Functional Modern Java

Streams, lambdas, method references and more...

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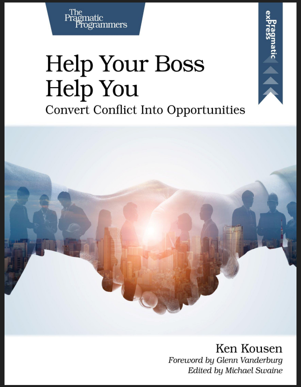
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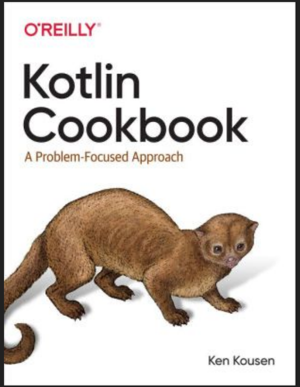

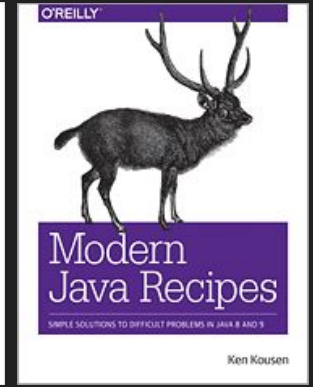

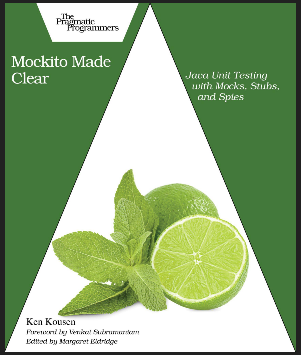
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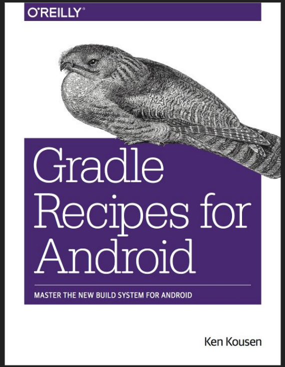
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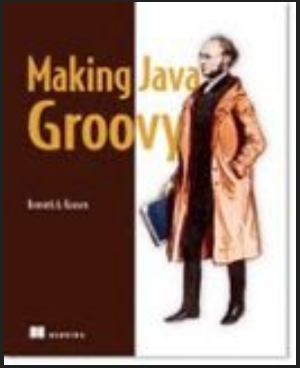


Modern Java Recipes

Materials and examples are from the upcoming book

Source code:

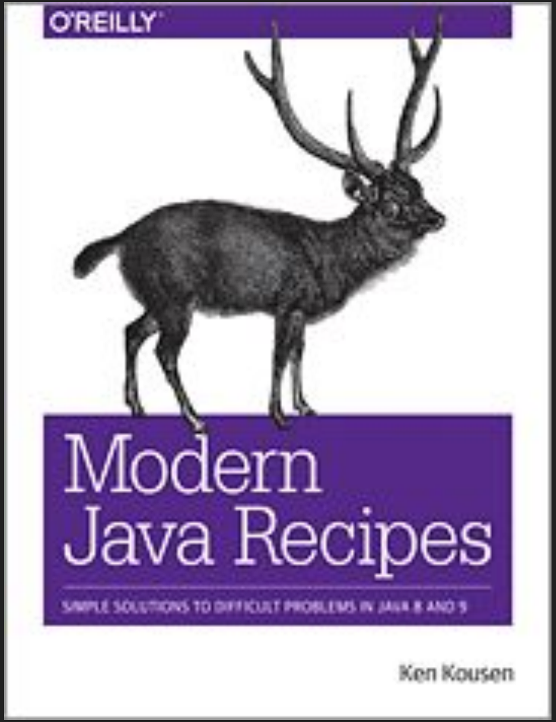
https://github.com/kousen/java_upgrade

https://github.com/kousen/java_8_recipes

https://github.com/kousen/java_latest

Materials:

http://www.kousenit.com/java/



Java Functional Features (JDK 8)

Streams, lambdas, method references

Lambda Expressions

Java lambda expressions

- Assigned to functional interfaces
- Parameter types inferred from context

```
Predicate<String> evenFilter = s → s.length() % 2 == 0
```

Predicate: functional interface with generic type

Lambda: RHS expression

Functional Interface

Interface with a Single Abstract Method

Lambdas (and method references) can ONLY be assigned
to functional interfaces

Functional Interfaces in the JDK

- See `java.util.function` package
- `@FunctionalInterface`
    - Not required, but used in library

Functional Interfaces

Consumer → single arg, no result

```
void accept(T t)
```

Predicate → returns boolean

```
boolean test(T t)
```

Supplier → no arg, returns single result

```
T get()
```

Function → single arg, returns result

```
R apply(T t)
```

Functional Interfaces

Primitive variations

`Consumer`

```
IntConsumer, LongConsumer,
DoubleConsumer,
BiConsumer<T,U>
```

Functional Interfaces

BiFunction → binary function from T and U to R

```
R apply(T, U)
```

UnaryOperator extends Function

(T and R same type)

BinaryOperator extends BiFunction

(T, U, and R same type)

Method References

Method references use :: notation

```
System.out::println
    x → System.out.println(x)
Math::max
    (x,y) → Math.max(x,y)
String::length
    x → x.length()
String::compareToIgnoreCase
    (x,y) → x.compareToIgnoreCase(y)
```

Constructor References

Can call constructors

```
ArrayList::new

Person[]::new
```

Streams

- A sequence of elements
  - Does not store the elements
  - Does not change the source
  - Operations are lazy when possible
  - Closed when terminal expression reached

Streams

A stream carries values

from a source

through a pipeline

Pipelines

- Okay, so what's a pipeline?
  - A source
  - Zero or more **intermediate** operations
  - A **terminal** operation

Streams

- Intermediate operations
    - Methods on Stream that return a Stream
    - `map, filter, flatMap, sorted, distinct, limit, peek`
- Terminal operations
    - Methods on Stream that return anything else
    - `count, allMatch, anyMatch, findFirst, forEach, min, max, reduce`

Reduction Operations

- Reduction operations
    - Terminal operations that produce
        - one value from a stream

```
average, sum, max, min, count, ...
```

Creating Streams

Creating streams

```
Collection.stream()

Stream.of(T... values)

Stream.generate(Supplier<T> s)

Stream.iterate(T seed, UnaryOperator<T> f)

Stream.empty()
```

Transforming Streams

Process data from one stream into another

`Stream<T> filter(Predicate<T> predicate)`

Return only elements satisfying the predicate

`Stream<R> map(Function<T,R> mapper)`

Convert a `Stream<T>` into a `Stream<R>`

Transforming Streams

There's also flatMap:

```
Stream<R> flatMap(Function<T, Stream<R>> mapper)
```

Maps from single element of type T
to *wrapped* element of type `Stream<R>`

Removes internal wrapping

Using Collectors

```
Stream.of( … )
    .collect( Collectors.toList() )
```
→ creates an ArrayList

```
    .collect( Collectors.toSet() )
```
→ creates a HashSet

```
    .collect( Collectors.toCollection( Supplier ))
```
→ creates the supplier (LinkedList::new, TreeSet::new, etc)

```
    .collect( Collectors.toMap( Function, Function ))
```
→ creates a map; first function is keys, second is values

Substreams

`limit(n)` returns a new stream

ends after n elements

What does this code do (Note: Trick question)?

```
DoubleStream.generate(Math::random)
    .limit(100)
```

Static And Default Methods in Interfaces (JDK 8)

Default methods

- Default methods in interfaces
  - Use keyword `default`

Default methods

What if there is a conflict?

Class vs Interface → Class always wins

Interface vs Interface →

- Child overrides parent
- Otherwise compiler error

Static methods in interfaces

- Can add static methods to interfaces
- Do not need to implement the interface to use it
- Access static methods from the interface name
  - See `Comparator.comparing`

Optional Type (JDK 8)

Optional

Alternative to returning object or null

`Optional<T>` value

- `isPresent()` → boolean
- `get()` → return the value

Goal is to return a default if value is null

Optional

`ifPresent()` accepts a consumer

`optional.ifPresent(` … do something …)

`orElse()` provides an alternative

`optional.orElse(`... default …)

```
optional.orElseGet(Supplier<? extends T> other)

optional.orElseThrow(Supplier<? extends X> exSupplier)
```

Deferred execution

- Logging

  ```
  log.info("x = " + x + ", y = " + y);
  ```

  - String formed even if not info level

  ```
  log.info(() -> "x = " + x + ", y = " + y);
  ```

  - Only runs if at info level
  - Arg is a `Supplier<String>`

Date and Time API

`java.util.Date` is a disaster

`java.util.Calendar` isn't much better

Now we have `java.time`

LocalDate

A date without time zone info

contains year, month, day of month

```
LocalDate.of(2023, Month.FEBRUARY, 2)
```

months actually count from 1 now

LocalTime

`LocalTime` is just LocalDate for times

hh:mm:ss

`LocalDateTime` is both, but then you

might need time zones

ZonedDateTime

Database of timezones from IANA

https://www.iana.org/time-zones

```
Set<String> ZoneId.getAvailableZoneIds()

ZoneId.of("... tz name …")
```

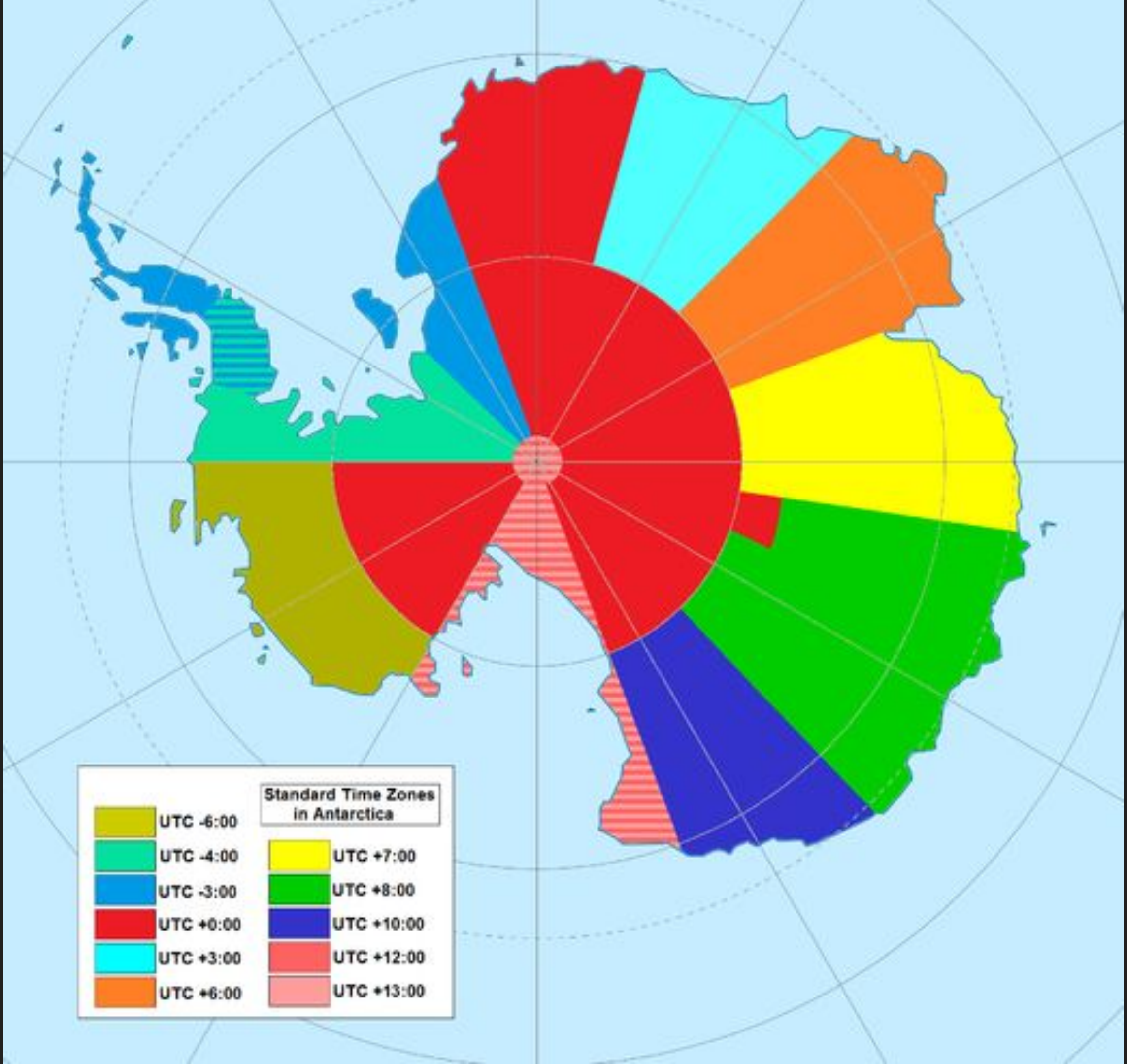
ZonedDateTime

`LocalDateTime` → `ZonedDateTime`

```
local.atZone(zoneId)
```

`Instant` → `ZonedDateTime`

```
instant.atZone(ZoneId.of("UTC"))
```


Standard Time Zones in Antarctica
UTC -6:00
UTC -4:00
UTC -3:00
UTC +0:00
UTC +3:00
UTC +6:00
UTC +7:00
UTC +8:00
UTC +10:00
UTC +12:00
UTC +13:00

Dates and Times

Java 8 Date-Time: java.time package

AntarcticaTimeZones.java

Summary

- Functional programming
  - Streams with map / filter / reduce
  - Lambda expressions
  - Method references
  - Concurrent, parallel streams
- Optional type
- Collectors and Comparators
  - Conversion from stream back to collections
  - Enable sorting, partitioning, and grouping
- Date/Time API
  - Good reason to upgrade