Modern Java
Master All NEW Features in Java
by Coding it

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About Me

- Dilip
- Building Software’s since 2008
- Teaching in **UDEMY** Since 2016

Course Objectives

- This course covers all the new features in the Modern Java since **Java 8 and Beyond Java 8**.
- Part 1 : New Modern Java features in **Java 8**.
  - Functional Programming, Lambdas, Streams, Optionals, New Date/Time APIs and more.
- Part 2 : New features in the Modern Java since **Java 9**.
  - Local Variable Type Inference (LVTI), Record Types, Enhanced Switch, TextBlocks, Sealed Classes, Pattern Matching, JPMS and more.
- This course will be continuously updated with all the new features.
- All the concepts will be explored by actually coding it.

Targeted Audience

- Experienced Java Developers.
- Java Developers who is interested in exploring the latest features in Java.
- Java Developers who likes to stay up to date.
- Hands-On Oriented course.

Source Code

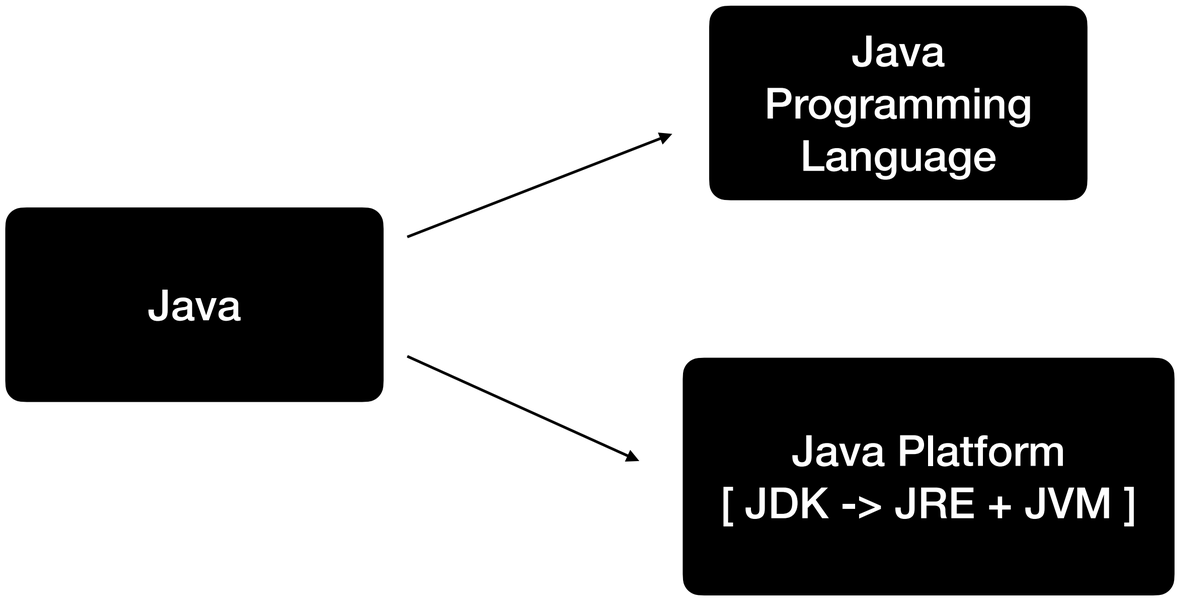
Thank You!

Prerequisites

- Java 21 or above.
- Prior Java Experience is a must
- **Intellij** or any other IDE.
- Experience Writing JUnit tests.
- Additional Tools and Skills:
  - Git
  - Experience working with Gradle (optional).

Introduction to the Modern Java

What does “Java” mean?



Evolution of Java = Modern Java

- Functional Programming (Java 8)
  - Lambdas, Streams
  - CompletableFuture
- Release of Java Modules (Java 9)
  - Java Platform Module System
  - Java Runtime Libraries are also modularized.
- Six Month Release Cycle(Java 10 onwards)
  - Release new features every 6 months

Java 8

- Lambdas
- Streams
- Optionals
- New Date/Time APIs

Java 9 & Beyond

- Java Platform Module System (JPMS)
- Local Variable Type Inference (LVTI)
- Record Types
- Enhanced Switch
- TextBlocks
- Sealed Classes
- Pattern Matching
- Virtual Threads 

Java 8

- Lambdas
- Streams
- Optionals
- New Date/Time APIs

Java 9 & Beyond

- Java Platform Module System (JPMS)
- Local Variable Type Inference (LVTI)
- Record Types
- Enhanced Switch
- TextBlocks
- Sealed Classes
- Pattern Matching

Development > Web Development > Multithreading

Modern Java - Multithreading in Java using Virtual Threads

A Complete Modern MultiThreading/Concurrency course to learn about Virtual Threads,Structured Concurrency and more.

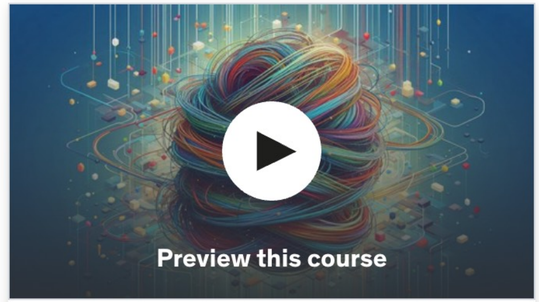
New 4.9 ★★★★★ (12 ratings) 161 students

Created by Pragmatic Code School

Last updated 3/2024 English English [Auto]

What you'll learn

- ✓ You will learn how to harness the power of Virtual Threads to create highly scalable and efficient Java applications.
- ✓ What are Platform Threads and the limitations attached to it ?
- ✓ Learn about Virtual Threads and how to work with them by coding it.
- ✓ Learn about the advantages and internals of virtual threads.
- ✓ Learn to launch one million virtualthreads.
- ✓ Learn to use Structured Concurrency API to implement business logic.
- ✓ HTTP calls using Virtual Threads.
- ✓ Build a SpringBoot Application using Virtual Threads.
- ✓ Compare the performance of Platform Threads vs Virtual Threads in a Springboot App using Apache "ab" benchmarking tool.
- ✓ Use Virtual Threads by building hands-on projects and real world examples.



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Java Release Model

- Java is an open source language and its managed under the OpenJDK project.
  - Java 7 was the first version that was relesed under the open source license.
- OpenJDK project is manitained by Oracle, Redhat and the community.
- There are different OpenJDK providers:
  - Orcale, Eclipse Adoptium(Temurin) , Amazon(Corretto), Azul Systems (Zulu), IBM, Microsoft, Red Hat, and SAP
- All of these vendors have this concept of LTS (Long Term Support) releases.
  - Primary applications run on these LTS releases even though new Java version is released every 6 months

Why Java 8 ?

- Most popular and widely accepted language in the world.

- Java creators wanted to introduce the Functional features such as:
  - Lambdas
  - Streams
  - Optional and etc.,

- Technological advancements with the mobile/laptops/systems.

- New **Java 8** features simplify the concurrency operations.

Functional Programming:

- Embraces creating Immutable objects.

- More concise and readable code.

- Using functions/methods as first class citizens.

Example:

```
Function<String,String> addSomeString =  (name) -> name.toUpperCase().concat("default");
```

- Write code using **Declarative approach**.

Imperative vs Declarative Programming

Imperative Style of Programming

- Focuses on how to perform the operations.
- Embraces Object mutability.
- This style of programming lists the step by step of instructions on how to achieve an objective.
- We write the code on what needs to be done in each step.
- Imperative style is used with classic Object Oriented Programming.

Declarative Style of Programming

- Focuses on what is the result you want.
- Embraces Object immutability.
- Analogous to **SQL** (Structured Query Languague).
- Use the functions that are already part of the library to achieve an objective.
- Functional Programming uses the concept of declarative programming.

Imperative vs Declarative Programming

Example 1

Sum of 100 numbers from 0 to 100

Imperative vs Declarative Programming

Example 2

Removing duplicates from a list of integers

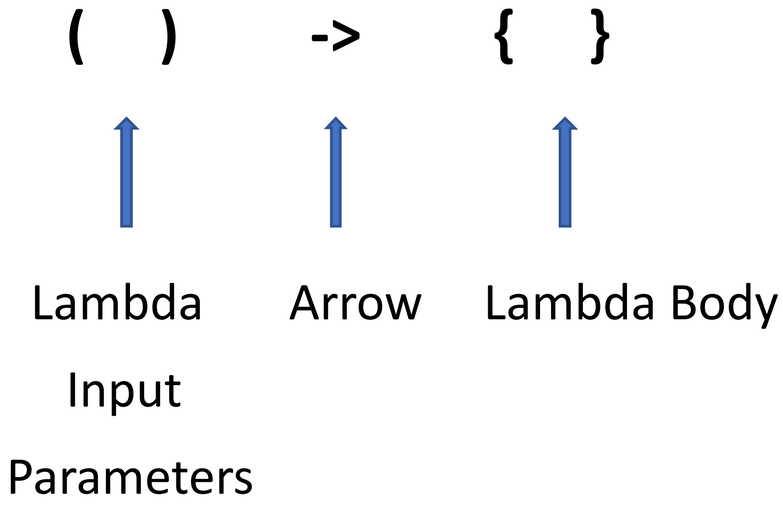
What is Lambda Expression?

- **Lambda** is equivalent to a function (method) without a name.

- Lambda's are also referred as **Anonymous** functions.
  - Method parameters
  - Method Body
  - Return Type
- Lambdas are not tied to any class like a regular method.
- Lambda can also be assigned to variable and passed around.

Syntax of the Lambda Expression

Lambda Expression:



Usages of Lambda

- Lambda is mainly used to implement Functional Interfaces(SAM).

```
@FunctionalInterface
public interface Comparator<T> {
        int compare(T o1, T o2);
}
```

```
@FunctionalInterface
public interface Runnable {
    public abstract void run();
}
```

Lets code our first Lambda!

Implement Runnable using Lambda

Lambda in Practice (Things to keep in Mind)

( ) -> Single Statement or Expression; // curly braces are not needed.

( )-> { <Multiple Statements> }; // curly braces are needed for multiple //statements

Lambdas vs Legacy Java(until Java7)

Legacy:

```
Runnable runnable = new Runnable() {
    @Override
    public void run() {
        System.out.println("Inside Runnable 1");
    }
};
```

Java 8:

```
Runnable runnableLambda = () -> {System.out.println("Inside Runnable 2");};
```

Functional Interfaces

- Exists since Java 1.0

Definition:

- A Functional Interface(SAM) is an interface that has exactly one abstract method.

@FunctionalInterface:

- This annotation is introduced as part of the JDK 1.8.

- Optional annotation to signify an interface as Functional Interface.

New Functional Interfaces in Java8

- Consumer
- Predicate
- Function
- Supplier

New Functional Interfaces in Java8

- Consumer – BiConsumer
- Predicate - BiPredicate
- Function – BiFunction, UnaryOperator, BinaryOperator
- Supplier

New Functional Interfaces in Java8

- **Consumer** – IntConsumer, DoubleConsumer, LongConsumer
- **Predicate** – IntPredicate, BiPredicate, LongPredicate
- **Function** – IntFunction, DoubleFunction, LongFunction,IntToDoubleFunction, IntoLongFunction,DoubletoIntFunction, DoubletoLongFunction,LongtoIntFunction, LongtoDoubleFunction,ToIntFunction, ToDoubleFunction,ToLongFunction
- **Supplier** – IntSupplier, LongSupplier, DoubleSupplier, BooleanSupplier

Method Reference

- Introduced as part of Java 8 and its purpose is to simplify the implementation Functional Interfaces.
- Shortcut for writing the **Lambda Expressions**.
- Refer a method in a class.

Syntax of Method Reference

ClassName::instance-methodName

ClassName::static-methodName

Instance::methodName

Where to use Method Reference?

- Lambda expressions referring to a method directly.

Using Lambda:

Function<String,String> *toUpperCaseLambda* = (s)->s.toUpperCase();

Using Method Reference:

Function<String,String> *toUpperCaseMethodRefernce* = String::toUpperCase;

Where Method Reference is not Applicable ?

Example:

Predicate<Student> *predicateUsingLambda* = (s) -> s.getGradeLevel()>=3;

Constructor Reference

- Introduced as part of Java 1.8

Syntax:

Classname::new

Example:

Supplier<Student> *studentSupplier* = Student**::new**;

Invalid:

Student student = Student::**new**; // compilation issue

Lambdas and Local Variables

What is a **Local variable** ?

- Any variable that is declared inside a method is called a local variable.

- Lambdas have some restrictions on using local variables:
  - Not allowed to use the same the local variable name as **lambda parameters** or inside the **lambda body**.
  - Not allowed **re-assign** a value to a local variable.

- No restrictions on **instance** variables.

Local Variables – Not Allowed

Repeated Variable Name:

- Variable **i** is declared in the same scope and used as a parameter in Lambda.
- You cannot use the same variable as a lambda parameter or inside the lambda body.

Same Variable as Input:

```
    int i=0;  //Repeated varibale name not allowed
Consumer<Integer> c1 = (i) -> {
                System.out.println(i+value);
};
```

Local Variables – Not Allowed

Same Variable as Lambda parameter:

```
int i=0;
Consumer<Integer> c1 = (i) -> {  //Repeated variable name not allowed
System.out.println(i+value);
 };
```

Same Variable in Lambda Body:

```
 int i=0;
Consumer<Integer> c1 = (a) -> {
   int i=0; //Repeated variable name not allowed
   System.out.println(i+value);
};
```

Local Variables – Not Allowed

- Not allowed to modify the value inside the lamda

```
int value =4;
Consumer<Integer> c1 = (a) -> {
    //value=6; //reassigning not allowed
    //  System.out.println(i+value);
};
```

Effectively Final

- Lambda's are allowed to use local variables but not allowed to modify it even though they are not declared final. This concept is called **Effectively Final.**

- Not allowed to modify the value inside the lamda

```
int value =4;
Consumer<Integer> c1 = (a) -> {
   //value=6; //reassigning not allowed
   //  System.out.println(i+value);
};
```

- Prior to Java 8 , any variable that's used inside the anonymous class should be declared **final.**

Advantages of Effectively Final:

- Easy to perform concurrency operations.
- Promotes Functional Programming and demotes the Imperative style programming.

Introduction to Streams API:

- Introduced as part of **Java8**
- Main purpose is to perform some **Operation on Collections.**
- **Parallel operations** are easy to perform with Streams API without having to spawn a multiple threads.
- Streams API can be also used with arrays or any kind of I/O .

What is a Stream ?

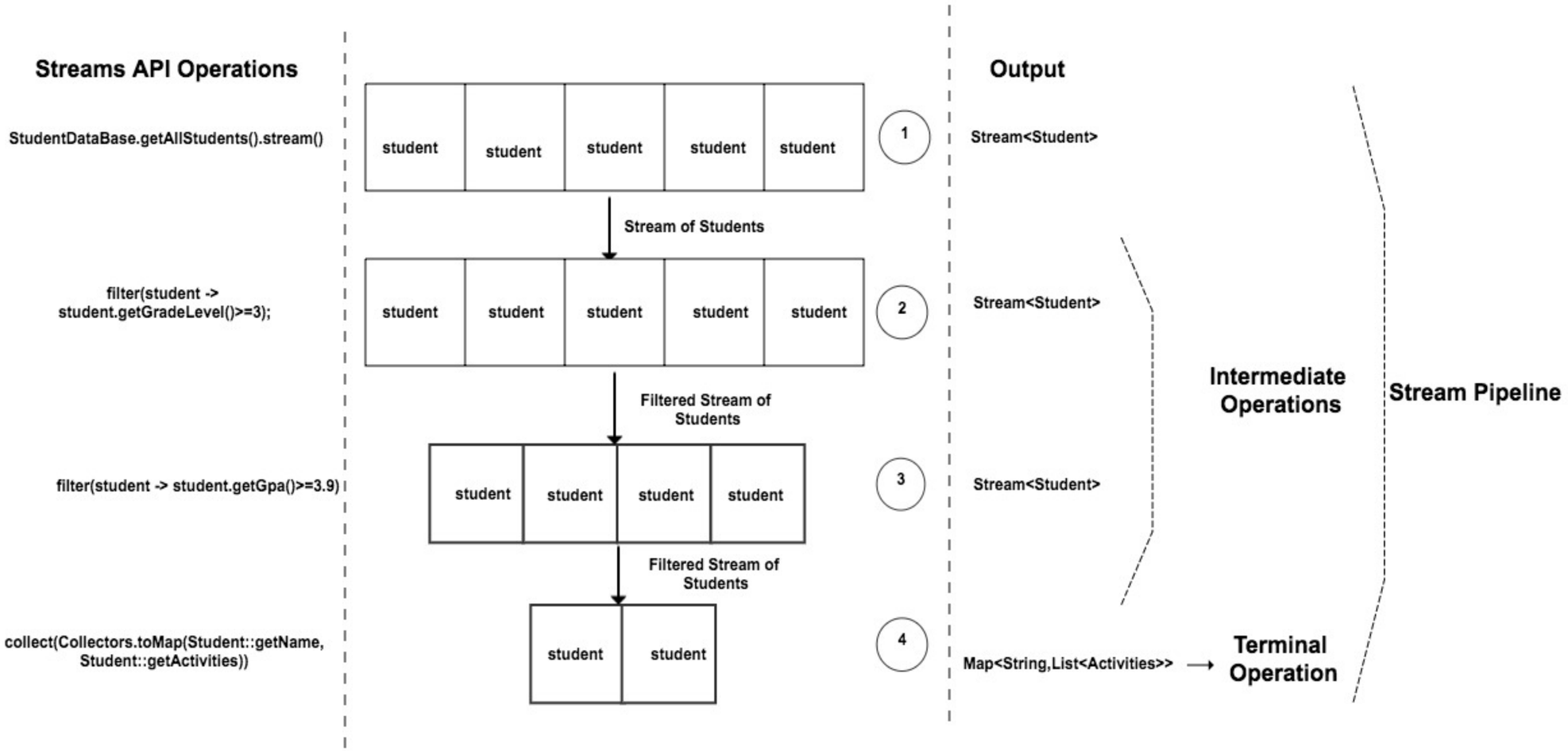
- Stream is a sequence of elements which can be created out of a collections such as **List or Arrays** or any kind of **I/O** resources and etc.,

```
List<String> names = Arrays.asList("adam","dan","jenny");
names.stream();  // creates a stream
```

- Stream operations can be performed either **sequentially** or **parallel**.

```
names.parallelStream(); // creates a parallel stream
```

How Stream API Works ?



Collections and Streams

Collections	Streams
Can add or modify elements at any point of time. For Example: **List -> list.add(<element>)**	Cannot add or modify elements in the stream. It is a data set.
Elements in the collection can be accessed in any order. Use appropriate methods based on the collection. For Example: **List -> list.get(4);**	Elements in the Stream can be accessed only in sequence.
Collection is eagerly constructed.	Streams are lazily constructed.

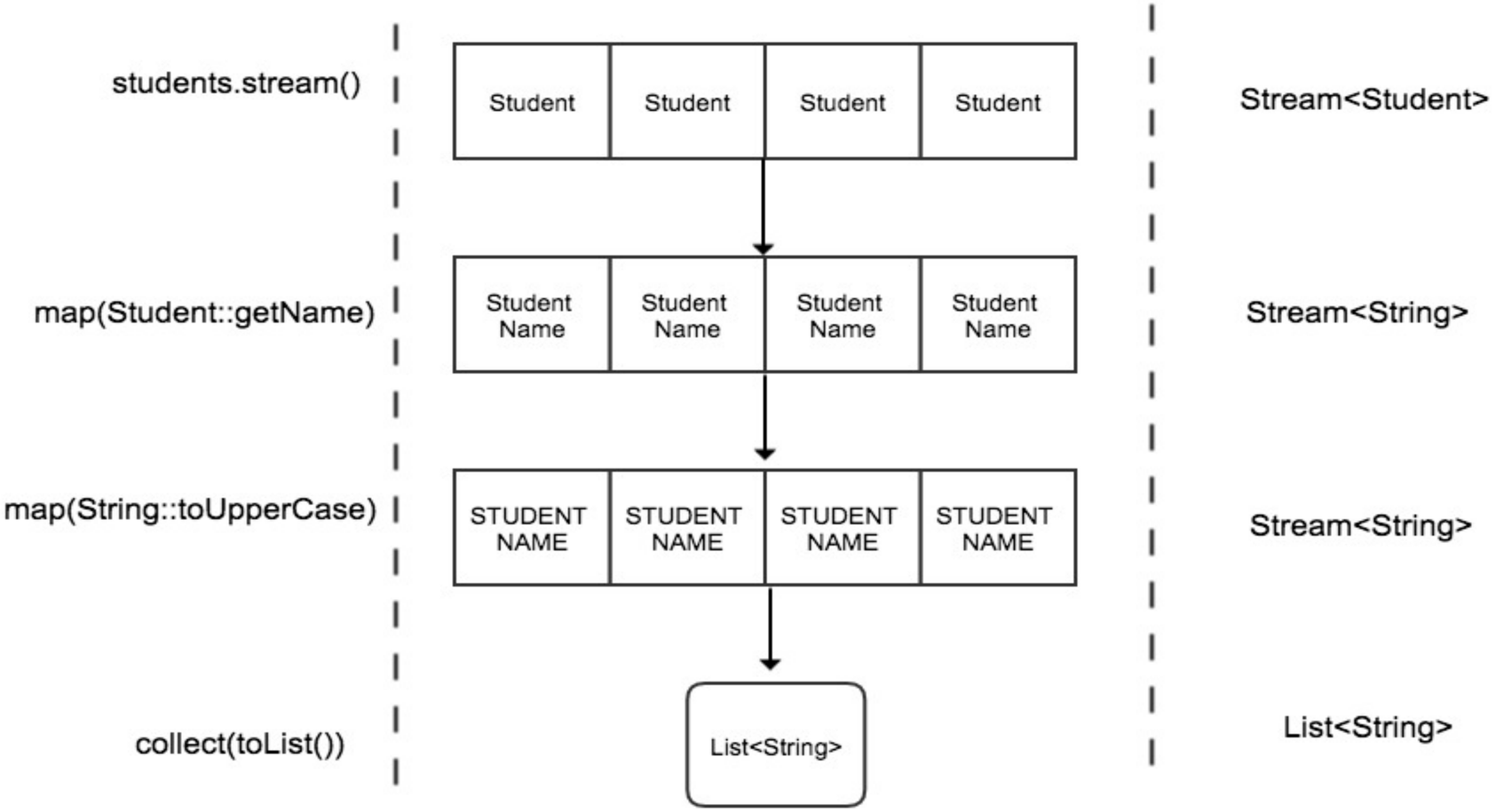
Collections and Streams

Collections	Streams
Collections can be traversed “n” number of times.	Streams can be traversed only once.
Performs **External Iteration** to iterate through the elements.	Performs **Internal Iteration** to iterate through the elements.

Stream API : map()

- **map** : Convert(transform) one type to another.

- Don’t get confused this with **Map** Collection.


students.stream()
Student
Student
Student
Student
Stream<Student>
map(Student::getName)
Student Name
Student Name
Student Name
Student Name
Stream<String>
map(String::toUpperCase)
STUDENT NAME
STUDENT NAME
STUDENT NAME
STUDENT NAME
Stream<String>
collect(toList())
List<String>
List<String>

Stream API : flatMap()

- **flatMap** : Converts(Transforms) one type to another as like map() method
- Used in the context of Stream where each element in the stream represents multiple elements.

Example:

- Each Stream element represents multiple elements.
  - Stream<List>
  - Steam<Arrays>

Stream API – distinct() , count() and sorted()

- **distinct** – Returns a stream with unique elements
- **count** – Returns a long with the total no of elements in the Stream.
- **sorted** - Sort the elements in the stream

Stream API – filter()

- **filter –** filters the elements in the stream.

Input to the filter is a **Predicate** Functional Interface.

Streams API - reduce()

- **reduce** – This is a terminal operation. Used to reduce the contents of a stream to a single value.

- It takes two parameters as an input.
  - **First parameters** – default or initial value
  - **Second Parameter** – BinaryOperator<T>

Stream API : Max/Min using reduce()

- **max** -> Maximum(largest) element in the stream.

- **min** -> Minimum(smallest) element in the stream.

Stream API : limit() and skip()

- These two function helps to create a sub-stream.
- **limit(n)** – limits the **“n”** numbers of elements to be processed in the stream.
- **skip(n) –** skips the **“n”** number of elements from the stream.

Streams API : anyMatch(), allMatch() , noneMatch()

- All these functions takes in a **predicate** as an input and returns a **Boolean** as an output.

- **anyMatch()**- Returns **true** if any one of the element matches the predicate, otherwise false.
- **allMatch()** - Returns **true** if all the element in the stream matches the predicate, otherwise false.
- **noneMatch()** – Just opposite to **allMatch()**. Returns **true** if none of the element in the stream matches the predicate, otherwise false.

Streams API : findFirst() and findAny()

- Used to find an element in the stream.

- Both the functions returns the result of type **Optional**.

- **findFirst()** – Returns first element in the stream.
- **findAny() –** Returns the first encountered element in the stream.

Streams API - Short Circuiting

What is Short Circuiting ?

Examples of Short Circuiting:

Example 1:

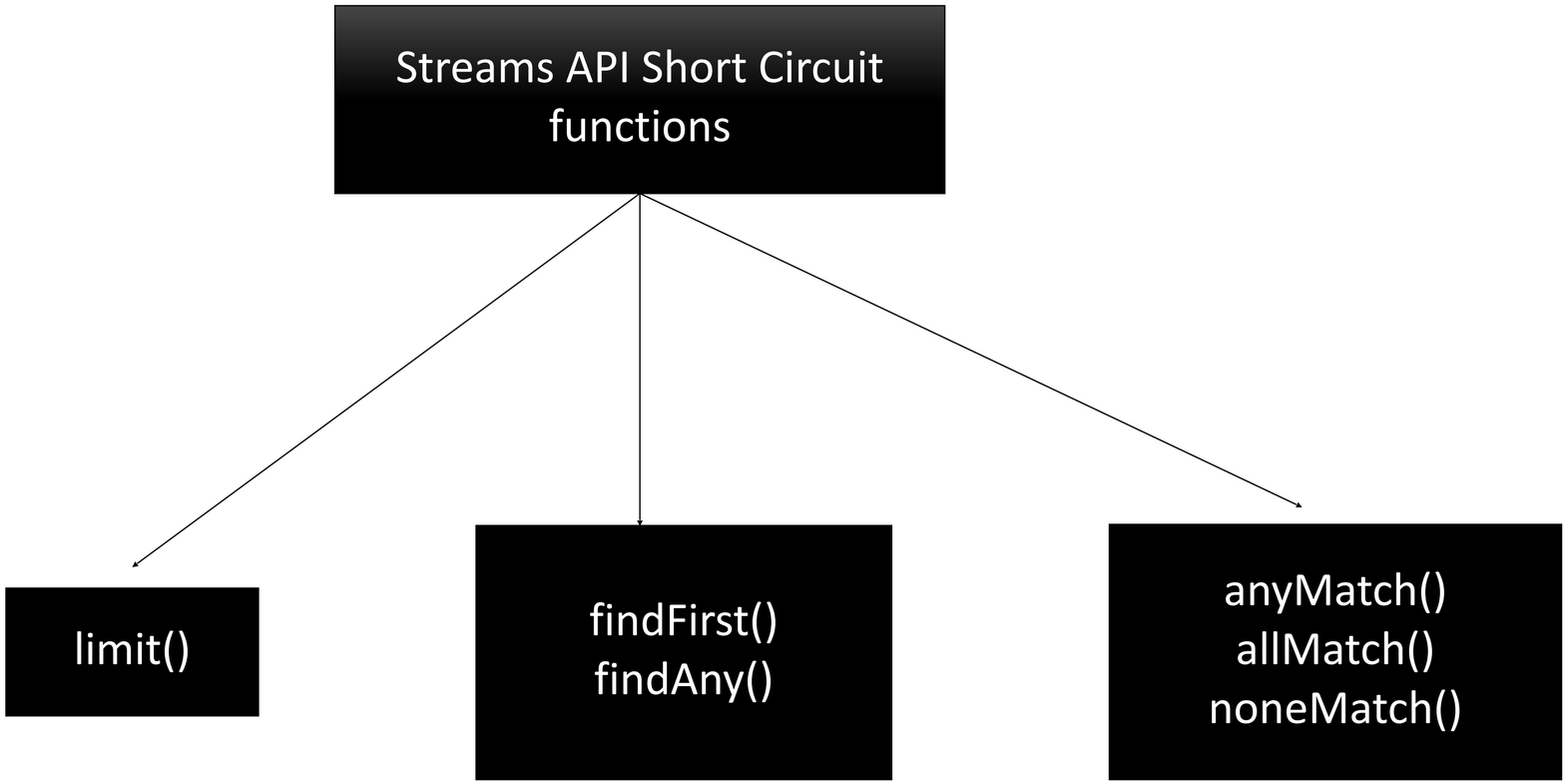
```
if(boolean1 && boolean2){ //AND
    //body
}
```

- If the first expression evaluates to false then the second expression wont even execute.

Example 2:

```
if(boolean1 || boolean2){ //OR
    //body
}
```

- If the first expression evaluates to true then the second expression wont even execute.



- All these functions does not have to iterate the whole stream to evaluate the result.

Streams API : Stateful vs Stateless

- Does Streams have an internal state?
  - **Yes**
- Does all the Stream functions maintain an internal state ?
  - **No**

What is a State in Streams API ?

Converts a List<Student> to List<String>

```
private static List<String> namesUpperCase(List<Student> names){
    List<String> namesUpperCase = names.stream()
            .map(Student::getName)
            .map(String::toUpperCase)
            .collect(toList());

    return namesUpperCase;
}
```

(Stream State)

(Stream Pipeline)

Intermediate Operations

- Stateful functions
  - distinct()
  - sorted()
  - skip()
  - limit()
- Stateless functions
  - map()
  - filter(), etc.,

Stateful functions:

Convert List<Student> to List<String>

```
public static List<String> printUniqueStudentActivities() {

    List<String> studentActivities = StudentDataBase.getAllStudents()
            .stream()
            .map(Student::getActivities)
            .flatMap(List::stream)
            .distinct() // needs the state of the previously processed elements
            .sorted() // needs the state of the previously processed elements
            .collect(toList());
    return studentActivities;

}
```

Stateless Functions:

Convert List<Student> to List<String>

```
private static List<String> namesUpperCase(List<Student> names){
    List<String> namesUpperCase = names.stream() //Stream<Student>
            .map(Student::getName) //Stream<String> - stateless
            .map(String::toUpperCase) // Stream<String> -> UpperCase - stateless
            .collect(toList()); // returns List  - stateless

return namesUpperCase;
}
```

Streams API – Factory methods

- Of()
- generate()
- iterate()

Streams API – of(), iterate() and generate()

- **Of()** -> Creates a stream of certain values passed to this method.

Example:

Stream<String> stringStream = Stream.of(“adam”,”dan”,”Julie”);

iterate(), generate() -> Used to create infinite Streams.

Example:

Stream.iterate(1, x->x*2)

Example:

Stream.generate(<Supplier>)

Numeric Streams

Represents the **primitive values** in a Stream.

- IntStream
- LongStream
- DoubleStream

Numeric Stream Ranges:

Int Stream:

IntStream.*range*(1,50) -> Returns an IntStream of 49 elements from 1 to 49.

IntStream.rangeClosed(1,50) -> Returns an IntStream of 50 elements from 1 to 50.

Long Stream:

LongStream.*range*(1,50) -> Returns a LongStream of 49 elements from 1 to 49.

LongStream.*rangeClosed*(1,50) -> Returns a LongStream of 50 elements from 1 to 50.

DoubleStream:

- It does not support the range ()and rangeClosed().

Numeric Stream – Aggregate Functions

- sum()
- max()
- min()
- average()

Numeric Streams : Boxing() and UnBoxing()

Boxing():

- Converting a primitive type to Wrapper Class type

Example:

- Converting an int (primitive) to Integer(wrapper).

UnBoxing():

- Converting a Wrapper Class type to primitive type.

Example:

- Converting an Integer(wrapper) to int(primitive).

Numeric Streams – mapToObj(), mapToLong(), mapToDouble()

- **mapToObj** –> Convert a each element numeric stream to some Object.

- **mapToLong** –> Convert a numeric stream to a Long Stream.

- **mapToDouble** –> Convert a numeric stream to a Double Stream.

Stream Terminal Operations

- Terminal Operations collects the data for you.
- Terminal Operations starts the whole stream pipeline.

- Terminal Operations:
  - forEach()
  - min()
  - max()
  - reduce()
  - collect() and etc.

Terminal Operation – collect()

- The **collect()** method takes in an input of type Collector.

- Produces the result as per the input passed to the collect() method.

Terminal Operations – joining()

- **joining()** Collector performs the String concatenation on the elements in the stream.

- **joining()** has three different overloaded versions.

Terminal Operations – counting()

- **counting()** Collector returns the total number of elements as a result.

Terminal Operation – mapping()

- **mapping()** collector applies a transformation function first and then collects the data in a collection(could be any type of collection)

Terminal Operations – maxBy() , minBy()

- **Comparator** as an input parameter and Optional as an output.
- **maxBy()**
  - This collector is used in conjunction with comparator. Returns the max element based on the property passed to the comparator.
- **minBy()**
  - This collector is used in conjunction with comparator. Returns the smallest element based on the property passed to the comparator.

Terminal Operations – summingInt(), averagingInt()

- **summingInt() –** this collector returns the sum as a result.

- **averagingInt() –** this collector returns the average as a result.

Terminal Operations - groupingBy()

- **groupingBy()** collector is equivalent to the groupBy() operation in SQL.
- Used to group the elements based on a property.
- The output of the groupingBy() is going to be a Map<K,V>
- There are three different versions of groupingBy().
  - groupingBy(classifier)
  - groupingBy(classifier,downstream)
  - groupingBy(classifier,supplier,downstream)

Terminal Operations – partitioningBy()

- **partitioningBy()** collector is also a kind of **groupingBy().**

- **paritioningBy()** accepts a predicate as an input.

- Return type of the collector is going to be Map<K,V>
  - The key of the return type is going to be a Boolean.
- There are two different versions of partitioningBy()
  - partitioningBy(predicate)
  - partitioningBy(predicate,downstream) // downstream -> could be of any collector

Introduction to Parallel Streams

What is a Parallel Stream ?

- Splits the source of data in to multiple parts.
- Process them parallelly.
- Combine the result.

How to Create a Parallel Stream ?

Sequential Stream:

```
IntStream.rangeClosed(1,1000)
        .sum();
```

Parallel Stream:

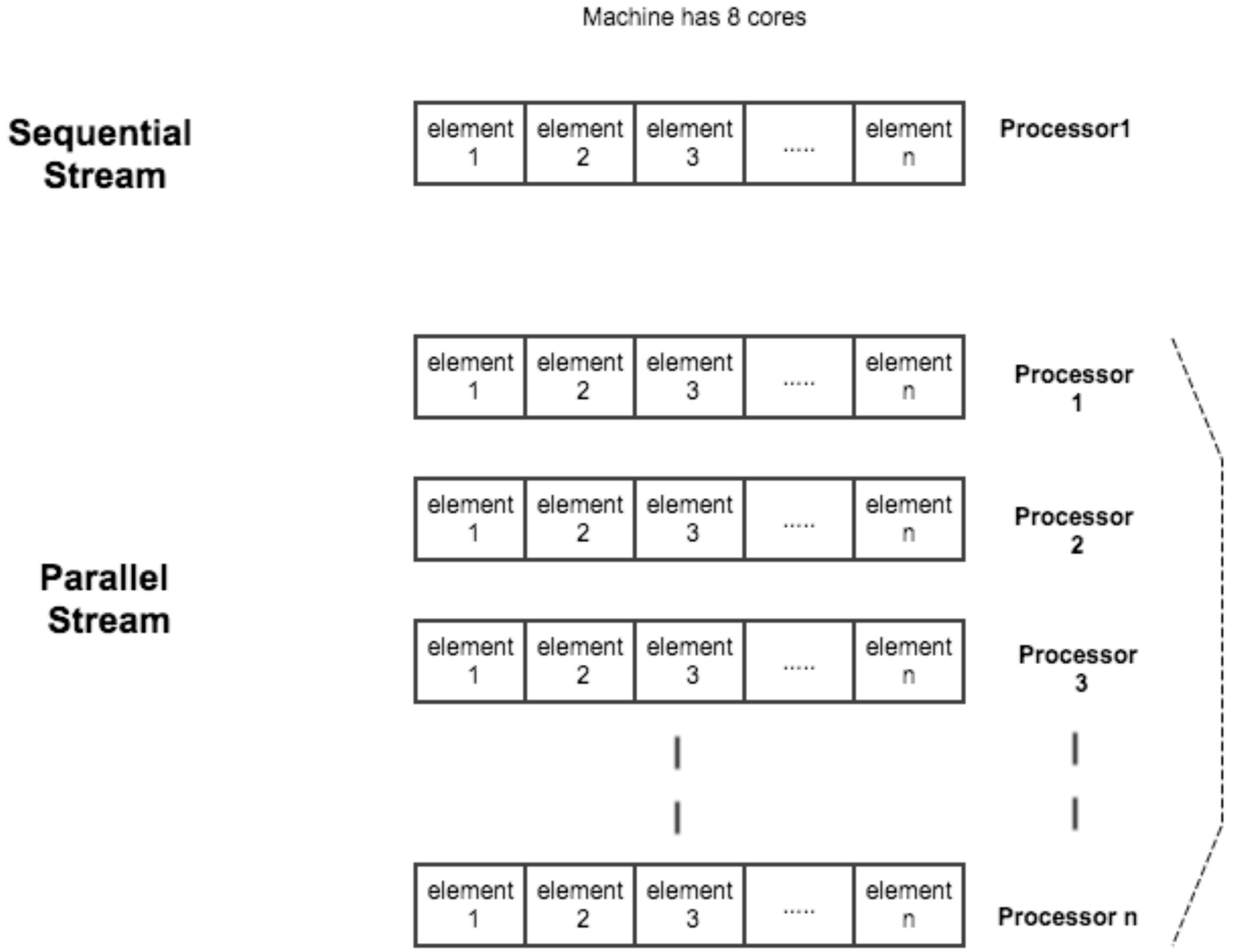
```
IntStream.rangeClosed(1,1000)
          .parallel()
        .sum();
```

How Parallel Stream works ?

- Parallel Stream uses the **Fork/Join framework** that got introduced in Java 7.

How many Threads are created ?

- Number of threads created **==** number of processors available in the machine.


Machine has 8 cores
Sequential Stream
element 1
element 2
element 3
.....
element n
Processor1
Parallel Stream
element 1
element 2
element 3
.....
element n
Processor 1
Processor 2
Processor 3
Processor n

Introduction to Optional

- Introduced as part of Java 8 to represent a Non-Null value
- Avoids **Null Pointer Exception** and **Unnecessary Null Checks.**
- Inspired from the new languages such as scala , groovy etc.,

Default and Static Methods in Interfaces

Interfaces in Java - Prior Java 8:

- Define the contract.
- Only allowed to declare the method. Not allowed to implement a method in Interface.
- Implementation is only allowed in the Implementation class.
- Not easy for an interface to evolve.

Default Methods – Java 8

- **default** keyword is used to identify a default method in an interface.

Example from List Interface:

```
default void sort(Comparator<? super E> c) {
    Object[] a = this.toArray();
    Arrays.sort(a, (Comparator) c);
    ListIterator<E> i = this.listIterator();
    for (Object e : a) {
        i.next();
        i.set((E) e);
    }
}
```

- Prior to Java 8 we normally use Collections.sort() to perform the similar operation.
- Can be overridden in the Implementation class.
- Used to evolve the Interfaces in Java.

Static Methods – Java 8

- Similar to **default** methods.

- This cannot be overridden by the implementation classes.

Abstract Classes vs Interfaces in Java 8

- Instance variables are not allowed in Interfaces.

- A class can extend only one class but a class can implement multiple interfaces.

Does this enable Multiple Inheritance in Java?

- Yes

- This was never possible before Java 8.

Introduction to New Date/Time Libraries

- LocalDate, LocalTime and LocalDateTime and part of the **java.time** package.
- These new classes are created with the inspiration from the **Joda-Time** library.
- All the new time libraries are **Immutable**.
- Supporting classes like **Instant, Duration,Period** and etc.
- Date, Calendar prior to Java 8.

LocalDate: Used to represent the date.

LocalTime: Used to represent the time.

LocalDateTime: Used to represent the date and time.

Period:

- Period is a date-based representation of time in **Days , Months and Years** and is part of the **java.time** package.

- Compatible with **LocalDate**.

- It represents a **Period of Time** not just a specific date and time.

Example:

Period period1 = Period.*ofDays*(10); // **represents a Period of 10 days**

Period period2 = Period.*ofYears*(20); // **represents a Period of 20 years**

Period : Use-Case

- Mainly used calculate the difference between the two dates.

Example:

```
LocalDate  localDate = LocalDate.of(2018,01,01);
LocalDate  localDate1 = LocalDate.of(2018,01,31);

Period period = Period.between(localDate,localDate1); // calculates the difference between the two dates
```

Duration

- A time based representation of time in **hours , minutes, seconds and nanoseconds.**
- Compatible with **LocalTime** and **LocalDateTime**
- It represents a duration of time not just a specific time.

Example:

Duration duration1 = Duration.*ofHours*(3);; **// represents the duration of 3 hours**

Duration duration1 = Duration. ofMinutes(3); **// represents the duration of 3 minutes**

Duration : Use-Case

- It can be used to calculate the difference between the time objects such as **LocalTime** and **LocalDateTime**.

Example:

```
LocalTime localTime = LocalTime.of(7,20);
LocalTime localTime1 = LocalTime.of(8,20);

Duration duration = Duration.between(localTime,localTime1);
```

Instant:

- Represent the time in a machine readable format.

Example:

Instant ins = Instant.now();

- Represents the time in seconds from January 01,1970**(EPOCH)** to current time as a huge number.

Time Zones

- ZonedDateTime, ZoneID, ZoneOffset

- **ZonedDateTime** - Represents the date/time with its time zone.

Example:

2018-07-18T08:04:14.541-05:00[America/Chicago]

ZoneOffset-> -05:00

ZoneId -> America/Chicago

DateTimeFormatter

- Introduced in **Java 8** and part of the **java.time.format** package.

- Used to parse and format the **LocalDate**, **LocalTime** and **LocalDateTime**.

Parse and Format

- **parse -** Converting a String to a LocalDate/LocalTime/LocalDateTime.

- **format -** Converting a LocalDate/LocalTime/LocalDateTime to a String.

Local Variable Type Inference(LVTI) using “var”

- Historically Java was always labelled as a verbose language.
- LVTI feature is specifically introduced to address the verbosity concern.
- **var** is a reserved type name `var var = "Java";` ✔

Before LVTI

```
List<String> names1 = List.of("adam", "dilip");
```

After LVTI

```
var names = List.of("adam", "dilip");
```

Variable name

Reserved type name

Local Variable Type Inference(LVTI) using “var”

Before LVTI

```
Map<Integer, Map<String, String>> usersLists =
        new HashMap<Integer, Map<String, String>>();
```

After LVTI

```
var usersLists = new HashMap<Integer, Map<String,String>>();
```

Limitations of using “var”

- “null” value cannot be assigned to a “var” as the type cannot be inferred.
  - var x = null ✗
- Changing the type is not allowed.

```
var s = "Hello, World”;

s=3 // Changing the type to integer is not allowed
```

- “var” cannot be used as a class property
- “var” cannot be used as function argument.

Collection Factory Methods

- These factory methods are created to ease the creation of collection.

```
var list = List.of(1,2, 3);
```

```
var set = Set.of("a", "b", "c");
```

```
var sampleMap = Map.of(1, "One", 2 , "2");
```

```
var sampleMap1 = Map.ofEntries(entry(1, "One"), entry(2, "two"));
```

- All these collections are immutable ones.
- These factory methods were introduced in **Java 9**.

TextBlocks - Enhanced the power of String

- This feature got released in Java 15.

- Java's **String** was always considered very primitive compared to other programming languages.

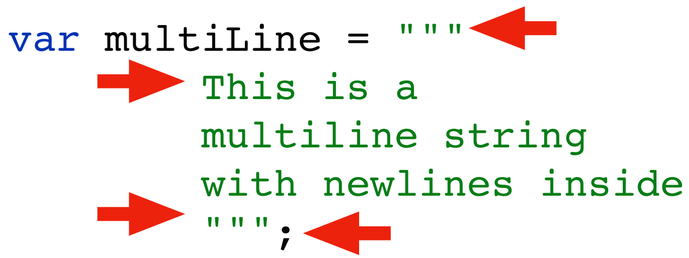
```
var home = "Dilip\"s Home '";
```

```
var multiLine = "This is a\n" +
        "    multiline string\n" +
        "with newlines inside";
```

"TextBlocks" are primarily introduced to make Strings better.

TextBlocks

- Begin and end with the triplequotes.
- A new line is must for a textblock.
- Indentation is based on the the closing triplequotes.
- This code much cleaner.



Text Blocks - Real Time Examples

- Sql:

```
var sql = """
        SELECT * FROM employee
        WHERE first_name = 'Dilip'
        AND last_name = 'Sundarraj'
        """;
```

- JSON:

```
var json =  """
        {
          "order_id": 123456,
          "status": "DELIVERED",
          "final_charge": 999.99,
          "order_line_items": [{
            "item_name": "iphone 14",
            "quantity": 1
          }]
        }
        """
        ;
```

Enhanced Switch

- Enhanced Switch got released as part of Java 14.
- Enhanced Switch is an “expression”.
  - The switch statement returns a value.

Enhanced Switch

- Function that returns the number of days based on the Month and Year.

Old "switch"

```
public static int getDays(Month month, int year) {
1   int noOfDays = 0;
    switch (month) {
        case APRIL:
        case JUNE:
2       case SEPTEMBER:
        case NOVEMBER:
            noOfDays = 30;
            break;
4       case FEBRUARY:
            noOfDays = Year.isLeap(year) ? 29 : 28;
            break;
5       default:
            noOfDays = 31;
    }
3   return noOfDays;

}
```

Enhanced "switch"

```
public static int getDaysV2(Month month, int year) {
    1 return switch (month) {
        2 case SEPTEMBER, APRIL, JUNE, NOVEMBER -> 30;
          case FEBRUARY -> Year.isLeap(year) ? 29 : 28;
          default -> 31;
      };
  }
```

1. Switch is an expression, so **return** is placed on the **switch** itself.
2. Multiple case lablels are allowed.
3. **break** is replaced by **arrow** and the **value**.

Records

- Records are a new type of class with a **record** keyword instead of the class keyword.
- Record classes are immutable data holders.
  - They are intended to just hold data.

```
public record Product(String name, BigDecimal cost, String type) { }
```

- This is available from Java 17.
- Record classes are **final**, no inheritance is supported.
- Record classes have autogenerated equals( ), hashcode( ) and toString( ) functions.

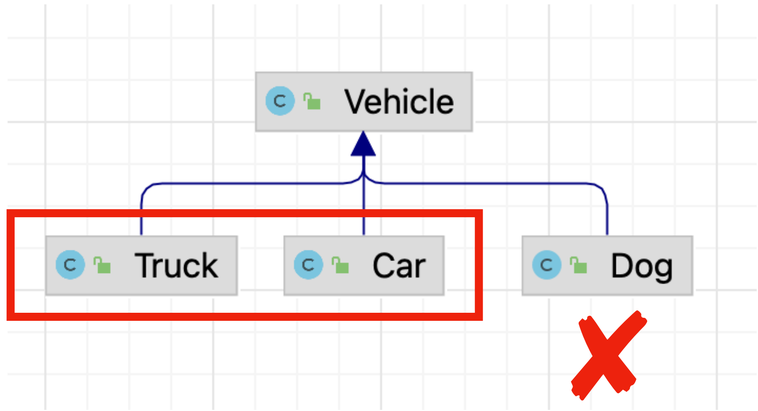
Records - Benefits

- Domain classes in Java can be represented in simpler form.
  - Now its part of the language itself.
- Avoids the need to write boiler plate code for domain classes.
  - This involves constructors, getter(), setter(), hashCode(), equals() and toString().
- Avoids the needs to rely on other libraries such as Lombok.
  - This requires us to have the knowledge of the different annotations.

Sealed Classes/Interfaces

- This concept was generally available from Java 17.
- Allow inheritance by permission.

- Java is very open by default.
  - Any class can extend other class as long its accessible.
- **Sealed classes/interfaces comes into play to prevent this kind of behavior.**



Sealed Classes/Interfaces

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

```
public final class Car extends Vehicle { }
```

```
public final class Truck extends Vehicle{ }
```

```
public class Dog extends Vehicle{ }
```

Subclasses of sealed classes

- final

```
public final class Car extends Vehicle { }
```

  - This ensures no other class can extend the Car class.

- sealed

```
public sealed class Car extends Vehicle permits FlyingCar { }
```

  - This ensures that inheritance is allowed but controlled for classes thats defined after the permits keyword.

- non-sealed

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

  - In this case, any class can extend the subclass **Car**. This basically disables the controlled inheritance behavior.

Why Pattern Matching?

- Code is verbose.
- Step 1 and Step 2 can be combined into one step.

```
public String pattern(Object o) {
    if (o instanceof Integer) {
        var i = (Integer) o;
        return "Integer:" + i;
    }
    if (o instanceof String) {
        var i = (String) o;
        return "String of length:" + i.length();
    }
    return "Not a String or Integer";

}
```

1 Check the type

2 cast and create a variable

3 Act on the variable

Pattern Matching to the rescue to write concise and elegant code.

What is Pattern Matching ?

- **Checks** the type, **Casts** the type and creates a **binding variable** if its a match.
- Act on the variable.
- Pattern Matching using **instanceOf** is available from Java 16.
- This particular type of pattern is also **Type Patterns**.
- Other Patterns:
  - Record Patterns
  - Guarded Patterns

```
public String patternMatchUsingInstanceOf(Object o) {
     // i is the binding variable.
    if (o instanceof Integer i) {1
        return "Integer:" + I;2
    }
    if (o instanceof String i) {
        return "String of length:" + i.length();
    }
    return "Not a String or Integer";
}
```

Pattern Matching - Different Approaches

Using “instanceOf”

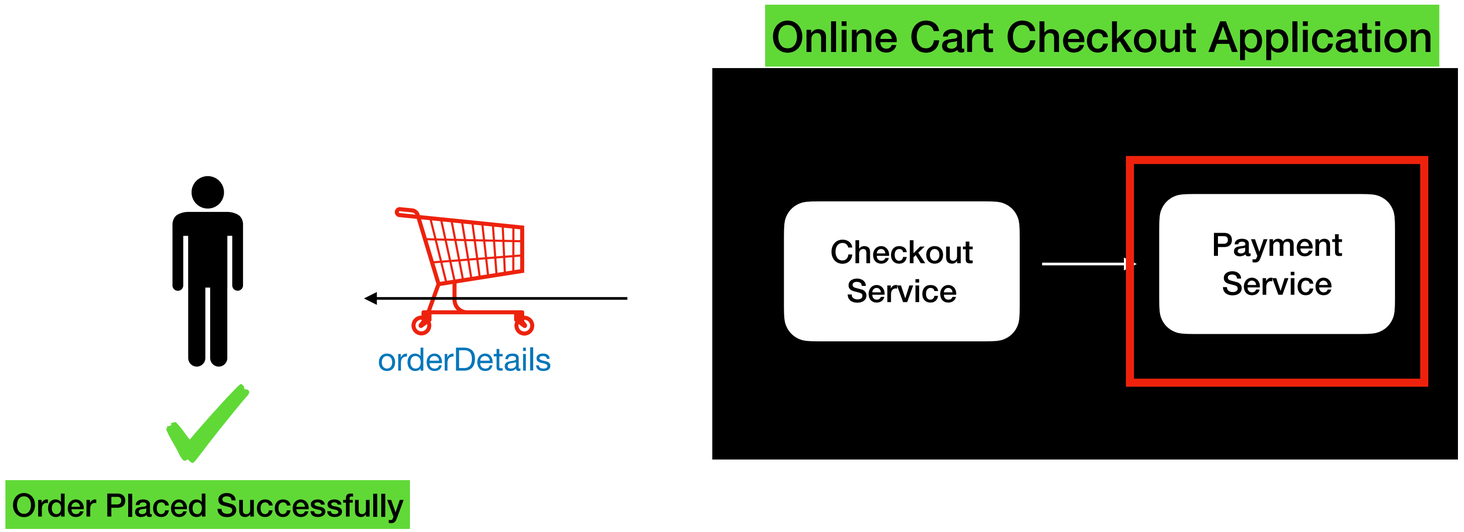
```
public String patternMatchUsingInstanceOf(Object o) {
     // i is the binding variable.
    if (o instanceof Integer i) {
       return "Integer:" + I;
    }
    if (o instanceof String i) {
        return "String of length:" + i.length();
    }
    return "Not a String or Integer";

}
```

Using “switch”

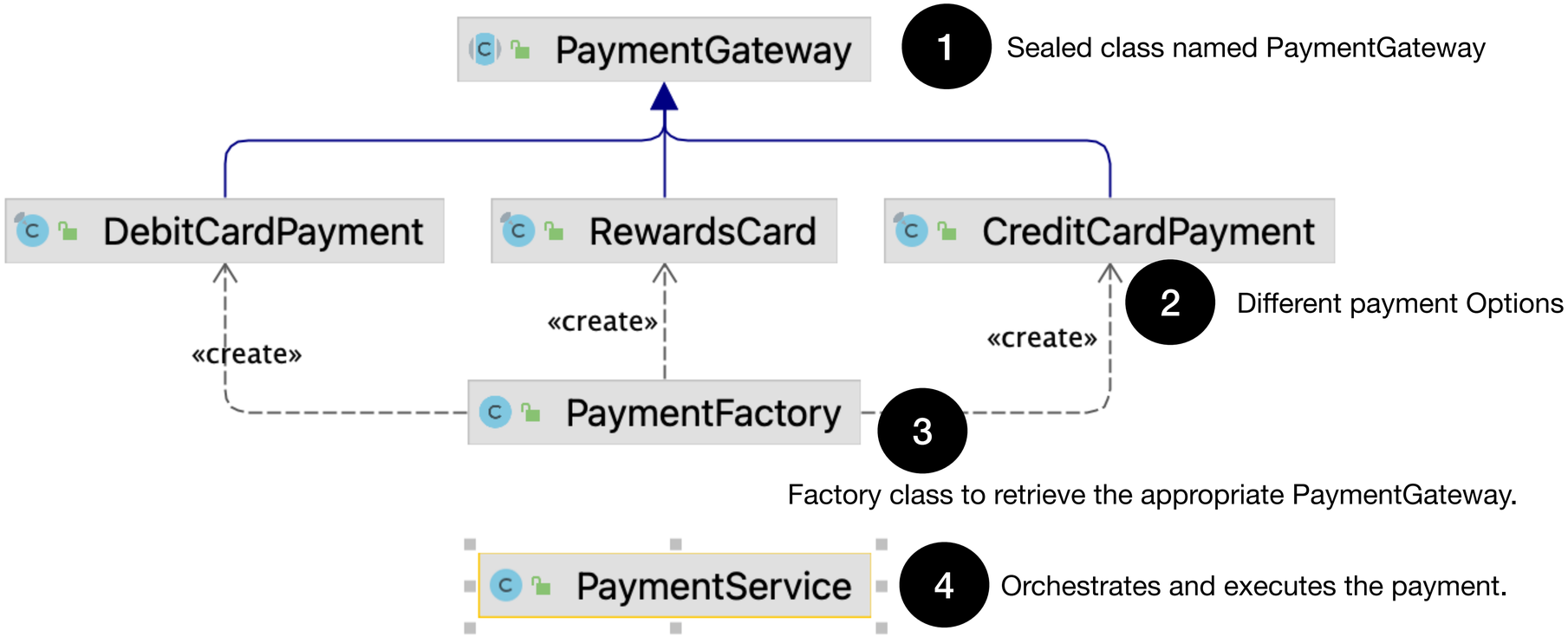
```
public String patternMatchingSwitch(Object o) {
    return switch (o) {
        case String s -> "String of length:" + s.length();
        case Integer i -> "Integer:" + i;
        case Number i -> "Integer:" + i;
        case null, default -> "Not a String or Integer";
    };
}
```

- Each case statement applies a pattern match.
- We can use lambdas for the case body.
- **case null** condition is a nice addition.

Online Cart Checkout Application



PaymentService Design



Simple Web Server

- Java18 released a **Simple Web Server.**
  - It’s part of the Java Distribution that’s installed in our machine.
  - This **webserver** servers files and folders from your machine.
- This can be primarily used for prototyping, testing and debugging.
- We can launch the webserver by running the **jwebserver** in the terminal.
  - It supports GET and HEAD requests only.
  - HTTPS is not supported.
  - Support HTTP/1.1.

HTTP 2 Client

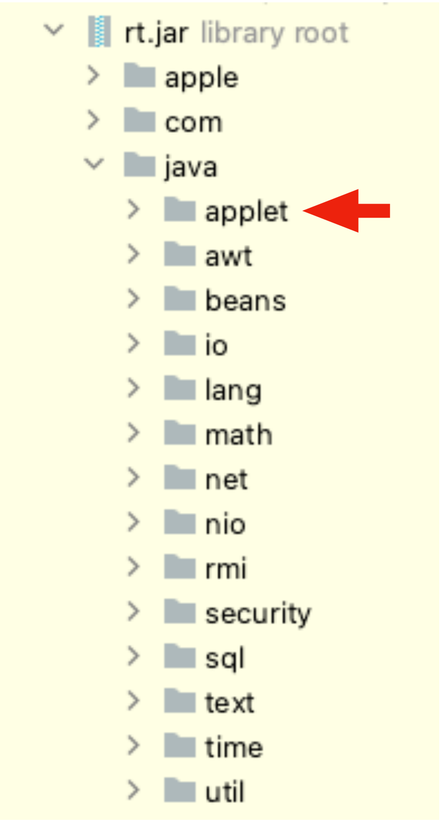
- New HTTP Client API got released in Java 11
    - It has the support for HTTP/2 and Websockets
- The Client has the support for build clients in both Synchronous and Asynchronous mode.

Java Platform Module System (JPMS) or Project Jigsaw

- This is a new concept that got introduced in **Java 9**.
- **JPMS** is introduced to package & deploy your applications in a better way.
- Why JPMS ?
  - Modularize the JDK.

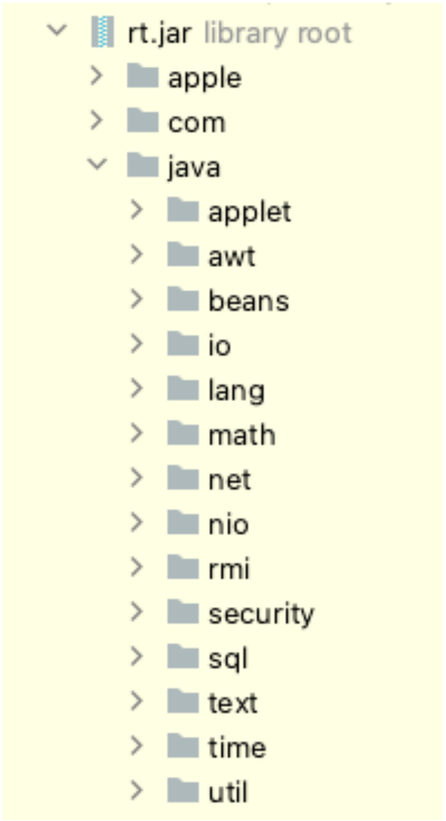
Why JPMS or Modules?

- 1. Modularize JDK
  - Until Java8 we used to have rt.jar file which is a giant monolith jar.
    - But in mostcases you dont need everything.
      - Eg., We dont need classes to be under the **applet** package for building a RestFul API.
  - By modularizing the JDK, the application can control on adding just the modules the app requires.



Modularized JDK

Until Java 8



From Java 9

JDK is structured as modules.

Why JPMS or Modules ?

- 2. Secure coding
  - By default , public is too open.
    - New restrictive controls are available to restrict access to certain internal classes.
      - Eg., We can control the packages in a library that can exposed to the client(library user).
  - In today’s words, any class can be accessed and modified using Reflection.
    - Using modules, we can restrict Reflection acces during runtime.

Benefits of JPMS

- Smaller jar files.
  - Reduce the process footprint.
  - Improve the application startuptime.
- Clean Separation of boundaries.
- Stricter access control.