STANDARD LIBRARIES

Standard libraries. Below is a table of the input and output libraries that we use throughout the textbook and beyond.

§	PROGRAM	DESCRIPTION / JAVADOC
1.5	StdIn.java	read numbers and text from standard input
1.5	StdOut.java	write numbers and text to standard output
1.5	StdDraw.java	draw geometric shapes in a window
1.5	StdAudio.java	create, play, and manipulate sound
2.2	StdRandom.java	generate random numbers
2.2	StdStats.java	compute statistics
2.2	StdArrayIO.java	read and write 1D and 2D arrays
3.1	In.java	read numbers and text from files and URLs
3.1	Out.java	write numbers and text to files
3.1	Draw.java	draw geometric shapes
3.1	DrawListener.java	support keyboard and mouse events in Draw
3.1	Picture.java	process color images
3.1	GrayscalePicture.java	process grayscale images
3.2	Stopwatch.java	measure running time (wall clock)
3.2	StopwatchCPU.java	measure running time (CPU)
–	BinaryStdIn.java	read bits from standard input
–	BinaryStdOut.java	write bits to standard output
–	BinaryIn.java	read bits from files and URLs
–	BinaryOut.java	write bits to files

Using the standard libraries. The file stdlib.jar bundles together all of our standard libraries into one file. To access the libraries, you must add `stdlib.jar` to your *Java classpath*. There are many ways to do so (and many opportunities to make mistakes). Here are the two recommended ways:

- *Use the javac-introcs and java-introcs commands.* If you followed our installation instructions for Mac OS X, Windows, or Linux, the commands `javac-introcs` and `java-introcs` are available from the command line (with OS X or Linux) or Git Bash (with Windows).

```
% javac-introcs MyProgram.java
% java-introcs  MyProgram
```

- *Use our IntelliJ project folders.* If you use IntelliJ, the project folders we supply are preconfigured to include `stdlib.jar` in the classpath.

Here are some alternatives:

- *Use the -classpath command-line option.* Put `stdlib.jar` in the same directory as the program you are writing (but do not unjar it). Then, compile and execute as follows:

```
OS X / Linux / Git Bash
-----------------------
% javac -classpath .:stdlib.jar MyProgram.java
% java  -classpath .:stdlib.jar MyProgram

Windows Commmand Prompt
-----------------------
% javac -classpath .;stdlib.jar MyProgram.java
% java  -classpath .;stdlib.jar MyProgram
```

  The `-classpath` option tells Java which directories to search for `.java` and `.class` files The `.` refers to the current directory (which contains `MyProgram.java` and `MyProgram.class`). The `stdlib.jar` refers to the `jar` file containing our standard libraries. On OS X, the `:` separates directories in the *classpath*; on Windows the `;` separates directories.

- *Current directory.* Perhaps the simplest (but definitely not the sanest) way to use the standard libraries to download `stdlib.jar` and unjar it in your current working directory.

```
% jar xf stdlib.jar
```

  Alternatively, you can download the individual `.java` files you need (such as `StdIn.java`) and put them in the same directory as the program you are writing. Then, compile and execute as usual.

```
% javac MyProgram.java
% java  MyProgram
```

  This approach has the drawback that you need a copy of each .java file you need in each directory where you need it.

- *Use the CLASSPATH environment variable.* You can set your system CLASSPATH environment variable to contain `stdlib.jar`. We do not recommend this approach because the CLASSPATH variable may be used by other applications.
- *Configure your IDE.* You can configure your IDE to include `stdlib.jar` in the classpath.
  - *IntelliJ: select File → Project Structure → Libraries.*
  - *Eclipse: select Project → Properties → Java Build Path → Libaries → Add External JARs.*
  - *DrJava: select Preferences → Extra Classpath → Add.*
  - *Windows Command Prompt: select Start → Computer → System Properties → Advanced → Environment Variables → User Variables → CLASSPATH.*

Standard input and standard output. StdIn.java and StdOut.java are libraries for reading in numbers and text from standard input and printing out numbers and text to standard output. Our versions have a simpler interface than the corresponding Java ones (and provide a few tecnical improvements). Average.java reads in a sequence of real numbers from standard input and prints their average on standard output.

```
% java Average
10.0 5.0 6.0 3.0 7.0 32.0
3.14 6.67 17.71
<Ctrl-d>
Average is 10.05777777777778
```

In.java and Out.java are object-oriented versions that support multiple input and output streams, including reading from a file or URL and writing to a file. Wget.java reads in data from the URL specified on the command line and save it in a file with the same name.

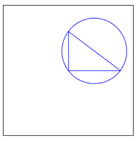
```
% java Wget "https://introcs.cs.princeton.edu/java/data/codes.csv"
% more codes.csv
United States,USA,00
Alabama,AL,01
Alaska,AK,02
...
```

Binary standard input and standard output. BinaryStdIn.java and BinaryStdOut.java are the analogs for binary data. Copy.java reads a binary file from standard input and writes it to standard output.

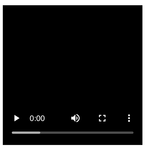
```
% java Copy < mandrill.jpg > copy.jpg
% diff mandrill.jpg copy.jpg
```

Standard drawing. StdDraw.java is an easy-to-use library for drawing geometric shapes, such as points, lines, and circles. RightTriangle.java draws a right triangle and a circumscribing circle.

```
% java RightTriangle
```



BouncingBall.java illustrates how to produce an animation using standard drawing.



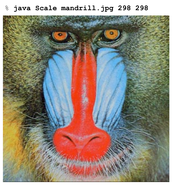
Draw.java is an object-oriented versions that support drawing in multiple windows.

Standard audio. StdAudio.java is an easy-to-use library for synthesizing sound. Tone.java reads in a frequency and duration from the command line, and it sonifies a sine wave of the given frequency for the given duration.

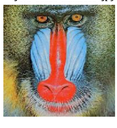
```
% java Tone 440.0 3.0
```


Image processing. Picture.java is an easy-to-use library for image processing. Scale.java takes the name of a picture file and two integers (width w and height h) as command-line arguments and scales the image to w-by-h.

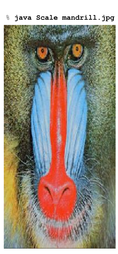
```
% java Scale mandrill.jpg 298 298
```



```
% java Scale mandrill.jpg 200 200
```



```
% java Scale mandrill.jpg 200 400
```



Q + A

Q. Can I use your code in my project?

A. Our library `stdlib.jar` is released under the GNU General Public License, version 3 (GPLv3). If you wish to license the code under different terms, please contact us to discuss.

Q. If I use a named package to structure my code, the compiler can no longer access the libraries in `stdlib.jar`. Why not?

A. The libraries in `stdlib.jar` are in the "default" package. In Java, you can't access classes in the default package from a named package. If you need to use our libraries with a named package, you can use algs4.jar.

Warning: if you are taking our Princeton or Coursera course, you must use `stdlib.jar` to facilitate grading.

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