Java 8 API by Example: Strings, Numbers, Math and Files

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Plenty of tutorials and articles cover the most important changes in Java 8 like [lambda expressions](https://winterbe.com/posts/2014/03/16/java-8-tutorial/) and [functional streams](https://winterbe.com/posts/2014/07/31/java8-stream-tutorial-examples/). But furthermore many existing classes have been enhanced in the [JDK 8 API](https://winterbe.com/posts/2014/03/29/jdk8-api-explorer/) with useful features and methods.

This article covers some of those smaller changes in the Java 8 API - each described with easily understood code samples. Let's take a deeper look into Strings, Numbers, Math and Files.

Slicing Strings[**#**](https://winterbe.com/posts/2015/03/25/java8-examples-string-number-math-files/#slicing-strings)

Two new methods are available on the String class: join and chars. The first method joins any number of strings into a single string with the given delimiter:

String.**join**(":", "foobar", "foo", "bar");

*// => foobar:foo:bar*

The second method chars creates a stream for all characters of the string, so you can use stream operations upon those characters:

String string = "foobar:foo:bar"

    .**chars**()

    .**distinct**()

    .**mapToObj**(c -> String.**valueOf**((char)c))

    .**sorted**()

    .**collect**(Collectors.**joining**());

*// the string is => :abfor*

Not only strings but also regex patterns now benefit from streams. Instead of splitting strings into streams for each character we can split strings for any pattern and create a stream to work upon as shown in this example:

String string = Pattern.**compile**(":")

    .**splitAsStream**("foobar:foo:bar")

    .**filter**(s -> s.**contains**("bar"))

    .**sorted**()

    .**collect**(Collectors.**joining**(":"));

*// the string is => bar:foobar*

Additionally regex patterns can be converted into predicates. Those predicates can for example be used to filter a stream of strings:

Pattern pattern = Pattern.**compile**(".\*@gmail\\.com");

long count = Stream.**of**("bob@gmail.com", "alice@hotmail.com")

    .**filter**(pattern.**asPredicate**())

    .**count**(); // note that count() returns LONG

System.*out*.println(count); *// => 1*

The above pattern accepts any string which ends with @gmail.com and is then used as a Java 8 Predicate to filter a stream of email addresses.

Crunching Numbers[**#**](https://winterbe.com/posts/2015/03/25/java8-examples-string-number-math-files/#crunching-numbers)

Java 8 adds additional support for working with unsigned numbers. Numbers in Java had always been signed. Let's look at Integer for example:

An int represents a maximum of 2³² binary digits. Numbers in Java are per default signed, so the last binary digit represents the sign (0 = positive, 1 = negative). Thus the maximum positive signed int is 2³¹ - 1 starting with the decimal zero.

* 32 bit **Unsigned** int is [0, 2³**²** - 1]
* 32 bit **Signed** int is [2³**¹** - 1, 2³**¹** + 1]

You can access this value via Integer.MAX\_VALUE:

System.out.**println**(Integer.MAX\_VALUE);      *// 2147483647*

System.out.**println**(Integer.MAX\_VALUE + 1);  *// -2147483648*

Java 8 adds support for parsing unsigned ints. Let's see how this works:

long maxUnsignedInt = (1l << 32) - 1; //4294967295

String string = String.**valueOf**(maxUnsignedInt);

int unsignedInt = Integer.**parseUnsignedInt**(string, 10);

String string2 = Integer.**toUnsignedString**(unsignedInt, 10);

As you can see it's now possible to parse the maximum possible unsigned number 2³² - 1 into an integer. And you can also convert this number back into a string representing the unsigned number.

This wasn't possible before with parseInt as this example demonstrates:

// string = “4294967295”

try {

    Integer.**parseInt**(string, 10);

}

catch (NumberFormatException e) {

    System.err.**println**("could not parse signed int of " + maxUnsignedInt);

}

The number is not parseable as a signed int because it exceeds the maximum of 2³¹ - 1.

Do the Math[**#**](https://winterbe.com/posts/2015/03/25/java8-examples-string-number-math-files/#do-the-math)

The utility class Math has been enhanced by a couple of new methods for handling number overflows. What does that mean? We've already seen that all number types have a maximum value. So what happens when the result of an arithmetic operation doesn't fit into its size?

System.out.**println**(Integer.MAX\_VALUE);      *// 2147483647*

System.out.**println**(Integer.MAX\_VALUE + 1);  *// -2147483648*

As you can see a so called **integer overflow** happens which is normally not the desired behavior.

Java 8 adds support for strict math to handle this problem. Math has been extended by a couple of methods who all ends with exact, e.g. addExact. Those methods handle overflows properly by throwing an ArithmeticException when the result of the operation doesn't fit into the number type:

try {

    Math.**addExact**(Integer.MAX\_VALUE, 1);

}

catch (ArithmeticException e) {

    System.err.**println**(e.**getMessage**());

*// => integer overflow*

}

The same exception might be thrown when trying to convert longs to int via toIntExact:

try {

    Math.**toIntExact**(Long.MAX\_VALUE);

}

catch (ArithmeticException e) {

    System.err.**println**(e.**getMessage**());

*// => integer overflow*

}

Working with Files[**#**](https://winterbe.com/posts/2015/03/25/java8-examples-string-number-math-files/#working-with-files)

The utility class Files was first introduced in Java 7 as part of Java NIO. The JDK 8 API adds a couple of additional methods which enables us to use functional streams with files. Let's deep-dive into a couple of code samples.

import java.io.BufferedReader;  
import java.io.BufferedWriter;  
import java.io.IOException;  
import java.nio.file.Files;  
import java.nio.file.Path;  
import java.nio.file.Paths;  
import java.util.List;  
import java.util.stream.Collectors;  
import java.util.stream.Stream;

Listing files[**#**](https://winterbe.com/posts/2015/03/25/java8-examples-string-number-math-files/#listing-files)

The method Files.list streams all paths for a given directory, so we can use stream operations like filter and sorted upon the contents of the file system.

try (Stream<Path> stream = Files.**list**(Paths.**get**(""))) {

    String joined = stream

        .**map**(String::valueOf)

        .**filter**(path -> !path.**startsWith**("."))

        .**sorted**()

        .**collect**(Collectors.**joining**("; "));

    System.out.**println**("List: " + joined);

}

The above example lists all files for the current working directory, then maps each path to it's string representation. The result is then filtered, sorted and finally joined into a string. If you're not yet familiar with functional streams you should read my [Java 8 Stream Tutorial](https://winterbe.com/posts/2014/07/31/java8-stream-tutorial-examples/).

You might have noticed that the creation of the stream is wrapped into a try/with statement. Streams implement AutoCloseable and in this case we really have to close the stream explicitly since it's backed by IO operations.

*The returned stream encapsulates a DirectoryStream. If timely disposal of file system resources is required, the try-with-resources construct should be used to ensure that the stream's close method is invoked after the stream operations are completed.*

Finding files[**#**](https://winterbe.com/posts/2015/03/25/java8-examples-string-number-math-files/#finding-files)

The next example demonstrates how to find files in a directory or it's sub-directories.

Path start = Paths.**get**("");

int maxDepth = 5;

try (Stream<Path> stream = Files.**find**(start, maxDepth, (path, attr) ->

        String.**valueOf**(path).**endsWith**(".js"))) {

    String joined = stream

        .**sorted**()

        .**map**(String::valueOf)

        .**collect**(Collectors.**joining**("; "));

    System.out.**println**("Found: " + joined);

}

The method find accepts three arguments: The directory path start is the initial starting point and maxDepth defines the maximum folder depth to be searched. The third argument is a matching predicate and defines the search logic. In the above example we search for all JavaScript files (filename ends with .js).

We can achieve the same behavior by utilizing the method Files.walk. Instead of passing a search predicate this method just walks over any file.

Path start = Paths.**get**("");

int maxDepth = 5;

try (Stream<Path> stream = Files.**walk**(start, maxDepth)) {

    String joined = stream

        .**map**(String::valueOf)

        .**filter**(path -> path.**endsWith**(".js"))

        .**sorted**()

        .**collect**(Collectors.**joining**("; "));

    System.out.**println**("walk(): " + joined);

}

In this example we use the stream operation filter to achieve the same behavior as in the previous example.

Reading and writing files[**#**](https://winterbe.com/posts/2015/03/25/java8-examples-string-number-math-files/#reading-and-writing-files)

Reading text files into memory and writing strings into a text file in Java 8 is finally a simple task. No messing around with readers and writers. The method Files.readAllLines reads all lines of a given file into a list of strings. You can simply modify this list and write the lines into another file via Files.write:

List<String> lines = Files.**readAllLines**(Paths.**get**("res/nashorn1.js"));

lines.**add**("print('foobar');");

Files.**write**(Paths.**get**("res/nashorn1-modified.js"), lines);

Please keep in mind that those methods are not very memory-efficient because the whole file will be read into memory. The larger the file the more heap-size will be used.

As an memory-efficient alternative you could use the method Files.lines. Instead of reading all lines into memory at once, this method reads and streams each line one by one via functional streams.

try (Stream<String> stream = Files.**lines**(Paths.**get**("res/nashorn1.js"))) {

    stream

        .**filter**(line -> line.**contains**("print"))

        .**map**(String::trim)

        .**forEach**(System.out::println);

}

If you need more fine-grained control you can instead construct a new buffered reader:

Path path = Paths.**get**("res/nashorn1.js");

try (BufferedReader reader = Files.**newBufferedReader**(path)) {

    System.out.**println**(reader.**readLine**());

}

Or in case you want to write to a file simply construct a buffered writer instead:

Path path = Paths.**get**("res/output.js");

try (BufferedWriter writer = Files.**newBufferedWriter**(path)) {

    writer.**write**("print('Hello World');");

}

Buffered readers also have access to functional streams. The method lines construct a functional stream upon all lines denoted by the buffered reader:

Path path = Paths.**get**("res/nashorn1.js");

try (BufferedReader reader = Files.**newBufferedReader**(path)) {

    long countPrints = reader

        .**lines**()

        .**filter**(line -> line.**contains**("print"))

        .**count**();

    System.out.**println**(countPrints);

}

So as you can see Java 8 provides three simple ways to read the lines of a text file, making text file handling quite convenient.

Unfortunately you have to close functional file streams explicitly with try/with statements which makes the code samples still kinda cluttered. I would have expected that functional streams auto-close when calling a terminal operation like count or collect since you cannot call terminal operations twice on the same stream anyway.

# Some Java Docs

## Try-with-resources

*// the following try() is a "try-with-resources" statement  
// The try-with-resources statement is a try statement that declares one or more resources.  
// A resource is an object that must be closed after the program is finished with it.  
// The try-with-resources statement ensures that each resource is closed at the end of the statement.  
// Any object that implements java.lang.AutoCloseable, which includes all objects which implement java.io.Closeable, can be used as a resource.  
// 相当于一个try block 加一个Final statement close() the connection in the end  
// try block的作用任然存在， 加上catch block可以catch try block的exception,但是try-with-resource的exception 会被suppress*

The following example reads the first line from a file. It uses an instance of BufferedReader to read data from the file. BufferedReader is a resource that must be closed after the program is finished with it:

static String readFirstLineFromFile(String path) throws IOException {

**try (BufferedReader br = new BufferedReader(new FileReader(path)))** {

return br.readLine();

}

}

In this example, the resource declared in the try-with-resources statement is a BufferedReader. The declaration statement appears within parentheses immediately after the try keyword. The class BufferedReader, in Java SE 7 and later, implements the interface java.lang.AutoCloseable. Because the BufferedReader instance is declared in a try-with-resource statement, it will be closed regardless of whether the try statement completes normally or abruptly (as a result of the method BufferedReader.readLine throwing an IOException).

Prior to Java SE 7, you can use a finally block to ensure that a resource is closed regardless of whether the try statement completes normally or abruptly. The following example uses a finally block instead of a try-with-resources statement:

static String readFirstLineFromFileWithFinallyBlock(String path) throws IOException {

BufferedReader br = new BufferedReader(new FileReader(path));

try {

return br.readLine();

} finally {

if (br != null) br.close();

}

}

## Arbitrary Number of Arguments – **varargs**

You can use a construct called *varargs* to pass an arbitrary number of values to a method. You use varargs when you don't know how many of a particular type of argument will be passed to the method. It's a shortcut to creating an array manually (the previous method could have used varargs rather than an array).

To use varargs, you follow the type of the last parameter by an ellipsis (three dots, ...), then a space, and the parameter name. The method can then be called with any number of that parameter, including none.

**Important Note:** The argument(s) passed in this way is always an array - even if there's just one. Make sure you treat it that way in the method body.

**Important Note 2:** The argument that gets the ... must be the last in the method signature. So, myMethod(int i, String... strings) is okay, but myMethod(String... strings, int i) is not okay.

You will most commonly see varargs with the printing methods; for example, this printf method:

public PrintStream printf(String format, Object... args)

allows you to print an arbitrary number of objects. It can be called like this:

System.out.printf("%s: %d, %s%n", name, idnum, address);

or like this

System.out.printf("%s: %d, %s, %s, %s%n", name, idnum, address, phone, email);

or with yet a different number of arguments.

public class test {  
 public static void main(String[] args){  
 *testVarargs*("1", "2", "3", "4");  
 *testVarargs*(); *// this is also valid, nothing printed out  
 testVarargs*("foo");  
 *testVarargs*("foo", "bar", "baz");  
 *testVarargs*(new String[]{"foo", "var", "baz"});  
 }  
  
 public static void testVarargs(String... strings){  
 Arrays.*stream*(strings).forEach(s -> {  
 System.*out*.println(s);  
 });  
 System.*out*.println("==========");  
 }  
}

## Generic Methods

<https://docs.oracle.com/javase/tutorial/java/generics/methods.html>

*Generic methods* are methods that introduce their own type parameters. This is similar to declaring a generic type, but the type parameter's scope is limited to the method where it is declared. Static and non-static generic methods are allowed, as well as generic class constructors.

The syntax for a generic method includes a list of type parameters, inside angle brackets, which appears before the method's return type. For static generic methods, the type parameter section must appear before the method's return type.

The Util class includes a generic method, compare, which compares two Pair objects:

public class Util {

**public static <K, V> boolean compare(Pair<K, V> p1, Pair<K, V> p2)** {

return p1.getKey().equals(p2.getKey()) &&

p1.getValue().equals(p2.getValue());

}

}

public class Pair<K, V> {

private K key;

private V value;

public Pair(K key, V value) {

this.key = key;

this.value = value;

}

public void setKey(K key) { this.key = key; }

public void setValue(V value) { this.value = value; }

public K getKey() { return key; }

public V getValue() { return value; }

}