Java Features

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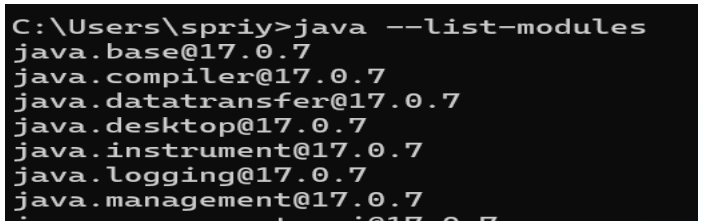
Java 9 Features

- JShell
- Factory Methods for Immutable List,Set,Map
- Private Method in interfaces
- Process API improvement
- Try With Resources improvement
- Enhanced @Deprecated Annotation
- DiamondOperator for anonymous inner classes
- Optional Class Improvements
- Reactive Streams
- ControlPanel - *removed in latest versions*

Java Modules

- Modules are a new level of abstraction above packages
- A module is a group of packages and resources together with a module descriptor file
- package of packages(separate project for each module)
- The naming rules for a module are similar to packages naming

  - reverse DNS names/project-style
- By default all packages are module private.
- Modules can be distrubuted as JAR or expolded compiled project
- can only have one module per JAR file.
- Modules are split into four groups - java,
  - java modules are implementation classes for core
  - **`java --list-modules`**



Java Modules

Packages

- Packages are used to determine what code is publicly accessible outside of the module.

Resources

- Resources like media or configuration files are available in the module

Module Descriptor

- **Name** – the name of the module
- **Dependencies** – a list of modules that this module depends on
- **Public Packages** – a list of packages that can be accessed outside the module
- **Services Offered** – service implementations that can be consumed by other modules
- **Services Consumed** – allows the current module to be a consumer of a service
- **Reflection Permissions** – explicitly allows other classes to use reflection to access the private members of a package

Module Directives

- Requires - both runtime and compile time
- Requires Static - required only during compile time
- Requires Transitive
- Exports - export the module for other modules to use
- Exports ... To - exports to specific package
- uses - consumes the service
- Provides ... With - provides the service implementation
- Open
- Opens
- Opens ... To

Example

```
module com.shristi.second {
    uses com.shristi.demo.Calculator;
    requires com.shristi.firstmodule;
    requires com.shristi.fourthmodule;
    // available only in compile time
    requires static com.shristi.thirdmodule;
}
```

```
module com.shristi.fourthmodule {
    provides com.shristi.demo.Calculator with com.shristi.demo.CalculatorImpl;
    // export package name to another package
    exports com.shristi.demo to com.shristi.second;
}
```

```
Greeter greet = new Greeter();
System.out.println(greet.greetUser("Sri"));
// consumes the service
Iterable<Calculator> calcIter = ServiceLoader.load(Calculator.class);
Calculator calculator = calcIter.iterator().next();
calculator.calculate(20,30);
```

JShell

- JShell is Java Shell and known as REPL (Read Evaluate Print Loop).

- It is used to execute and test any Java Constructs like class, interface, enum, object, statements etc. very easily.

```
C:\Users\spriy>jshell
|  Welcome to JShell -- Version 17.0.7
|  For an introduction type: /help intro

jshell> int a=90;
a ==> 90

jshell> System.out.print("Hello");
Hello
jshell>
```

Example

```
jshell> 3+1
$1 ==> 4

jshell> 2+10
$2 ==> 12

jshell> String call(String name){
   ...>     return "Great Day "+name;
   ...> }
|  created method call(String)

jshell> System.out.println(call("Sri"));
Great Day Sri
```

```
jshell> /imports
|    import java.io.*
|    import java.math.*
|    import java.net.*
|    import java.nio.file.*
|    import java.util.*
|    import java.util.concurrent.*
|    import java.util.function.*
|    import java.util.prefs.*
|    import java.util.regex.*
|    import java.util.stream.*
```

Example - UnmodifiableList, Set

```
// pre java 9
List<String> courses = new ArrayList<>();
courses.add("Java");
courses.add("Angular");
List<String> newcourses = Collections.unmodifiableList(courses);
newcourses.add("Node");

// from java 9 unModifiableList
List<String> ncourses = List.of("Perl", "Java", "Angular", "Node");
ncourses.add("Node");
ncourses.forEach(System.out::println);
List<String> emptyList = List.of();
System.out.println();

// immutable Set
Set<String> imSet = Set.copyOf(ncourses);
imSet.add("Node");
imSet.forEach(System.out::println);
```

Example - Immutable Map

```
Map.of(1, "Java", 2, "Angular")
        .forEach((courseId, courseName) ->
                    System.out.println(courseName + " " + courseId));

// using Map.Entry
Map<Integer,String> map = Map.ofEntries(
                    Map.entry(1, "Leadership"),
                    Map.entry(2, "Five Point"),
                    Map.entry(3, "Life"));
map.forEach((bookId, title) ->
    System.out.println(bookId + " " + title));
```

Private methods in an interface

```
@FunctionalInterface
public interface Checker {

    boolean checkName(String username, String city);
    // private methods
    private void call() {
        System.out.println("Hello");
    }
    default void show() {
        System.out.println("Great Day");
        call();
    }

}
```

Process API improvement

- Process API is responsible to control and manage OS processes
- Has new classes and methods to manage the OS processes
- ProcessHandle class helps to get
  - the native process Id,
  - start time,
  - accumulated CPU time,arguments,command,
  - user and parent process
  - check pocess liveliness and to destroy processes

Example for ProcessHandle

```
ProcessBuilder builder = new ProcessBuilder("notepad.exe");
// opens the process notepad
Process process = builder.start();
ProcessHandle currentProcess = ProcessHandle.current();     // Current processhandle
System.out.println("Process Id: "+currentProcess.pid());    // Process id
System.out.println("Direct children: "+ currentProcess.children()); // Direct children of the process
System.out.println("Class name: "+currentProcess.getClass());       // Class name
System.out.println("All processes: "+ProcessHandle.allProcesses()); // All current processes
System.out.println("Process info: "+currentProcess.info());         // Process info
System.out.println("Is process alive: "+currentProcess.isAlive());
System.out.println("Process's parent "+currentProcess.parent());  // Parent of the process
```

Try With Resources Improvement

```
// Using Java 7
FileReader fileReader = new FileReader("demo.txt");
try (FileReader reader11 = fileReader;) {
    // logic goes here
}
// Using Java 11
FileReader reader = new FileReader("demo.txt");
try (reader) {
    logic goes here
}
```

```
RandomAccessFile rFile = new RandomAccessFile("demo.txt", "rw");
FileWriter writer = new FileWriter("demo1.txt");
try with resources 9
try (rFile;writer) {
    FileChannel channel = rFile.getChannel();
    ByteBuffer buffer = ByteBuffer.allocate(100);
```

Enhanced @Deprecated annotation

- @Deprecated annotation is from java 5
- It means it should not be uased as it may lead to errors.

```
// forRemoval - true this method may be removed in future
@Deprecated(since = "8",forRemoval = true)
public String call() {
    return "Hello";
}
```

Diamond operator in inner Class

- use <> operator with anonymous class after java 9

```
// before java 9
Mapper<String> mapper = new Mapper<String>("John") {
    @Override
    public void mapData() {
        System.out.println(data.toUpperCase());
    }
};
mapper.mapData();

// post java 9
Mapper<String> mapperOne = new Mapper<>("John") {
    @Override
    public void mapData() {
        System.out.println(data.toUpperCase());
    }
};
mapperOne.mapData();
```

Reactive Streams

- **takeWhile()** - takes all the values till the predicate returns false
- **dropWhile()** - throws all the values at the start till the predicate returns true.
- **iterate()**
- **ofNullable()**

Example of takeWhile and dropWhile

```
System.out.println("Prints till the blank line- exclusive");
//Java, Angular
Stream.of("Java", "Angular", " ", "Node", "Spring", "React")
    .takeWhile(s -> !s.isBlank()).forEach(System.out::println);

System.out.println("Starts after the blank line- inclusive");
//" ", Node,Spring,React
Stream.of("Java", "Angular", " ", "Node", "Spring", "React")
.dropWhile(s -> !s.isBlank()).forEach(System.out::println);

//1,2 ,3
Stream.of(1,2,3,4,5,6).takeWhile(i->i<4).forEach(System.out::println);
System.out.println();
//4,5,6
Stream.of(1,2,3,4,5,6).dropWhile(i->i<4).forEach(System.out::println);
```

Example of iterate

- iterate()

Stream<T> iterate(T seed, Predicate<? super T> hasNext, UnaryOperator<T> next)

```
syntax
Stream<T> iterate(T seed, Predicate<? super T> hasNext, UnaryOperator<T> next)

for (int index=seed; hasNext.test(index); index = next.applyAsInt(index)) {}

// initial value- seed,condt using predicate,increment using UnaryOperator
IntStream.iterate(10,x->x<100,x->x+10).forEach(System.out::println);
```

Optional class improvements

New methods of Optional class

- stream()
- ifPresentOrElse()
- or()

```
Optional<String> opt = Optional.empty();
opt.ifPresentOrElse(System.out::println,
            ()->System.out.println("No data"));
```

```
Optional<String> opt = Optional.empty();
// returns an Optional using Supplier
Optional<String> opt2 = opt.or(()->Optional.of("No data"));
System.out.println(opt2.get()); // no data

Optional<String> opt1 = Optional.of("Hello");
Optional<String> opt3 = opt1.or(()->Optional.of("No data"));
System.out.println(opt3.get()); // Hello
```

Java 10 Features

- Local-Variable Type Inference
- Consolidate the JDK Forest into a Single Repository
- Parallel Full GC for G1
- Heap Allocation on Alternative Memory Devices

Local-Variable Type Inference

- is the new feature in Java 10
- Adds type inference to declarations of local variables with initializers.
- It can be used in for each / for loop as index
- variable with ‘var’ should be initialized
- It cannot be initialized to null
- It cannot be used with non local variables

```
Illegal Declaration
var num; // should be initialized
var myList = null; // should be initialized
public var name = "Sri"; // cannot use on public variables
var con = (num)->{} ;// lambda needs explicit target type
var myarr = {1,2,3,4}; // array needs explicit target type
```

Example - var

```
// Example
// inferred value for List
var numbers = List.of(1, 2, 3, 4, 5);

// in for each loop
for (var number : numbers) {
    System.out.println(number);
}
// in for loop for index
for (var i = 0; i < numbers.size(); i++) {
    System.out.println(numbers.get(i));
}
```

```
// Ok. But not a good idea
var result = greet();// dont know the return type
// no var in streams
var res = Arrays.asList("Ram","Raj")
        .stream()
        .findFirst().map(String::length)
        .orElse(0);
// this becomes a ArrayList<Object> not book
var bookList = new ArrayList<>();
var books = new ArrayList<Book>(); //ok
```

Consolidated JDK Forest as Single Repository

- In JDK 9, there are eight module based directories termed as repos.
  - root, corba, hotspot, jaxp, jaxws, jdk, langtools, nashorn

- From Java 10 onwards, JDK forests are organized into single repository to streamline development.
- Now code in organized as -

$ROOT/src/java.base

$ROOT/src/java.compiler

Stream Methods

- **toUnModifiableList()**
- **copyOf()**
- **OrElseThrow() -** to throw NoSuchElementException

```
// Immutable List
List<String> newcourses =
        Arrays.asList("Java","Angular")
        .stream()
        .collect(Collectors.toUnmodifiableList());

// Immutable List
Set.copyOf(newcourses);
```

Time-Based Release Versioning

- Now it is time-based release of Java - a new release every six months.
- March 2018 release is JDK 10, September 2018 release is JDK 11 - - These are called feature releases and contains at least one or two significant features
- Java 11 is an LTS release

Feature Release

- contains language specific features, JVM features, New/Improved APIs, Removal/Deprecation of APIs.

Update Release

- includes bug fixes, security issue fix, regression fixes etc.
- Each update release happens per quarter in Jan, April, July and Oct months

Long Term Stable Release

- Long term support release will be announced after every three years

Version Format

version format: **$FEATURE.$INTERIM.$UPDATE.$PATCH**

$FEATURE − It denotes the major feature release and will get incremented by 1 after every Feature Release. like 10,11

$INTERIM − It denotes any non-feature, non-update release which contains bug fixes and enhancements.

$UPDATE − It denotes the Update release done after a feature release. eg,, an update release of Java in Apr 2018 is JDK 10.0.1 and for July 2018 is JDK 10.0.2 and so on.

$PATCH − It denotes any emergency release incremented only in case an critical issue is to be promoted on emergent basis.

Parallel Full GC for G1

- Before java 10 - GC (Garbage Collector) implementation components were scattered within code base
- In Java 9 - **G1 (Garbage First) garbage collector** was used.
- G1 avoids full garbage collection but in case of concurrent threads look for collection and memory is not revived fast.
- With Java 10, now G1 will use a fall back Full Garbage Collection
- Moved from single threaded to parallel thread
- With JEP 307, a parallel thread will start mark-sweep-compact algorithm.
- The number of threads can be controlled using following option.

```
$java -XX:ParallelGCThreads=4
```

Heap Allocation on alternative memory

- User can specify an alternative memory device, to allocation the java heap space.
- User need to pass a path to the file system using a new option **-XX:AllocateHeapAt**.

  -XX:AllocateHeapAt=~/etc/heap
- It takes file path and do a memory mapping

Java 11 Features

- Running Java File with single command
- New utility methods in String class
- Local-Variable Syntax for Lambda Parameters
- Nested Based Access Control

Running Java File with single command

- No need to compile the java source file with **javac** tool first.
- Directly run the file with **java** command and it implicitly compiles

```
D:\2021\apps\eclipseexamples\javanew23>java Trial.java
Hello
```

New utility methods in String class

- **isBlank()** - checks if the string is blank
- **lines()** - returns a stream of strings, is a collection of all substrings split by lines.
- **strip()** - removes all kinds of whitespaces leading and trailing
- **stripTrailing()** - removes all kinds of trailing whitespaces
- **stripLeading()** - removes all kinds of leading whitespaces
- **repeat(int n)** - repeat the string n number of times

Example

```
//isBlank and strip
System.out.println("".isBlank()); // true
System.out.println(" ".isBlank()); // true
// removes trailing and leading
System.out.println("Great!!!"+(" Sripriya ").strip()+"Bye");

String message = " Have a great day\n  Reading is fun\n Enjoy Sports ";

// converts a String separated by new lines into a Stream<String>
message.lines().forEach(str -> System.out.println(str.strip()));
// strip Leading
System.out.println("Have fun!"+(" Music Lovers ").stripLeading() + "Bye");
// strip Trailing
System.out.println("Music Lovers".concat(" Have fun ").stripTrailing() + "Bye");
// repeat
System.out.println("Good Life ".repeat(3));
```

Local-Variable Syntax for Lambda Parameters

- This is the only language feature release in Java 11
- If an annotation like @Nullable is applied, then type definition is required
- Specify for all parameters or none
- Even in case of one paramater paranthesis is needed

```
BiConsumer<String,String> con =
        (var s1,var s2)->System.out.println(s1.concat(s2));
con.accept("Welcome", "home");

// error as both paramaters should have type declared
BiConsumer<String,String> con1 =
        (s1, var s2)->System.out.println(s1.concat(s2));

// data type is must if annotation is used with variable
// can use String or var
BiConsumer<String,String> con2 =
    (@Nullable var s1, var s2)->System.out.println(s1.concat(s2));
```

Nested Based Access Control

Problem:

- The nested types have unrestricted access to each other, including to private fields,

Solution

- One nest member (typically the top-level class) is designated as the nest host.
- It contains an attribute (NestMembers) to identify the other statically known nest members.
- Each of the other nest members has an attribute (NestHost) to identify its nest host.

Performance Tuning

- Use a profiler to find the real bottleneck
- Avoid BigDecimal or BigInteger
- Use StringBuilder to concatenate Strings programmatically
- Use + to concatenate Strings in in one statement(in case of a query)
- Use primitives whereever possible
- Cache expensive resources, like database connections and creating Integer objects

Performance Tuning

- Use the Latest Stable Java Version
- Size the Java Heap memory correctly - using Xmx, Xms
  - Donot have the heapsize too small
- Set the initial heap size ***java -Xms256m -Xmx2048m***
  - Xms is the initial setting of the heap memory size
- Use StoredProcedures instead of queries as SP are precompiled
- Choose the right garbage collector (SerialGC, Parallel GC)
- Tune the JVM Garbage Collector to reduce the time required for a full GC
- Avoid Database connection delays. Use Pools

JNI - Java Native Interface

- JNI is an interface that allows Java to interact with code written in another language.
- Supports code reusability and performance.
- Can reuse existing/legacy code with Java (mostly C/C++).
- The native code used to be up to 20 times faster than Java, when running in interpreted mode.
- JNI can be used to invoke Java code from within natively-written applications written in C/C++.
- Java command-line utility is an example, that launches Java code in a Java Virtual Machine.

JNI Components

- **Java Code** – The class with native method.
- **Native Code** – the actual logic of native methods, coded in C or C++.
- **JNI header file** – this header file for C/C++ (include/jni.h into the JDK directory) includes all definitions of JNI elements that we may use into our native programs.
- **C/C++ Compiler** – Choose between GCC, Clang, Visual Studio, or to generate a native shared library for our platform.

JNI Data Mapping to variables

boolean	jboolean
byte	jbyte
char	jchar
double	jdouble
float	jfloat
int	jint
long	jlong
short	jshort
void	void

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- Records

Records

- Record Class is the common base class of all record classes

- It is a transparent carrier for a fixed set of values
- The variables are called the record components - they are final
- Records can have static fields, static block
- Records have *fields, all-args constructor, getters, toString, and equals/hashCode* methods

- Records are immutable. No setter methods
- Record classes are final. Records can implement other interfaces
- Records are used as data transfer objects (DTOs)

Example

```
// username and city are record components
public record User(String username, String city) {

    // can have static fields, block
    static String message;
    static {
        message = "Great day";
    }

    // can have static methods
    public static void show() {
        System.out.println("static method");
    }

    // can have concrete methods
    public void call() {
        System.out.println("in record");
    }
}
```

```
    User userRecord = new User("Sri", "Bangalore");
    // to get the record components
    System.out.println(userRecord.username());
    System.out.println(userRecord);
    System.out.println(User.message);
    User.show();
    userRecord.call();
}
```

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- Sealed Classes

Sealed Classes

- A sealed class allows to choose its sub-classes.
- Use the keyword ***sealed*** to create a sealed class.
- A sealed class must be followed by ***permits*** keyword along with the list of classes that can extend it.
- The permits clause specifies the classes that are permitted to extend the sealed class/implement the sealed interface
- The extending classes should be sealed/non-sealed/final

eg.,

```
public sealed class Vehicle permits Car, Bike{}
```

```
public non-sealed class Car extends Vehicle {}
```

Non-Sealed Classes

- If a class is non-sealed the parent-child hierarchy ends here.
- But the non-sealed class can be extended by other classes
- Use the keyword ***non-sealed*** to create a non-sealed class.
- This class cannot be extended

Rules

- A sealed class must define the classes that may extend it using ***permits***
- The permitted child class must extend the sealed class and must either be final, sealed or non-sealed.
- If the parent sealed class is in a module, then the child classes must also be in the same module
- If the parent sealed class is in an unnamed module, then the child classes must in the same package,
- The non-sealed class can be extended

Sealed Interface

- An interface may allow to choose its child interfaces or classes that can extend it using permits.

```
public sealed interface Calculator permits  CalculatorImpl,Scientific{}
```

```
public non-sealed class CalculatorImpl implements Calculator {}
```

```
public non-sealed interface Scientific extends Calculator {}
```

Sealed Records

- A record can not extend a normal class,but can implement a ***sealed*** interface.
- Further, a record is implicitly final.

```
sealed interface Device permits Mobile{}
public record Mobile() implements Device {}
```

Thank you