55 New Features in Java SE 8

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Java SE 8 (JSR 337)

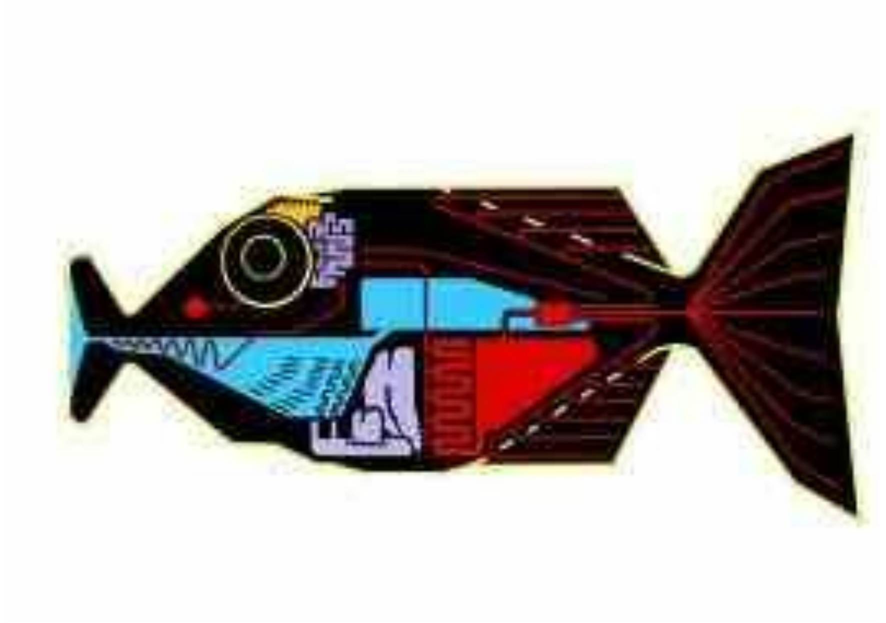
Component JSRs

- New functionality
  - JSR 308: Annotations on types
  - JSR 310: Date and Time API
  - JSR 335: Lambda expressions
- Updated functionality
  - JSR 114: JDBC Rowsets
  - JSR 160: JMX Remote API
  - JSR 199: Java Compiler API
  - JSR 173: Streaming API for XML
  - JSR 206: Java API for XML Processing
  - JSR 221: JDBC 4.0
  - JSR 269: Pluggable Annotation-Processing API

JDK Enhancement Proposals (JEPs)

- Regularly updated list of proposals
  - Serve as the long-term roadmap for JDK release projects
  - Roadmap extends for at least three years
- Uniform format and a central archive for enhancement proposals
  - Interested parties can find, read, comment, and contribute
- Process is open to every OpenJDK Committer
- Enhancement is a non-trivial change to the JDK code base
  - Two or more weeks of engineering effort
  - significant change to JDK or development processes and infrastructure
  - High demand from developers or customers

Language



Lambda Expressions

Functional Programming

- Lambda expressions provide anonymous function types to Java
  - Replace use of anonymous inner classes
  - Provide more functional style of programming in Java

```
doSomething(new DoStuff() {
  public boolean isGood(int value) {
    return value == 42;
  }
});
```

↕ Simplified to

```
doSomething(answer -> answer == 42);
```

Extension Methods

Bringing Multiple Inheritance (of Functionality) to Java

- Provide a mechanism to add new methods to existing interfaces
  - Without breaking backwards compatability
  - Gives Java multiple inheritance of behaviour, as well as types (but not state!)

```
public interface Set<T> extends Collection<T> {
   public int size();

   ...   // The rest of the existing Set methods

   public T reduce(Reducer<T> r)
     default Collections.<T>setReducer;
}
```

Static Methods In Interfaces

- Previously it was not possible to include static methods in an interface
- Static methods, by definition, are not abstract
  - `@FunctionalInterface` can have zero or more static methods

```
static <T> Predicate<T> isEqual(Object target) {
        return (null == target)
                ? Objects::isNull
                : object -> target.equals(object);
}
```

Functional Interface

- Single Abstract Method (SAM) type
- A functional interface is an interface that has one abstract method
  - Represents a single function contract
  - Doesn’t mean it only has one method
- `@FunctionalInterface` annotation
  - Helps ensure the functional interface contract is honoured
  - Compiler error if not a SAM

Method References

- Method references let us reuse a method as a lambda expression

```
FileFilter x = File f -> f.canRead();
```

$\Downarrow$

```
FileFilter x = File::canRead;
```

Constructor References

- Same concept as a method reference
  - For the constructor

```
Factory<List<String>> f = () -> return new ArrayList<String>();
```

↓

```
Factory<List<String>> f = ArrayList<String>::new;
```

Annotations On Java Types

- Annotations can currently only be used on type declarations
  - Classes, methods, variable definitions
- Extension for places where types are used
  - e.g. parameters
- Permits error detection by pluggable type checkers
  - e.g. null pointer errors, race conditions, etc

```
public void process(@notnull List data) {…}
```

Generalised Target-Type Inference

Improved usability of generics

```
class List<E> {
   static <Z> List<Z> nil() { ... };
   static <Z> List<Z> cons(Z head, List<Z> tail) { ... };
   E head() { ... }
}

List<String> ls = List.nil();  // Inferred correctly
```

error: expected List<Integer>, found List<Object>

```
List.cons(42, List.nil());
```

Access To Parameter Names At Runtime

- Mechanism to retrieve parameter names of methods and constructors
  - At runtime via core reflection
- Improved code readability
  - Eliminate redundant annotations
- Improve IDE capabilities
  - Auto-generate template code
- **`Method`** and **`Constructor`** now inherit from new **`Executable`** class
  - **`getParameters()`** returns array of **`Parameter`** objects
  - Name, type, annotations for each parameter

Small Things

- Repeating annotations

  Multiple annotations with the same type applied to a single program element
- No more **`apt`** tool and associated API
  - Complete the transition to the JSR 269 implementation
- DocTree API
  - Provide access to the syntactic elements of a javadoc comment
- DocLint tool
  - Use DocTree API to identify basic errors in javadoc comments
- Javadoc support in **`javax.tools`**
  - Invoke javadoc tools from API as well as command line/exec

Core Libraries

Enhance Core Libraries With Lambdas

- No small task!
  - Java SE 7 has 4024 standard classes
- Modernise general library APIs
- Improve performance
  - Gains from use of invokedynamic to implement Lambdas
- Demonstrate best practices for extension methods

Concurrency Updates

- Scalable update variables
  - `DoubleAccumulator`, `DoubleAdder`, etc
  - Multiple variables avoid update contention
  - Good for frequent updates, infrequent reads
- `ConcurrentHashMap` updates
  - Improved scanning support, key computation
- `ForkJoinPool` improvements
  - Completion based design for IO bound applications
  - Thread that is blocked hands work to thread that is running

Bulk Data Operations For Collections

Filter, Map, Reduce for Java

- `java.util.stream` package
  - `Stream`, `Collector` interfaces
- Serial and parallel implementations
  - Generally expressed with Lambda statements
- Parallel implementation builds on Fork-Join framework
- Lazy evaluation
  - Things like `getFirst()` terminate stream

Add Stream Sources

- From collections and arrays
  - **`Collection.stream()`**
  - **`Collection.parallelStream()`**
  - **`Arrays.stream(T array)`** or **`Stream.of()`**
- Static factories
  - **`IntStream.range()`**
  - **`Files.walk()`**
- Roll your own
  - **`java.util.Spliterator()`**

`java.util.function` Package

- **`Predicate<T>`**
  - Determine if the input of type T matches some criteria
- **`Consumer<T>`**
  - Accept a single input argumentof type T, and return no result
- **`Function<T, R>`**
  - Apply a function to the input type T, generating a result of type R
- **`Supplier<T>`**
  - A supplier of results
- Plus several more type specific versions

Optional<T>

Reducing **NullPointerException** Occurences

```
String direction = gpsData.getPosition().getLatitude().getDirection();

String direction = "UNKNOWN";

if (gpsData != null) {
  Position p = gpsData.getPosition();

  if (p != null) {
    Latitude latitude = p.getLatitude();

    if (latitude != null)
      direction = latitude.getDirection();
  }
}
```

Optional<T>

Reducing NullPointerException Occurences

- Indicates that reference may, or may not have a value
  - Makes developer responsible for checking
  - A bit like a stream that can only have zero or one elements

```
Optional<GPSData> maybeGPS = Optional.of(gpsData);
maybeGPS = Optional.ofNullable(gpsData);

maybeGPS.ifPresent(GPSData::printPosition);

GPSData gps = maybeGPS.orElse(new GPSData());

maybeGPS.filter(g -> g.lastRead() < 2).ifPresent(GPSData.display());
```

Parallel Array Sorting

- Additional utility methods in **`java.util.Arrays`**
  - **`parallelSort`** (multiple signatures for different primitives)
- Anticipated minimum improvement of 30% over sequential sort
  - For dual core system with appropriate sized data set
- Built on top of the fork-join framework
  - Uses Doug Lea’s **`ParallelArray`** implementation
  - Requires working space the same size as the array being sorted

Date And Time APIs

- A new date, time, and calendar API for the Java SE platform
- Supports standard time concepts
  - Partial, duration, period, intervals
  - date, time, instant, and time-zone
- Provides a limited set of calendar systems and be extensible to others
- Uses relevant standards, including ISO-8601, CLDR, and BCP47
- Based on an explicit time-scale with a connection to UTC

JDBC 4.2

Minor enhancements for usability and portability

- Add setter/update methods
  - `ResultSet`, `PreparedStatement`, and `CallableStatement`
  - Support new data types such as those being defined in JSR 310
- REF_CURSOR support for `CallableStatement`
- `DatabaseMetaData.getIndexInfo` extended
  - new columns for CARDINALITY and PAGES which return a long value
- New `DatabaseMetaData` method
  - `getMaxLogicalLobSize`
  - Return the logical maximum size for a LOB

Base64 Encoding and Decoding

- Currently developers are forced to use non-public APIs
  - `sun.misc.BASE64Encoder`
  - `sun.misc.BASE64Decoder`
- Java SE 8 now has a standard way
  - `java.util.Base64.Encoder`
  - `java.util.Base64.Decoder`
  - `encode`, `encodeToString`, `decode`, `wrap` methods

Small Things

- Charset implementation improvements
  - Reduced size of charsets, improved performance of encoding/decoding
- Reduced core-library memory usage
  - Reduced object size, disable reflection compiler, internal table sizes, etc
- Optimize `java.text.DecimalFormat.format`
  - Improve performance, multiply by 100.0 or 1000.0 (2 or 3 DP only)
- Statically Linked JNI Libraries
  - Needed for embedded applications
  - Currently only dynamically linked supported

Internationalisation (I18N)

Locale Data Packing

- Tool to generate locale data files
  - From LDML format
- Unicode Common Locale Data Repository (CLDR) support
- Locale elements supported from underlying platform

BCP 47 Locale Mapping

- Language tags to indicate the language used for an information object
  - RFC-5646 (Language range)
  - RFC-5456 (Language priority, preference)
- Language range `Collection<String>`
- Language priority `List <String>`
- Three operations added to `Locale` class
  - `filterBasic`
  - `filterExtended`
  - `lookup`

Unicode 6.2

- Java SE 7 support Unicode 6.0
- Changes in Unicode 6.1 (February, 2012)
  - Add 11 new blocks to **`java.lang.Character.UnicodeBlock`**
  - Add 7 new scripts to **`java.lang.Character.UnicodeScript`**
  - Support over 700 new characters in **`java.lang.Character`**, **`String`**, and other classes
- Changes in Unicode 6.2 (September, 2012)
  - Support a new Turkish currency sign (U+20BA)

Security

Configurable Secure Random Number Generator

- Better implementation of `SecureRandom`
- Currently applications can hang on Linux
  - JVM uses `/dev/random`
  - This will block if the system entropy pool is not large enough

Enhanced Certificate Revocation-Checking API

- Current `java.security.cert` API is all-or-nothing
  - Failure to contact server is a fatal error
- New interfaces
  - `CertPathChecker`
  - `CertPathParameters`
- New command line debug option
  - `-Djava.security.debug=certpath`

HTTP URL Permissions

- New type of network permission
  - Grant access in terms of URLs, rather than IP addresses
- Current way to specify network permissions
  - `java.net.SocketPermission`
  - Not restricted to just HTTP
  - Operates in terms of IP addresses only
- New, higher level capabilities
  - Support HTTP operations (POST, GET, etc)
  - Build on limited `doPrivileged` feature

Small Items

- Limited `doPrivileged`
  - Execute Lambda expression with privileges enabled
- NSA Suite B cryptographic algorithms
  - Conform to standards to meet U.S. government, banking requirements
- AEAD CipherSuite support
  - Conform to standards to meet U.S. government, banking requirements
- SHA-224 message digests
  - Required due to known flaw in SHA-1
- Leverage CPU instructions for AES cryptography
  - Improve encryption/decryption performance

Small Changes

- Microsoft Services For UNIX (MS-SFU) Kerberos 5 extensions
  - Enhanced Microsoft interoperability
- TLS Server Name Indication (SNI) extension
  - More flexible secure virtual hosting, virtual-machine infrastructure
- PKCS#11 crypto provider for 64-bit Windows
  - Allow use of widely available native libraries
- Stronger algorithms for password-based encryption
  - Researchers and hackers move on
- Overhaul JKS-JCEKS-PKCS12 keystores
  - Simplify interacting with Java SE keystores for cryptographic applications

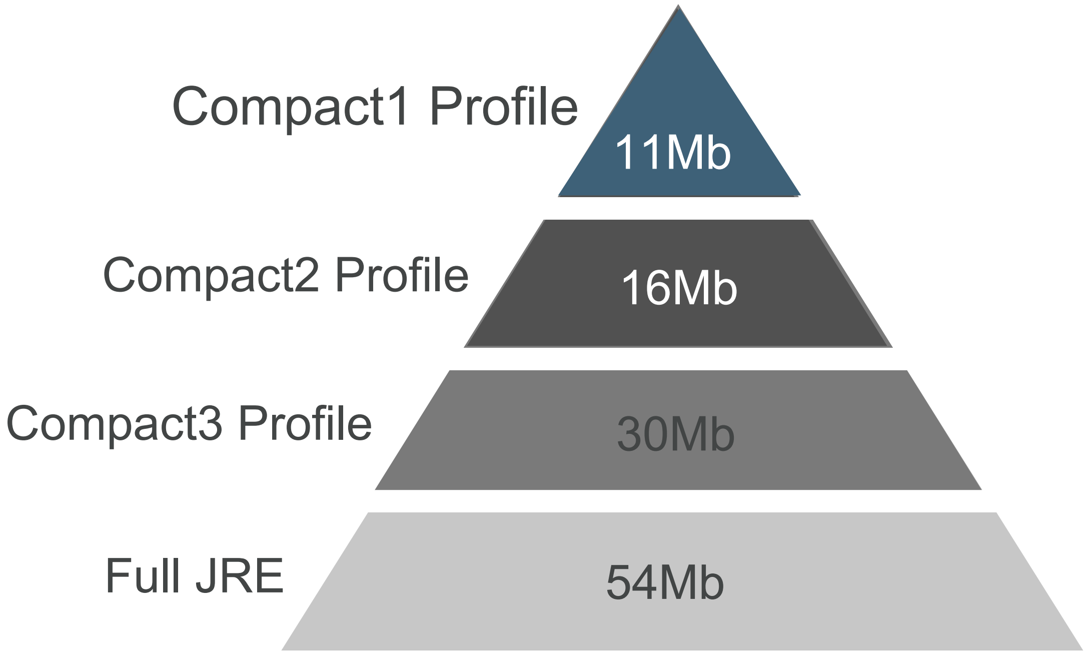
The Platform

Launch JavaFX Applications

- Support the direct launching of JavaFX applications
- Enhancement to the java command line launcher

Compact Profiles

Approximate static footprint goals

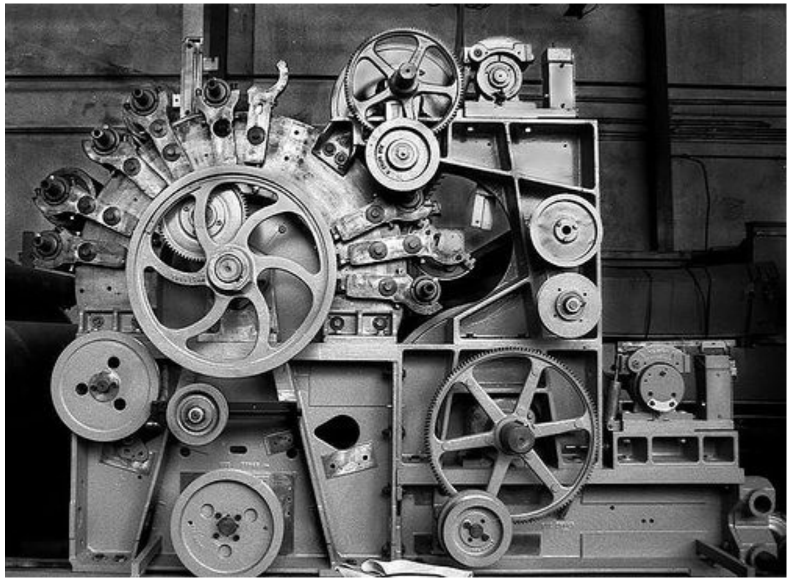


Modularisation Preparation

Getting Ready For Jigsaw

- Fix some assumptions about classloaders
- Use `ServiceLoader` rather than proprietary SPI code
- JDK tool to analyse application code dependencies
- Deprecate APIs that will impede modularisation
  - e.g. `java.util.logging.LogManager.addPropertyChangeListener`
- Review and possibly change `$JAVA_HOME` normative references
  - Relative v. absolute pathnames

Virtual Machine



Nashorn JavaScript Engine

- Lightweight, high-performance JavaScript engine
  - Integrated into JRE
- Use existing **`javax.script`** API
- ECMAScript-262 Edition 5.1 language specification compliance
- New command-line tool, **`jjs`** to run JavaScript
- Internationalised error messages and documentation

Retire Rarely-Used GC Combinations

- Rarely used
  - DefNew + CMS
  - ParNew + SerialOld
  - Incremental CMS
- Large testing effort for little return
- Will generate deprecated option messages
  - Won’t disappear just yet

Remove The Permanent Generation

Permanently

- No more need to tune the size of it
- Current objects moved to Java heap or native memory
  - Interned strings
  - Class metadata
  - Class static variables
- Part of the HotSpot, JRockit convergence

Small Things

- Reduce class metadata footprint
  - Use techniques from CVM of Java ME CDC
- Reduce cache contention on specified fields
  - Pad variables to avoid sharing cache lines
- Small VM
  - `libjvm.so` <3MB by compiling for size over speed

Conclusions

- Java SE 8 adds plenty of new features (and removes a few)
  - Language
  - Libraries
  - JVM
- Java continues to evolve!
  - jdk8.java.net
  - www.jcp.org
  - openjdk.java.net/jeps

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