

# Libraries

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Libraries



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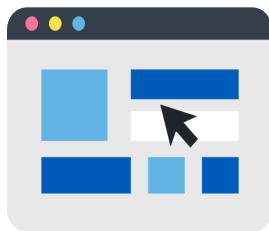
# Section 1

## Libraries



# Common functionality

- When writing Java code, it is often likely that a problem you want to solve has already been solved by another programmer elsewhere, e.g.
  - Adding authentication
  - Adding database functionality
  - Adding a Graphical User Interface (GUI)
  - Adding machine learning functions
- It doesn't make sense to re-invent the wheel and implement these from scratch.
- Ideally you would want to use methods and objects that others have already written.
  - We touched a little on this when we looked at packages in Week 7.



# A summary of Java libraries

- A library is a collection of classes and methods that have already been written, available to use.
- The library is accessed through an application programming interface (API), which connects the code the user is writing with the pre-written code in the library.
- Documentation is usually in the form of a *Javadoc*, an HTML document which specifies all of the methods, classes and parameters of the library API.



# Linking to Java libraries

- Connecting your code to the library is known as *linking* to the library.
- When compiling a program on the command line, Java will look for libraries the directory of the class you want to compile.
  - e.g compiling with `javac MyProgram.java` will look for libraries in the directory where `MyProgram.java` lies.
- However, we might want to link to libraries in other locations.



# Environment variables and Classpath

- An environment variable is a system-wide variable that can be accessed by any program running on your operating system.
- In addition to looking in the current directory, Java will also look for libraries in directories specified in the *CLASSPATH* environment variable.
  - Many programming languages use environment variables to specify where they should look for libraries.
  - In C++, the environment variable is called *LD\_LIBRARY\_PATH*.
  - In Python, the environment variable is called *PYTHONPATH*.
  - In Java, the environment variable is called *CLASSPATH*.



# Classpath on Linux/Mac (Demo)

- To see the current value of CLASSPATH, you can open up a Terminal window and use the *echo* command:
  - `echo $CLASSPATH`
- To add to the directory, you use the *export* command:
  - `export CLASSPATH=/path/to/your/directory:$CLASSPATH`
- Alternatively, you can add the parameter *-cp* to the compile statement:
  - `javac -cp .:path/to/first/jarFile.jar:path/to/second/jarFile.jar MyProgram.java`
- If you add the parameter to the compile statement, you must also add it to the run statement.



# Classpath on Windows

- To see the current value of CLASSPATH, you can open up a Command Prompt window and use the *echo* command:
  - `echo %CLASSPATH%`
- To add to the directory, you use the *set* command:
  - `set CLASSPATH=C:\path\to\your\directory;%CLASSPATH%`
- Alternatively, you can add the parameter *-cp* to the compile statement:
  - `javac -cp .;path\to\first\jarFile.jar;path\to\second\jarFile.jar MyProgram.java`
- If you add the parameter to the compile statement, you must also add it to the run statement.



# Adding directories to Classpath permanently

- If you close the terminal or command prompt window, the CLASSPATH variable will reset.
- To permanently add directories on Mac/Linux, you can add the export statement to your bash configuration file (e.g., ~/.bashrc, ~/.bash\_profile, ~/.zshrc):
  - `echo 'export CLASSPATH=/path/to/your/directory:$CLASSPATH'`  
`>> ~/.bashrc`
- To permanently add directories on Windows, you can add the CLASSPATH variable via System Properties:
  - Right click *Computer* or *This PC* and select *Properties*
  - Click *Advanced system settings*
  - Click *Environment Variables*
  - In the *System variables* section, click on *New* and add a variable named *CLASSPATH* with the value being the path to your directory.



## Section 2

# Maven



# A need for better library management

- We've seen how to link individual Java libraries to your java code using the CLASSPATH environment variable or via an IDE.
- Can anyone think of any problems when using libraries in this way?



# A need for better library management

- We've seen how to link individual Java libraries to your java code using the CLASSPATH environment variable or via an IDE.
- Can anyone think of any problems when using libraries in this way?
  - At scale it becomes difficult to keep track of all the libraries.
  - We have no way of updating libraries to more recent versions.
  - There may be dependencies shared between libraries which can cause problems.
  - We may want different libraries for different projects, requiring us to modify our CLASSPATH each time.



# Introducing Maven

- Maven is a project management and build automation tool, which addresses all of the problems that you encounter when using libraries manually.
- Within a Java project, an additional Project Object Model (POM) file will be included, called *pom.xml*.
- This file contains a description of all the libraries and dependencies of a project, which are retrieved from a central repository.



# pom.xml (Demo)

```
m pom.xml (ChartsDemoMaven) x Main.java
1  <?xml version="1.0" encoding="UTF-8"?>
2  <project xmlns="http://maven.apache.org/POM/4.0.0"
3      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
4      xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/xsd/maven-4.0.0.xsd">
5      <modelVersion>4.0.0</modelVersion>
6
7      <groupId>org.example</groupId>
8      <artifactId>ChartsDemoMaven</artifactId>
9      <version>1.0-SNAPSHOT</version>
10
11     <properties>
12         <maven.compiler.source>21</maven.compiler.source>
13         <maven.compiler.target>21</maven.compiler.target>
14         <project.build.sourceEncoding>UTF-8</project.build.sourceEncoding>
15     </properties>
16
17     <dependencies>
18         <dependency>
19             <groupId>org.jfree</groupId>
20             <artifactId>jfreechart</artifactId>
21             <version>1.5.4</version>
22         </dependency>
23
24     </dependencies>
25
26 </project>
```

## Section 3

# Lambda Expressions

# What is a Lambda Expression and Why?

- Lambda expressions are a new feature introduced in Java 8 (March 2014).
- In essence, a lambda expression is a short block of code which takes in parameters and returns a value. Lambda expressions are similar to methods, but they do not need a name and they can be implemented right in the body of a method.
- Why use lambda expressions?
  - Better and more compact code representation.
  - Better support for multi-core CPUs to process the data.
  - Allows you to implement an interface in a single line.



- Operator:  $\rightarrow$ 
  - The left side of the operator is the parameter(s), and the right side is the main body.
- A single parameter with one expression:
  - $\text{parameter} \rightarrow \text{expression}$
- Multiple parameters with one expression:
  - $(\text{parameter1}, \text{parameter2}, \dots) \rightarrow \text{expression}$
- With multiple statements:
  - $(\text{parameter1}, \text{parameter2}, \dots) \rightarrow \{\text{statements};\}$



# Lambda Expression Examples (Demo)

- You can easily access other local variables within the lambda expression, but there are some conditions:
  - Within lambda expression, it is NOT allowed to declare a parameter that shares the same name with a local variable.
  - The value of the local variables referenced/used in a lambda expression cannot be changed.
- Iterating collections using Lambda Expressions:
  - Select all the students who are male and younger than 22, put them into a new List and print out their name and id from that new List.



## Section 4

### Lecture summary

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**Thank you! Questions?**