

How to Install JDK 8 (on Windows, Mac & Ubuntu) and Get Started with Java Programming

Java Development Kit (JDK) 1.8 (officially named Java SE 8), which is freely available from Sun Microsystems (now part of Oracle), is needed for writing Java programs. JDK can be downloaded from the Java mother site @<http://www.oracle.com/technetwork/java/index.html> (or the legacy <http://java.sun.com>).

"JDK" or "JRE"?

JRE (Java Runtime) is needed for *running* Java programs. JDK (Java Development Kit), which includes JRE plus the development tools (such as compiler and debugger), is need for *writing* as well as running Java programs. Since you are supposed to write Java Programs, you should install JDK, which includes JRE.

JDK Versions

The various JDK versions are:

1. **JDK Alpha and Beta** (1995): Sun announced Java in September 23, 1995.
2. **JDK 1.0** (January 23, 1996): Originally called *Oak* (named after the oak tree outside James Gosling's office). Renamed to Java 1 in JDK 1.0.2.
3. **JDK 1.1** (February 19, 1997): Introduced AWT event model, inner class, JavaBean, JDBC, and RMI.
4. **J2SE 1.2** (codename *Playground*) (December 8, 1998): Re-branded as "Java 2" and renamed JDK to J2SE (Java 2 Standard Edition). Also released J2EE (Java 2 Enterprise Edition) and J2ME (Java 2 Micro Edition). Included JFC (Java Foundation Classes - Swing, Accessibility API, Java 2D, Pluggable Look and Feel and Drag and Drop). Introduced Collection Framework and JIT compiler.
5. **J2SE 1.3** (codename *Kestrel*) (May 8, 2000): Introduced Hotspot JVM.
6. **J2SE 1.4** (codename *Merlin*) (February 6, 2002): Introduced assert, non-blocking IO (nio), logging API, image IO, Java webstart, regular expression support.
7. **J2SE 5.0** (codename *Tiger*) (September 30, 2004): Officially called 5.0 instead of 1.5. Introduced generics, autoboxing/unboxing, annotation, enum, varargs, for-each loop, static import.
8. **Java SE 6** (codename *Mustang*) (December 11, 2006): Renamed J2SE to Java SE (Java Standard

Edition).

9. **Java SE 7** (codename *Dolphin*) (July 28, 2011): First version after Oracle purchased Sun (called Oracle JDK).
10. **Java SE 8** (March 18, 2014): included support for Lambda expressions, default methods, and JavaScript runtime.

1. How To Install JDK on Windows

Step 0(a): Un-Install Older Version(s) of JDK/JRE

I recommend that you install the latest JDK, but it can be messy if you have multiple versions of JDK/JRE.

If you have previously installed older version(s) of JDK/JRE, un-install ALL of them. Run "Control Panel" ⇒ Program and Features ⇒ Un-install programs begin with "Java", such as "Java SE Development Kit" and "Java SE Runtime". If you are not sure whether you have older version(s) of JDK, check!

Step 0(b): Understand Windows' CMD Shell

Programmers need to know how to use CMD shell to issue commands. If you are completely new to CMD, read "[Programmer's Survival Guide for Windows](#)".

Step 1: Download JDK

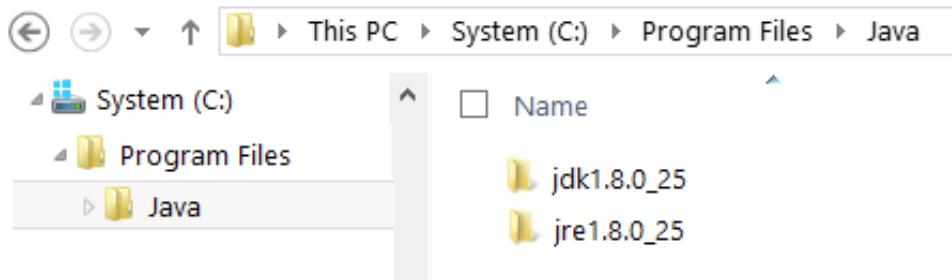
1. Goto Java SE download site @<http://www.oracle.com/technetwork/java/javase/downloads/index.html>.
2. Under "Java Platform, Standard Edition" ⇒ "Java SE 8ux" ⇒ Click the "JDK Download" button.
3. Check "Accept License Agreement".
4. Choose your operating platform, e.g., Windows x86 for 32-bit Windows OS or Windows x64 for 64-bit Windows OS. You can check whether your Windows OS is 32-bit or 64-bit via "Control Panel" ⇒ System ⇒ Under the "System Type".

Step 2: Install JDK and JRE

Run the downloaded installer (e.g., "jdk-8uxx-windows-x64.exe"), which installs both the JDK (Java Development Kit) and JRE (Java Runtime). By default, the JDK will be installed in directory "C:\Program Files\Java\jdk1.8.0_xx", where xx denotes the latest upgrade number; and JRE in "C:\Program Files\Java\jre1.8.0_xx".

For novices, accept the defaults. Simply click "next"... "next"... to install JDK and JRE.

Take note of your JDK installed directory (which you will need to use in the next step). Check the JDK installed directory by inspecting these folders using Windows' Explorer.



I shall refer to the JDK installed directory as <JAVA_HOME>, hereafter, in this article.

Step 3: Include JDK's "bin" Directory in the PATH

Windows OS searches the current directory and the directories listed in the `PATH` *environment variable* for executable programs. JDK's programs (such as Java compiler `javac.exe` and Java runtime `java.exe`) reside in directory "<JAVA_HOME>\bin" (where <JAVA_HOME> denotes the JDK installed directory, e.g., `C:\Program Files\Java\jdk1.8.0_xx`). You need to include the "<JAVA_HOME>\bin" directory in the `PATH`.

To edit the `PATH` environment variable in Windows XP/Vista/7/8:

1. Control Panel ⇒ System ⇒ Advanced system settings
2. Switch to "Advanced" tab ⇒ Environment Variables
3. In "System Variables", scroll down to select "PATH" ⇒ Edit
4. **(CAUTION: Read this paragraph 3 times before doing this step! There is no UNDO)**

In "Variable value" field, INSERT "`c:\Program Files\Java\jdk1.8.0_xx\bin`" (Replace `xx` with the upgrade number and **VERIFY** that this is your JDK's binary directory!!!) IN FRONT of all the existing directories, followed by a semi-colon (;) which separates the JDK's binary directory from the rest of the existing directories.

DO NOT DELETE any existing entries; otherwise, some existing applications may not run.

```
Variable name : PATH
Variable value : c:\Program Files\Java\jdk1.8.0_xx\bin;[existing entries...]
```

For some Windows 10: You see a table listing the existing entries. Click "New" ⇒ Enter the JDK's binary directory ⇒ Select "Move Up" to move the JDK's binary directory to the top.

Step 4: Verify the JDK Installation

Launch a CMD shell (Click "Start" button ⇒ run... ⇒ enter "`cmd`"; OR from "Start" button ⇒ All Programs ⇒ Accessories ⇒ Command Prompt).

1. Issue "`path`" command to list the contents of the `PATH` environment variable. Check to make sure that your <JAVA_HOME>\bin is listed in the `PATH`.

```
prompt> path
PATH=c:\Program Files\Java\jdk1.8.0_xx\bin;[other entries...]
```

2. Issue the following commands to verify that JDK/JRE are properly installed and display their version:

```
prompt> java -version
java version "1.8.0_xx"
Java(TM) SE Runtime Environment (build 1.8.0_xx-b13)
Java HotSpot(TM) 64-Bit Server VM (build 25.5-b02, mixed mode)

prompt> javac -version
javac 1.8.0_xx
```

Step 5: Write a Hello-World Java Program

1. Create a directory to keep your works, e.g., "d:\myProject" (or any directory of your choice). Do NOT save your works in "Desktop" or "Documents" as their paths are hard to locate. The directory name shall not contain *blank* or special characters. Use meaningful but short name as it is easier to type.
2. Launch a programming text editor (such as [TextPad](#) or [Notepad++](#)). Begin with a *new file* and enter the following source code. Save the file as "Hello.java", under your work directory (e.g., d:\myProject).

```
/*
 * First Java program to say Hello
 */
public class Hello {    // Save as "Hello.java" under "d:\myProject"
    public static void main(String[] args) {
        System.out.println("Hello, world!");
    }
}
```

Step 6: Compile and Run the Hello-World Java Program

To compile the source code "Hello.java":

1. Start a CMD Shell (Click the "Start" button ⇒ "run..." ⇒ Enter "cmd").
2. Set the *Current Drive* to the drive where you saved your source file "Hello.java". For example, suppose that your source file is saved in drive "d", enter "d:" as follow:

```
prompt> d:
D:\xxx>
```

3. Set the *Current Working Directory* to the directory that you saved your source file via the **cd** (*Change Directory*) command. For example, suppose that your source file is saved in directory "d:\myProject".

```
D:\xxx> cd \myProject
D:\myProject>
```

4. Issue a **dir** (*List Directory*) command to confirm that your source file is present in the *current directory*.

```
D:\myProject> dir
.....
xx-xxx-xx  06:25 PM                277 Hello.java
.....
```

5. Invoke the JDK compiler "**javac**" to compile the source code "Hello.java".

D:\myProject> javac Hello.java

The compilation is successful if the command prompt returns. Otherwise, error messages would be shown. Correct the errors in your source file and re-compile. Check "[Common JDK Installation Errors](#)", if you encounter problem compiling your program.

6. The output of the compilation is a Java class called "Hello.class". Issue a **dir** (*List Directory*) command again to check for the output.

```
D:\myProject> dir
.....
xx-xxx-xx 01:53 PM 417 Hello.class
xx-xxx-xx 06:25 PM 198 Hello.java
.....
```

To run the program, invoke the Java Runtime "java":

```
D:\myProject> java Hello
Hello, world!
```

```
C:\Windows\system32\cmd.exe

C:\Users>d:

d:\temp>cd \myproject

d:\myproject>dir
Volume in drive D is User
Volume Serial Number is 2049-C58F

Directory of d:\myproject

14-Sep-12  04:04 PM    <DIR>          .
14-Sep-12  04:04 PM    <DIR>          ..
14-Sep-12  04:02 PM                198 Hello.java
                        1 File(s)            198 bytes
                        2 Dir(s)  49,035,927,552 bytes free

d:\myproject>javac Hello.java

d:\myproject>dir
Volume in drive D is User
Volume Serial Number is 2049-C58F

Directory of d:\myproject

14-Sep-12  04:04 PM    <DIR>          .
14-Sep-12  04:04 PM    <DIR>          ..
14-Sep-12  04:04 PM                417 Hello.class
14-Sep-12  04:02 PM                198 Hello.java
                        2 File(s)            615 bytes
                        2 Dir(s)  49,035,927,552 bytes free

d:\myproject>java Hello
Hello, world!
```

Everything that can possibly go wrong will go wrong: Read "[JDK Installation Common Errors](#)".

Step 7: (Optional) Download JDK API Documentation, Samples and Demos

The JDK download does not include the documentation, which needs to be downloaded separately. In the

past, I always insist that my students should have a local copy of JDK API Documentation. But, today, you can easily access the online copy by googling "JDK 8 Documentation".

To install JDK API documentation:

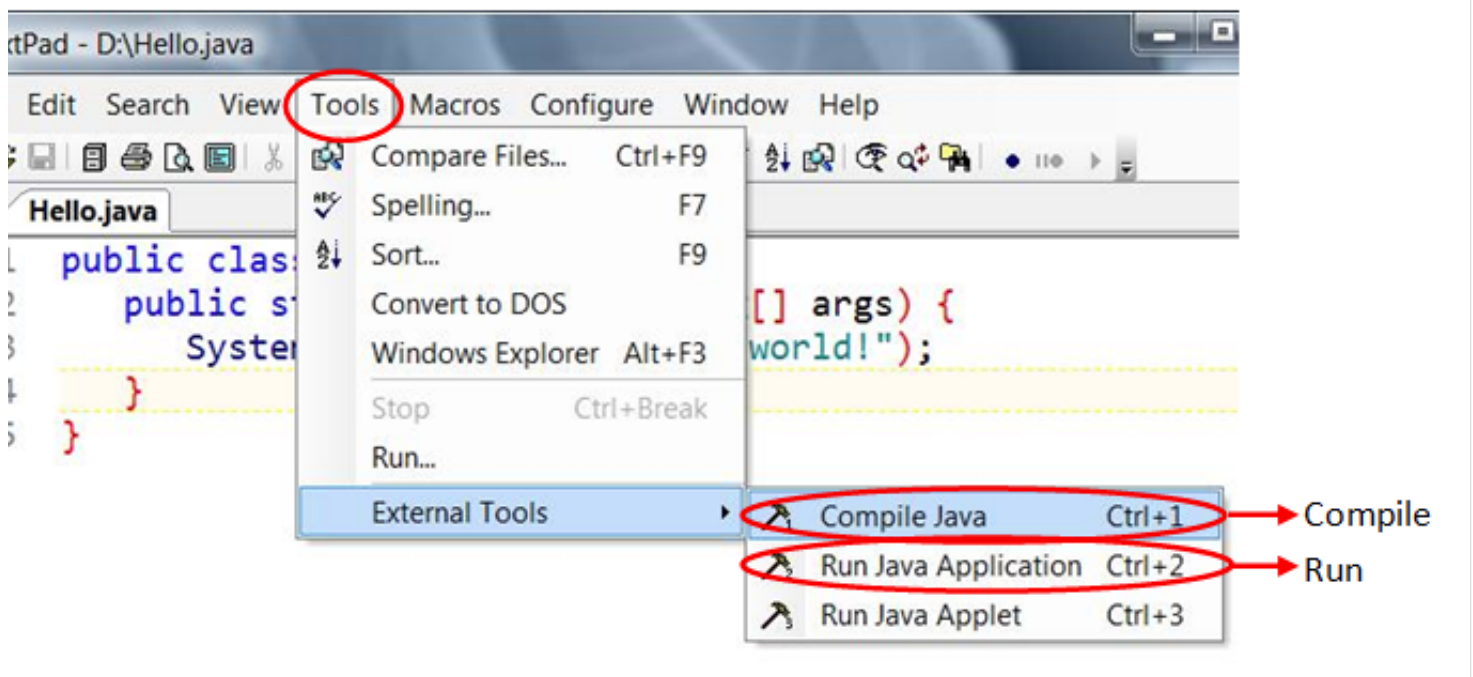
1. From the Java SE download page (<http://www.oracle.com/technetwork/java/javase/downloads/index.html>), under "Additional Resources", look for "Java SE 8 Documentation" ⇒ Download ⇒ Accept the license agreement ⇒ Download the zip-file (e.g., "jdk-8uxx-apidocs.zip" - about 85MB).
2. Unzip into the JDK installed directory <JAVA_HOME>. The documentation will be unzipped into "<JAVA_HOME>\docs". Browse the JDK documentation by opening "<JAVA_HOME>\docs\index.html".

You should also download the "JDK 8 Samples and Demos" from the Java SE download site.

Step 8: (For Advanced Users Only) JDK's Source Code

Source code for JDK is provided and kept in "<JAVA_HOME>\src.zip". I strongly recommend that you go through some of the source files such as "String.java", "Math.java", and "Integer.java", under "java\lang".

1.1 Using TextPad for Java Programming (on Windows)



TextPad (@ www.textpad.com) is an excellent programming text editor for writing *toy* Java programs. It can be configured to couple with the JDK, hence, bypassing the CMD shell.

From the TextPad editor, you can invoke the JDK compiler/runtime directly via "Tools" menu ⇒ External Tools ⇒ "Compile Java" or "Run Java Application". Take note of the keyboard shortcuts - Ctrl+1 for compile and Ctrl+2 for run.

If you cannot find these commands in the "Tools" menu, goto "Configure" ⇒ Preferences... ⇒ Tools ⇒ Add ⇒

JDK Commands.

TextPad Tips and Configuration

Check [HERE!](#)

1.2 Using Notepad++ for Java Programming (on Windows)

Notepad++ (@ <http://notepad-plus-plus.org>) is a free and open-source programming editor.

You can use Notepad++ to write your Java source code. But you need to use CMD shell to compile and run the Java program.

NotePad++ Customization and Tips

You can customize Notepad++ to compile and run Java programs with hot-keys. Read "[NotePad++](#)".

2. How to Install JDK on Mac

Step 1: Check if JDK has been Pre-Installed

In some Mac systems (earlier than Mac OS X 10.7 Lion), JDK has been pre-installed. To check if JDK has been installed, open a "Terminal" (Go ⇒ Utilities ⇒ Terminal) and issue these commands:

```
$ javac -version
```

- If a JDK version number is returned (e.g., JDK 1.x.x), then JDK has already been installed. If the JDK version is prior to 1.7, proceed to Step 2 to install the latest JDK; otherwise, proceed to "Step 3: Write a Hello-world Java program".
- If message "command not found" appears, JDK is NOT installed. Proceed to the "Step 2: Install JDK".
- If message "To open javac, you need a Java runtime" appears, select "Install" and follow the instructions to install JDK. Then, proceed to "Step 3: Write a Hello-world Java program".

Step 2: Download and Install JDK

1. Goto Java SE download site @<http://www.oracle.com/technetwork/java/javase/downloads/index.html>. Under "Java Platform, Standard Edition" ⇒ "Java SE 8ux" ⇒ Click the "JDK Download" button ⇒ Check "Accept License Agreement" ⇒ Choose your operating platform, e.g., Mac OS X x64 (jdk-8uxx-macosx-x64.dmg).
2. Double-click to install the downloaded Disk Image (DMG) file.
3. Eject the DMG file, if required.
4. To verify your installation, open a "Terminal" and issue these commands:

```
// Check the version of "javac" (Java Compiler) and "java" (Java Runtime)
$ javac -version
javac 1.x.x_xx
```



```
$ java -version
java version "1.x.x_xx"
Java(TM) SE Runtime Environment (build 1.x.x_xx-xxx)
Java HotSpot(TM) Client VM (build 22.1-b02, mixed mode, sharing)

// Find the location of programs "javac" (Java Compiler) and "java" (Java Runtime)
$ which javac
/usr/bin/javac

$ which java
/usr/bin/java
```

Step 3: Write a Hello-World Java Program

1. Create a directory called "myProject" under your *home* directory (Finder ⇒ Go ⇒ Home; File ⇒ New Folder ⇒ "myProject").

In Mac under the Terminal, the home directory of the current login user is denoted as "~". Hence, this new directory is represented as "~/myProject".

2. Use a programming text editor (such as [jEdit](#), [gedit](#)) to input the following source code and save as "Hello.java" under the directory "~/myProject".

If you use "TextEdit" (NOT encouraged, as it is a *plain* text editor, NOT a *programming* text editor), you need to open a new file ⇒ choose "Format" ⇒ "Make Plain Text" ⇒ Enter the source code ⇒ Save as "Hello.java" (without the ".txt").

```
/*
 * My First Java program to say Hello
 */
public class Hello { // Save as "Hello.java" under "~/myProject"
    public static void main(String[] args) {
        System.out.println("Hello, world from Mac!");
    }
}
```

Step 4: Compile and Run the Hello-World Java Program

1. To compile the source code "Hello.java", open a new "Terminal" (Go ⇒ Utilities ⇒ Terminal) and issue these commands (as illustrated):

```
Administrators-MacBook-Pro:~ seluser$ cd ~/myproject
Administrators-MacBook-Pro:myproject seluser$ ls
Hello.java
Administrators-MacBook-Pro:myproject seluser$ javac Hello.java
Administrators-MacBook-Pro:myproject seluser$ ls
Hello.class  Hello.java
Administrators-MacBook-Pro:myproject seluser$ java Hello
Hello, world from Mac
Administrators-MacBook-Pro:myproject seluser$
```

```
// Change Directory (cd) to where "Hello.java" resides
$ cd ~/myProject

// Check if "Hello.java" exists using list (ls) command
```



```
$ ls
Hello.java      .....

// Compile "Hello.java" using JDK compiler "javac"
$ javac Hello.java
// If error message appears, correct your source code and re-compile

// Check for the compiled output "Hello.class"
$ ls
Hello.class    Hello.java      .....
```

2. To run the Hello-world, invoke the Java Runtime "java" as follows:

```
// Run "Hello.class"
$ java Hello
Hello, world from Mac!
```

3. How to Install JDK on Ubuntu

Read "[How to Install JDK on Ubuntu](#)".

4. First Java Program with Eclipse

1. You need to first install Eclipse. Read "[How to Install Eclipse](#)".
2. You can then proceed to write your first Java program. Read "[Writing your first Java Program with Eclipse](#)".
3. Eclipse allow you to debug program graphically. Read "[Debugging program in Eclipse](#)".

5. First Java Program with NetBeans

1. You need to first install NetBeans. Read "[How to Install NetBeans](#)".
2. You can then proceed to write your first Java program. Read "[Writing your first Java program with NetBeans](#)".
3. NetBeans allow you to debug program graphically. Read "[Debugging program in NetBeans](#)".

6. (Advanced) External JAR Files and Native Libraries

External Java packages (such as Servlet, MySQL Connector/J, JOGL, JUnit) are often distributed in JAR files (Java Archive - a single-file package of many Java classes), with possibly Native Libraries (".lib" and ".dll" in Windows, or ".a" and ".so" in Linux/Mac).

External JAR Files (".jar")

If external JAR files are not properly included:

- During the compilation, you will receive compilation error "cannot find symbol" on classes belonging to the external packages.
- During execution, you will get a runtime error "Could not find or load main class xxx" or "NoClassDefFoundError".

To include external JAR files, you can either:

1. Copy all the JAR files of the external packages to the *Java's Extension Directories*.
 - For Windows, the JDK extension directory is located at "<JAVA_HOME>\jre\lib\ext" (e.g., "c:\Program Files\Java\jdk1.8.0_xx\jre\lib\ext").
 - For Mac, the JDK extension directories are "/Library/Java/Extensions" and "/System/Library/Java/Extensions".
 - For Ubuntu, the JDK extension directories are "<JAVA_HOME>/jre/lib/ext" (e.g., "/usr/user/java/jdk1.8.0_xx/jre/lib/ext") and "/usr/java/packages/lib/ext".

The location of JDK's extension directories is kept in Java's System Property "java.ext.dirs". You can print its contents via `System.out.println(System.getProperty("java.ext.dirs"))`.

2. You can also include all the JAR files in the CLASSPATH environment variable. CLASSPATH may contain directories (of Java classes) or JAR files (single-file archive of Java classes). If you set the CLASSPATH, you must also include the *current directory* (denoted as ".").
 - For Windows, set the CLASSPATH in Control Panel ⇒ System ⇒ Advanced system settings ⇒ Advanced ⇒ Environment Variables ⇒ System Variables ⇒ New ⇒ In "Variable name", enter "CLASSPATH" ⇒ In "Variable value", enter ".;path1\xxx.jar;path2\yyy.jar", where the entries are separated by a semi-colon (;).
 - For Linux and Mac OS: Edit ~/.profile or ~/.bash_profile (or/etc/profile for system-wide setting) to include the following line at the end of the file:

```
export CLASSPATH=.:path1/xxx.jar:path2/yyy.jar
```

The entries are separated by colon (:).

3. You can also set the CLASSPATH in the javac/java command-line via the option -cp <paths> (or -classpath <paths>), for example,

```
// Compile Java source code
> javac -cp .:path1/xxx.jar:path2/yyy.jar ClassName.java
// Run Java class
> java -cp .:path1/xxx.jar:path2/yyy.jar ClassName
```

External Native Libraries (".lib", ".dll", ".a", ".so")

Some external package may provide static or shared native libraries in the form of ".lib" (Windows' static library), ".dll" (Windows' dynamically link library), ".a" (Unix's static library), or ".so" (Unix's shared library).

Native Libraries are to be kept in a directory accessible via JRE's Property "java.library.path",

which *normally but not necessarily* includes all the directories in the PATH environment variable.

Native libraries are not involved in the compilation. But if they are not properly included during runtime time, you will get a runtime error "java.lang.UnsatisfiedLinkError: no xxx in java.library.path".

To include external native libraries:

1. Copy the native libraries into a system library directory, e.g., c:\windows\system32 (Windows), /usr/lib or /usr/local/lib (Linux or Mac OS). You can verify that the directory is included in Java's System Property "java.library.path", via `System.out.println(System.getProperty("java.library.path"))`.
2. You can also set the native library path via the java's command-line option - `Djava.library.path=xxx`, for example,

```
> java -Djava.library.path=xxx ClassName
```

Eclipse/NetBeans

Using an IDE can greatly simplify inclusion of external packages. Read "[Eclipse How-To](#)" or "[NetBeans How-To](#)".