

Functional Programming

Functions and Lambda Expressions



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#java-advanced

1. Lambda Expressions
2. What Is a Function?
 - **Function<T,R>**
3. Other Function Types
 - **Consumer<T>**
 - **Supplier<T>**
 - **Predicate<T>**
4. **BiFunction<T, U, R>**
 - Passing Functions to Methods





Lambda Expressions

What is a Function?

- Mathematic function

Name $f(x) = x^2$

Input Output

A **function** is a special relationship where **each** input has a **single** output

x	$f(x)$
3	9
1	1
0	0
4	16
-4	16

Lambda Expressions (1)

- Lambda expression - **unnamed function**

- Has parameters and a body

(parameters) -> {body}

Lambda Syntax

- Use the lambda operator -> Read as "**goes to**"

Lambda Expressions (2)

- **Implicit** lambda expression

```
(msg) -> { System.out.println(msg); }
```

Parameters can be enclosed
in **parentheses ()**

The body can be
enclosed in **braces {}**

- **Explicit** lambda expression

```
String msg -> System.out.println(msg);
```

Declares parameters' type

- Can have a different number of parameters:

- **Zero** parameters

```
() -> { System.out.println("Hello!"); }  
() -> { System.out.println("How are you?"); }
```

- **More** parameters

```
(int x, int y) -> { return x + y; }  
(int x, int y, int z) -> { return (y - x) * z; }
```


Problem: Sort Even Numbers

- **Read** Integers from the console
- **Print** the even numbers
- **Sort** the even numbers
- **Print** the sorted numbers

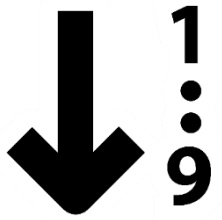
4, 2, 1, 3, 5, 7, 1, 4, 2, 12



4, 2, 4, 2, 12



2, 2, 4, 4, 12



Solution: Sort Even Numbers

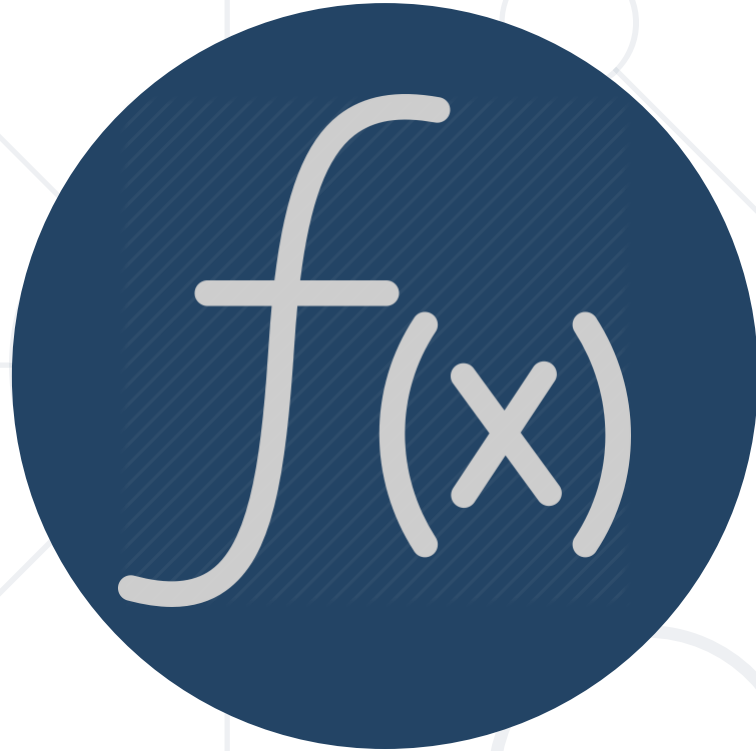
//TODO: Read numbers and parse them to List Of Integers

```
numbers.removeIf(n -> n % 2 != 0);
```

// TODO: Print the even numbers

```
numbers.sort((a, b) -> a.compareTo(b));
```

//TODO: Print the sorted numbers



Functions

Mathematical and Java Functions

- In Java, we can create functions analogical to mathematical functions

$$f(x) = x^2$$



Output Type

Input Parameter

Return Expression

```
Function<Integer, Integer> func = x -> x * x;
```

Input Type

Name

Lambda Expression

- In Java **Function<T, R>** is an interface that accepts a parameter of type **T** and returns a variable of type **R**

```
int increment(int number) {  
    return number + 1;  
}
```

- We use function with **.apply()**

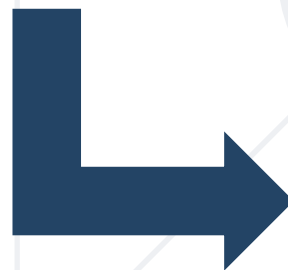
```
Function<Integer, Integer> increment =  
    number -> number + 1;  
  
int a = increment.apply(5);  
int b = increment.apply(a);
```

Problem: Sum Numbers

- **Read** numbers from the console
- **Print** their count
- **Print** their sum
- Use a **Function**



4, 2, 1, 3, 5, 7, 1, 4, 2, 12



Count = 10
Sum = 41

Solution: Sum Numbers

```
// TODO: Read input
if (input.length < 2) {
    System.out.println("Count = " + input.length);
    System.out.println("Sum = " + input[0]);
} else {
    Function<String, Integer> parser = x -> Integer.parseInt(x);
    int sum = 0;
    for (String s : input) sum += parser.apply(s);
    // TODO: Print output
}
```



Other Function Types

Special Functions

- In Java **Consumer<T>** is a void interface:

```
void print(String message) {  
    System.out.println(message);  
}
```

- We use a Consumer with **.accept()**:

```
Consumer<String> print =  
    message -> System.out.print(message);  
print.accept("Peter");
```

- In Java **Supplier<T>** takes no parameters:

```
int genRandomInt() {  
    Random rnd = new Random();  
    return rnd.nextInt(51);  
}
```

- We use a Supplier with **.get()**:

```
Supplier<Integer> genRandomInt =  
    () -> new Random().nextInt(51);  
int rnd = genRandomInt.get();
```

- In Java **Predicate<T>** evaluates a condition:

```
boolean isEven(int number) {  
    return number % 2 == 0;  
}
```

- We use the Predicate with **.test()**:

```
Predicate<Integer> isEven =  
    number -> number % 2 == 0;  
System.out.println(isEven.test(6)); // true
```

Problem: Count Uppercase Words

- Read text from the console
- Find the words starting with an Uppercase letter
- Print the count and the words
- Use a **Predicate**



The following example shows how to use Predicate



2
The
Predicate

Solution: Count Uppercase Words

```
// TODO: Read text

Predicate<String> checkerUpperCase =
    word -> Character.isUpperCase(word.charAt(0));

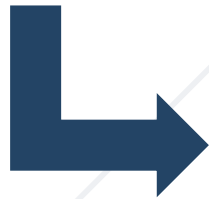
ArrayList<String> result = new ArrayList<>();
for (int i = 0; i < textAsList.length; i++) {
    if (checkerUpperCase.test(textAsList[i]))
        result.add(textAsList[i]);
}

// TODO: Print results
```

Problem: Add VAT

- Read some items' prices from the console
- Add **VAT** of **20%** to all of them

1.38, 2.56, 4.4



Prices with VAT:

1,66

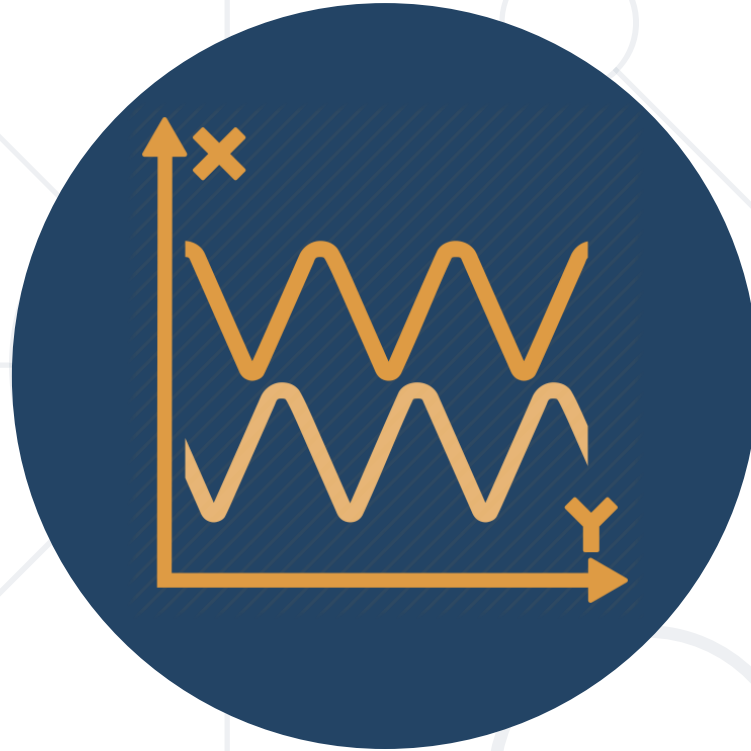
3,07

5,28



Solution: Add VAT

```
// TODO: Read input
List<Double> numbers = new ArrayList<>();
for (String s : input)
    numbers.add(Double.parseDouble(s));
UnaryOperator<Double> addVat = x -> x * 1.2;
System.out.println("Prices with VAT:");
for (Double str : numbers)
    System.out.println(String.format("%1$.2f",
                                     addVat.apply(str)));
```



Bi Functions

Using Functions With More Parameters

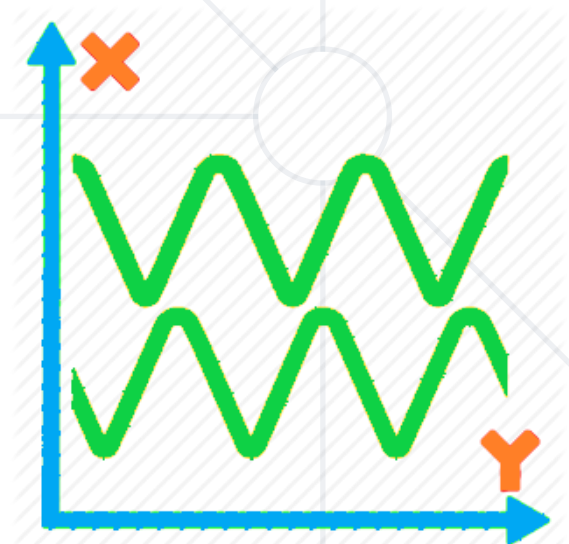
- **BiFunction** $\langle T, U, R \rangle$

```
BiFunction <Integer, Integer, String> sum = (x, y) -> "Sum is" + (x + y);
```

Two input parameters

- Analogically you can use:

- **BiConsumer** $\langle T, U \rangle$
- **BiPredicate** $\langle T, U \rangle$



Problem: Sum Numbers

- Read numbers from the console
- Print their count
- Print their sum
- Use **BiFunctions**



4, 2, 1, 3, 5, 7, 1, 4, 2, 12



Count = 10
Sum = 41

Solution: Sum Numbers

```
// TODO: Read input
int length = input.length;
int sum = Integer.parseInt(input[0]);
if (input.length >= 2) {
    BiFunction<Integer, String, Integer> parser =
        (x, y) -> x + Integer.parseInt(y);
    for (int i = 1; i < input.length; i++)
        sum = parser.apply(sum, input[i]);
}
// TODO: Print output
```

- We can pass **Function<T,R>** to methods:

```
static int operation(int number, Function<Integer, Integer> function) {  
    return function.apply(number);  
}
```

- We can use the method like that:

```
int a = 5;  
int b = operation(a, number -> number * 5); // b = 25  
int c = operation(a, number -> number - 3); // c = 2  
int d = operation(b, number -> number % 2); // d = 1
```

Problem: Filter by Age

- Read from console **n** people with their age
- Read a condition and an age so to **filter** them
- Read **format type** for the output
- Print all people that fulfill the condition

Peter	20
George	18
Raddy	29
Maria	32
Ivan	16



- Condition - "older"
- Age - 20
- Format - "name age"

Peter	20
Raddy	29
Maria	32

Solution: Filter by Age (1)

//TODO: Read info from the console

```
Predicate<Integer> tester = createTester(condition, age);  
Consumer<Map.Entry<String, Integer>> printer =  
    createPrinter(format);  
printFilteredStudent(people, tester, printer);
```

Solution: Filter by Age (2)

```
static Consumer<Map.Entry<String, Integer>> createPrinter(String format) {  
    Consumer<Map.Entry<String, Integer>> printer = null;  
    switch (format) {  
        case "name age":  
            printer = person -> System.out.printf("%s - %d%n",  
                                                    person.getKey(), person.getValue());  
            break; //TODO: Add more cases  
    }  
    return printer;  
}
```

Solution: Filter by Age (3)

```
static Predicate<Integer> createTester(String condition, Integer age) {  
    Predicate<Integer> tester = null;  
    switch (condition) {  
        case "younger":  
            tester = x -> x <= age;  
            break; //TODO: Add more cases  
    }  
    return tester;  
}
```

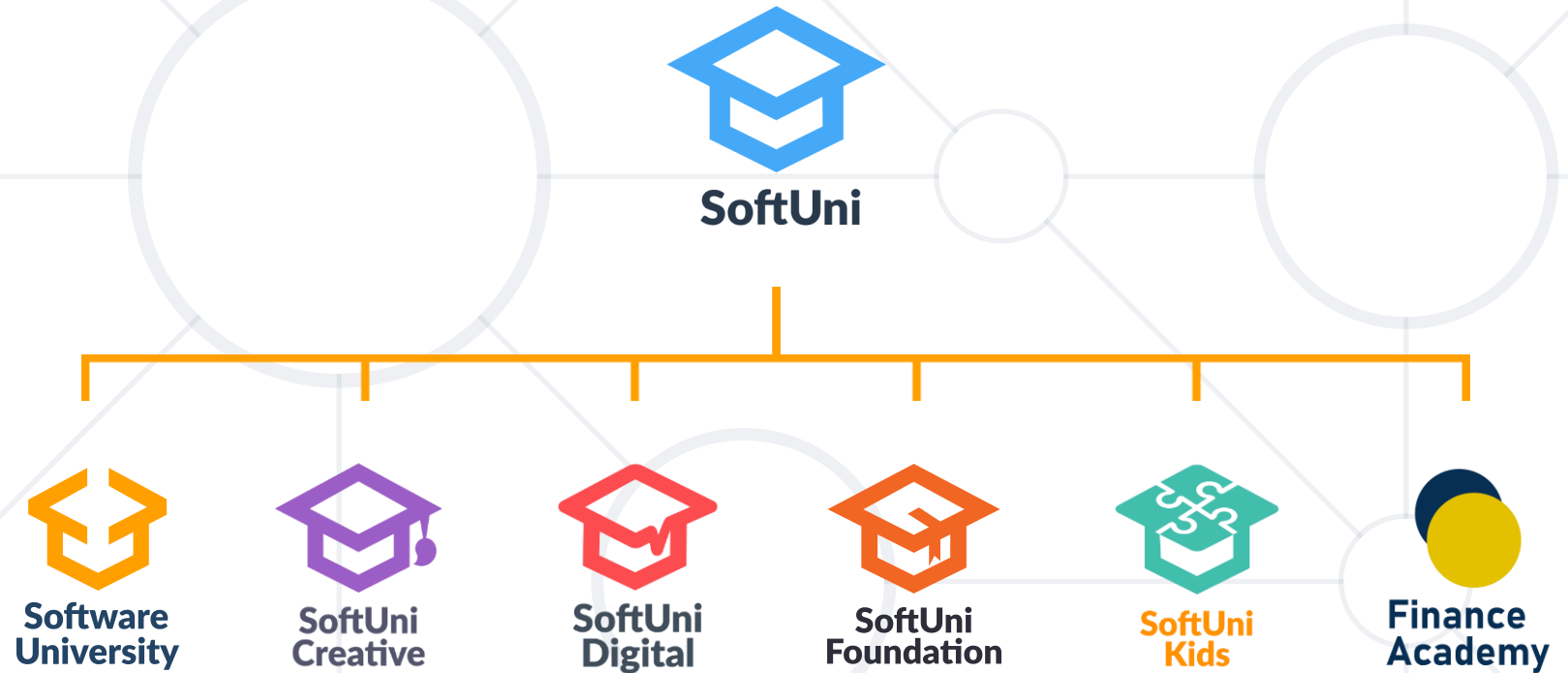

Solution: Filter by Age (4)

```
static void printFilteredStudent(  
    LinkedHashMap<String, Integer> people,  
    Predicate<Integer> tester,  
    Consumer<Map.Entry<String, Integer>> printer) {  
    for (Map.Entry<String, Integer> person : people.entrySet()) {  
        if (tester.test(people.get(person.getKey())))  
            printer.accept(person);  
    }  
}
```

- Lambda expressions are anonymous methods
- **Function<T,R>** is a function that returns R type
- **Consumer<T>** is a void function
- **Supplier<T>** gets no parameters
- **Predicate<T>** evaluates a condition
- **BiFunction<T, U, R>** accepts two parameters
- Functions can be passed like variables to methods



Questions?



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