end users, system administrators, and developers with reports for troubleshooting and maintaining their systems. Logging systems are typically used for:

- Monitoring security
- Providing configuration information
- Reporting on errors or problems with a system
- Troubleshooting systems

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When considering whether to use logging in you application, consider this statement from Brian W. Kernighan and Rob Pike from the book *The Practice of Programming*:

As personal choice, we tend not to use debuggers beyond getting a stack trace or the value of a variable or two. One reason for this is that it is easy to get lost in the details of complicated data structures and control flow; we find stepping through a program less productive than thinking harder and adding output statements and self-checking code at critical places. Clicking over statements takes longer than scanning the output of judiciously-placed displays. It takes less time to decide where to put print statements than to single-step to the critical section of code, even assuming that we know where that is. More important, debugging statements stay with the program; debugging sessions are transient.

Reference: http://logging.apache.org/log4j/1.2/manual.html

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Using the Java Logging API

To use the Java Logging API you need to:

- Create a logger object
  - Logging objects are found in the `java.util.logging` package

```
Logger logger = Logger.getLogger("com.example.ClassName");
```

- Configure the logger object
- Send messages to the logger object

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The Java Logging API classes can be found in the `java.util.logging` package.

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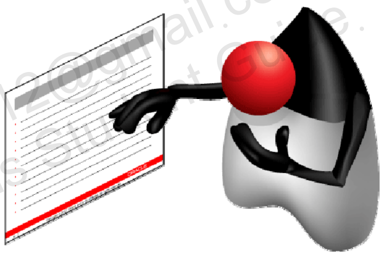

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Configure the Logger Handler

The logging API is contained in the `java.util.logging` package. The core class in the API is the **Logger** class. Setting the level for a Logger determines what messages are logged. A Logger object is associated with one or more handlers. The handler is responsible for publishing the log message. Predefined handlers include:

- `StreamHandler`
- `ConsoleHandlder`
- `FileHandler`
- `SocketHandler`
- `MemoryHandler`

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A logger object is associated with one or more handlers. The handler is responsible for the publication of the log message. This responsibility includes specifying both the format and the output location. Examples of an output location are a console and a file.

The logging API provides the following handlers:

- `StreamHandler`: A simple handler for writing formatted records to an OutputStream object
- `ConsoleHandler`: A simple handler for writing formatted records to the System.err stream
- `FileHandler`: A handler that writes formatted log records either to a single file or to a set of rotating log files
- `SocketHandler`: A handler that writes formatted log records to remote TCP ports
- `MemoryHandler`: A handler that buffers log records in memory

Note: The default handler associated with the logger instance is the `StreamHandler`.

Configure the Logger Formatter

Once a handler is assigned, set the Formatter that determines the format of the log file. There are two predefined formatters:

- `SimpleFormatter`
- `XMLFormatter`

The `XMLFormatter` is the default in Java 7.

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Java includes two standard Formatters:

`SimpleFormatter`: Writes brief “human-readable” summaries of log records.

`XMLFormatter`: Writes detailed XML-structured information.

As with Handlers, it is fairly straightforward to develop new Formatters.

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Configure the Logger Level

Logging output is controlled by using levels to define the importance of messages.

- The predefined levels, from highest to lowest, are:
  - SEVERE
  - WARNING
  - INFO
  - CONFIG
  - FINE
  - FINER
  - FINEST
- Two special levels of ALL or OFF are also available.

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The level information is used in two ways: Firstly for recording logging error messages. SEVERE error would be the most serious, and probably should always be logged. FINEST would be the least important and probably should not be logged.

Setting the log lever for a logger. For example, `logger.setLevel(Level.INFO);` would log any messages that had their severity set to INFO, WARNING, or SEVERE.

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Quiz

Setting the logging level:

a. Determines the location and the name of the log file
b. Has no effect on the log file
c. Provides military grade security and encryption to your application, making it much tougher to hack
d. Determines which messages are logged and, therefore, the amount of detail in the log

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Answer: d

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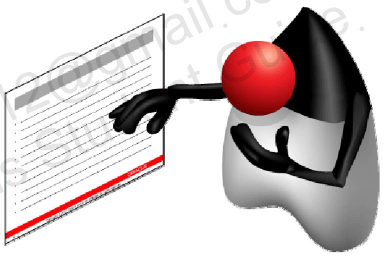

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Logger Example: `main()`

```
public static void main(String[] args) {
   BasicLogging bl = new BasicLogging();
   bl.logger = Logger.getLogger("com.example.BasicLogging");

   try {
       bl.logger.addHandler(new FileHandler("Basic.log"));
       bl.logger.setLevel(Level.INFO);
       bl.logMessages();
   } catch (IOException e){
       e.getMessage();
   }
}
```

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Logger Example: `logMessages()`

```
public void logMessages(){
    logger.severe("A very severe problem has occurred");
    logger.warning("Warning, something bad may be happening");
    logger.log(Level.INFO,"Here is INFO you may want to know
   about");
    logger.config("Here is some info about your CONFIG");
    logger.fine("This is some really FINE info");
    logger.finer("This is even FINER info");
    logger.finest("This is the FINEST info");
}
```

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Logger Example: `basic.log`

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<!DOCTYPE log SYSTEM "logger.dtd">
<log>
<record>
  <date>2011-12-21T19:11:51</date>
  <millis>1324519911801</millis>
  <sequence>0</sequence>
  <logger>com.example.BasicLogging</logger>
  <level>SEVERE</level>
  <class>com.example.BasicLogging</class>
  <method>logMessages</method>
  <thread>1</thread>
  <message>A very severe problem has occured</message>
</record>
<!- Additional records here -->
</log>
```

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If you look at the file created from the program, only three messages are included the SEVERE, WARNING, and INFO messages. The other messages are not included, why?

Because of the logging level. Setting the logging level to INFO means that only messages of the INFO level and more severe are included.

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Logger Example: `SimpleLogging.java`

```
public static void main(String[] args) {
    SimpleLogging sl = new SimpleLogging();
    sl.logger = Logger.getLogger("com.example.SimpleLogging");

    try {
        FileHandler fh = new FileHandler("simple.log");
        fh.setFormatter(new SimpleFormatter());
        sl.logger.addHandler(fh);
        sl.logger.setLevel(Level.CONFIG);
        sl.logMessages();
    } catch (IOException e){
        e.getMessage();
    }
}
```

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Once you create a handler, you assign the formatter of your choice as shown in the slide.

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Logger Example: `simple.log`

```
Dec 21, 2011 7:44:49 PM com.example.SimpleLogging logMessages
SEVERE: A very severe problem has occured
Dec 21, 2011 7:44:49 PM com.example.SimpleLogging logMessages
WARNING: Warning, something bad may be happening
Dec 21, 2011 7:44:49 PM com.example.SimpleLogging logMessages
INFO: Here is INFO you may want to know about
Dec 21, 2011 7:44:49 PM com.example.SimpleLogging logMessages
CONFIG: Here is some info about your CONFIG
```

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The SimpleFormatter produces simple single-line messages like those shown in the slide. Notice that, because the logging level was set to CONFIG, four messages are included in this log file.

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Quiz

Which two are default logging formatters?

a. SimpleFormatter
b. XMLFormatter
c. BasicFormatter
d. HTMLFormatter

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Answer: a, b

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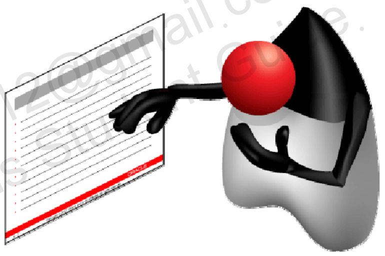

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File-Based Configuration

Logging configuration can be set up using a configuration file.

- The file is read at startup.
- It is a standard `java.util.Properties` file.
- A default sample file can be found in:
  `C:\ProgramFiles\Java\jdk1.7.0_03\jre\lib\logging.properties`

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Logging configuration can be controlled from a Java Properties file, `logging.properties`. An example file is included in:
`C:\ProgramFiles\Java\jdk1.7.0_03\jre\lib\logging.properties`

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Custom Log Handler

You can write your own handler to format logging messages.

- Extend the `Handler` class.
- Implement the `publish`, `flush` and `close` methods.
- `CustomLogHandler.java`

Sample output:

```
0 Dec 21, 2011 8:53:33 PM SEVERE A very severe problem has
occured com.example.CustomLogging logMessages
1 Dec 21, 2011 8:53:33 PM WARNING Warning, something bad may be
happening com.example.CustomLogging logMessages
2 Dec 21, 2011 8:53:33 PM INFO Here is INFO you may want to know
about com.example.CustomLogging logMessages
```

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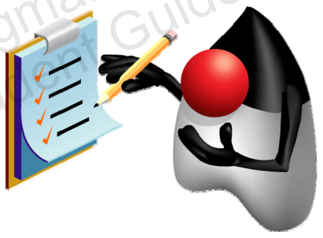
If you want more control over the information included in the log, you can create your own log handler.

Summary

In this lesson, you should have learned how to:

- Add a logging mechanism to your Java application
- Log messages to a file at an appropriate level
- Configure your logger
- Configure logging formatters and handlers



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Practice 16: Overview

Practice 16-1: Logging in Java Applications

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