1 Java 8 Features

1.1 Lambdas and Method References

Behaviour Parametrization

What do these have in common?

```
for (Report r : reports) {
   if (!r.getAuthor().equals(me)) {
     throw new AuthorizationException("You cannnot edit other people's reports.");
   }
}
```

```
for (Report r : reports) {
   if (cache.contains(r)) {
      cache.evict(r);
   }
}
```

Behaviour Parametrization before Java 8

Functors

```
interface Filter {...}
class AuthorizationFilter implements Filter {...}
class CacheEvictingFilter implements Filter {...}

processReports(reports, new AuthorizationFilter());
```

Anonymous Class

```
interface Filter {...}

processReports(reports, new Filter {

   process(Report r) {
      // ...
   }
});
```

Behaviour Parametrization in Java 8

```
processReports(reports, r -> {
   if (!r.getAuthor().equals(me)) {
      throw new AuthorizationException("You cannnot edit other people's reports.");
   }
});
```

Lambdas

A *lambda* is an anonymous function.

- Based on *Lambda calculus*,

- Quick throwaway function without a name,
- A way to express a *closure*,
  - Closure can access the lexical scope it is defined in,
  - In Java, this access is read-only.

```
Function<Integer> createAdder(int toAdd) {
   return n -> n + toAdd;
}

Function<Integer> addTwo = createAdder(2);
Function<Integer> addFive = createAdder(5);
int result = addTwo(1);  // result = 3
result = addFive(result); // result = 8
```

References to Functions

- Functions become first-class citizens in Java 8,
  - Can have references to function/methods,
- Further step in behaviour parametrization.

They allows us to:

- Store references to functions/methods,
- Pass references as arguments to other functions/methods.

```
Predicate<Integer> isEven = n -> n % 2 == 0;
```

```
void processReports(Collection<Report> reports, Consumer<Report> fn) {
   for (Report r : reports) {
      fn.accept(r);
   }
}
```

How Does it Work?

Functional Interfaces

- Interface with a single abstract method,
- Provide target types for lambdas and method references,
  - i.e. They are used as parameter/variable types.
- A number of them defined in `java.util.function`:
  - e.g. `Consumer`, `Function`, `Producer`, `Predicate`.

Technically

- Lambda captures all *effectively final* variables in its lexical scope,
- Improved *type inference*.

Method References

- Syntactic shortcut,
- References to:
  - Static method,
  - Instance method of a particular object,
  - Instance method of an arbitrary object of a particular type,
  - Constructor.

```
Arrays.sort(stringArray, String::compareToIgnoreCase);

// instead of

Arrays.sort(stringArray, (a, b) -> a.compareToIgnoreCase(b));
```

Syntax

Lambda

```
(arg1, arg2) -> {
   // Do something
   return result;
}
```

```
() -> result
```

Method Reference

```
processReports(reports, Filter::accept);
```

```
processReports(reports, myFilter::accept);
```

1.2 Stream API

Stream API

A stream is a sequence of elements supporting aggregate operations.

- Mostly used in collection processing,
- Generation of numeric data,
- Pipelines – operations on streams returning streams,
- Provide internal iteration,
- Code is:
  - Declarative,
  - Composable,
  - Parallelizable.

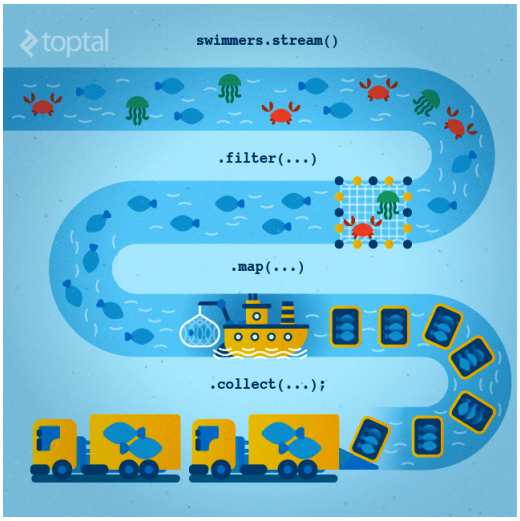


Figure 1: Stream processing visualization. Source: `https://www.toptal.com/java/why-you-need-to-upgrade-to-java-8-already`

Stream v Collection

Collection

- Eager collection of data,
- Data structure holds all values the collection currently has,
- External iteration (for cycle, iterator).

Stream

- Elements computed on demand,
- Allows processing of possibly infinite data structures (e.g. prime numbers),
- Traversable only once,
- Internal iteration (not controlled by programmer).

Stream

Stream Operations

Intermediate operations support pipeline processing – multiple operations executed on data. E.g. `filter`, `map`, `limit`.

Terminal Operations close the stream. E.g. `collect`, `forEach`.

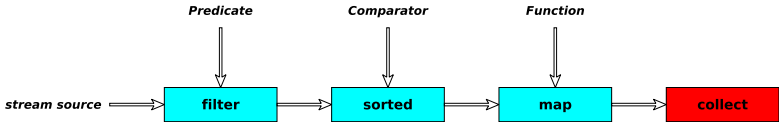


Figure 2: Stream operations.

Stream Examples

```
reports.parallelStream().filter(r -> !r.getAuthor().equals(me)).findAny();


reports.stream().filter(cache::contains).forEach(cache::evict);


List<String> todaysReports = reports.stream()
                                .filter(r -> r.getDate().after(midnight))
                                .map(Report::getName)
                                .collect(Collectors.toList());


int sum = numbers.stream().reduce(0, Integer::sum);


Stream.generate(Math::random).limit(5).collect(Collectors.toList());
```

1.3 Optional

Optional

Allows to avoid `null` reference checks and `NullPointerExceptions`.

- `Optional.empty()`
- `Optional.of(T)`
- `Optional.ofNullable(T)`
- `get()`
- `ifPresent(Consumer)`
- `isPresent()`
- `map(Function)`
- `orElse(T)`
- `orElseGet(Supplier)`
- `orElseThrow(Supplier)`

Optional Examples

Null Check

```
final Report latest = findLatestRevision(fileNumber);
if (latest == null) {
   throw new NotFoundException("Report with fileNumber " + fileNumber + " not found.");
}
return latest;
```

↓

```
final Optional<Report> latest = findLatestRevision(fileNumber);
return latest.orElseThrow(() -> new NotFoundException("Report with fileNumber " +
  fileNumber + " not found."));
```

```
Optional<Report> notMine = reports.parallelStream().filter(r ->
  !r.getAuthor().equals(me)).findAny();
notMine.ifPresent(r -> {
   throw new AuthorizationException();
});
```

2 Continuous Integration

Continuous Integration

- Term coined by Grady Booch,
- Adopted by the Extreme Programming community,
- Developers in a team integrate work at least daily,
- Integration verified by an automated build,
- Quick detection of errors, cheaper fixes, fewer integration issues.

CI Practices

- Single source code repository, use CI server,
  - Should contain all the code and configuration, so that clean clone from the repository is buildable,
- Automated build,
  - e.g. using Maven, Gradle,
  - Quick on developer machine,
  - Including automated tests,
- Build before commit/push,

- Push every day (commit → pull changes → resolve conflicts → push),
- Every push triggers build on the CI server,
- Fix broken builds immediately,
- Test in a clone of the production environment,
- Automate deployment.

CI Tools

SCM

- **Git**,
- **Subversion**,
- **RTC**.

CI Servers

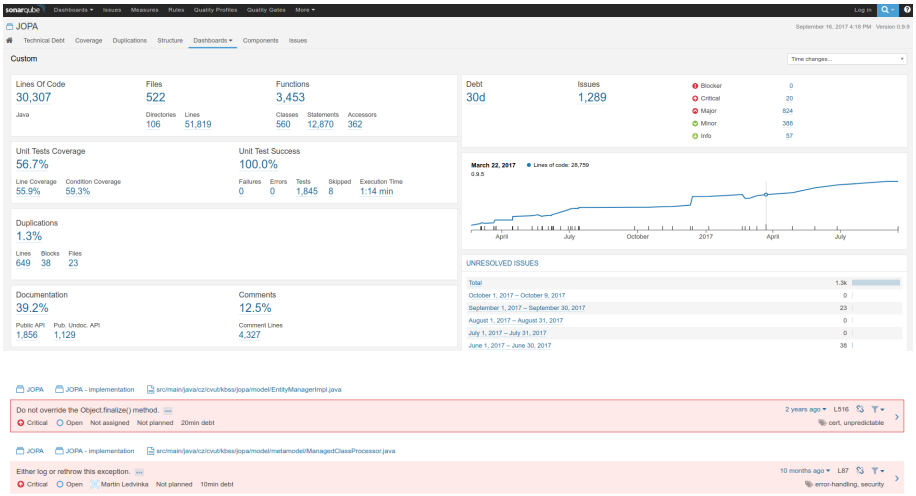
- **Jenkins**
  - Open-source, free,
  - Highly configurable, lots of plugins.
- **TeamCity**
  - Free for 3 agents and 20 build configurations,
  - Developed by JetBrains,
  - More suitable for enterprises.
- **Travis CI**
  - Hosted solution,
  - Free for open-source projects (often used by Github projects).

3 Static Source Code Analysis Tools

Static Code Analysis

Analysis of software without actually executing the program.

- Can be formal, but usually not feasible for larger programs,
  - Used in high risk industries,
  - E.g. aviation, power plants, medicine,
- Mostly based on heuristics,
  - False positives possible,
- Detects suspicious patterns in code.



SCA Tools

- **IDE**
  - Most IDEs contain some sort of SCA feature.
- **Checkstyle**
  - Can be integrated into Maven build.
- **FindBugs**
  - Older tool. Plugins exist for all major IDEs and CI servers.
- **Sonarqube**
  - Multiplatform code analysis tool.
- **Upsource**
  - Code review, SCA, team collaboration.

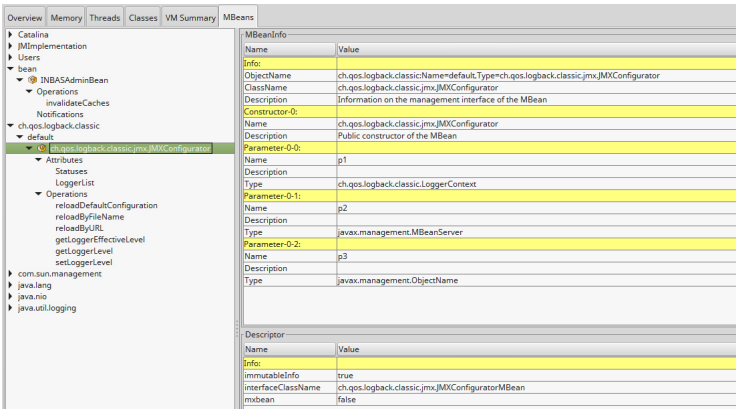
Sonarqube

4 Application Monitoring and Administration

4.1 JMX

Java Management Extensions (JMX)

- Allow management of resources in an application,
- Standard part of the Java platform,
- Resources represented by *Managed Beans* (*MBeans*), registered in an *MBean* server,



- Accessible via JMX connectors.

Managed Beans

- Operations (MBean methods), through which the application can be managed,
- Attributes (getters/setters) for information/configuration.

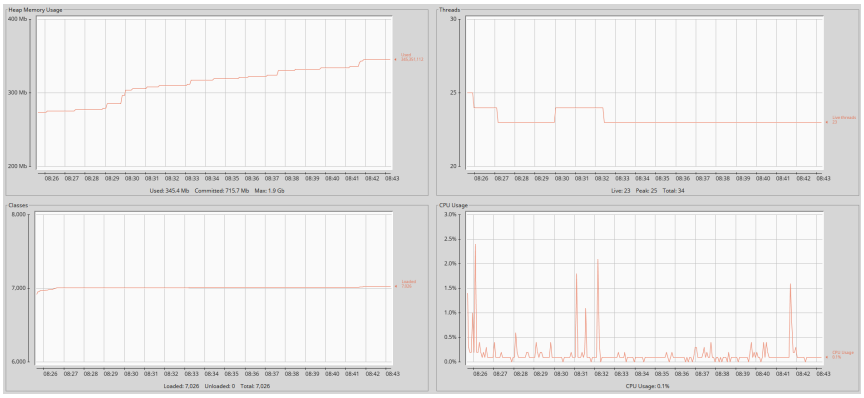
Application Management via JMX

- Connect to application with *JConsole*,
- Locate the desired MBean,
  - Invoke managed operations,
  - View/configure attributes,
- MBean server set up in Spring – `@EnableMBeanExport`.

4.2 Monitoring Tools

JConsole

- GUI-based Java monitoring tool,
- JMX compliant,
- Allows connection to local or remote (if configured) processes,
- Part of the JDK.



VisualVM

- GUI-based Java monitoring tool,
- Allows collection and saving of monitoring data,
  - Thread dump, heap dump,
- Profiling, sampling,
  - CPU, memory,
  - Local applications only,
  - Profiling has major impact on application performance,
- Support for plugins,
- Analysis of stored thread or heap dumps.

More Tools

JDK

- **jmap** – memory-related statistics about a VM, obsolete,
- **jcmd** – send diagnostic commands to JVM, internally used by the GUI tools,
- **jstat** – monitors JVM statistics, lots of options.

- **Eclipse MAT** – advanced memory analyzer,
- **Java Mission Control** and **Java Flight Recorder** – commercial JVM monitoring tools by Oracle,
- **StageMonitor**, **MoSKito** etc. – open source alternatives.

5 Conclusions

The End

Thank You

Resources

- R. Urma, M. Fusco and A. Mycroft: Java 8 in Action,
- http://www.oracle.com/technetwork/articles/java/architect-lambdas-part1-2080972.html,
- http://www.oracle.com/technetwork/articles/java/ma14-java-se-8-streams-2177646.html,
- https://martinfowler.com/articles/continuousIntegration.html,
- http://docs.oracle.com/javase/tutorial/jmx/mbeans/index.html,
- http://docs.oracle.com/javase/7/docs/technotes/guides/management/jconsole.html,
- https://visualvm.github.io/documentation.html.