Records and Sealed Types
Coming Soon to a JVM Near You!
Ben Evans (He / Him)
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• New Relic, Principal Engineer
• jClarity, Co-founder
  • Sold to Microsoft
• Deutsche Bank
  • Chief Architect (Listed Derivatives)
• Morgan Stanley
  • Google IPO
• Sporting Bet
  • Chief Architect
About Me – Community

- Java Champion
- JavaOne Rock Star Speaker
- Java Community Process Executive Committee
- London Java Community
  - Organising Team
  - Co-founder, AdoptOpenJDK
Enums
Enums

Enums

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Enums
Why Enums?

• General Principle
  • Patterns in one language become features in the next
Why Enums?

- **General Principle**
  - Patterns in one language become features in the next
    - Vtables in C $$\Rightarrow$$ virtual in C++
    - Iterator pattern in C++ $$\Rightarrow$$ Iterator in Java
    - Enum in C++ $$\Rightarrow$$ Typesafe enum in Java
Why Enums?

- **General Principle**
  - Patterns in one language become features in the next
    - Vtables in C == virtual in C++
    - Iterator pattern in C++ ==> Iterator in Java
    - Enum in C++ ==> Typesafe enum in Java

- **Specific Case**
  - Java enum is a restricted form of class
    - With semantics defined by a pattern (“Finitely Many Instances”)
    - With compact syntax that stems from the pattern
Demo - Decompile an Enum

DEMO
“... explore and incubate smaller, productivity-oriented Java language features ...”

– Goal of Project Amber
Why Records?

- First-class support for modeling data-only aggregates
  - “The state, the whole state and nothing but the state”
- Close a possible gap in Java's type system
- Language-level syntax for a common pattern
- Reduce class boilerplate
“Emotional intensity of debate on a language feature increases as one moves down the following scale: Semantics, Syntax, Lexical syntax, Comments.”

– Philip Wadler
- `toString()`
- `hashCode()` and `equals()`
- Getter methods
- Public constructor
public final class Cashflow {
    private final double amount;
    private final String currency;
    private final LocalDateTime due;

    public Cashflow(String currency, double amount, LocalDateTime due) {
        this.amount = amount;
        this.currency = currency;
        this.due = due;
    }

    public double amount() {
        return amount;
    }

    public String currency() {
        return currency;
    }

    public LocalDateTime due() {
        return due;
    }
}
public final class Cashflow {
    private final double amount;
    private final String currency;
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    public Cashflow(String currency, double amount, LocalDateTime due) {
        this.amount = amount;
        this.currency = currency;
        this.due = due;
    }

    public double amount() {
        return amount;
    }

    public String currency() {
        return currency;
    }

    public LocalDateTime due() {
        return due;
    }
}

record Cashflow(double amount, String currency, LocalDateTime due) { }
What Could Records Be?

- Boilerplate reduction of POJOs
- Java Beans 2.0
- Named Tuples
- Product Types (a form of Algebraic Data Type)
Records Are Named Tuples

• Nominal Typing
  • Not Structural Typing

• Emphasize the semantics above everything else

• Records have benefits over Plain Old Tuples
  • Compact constructors
• If a record $R$ has components $c_1, c_2, \ldots, c_n$
  • Is copied as follows:
    • $R \ r2 = \text{new } R(r.c1(), r.c2(), \ldots, r.cn());$
    • Then $r.equals(r2)$ must be true
  • Usual $equals() - hash\_code()$ contract also applies
“Serialization constitutes an invisible but public constructor, and an invisible but public set of accessors for your internal state.”

– Brian Goetz
import java.time.DayOfWeek;

public class Days {

    public static boolean isWorkDay(DayOfWeek day){
        var today = switch (day) {
            case SATURDAY, SUNDAY -> false;
            case MONDAY, TUESDAY, WEDNESDAY, THURSDAY, FRIDAY -> true;
        };

        // Do any further processing for e.g. public holidays...

        return today;
    }

}
Recall enums...
- Enums are instances of a class
- Enums are exhaustive

How can we say: “A Pet IS-A Cat or Dog”?

How can we model many different Cats and Dogs?
Option 1 - The State Field

- Single implementing Pet class
  - Enum field that holds the “real” type

- Ugly and messy
  - Programmer must keep track of “type bits”
  - No type-specific functionality - “Cat can’t purr()”
Option 2 - Abstract Base

- Use an abstract base with package-private ctor
  - Concrete subclasses

- Leaky abstraction
  - Outside of JDK packages no protection of packages
  - Maybe modules help?
  - But what about API packages?
  - And reflection?
• Sealed types
  • Can be extended by a known list of types
  • But no others
  • “almost final” classes

• New restricted keywords
  • sealed
  • permits

• Known as “union types” in some languages
Java 11 Nestmates
Sealed Types

DEMO
The Path So Far...

11. Nestmates
   Inner classes done right

13. Switch Expressions
   Second preview

14. Records
   Preview of Records

16?. Sealed Types
   At some point in the future
Conclusion

• Records are about semantics
  • Restricted classes that implement a pattern
  • Not a general replacement, just very useful

• Sealed Types are about a new OO construct

• They are part of a journey towards pattern matching
  • Made up of smaller language parts - incremental delivery
  • Algebraic Data Types

• Hopefully everything will be final by Java 17
Further Reading

- https://www.infoq.com/articles/java-14-feature-spotlight/
- https://blogs.oracle.com/javamagazine/records-come-to-java
What Can You Do To Help?

- Try out the Java 14 / 15 betas (and the new features)
- Keep an eye out for
  - Sealed Types betas
  - Deconstruction patterns
- Write code using the new features
  - Even just as research / innovation time
- Give feedback!
  - Sooner is better
THANK YOU & QUESTIONS?

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