New Features in Java 8

- Lambda expressions
- Functional interfaces
- Streaming support for Collections

定义与性质

Lambda expressions

- Are a block of java code with parameters
- Can be assigned to variables
- Can be executed one or more times
- Can access final variables from surrounding block
- Represent a functional interface
- Can be passed to other methods like data

- 代表functional interface
- 可用于variables
- 可多次执行
- 可获取final variables(在le内部，可以使用在其外部定义的final变量)
- 可像data一样pass to methods（通常用於需要函數式接口的地方，比如 Comparator、Runnable或自定義的接口。）

```
public class LambdaExample {
    public static void main(String[] args) {
        // 定義一個 final 變量
        final int number = 5;

        // 或者定義一個「有效 final 變量」
        int anotherNumber = 10;

        // 使用 lambda 表達式
        Runnable runnable = () -> {
            System.out.println("The number is: " + number);
            System.out.println("Another number is: " + anotherNumber);
        };

        // 試圖改變變量的值（如果取消註釋這行代碼，編譯器會報錯）
        // anotherNumber = 20;

        // 運行 lambda 表達式
        runnable.run();
    }
}
```

```
public class LambdaAsParameterExample {
    public static void main(String[] args) {
        // 使用 lambda 表達式作為 Runnable 的實現
        Runnable task = () -> {
            System.out.println("Task is running");
        };

        // 將 lambda 表達式作為參數傳遞給方法
        process(task);
    }

    // 接受 Runnable 參數的方法
    public static void process(Runnable runnable) {
        System.out.println("Processing...");
        runnable.run();
    }
}
```

Before Java 8 Java instances where created and then passed to methods.

Each instance must belong to a certain interface which is defined in the parameter section of the receiving method.

Java compiler can check if the instances passed to a method are of the correct type.

Passing expressions - lambdas

Example EventListener

```
JButton testButton = new JButton("Test Button");
testButton.addActionListener(
e -> System.out.println("Click Detected")
);
```

`e`代表一个ActionAvent对象，是表达式的参数，當按鈕被點擊時，這個對象會被傳遞給表達式。

这句表达式：用于为`JButton`注册一个`ActionListener`

OLD: Previously (inner) classes which implement a certain interface where used as method parameters

```
JButton testButton = new JButton("Test Button"); //same

testButton.addActionListener(new ActionListener(){
    @Override
    public void actionPerformed(ActionEvent e){
          System.out.println("Click Detected");
    }
});
```

Example Comparator

```
public interface Comparator {
        int compare(Object o1, Object o2);
        boolean equals(Object o);
}

 class LengthComparator implements Comparator<String>
{
  public int compare(String first, String second) {
     return Integer.compare(first.length(),
                            second.length());
  }
  public boolean equals(Object o) {...}
}


Arrays.sort(strings, new LengthComparator());
```

Example Comparator

Example Comparable:

```
List<String> stringList = new ArrayList<String>();
stringList.add("John");
..

Collections.sort(stringList,
                 (String s1, String s2) -> s2.compareTo(s1));
```

Collections.sort() 方法的第一个参数是要排序的List,
第二个参数是一个 Comparator，用于定义排序逻辑。

这里的 (String s1, String s2) -> s2.compareTo(s1) 是一个 Lambda 表达式,
它实现了 Comparator 接口的 compare 方法，用来定义两个字符串之间的比较方式:
s2.compareTo(s1): 这行代码的意思是: 按照字典顺序进行降序排序。
compareTo 方法返回一个整数值:
负数 表示 s2 小于 s1。零 表示 s2 等于 s1。正数 表示 s2 大于 s1。

Defining lamda expressions

Lambda syntax:

有type就加(),
空的也要加。
一有type一没有的时候，不加

```
input arguments -> body
```

Examples parameter list

`(int x) -> x+1`	Parameter list with explicit type
`int x -> x+1`	Wrong: Parameter type need braces
`(x)->x+1`	Type of parameter is deduced by compiler
`x -> x+1`	
`(int x,int y) -> x+y`	
`int x,int y -> x+y`	Wrong: Parameter type need braces
`(x,int y) -> x+y`	Wrong:Do not use parameter with and without type.
`() -> 42`	Empty parameter list is fine

Defining lamda expressions

Examples lambda body

```
() -> System.gc()
```

Only one expression

```
(String s1, String s2) -> {
    return s1.compareTo(s2);
}
```

return statement. Body needs curly braces {}

```
(String s1, String s2) -> {
   if (s1.length() < s2.length())
      return -1;
   else if (s1.length() > s2.length())
      return 1;
   else
      return 0;
}
```

Multi line statement. Body needs curly braces {}

Lamda type identification

LD表达式有特定类型的值，非随机代码片段

Lamda expressions have a type.

Type of expression is an instance of a functional interface.

其类型是一个函数式接口的实例.
函数式接口：只有一个抽象方法的接口。

The interface is deduced from the context of the expression.

当你使用LD表达式时,
Java编译器会根据它所在的上下文
推断出它对应的函数式接口

Predefined functional interfaces are defined in package `java.util.function`.

Lambda expression must have the same parameter types and the same return type of a functional interface.

LD表达式必须具有与函数式接口的抽象方法相同的参数类型和返回类型。
也就是说，lambda表达式的签名（参数和返回类型）必须匹配它实现的函数式接口的唯一抽象方法。

Examples

Lambda

```
x -> x*2
```

One argument. Produces a value with the same type of x.

Lambda

```
x -> {return x<2;}
```

One argument. Produces a boolean value.

可用predefined,
也可以自定义

Predefined interfaces

Name	Method	Parameters	Description
Supplier<T>	T get()	None	Provides a value of type T. To retrieve the value call get()
Consumer<T>	accept(T t)	One	Acts upon a value but does not return a value
Predicate<T>	boolean test(T t)	One	Represents a boolean function
Function<T,R>	R apply(T t)	One	Take an argument of type T and returns a value of type R
BiConsumer<T,U>	accept(T t, U u)	Two	Accepts two arguments and returns no value
BiFunction<T,U,R>	R apply(T t,U u)	Two	Function that takes two arguments and returns a value of type R

More interfaces in `java.util.function`.

```java
// Supplier<T>: 不接受参数，返回一个类型T的结果

import java.util.function.Supplier;

public class SupplierExample {
    public static void main(String[] args){
        Supplier<String> supplier = () -> "Hello, World!";
        System.out.println(supplier.get());  // 输出: Hello, World!
    }
}
```

```java
public class SupplierExample {
    public static void main(String[] args) {
        // 使用匿名类实现 Supplier 接口
        Supplier<String> supplier = new Supplier<String>() {
            @Override
            public String get() {return "Hello, World!";}};

        System.out.println(supplier.get());}
```

```java
// Consumer<T>: 接受一个类型T的参数，不返回结果

public class ConsumerExample {
    public static void main(String[] args) {
        Consumer<String> consumer = s -> System.out.println(s);
        consumer.accept("Hello, World!");  // 输出: Hello, World!
    }
}
```

```java
Consumer<String> consumer = new Consumer<String>() {
            @Override
            public void accept(String s) {
                System.out.println(s);
            }
        };

        consumer.accept("Hello, World!");
```

```java
// Predicate<T>: 接受一个类型T的参数，返回一个布尔值

public class PredicateExample {
    public static void main(String[] args) {
        Predicate<Integer> predicate = n -> n > 5;
        System.out.println(predicate.test(10));  // 输出: true
        System.out.println(predicate.test(3));   // 输出: false
    }
}
```

```java
Predicate<Integer> predicate = new Predicate<Integer>() {
            @Override
            public boolean test(Integer n) {
                return n > 5;
            }
        };

        System.out.println(predicate.test(10));  // 输出: true
        System.out.println(predicate.test(3));   // 输出: false
```

也就是

`= 原method param -> 原method statement`

```
// Function<T, R>: 接受一个类型T的参数，返回一个类型R的结果。
import java.util.function.Function;

public class FunctionExample {
    public static void main(String[] args) {
        Function<String, Integer> function = s -> s.length();
        System.out.println(function.apply("Hello"));  // 输出: 5
    }
}


// BiConsumer<T, U>: 接受两个类型T和U的参数，不返回结果。
public class BiConsumerExample {
    public static void main(String[] args) {
        BiConsumer<String, Integer> biConsumer =
                (s, i) -> System.out.println(s + " " + i);
        biConsumer.accept("Age:", 25);  // 输出: Age: 25
    }
}


// BiFunction<T, U, R>: 接受两个类型T和U的参数，返回一个类型R的结果。

public class BiFunctionExample {
    public static void main(String[] args) {
        BiFunction<String, String, Integer> biFunction =
                (s1, s2) -> s1.length() + s2.length();
        System.out.println(biFunction.apply("Hello", "World")); // 输出: 10
    }
}
```

```
public class FunctionExample {
    public static void main(String[] args) {
Function<String, Integer> function = new Function<String, Integer> {
    @Override
    public Integer apply(String s) {return s.length();}};
```

```
@Override
public Integer accept(String s, Integer i) {System.out.println(s+" "+i)}};
```

Create your own interfaces

可用predefined,
也可以自定义

Create an interface with a **s**ingle **a**bstract **m**ethod. (SAM is another name for functional interfaces.)

```
public interface DumpPrinter {
    public void doIt();
}
```

创建了一个DumpPrinter接口的lambda实现,
并调用其doIt方法,
输出了"I am dumb"

Usage:

```
public class Main {
   public static void main(String[] args) {
       DumpPrinter dp = () -> System.out.println("I am dumb");
       dp.doIt();
    }
}
```

```
// iterface +
DumpPrinter dp = new DumpPrinter() {
    @Override
    public void doIt() {
    System.out.println("I am dumb");
    }
};

dp.doIt();
```

Scope of lambda expressions

i.e Java对于在 Lambda 表达式内部使用的局部变量的一些限制

Instance and static variables can be used in the body of a lambda expression

```
class Bar {
     int i;  // instance variables
     Foo  foo = i -> i * 2;// Lambda表达式，参数i遮蔽了实例变量i
};
```

Parameter `i` in foo shadows instance variable `i`.

在 Lambda 表达式中，参数 i 与外部类中的实例变量 i 具有相同的名字。这种情况称为“遮蔽”（shadowing）。
在这种情况下，Lambda 表达式中的参数 i 会遮蔽（或隐藏）外部类的实例变量 i。
因此，当你在 Lambda 表达式内引用 i 时，实际上引用的是参数 i，而不是实例变量。
建议将LE中的i修改为param或者其它名字。

Scope of lambda expressions

Local variables must be final or effectively final when used in the body of a lamda expression:

- final 变量表示它的值在初始化后不可更改。
- 有效 final 变量是指虽然没有显式声明为 final，但在变量初始化后没有被修改过。

```
void bar() {
    int i;
    Foo foo = i -> i * 2;
};
```

Wrong:

```
void bar() {
    int i;
    Foo foo = i -> i * 2;
    i = 2;
};
```

Method references

Lambda expressions are anonymous representations of functional interfaces.

Method references are concrete implementations of an interface by a class which match the required functional interface.

Usage:

```
<ClassName>::<methodName>
```

```
String::valueOf
```

```
String::length
```

```
Integer::compare
```

Method references

`java.util.Arrays` has a static method

```
public static <T>
void sort(T[] a, Comparator <T> c);
```

`Integer::compare` has a compatible signature to the Comparator interface.

```
Arrays.sort(myIntArray, Integer::compare)
```

Same as:

```
Arrays.sort(myIntArray, (i1, i2) -> {
    return i1.compareTo(i2);
});
```

Streams

Streams are an addition to Javas Collections

Streams are a sequence of values

Streams can be processed by lambda expressions

Streams are not a datastructure

Streams, like iterators are consumable. To revisit a stream ask collection for its stream

一次性使用的，它们在使用后无法重复使用。
必须重新从原始集合中获取一个新的流。

```
e.g. List<String> names = Arrays.asList("Alice", "Bob", "Charlie");
// 创建一个流
Stream<String> stream = names.stream();
// 第一次使用流
stream.forEach(System.out::println); // 输出所有名字
// 尝试再次使用同一个流
stream.forEach(System.out::println); // 这将抛出 IllegalStateException
```

Streams

A stream is a pipeline of functions.

Streams can transform data.

Streams cannot mutate data.

change

Think of Streams as Java pipes.

You can create a Collection or an Array from a Stream.

Getting a stream

Ask a collection with `stream()` or `parallelStream()` method.

With `Arrays.stream(Object[])`

Ask a `BufferedReader` instance with `lines()`

Get files in a directory with `Files.list()`

在java中如何获取streams:

1. 从collections中用stream()和parallelStream()获取;

```
List<String> names = Arrays.asList("Alice", "Bob", "Charlie");
Stream<String> sequentialStream = names.stream(); // 顺序流
Stream<String> parallelStream = names.parallelStream(); //并行流
```

2. 从array数组中，用Arrays.stream(Object[])获取。将array转换为streams。

```
String[] nameArray = {"Alice", "Bob", "Charlie"};
Stream<String> arrayStream = Arrays.stream(nameArray); // 从array获取流
```

3. 从br中，用lines()获取。流中的元素是读取的每一行文本，用于逐行获取文本。

```
try (BufferedReader reader = new BufferedReader(new FileReader("file.txt"))) {
    Stream<String> lineStream = reader.lines(); // 从br获取流
    lineStream.forEach(System.out::println); // 处理每一行
} catch (IOException e) {
    e.printStackTrace();
}
```

4. 从目录中，用Files.list()。元素包含指定目录下的文件和子目录的路径。

```
try (Stream<Path> filePathStream = Files.list(Paths.get("some/directory"))) {
  // 输出目录中的文件
  filePathStream.forEach(System.out::println); } catch (IOException e) {
    e.printStackTrace();
}
```

Creating a pipeline

Create a stream from a source

Append intermediate operations like filter() or map(). Each intermediate operation creates a new stream holding only elements matching the predicate of the intermediate operation.

Append terminal operation to produce a result. After the terminal operation the stream can no longer be used. No processing is done before terminal operation.

创建流处理管道

1. 创建流：从数据源（如集合、数组或文件）创建一个流。这个流将成为处理数据的基础。

```
List<String> names = Arrays.asList("Alice", "Bob", "Charlie");
Stream<String> stream = names.stream(); // 从集合创建流
```

2. 追加中间操作：

使用中间操作（如 filter()、map() 等）对流进行处理。每个中间操作都会返回一个新的流，只有符合给定条件的元素才会被保留。中间操作是惰性（lazy）的，只有在最终操作时才会执行。

```
// 仅保留以 "A" 开头的名字
Stream<String> filteredStream = stream.filter(name -> name.startsWith("A"));
// 映射为名字的长度
Stream<Integer> lengthStream = filteredStream.map(String::length);
```

3. 追加终止操作：

使用终止操作（如 forEach()、collect()、reduce() 等）来实际处理流并产生结果。一旦执行了终止操作，流就无法再次使用。重要的是，在执行终止操作之前，所有的中间操作不会被执行。

```
lengthStream.forEach(System.out::println); // 输出每个名字的长度
```

Intermediate operations 中间操作

Function	Description
map()	Returns a stream consisting of the result applying the given function `return the required stream`
filter()	Returns a stream consisting of the element that match the given predicate
distinct()	Returns a stream consisting of distinct elements
sorted()	Returns sorted elements
peek()	Applies a consumer to each element. Can be used for debugging.
flatMap()	Returns a stream consisting of the data of streams produced by the given function.

Most useful operations. For all operations see Streams javadoc

`https://docs.oracle.com/javase/8/docs/api/java/util/stream/Stream.html`

Terminal operations

终止操作

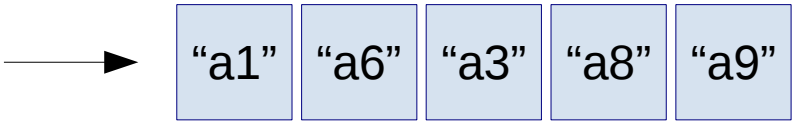
Function	Description
reduce()	Performs a reduction on the elements of this stream to a single value.
collect()	Groups the elements in this stream. You can use the Collectors from package `java.util.streams.Collectors`.
forEach()	Performs an action for each element of this list.

Most useful operations. For all operations see Streams javadoc

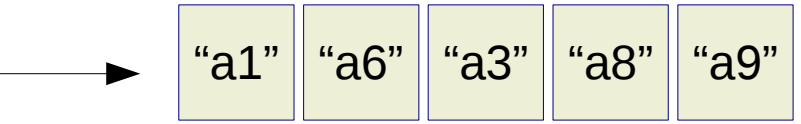
Streams revisited

```
public static void pipe7Test() {
    String sa[] = {"a1", "a6", "a3", "a8", "a9"};

    int summe = Arrays.stream(sa)
                .map(s -> s.substring(1))
                .map(s -> Integer.parseInt(s))
                .filter(i -> i > 6)
                .reduce(0, Integer::sum);

    System.out.println("Summe: " + summe);
}
```

String sa[] = {"a1", "a6", "a3", "a8", "a9"};

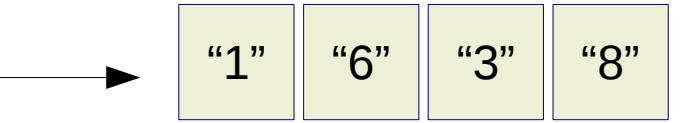


Arrays.stream(sa)

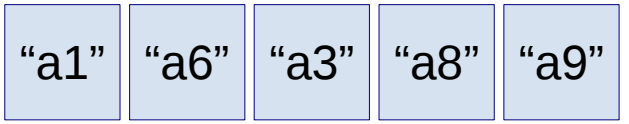


map(s -> s.substring(1))

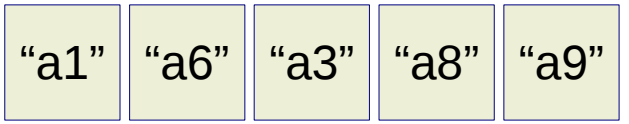
“a8”->”a8”.substring(1)



String sa[] = {"a1", "a6", "a3", "a8", "a9"};

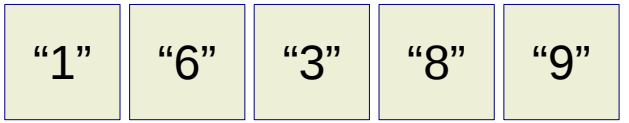


Arrays.stream(sa)



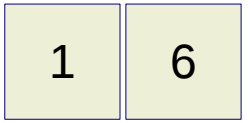
map(s -> s.substring(1))

“a9”->”a9”.substring(1)

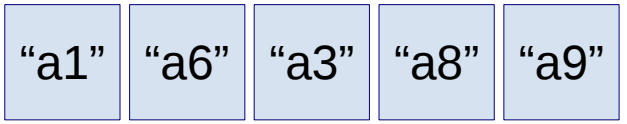


map(s -> Integer.parseInt(s))

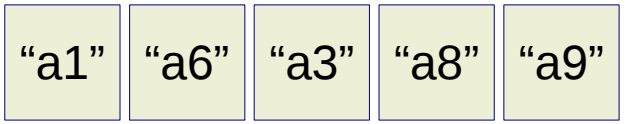
“6”->Integer.parseInt(“6”)



String sa[] = {"a1", "a6", "a3", "a8", "a9"};

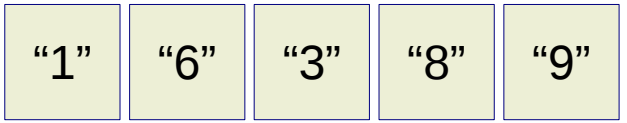


Arrays.stream(sa)



map(s -> s.substring(1))

“a9”->”a9”.substring(1)



map(s -> Integer.parseInt(s))

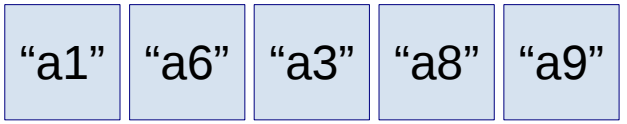
“9”->Integer.parseInt(“9”)

filter(i -> i > 6)

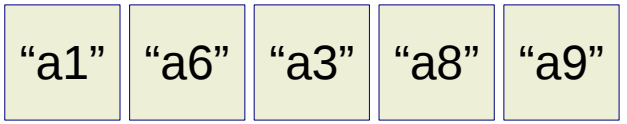
1->1>6

Results false. Nothing is added to result set

String sa[] = {"a1", "a6", "a3", "a8", "a9"};

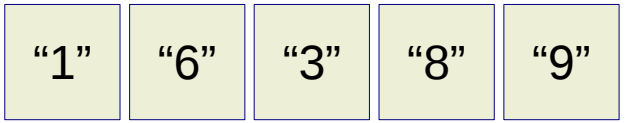


Arrays.stream(sa)



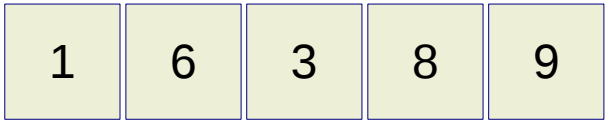
map(s -> s.substring(1))

“a9”->”a9”.substring(1)



map(s -> Integer.parseInt(s))

“9”->Integer.parseInt(“9”)

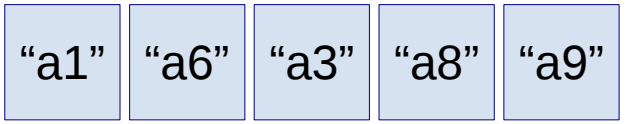


filter(i -> i > 6)

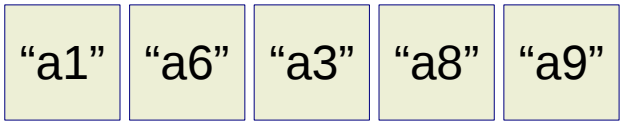
6->6>6

Results false. Nothing is added to result set

String sa[] = {"a1", "a6", "a3", "a8", "a9"};

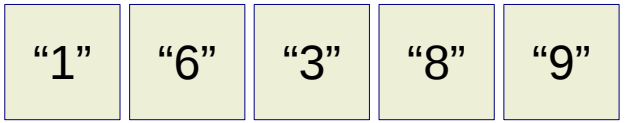


Arrays.stream(sa)



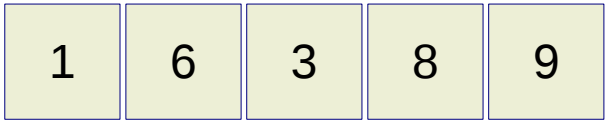
map(s -> s.substring(1))

“a9”->”a9”.substring(1)



map(s -> Integer.parseInt(s))

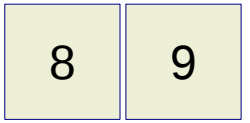
“9”->Integer.parseInt(“9”)



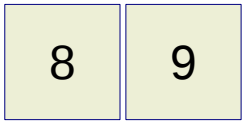
filter(i -> i > 6)

9->9>6

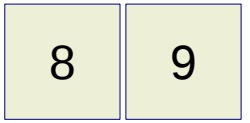
Results true. 9 is added to result set



reduce(0, Integer::sum);

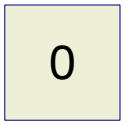


reduce(0, Integer::sum);



`Integer::sum` is a `BiFunction`

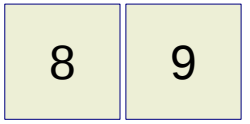
```
public static int sum(int a,int b)
```

Initialize result with 0 → 

then

`Integer.sum(0, 8)` → `8`

reduce(0, Integer::sum);

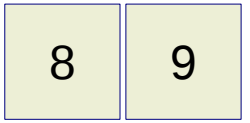


`Integer::sum` is a `BiFunction`

```
public static int sum(int a,int b)
```

`Integer.sum(8,9)` → 17

reduce(0, Integer::sum);



`Integer::sum` is a `BiFunction`

```
public static int sum(int a,int b)
```

`int summe`