New in java8

Streams a.k.a. pipeline

Map reduce pipeline

Demos

New features in Java8

Relevant to concurrency:

- Lambda expressions.
  - only just syntactic sugar
  - shorter source code
  - less generated code (no anonymous inner classes)
  - easy passing a function to methods. e,g, work on a collection
- Single Abstract Method (SAM) interfaces.
  - Help in defining use for lamba.
- `Stream`s
  - New way to deal with data sources and operations on them
  - IO, collections, arrays
  - parallelisable
  - fluent coding pattern

New? not really. . .

Lambda expressions also known as closures are no Java invention. In fact java was a bit late. But the implementation is very powerful when considering parallelism.
In the examples (on the net) you can see that using java is moving a bit towards **functional programming**.

Changes to class file

New class file format (similar to java6 to java7) so a few issues with e.g. instrumentation (coverage). The important new instruction `invokedynamic` is already in java7.

Lambda expressions

A lambda expression, or closure is all about defining a method in line with the code. An anonymous **function**. What are functions?

- methods without side effects.
- that do Not change (mutate) the parameters that go in
- that produce a result

No Side Effects or no changes to objects works well with concurrency: Immutable objects.
Some languages, on the JVM, like scala already take this a step further.

```
//   argument list      arrow token      body
    (int x, int y)  ->   x + y
```

http://www.oracle.com/webfolder/technetwork/tutorials/obe/java/Lambda-QuickStart/index.html

Examples

```
(int x, int y) -> x + y  // function add

() -> 42   // source

(String s) -> { System.out.println(s); } // sink
```


Our friend Runnable

Runnable matches the requirement of functional interface or single abstract method.

```
public class RunnableTest {
    public static void main(String[] args) {
        System.out.println("=== RunnableTest ===");

        // Anonymous Runnable
        Runnable r1 = new Runnable(){

                @Override
                public void run(){
                    System.out.println("Hello world one!");
                }
            };

        // Lambda Runnable
        Runnable r2 = () -> System.out.println("Hello world two!");

        // Run em!
        r1.run();
        r2.run();
    }
}
```


Comparable

- Comparable as example
- Note: *take care when using simple subtraction to implement comparable.*

```
X arr = ...;
Arrays.sort( arr, ( a, b )-> a.intValue() - b.intValue() );
```

- comparison based on comparable members
- Note that `java.util.List` has default methods like `sort(...)`.

```
List<Student> list = ...;
list.sort( ( a, b )-> a.getFirstName().compareTo( b.getFirstName() ) );
```

or, even shorter (with

`import static java.util.Comparable.comparing;`)

```
list.sort( comparing(Student::getFirstName) );
```

Map Reduce Pipeline

Task Find all transactions of type `grocery` and return a list of transaction IDs sorted in decreasing order of transaction value.

Three steps are involved:

1. filter for GROCERY
2. sort by value
3. map transAction to id

Java SE 7 code

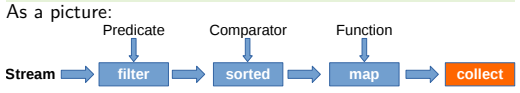
The legacy java way of doing it:

```
List<Transaction> groceryTransactions
    = new Arraylist<>();
for(Transaction t: transactions){ //filter
    if(t.getType() == Transaction.GROCERY){
        groceryTransactions.add(t);
    }
}
Collections.sort(groceryTransactions, new Comparator(){
        public int compare(Transaction t1, Transaction t2){
            return t2.getValue().compareTo(t1.getValue());
        }
    });
List<Integer> transactionIds = new ArrayList<>();
for(Transaction t: groceryTransactions){// map and collect
    transactionsIds.add(t.getId());
}
```


Java 8 Pipeline

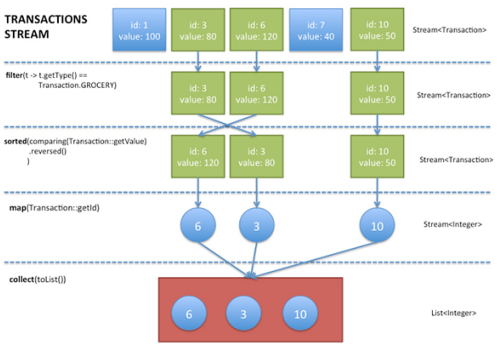

```
List<Integer> transactionsIds =
    transactions.stream()
                .filter(t -> t.getType() == Transaction.GROCERY)
                .sorted(comparing(Transaction::getValue).reversed())
                .map(Transaction::getId)
                .collect(toList());
```

As a picture:



- The operations are done 'at once'.
- The stream starts as soon as there is a terminal operation, as in this case the `collect`.
- There are no intermediate results (collections).
- Filtering trims down the remaining work.
- Doing this in parallel is trivially easy: replace `stream()` with `parallelStream()`.

Pipeline in action



source:

http://www.oracle.com/technetwork/articles/java/ma14-java-se-8-streams-2177646.html

Stream vs Iterable

- All Java collections are `Iterable`.
- New is that `Iterable` provides a `void forEach(Consumer<? super T> action)`.
- The streams also provide a sequence of elements.
- Both are one time use only. You can neither restart as sequence nor a stream. They are 'consumed'.

So what's the difference?

- Collections are about data. Iterators typically produce all values in the collection. (for each loop)
- and streams are about computations (functions).
- A stream can apply a sequence of functions to each element passes, and evaluates these functions only when really needed.
  This is called **Lazy evaluation**.

Peek: Looking a stream go by


```
List<String> l = Stream.of( "one", "two", "three", "four" )
    .peek( e
            -> System.out.println( "all values: " + e ) )
    .filter( e
             -> e.length() > 3 )
    .peek( e
            -> System.out.println( " Filtered value: " + e ) )
    .map( String::toUpperCase )
    .peek( e
            -> System.out.println( "  Mapped value: " + e ) )
    .collect( Collectors.toList() );
```

this produces:

```
all values:  one
all values:  two
all values:  three
Filtered value:  three
Mapped value:  THREE
all values:  four
Filtered value:  four
Mapped value:  FOUR
```

- The elements one, two . . . are "pulled" through the pipe, one after the other, but no further then needed.
- element one and two never come past the filter stage.
- See demo.

Filter and map example


```
List<Integer> numbers = Arrays.asList(1, 2, 3, 4, 5, 6, 7, 8);
List<Integer> twoEvenSquares =
    numbers.stream()
           .filter(n -> {
                    System.out.println("filtering " + n);
                    return n % 2 == 0;
                   })
           .map(n -> {
                    System.out.println("mapping " + n);
                    return n * n;
                   })
           .limit(2)
           .collect(toList());
```

- Note the curly braces and return in the lambda bodies.
- Each element runs through the **complete** stream before the next is considered
- So the whole process stops when the limit operation is 'satisfied'.
- Now that is **lazy**. . .

Some Stream functions

Intermediate (filter)

- **Stream**<T> filter(Predicate<? **super** T> predicate),
- **Stream**<T> limit(**long** maxSize)

Map or transform

- <R> **Stream**<R> map(Function<? **super** T,? **extends** R> mapper)

Terminal (non shortcut)

- **Optional**<T> reduce(BinaryOperator<T> accumulator)
- **Optional**<T> max(Comparator<? **super** T> comparator)
- **Optional**<T> min(Comparator<? **super** T> comparator)

Terminal (shortcut)

- **boolean** allMatch(Predicate<? superT>)
- **boolean** anyMatch(Predicate<? superT>)
- **Optional**<T> findAny()

Creating streams is easy


```
List<String> myList
        = Arrays.asList( "a1", "a2", "b1", "c2", "c1" );

myList
        .stream().
        filter( s -> s.startsWith( "c" ) ).
        map( String::toUpperCase ).
        sorted().
        forEach( System.out::println );
```

This, just as the remaining example com from the tutorial by Benjamin Winterberg. See `http://winterbe.com/`
So lets dive in and discuss things using netbeans.