

Pattern Matching in Java

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Don't believe what I'm saying !

Pattern Matching ?

String Pattern Matching ?

~~String Pattern Matching ?~~

Tree Pattern Matching

Tree data structure

Given a recursive? data structure

```
Item = VideoGame(String name, PEGI rating)
      | ActionFigure(int id, String universe)
      | Box(List<Item> items)
```

we want to compute thing on it

Tree data structure in Java

```
interface Item {}  
  
class VideoGame implements Item {  
    final String name;  
    final PEGI rating;  
    ...  
}  
  
class ActionFigure implements Item {  
    final String id;  
    final String universe;  
    ...  
}  
  
class Box implements Item {  
    final List<Item> items;  
    ...  
}
```

Defining a computation

```
static int price(Item item) {  
    if (item instanceof VideoGame) {  
        var videoGame = (VideoGame) item;  
        return videoGame.rating().year() * 50;  
    }  
    if (item instanceof ActionFigure) {  
        var actionFigure = (ActionFigure) item;  
        return actionFigure.universe.equals("Marvel")? 30: 20;  
    }  
    if (item instanceof Box) {  
        var box = (Box) item;  
        return 5 + box.items.stream().mapToInt(i -> price(i)).sum();  
    }  
    throw new AssertionError("oops");  
}
```


In OOP

```
interface Item {  
    abstract int price();  
}  
  
class VideoGame implements Item {  
    ...  
    int price() { return ratings.year() * 50; }  
}  
  
class ActionFigure implements Item {  
    ...  
    int price() { return universe.equals("Marvel")? 30: 20; }  
}  
  
class Box implements Item {  
    ...  
    int price() { return 5 + items.stream().mapToInt(Item::price).sum(); }  
}
```

If ... instanceof vs OOP

If ... instanceof

- new computation: **yes**
- new subtype: **not detected at compile time**

OOP

- new computation: **yes only if maintainer**
- new subtype: **yes even if not maintainer**

I'm a huge proponent of designing your code around the data, rather than the other way around [...]

Bad programmers worry about the code. Good programmers worry about data structures and their relationships.

-- *Linus Torvalds*

Designing code around data

data class Scala (or Kotlin)

sealed trait Item

case class VideoGame(name: String, rating: PEGI) **extends** Item

case class ActionFigure(id: int, universe: String) **extends** Item

case class Box(items: List<Item>) **extends** Item

def price(item: Item): int = item **match** {

case VideoGame(name, rating) => ...

case ActionFigure(id, universe) => ...

case Box(items) => ...

}

Good Artists Copy, Great Artists Steal
-- *Pablo Picasso*

What we want in Java

```
sealed interface Item permits VideoGame, ActionFigure, Box {}  
record VideoGame(String name, PEGI rating) implements Item {}  
record ActionFigure(int id, String universe) implements Item {}  
record Box(List<Item> items) implements Item {}  
  
int price(Item item) {  
    return switch(item) {  
        case VideoGame(String name, PEGI rating) -> ...  
        case ActionFigure(int id, String universe) -> ...  
        case Box(List<Item> items) -> ...  
    };  
}
```

OpenJDK Project Amber

Java 17

- Arrow switch, switch expression
- Instanceof + Type pattern
- Record
- Sealed type

Java 19 (preview feature)

- Switch and null
- Switch on patterns
 - Type pattern
 - Record pattern
- Guard on switch case

Demo Java 17

Problems of the Old / C switch

Problems: Fall-through, Declaration scoped to the whole switch, Not expression oriented

```
enum PEGI {  
    PEGI12, PEGI16, PEGI18;  
}  
  
int year() {  
    int year;  
    switch(this) {  
        case PEGI12:  
            year = 12;  
            break;  
        case PEGI16:  
            year = 16;  
            break;  
        case PEGI18:  
            System.out.println("DEBUG");  
            year = 18;  
            break;  
        default:  
            throw new AssertionError(...);  
    }  
    return year;  
}
```

Enhanced switch

An arrow is followed by a statement or a block (if there are several instructions)

```
enum PEGI {  
    PEGI12, PEGI16, PEGI18;  
}  
  
int year() {  
    int year;  
    switch(this) {  
        case PEGI12 -> year = 12;  
        case PEGI16 -> year = 16;  
        case PEGI18 -> {  
            System.out.println("DEBUG");  
            year = 18;  
        }  
        default:  
            throw new AssertionError(...);  
    }  
    return year;  
}
```

Switch Expression

Switch is extended to also work as an expression (and be exhaustive)

```
enum PEGI {  
    PEGI12, PEGI16, PEGI18;  
}  
  
int year() {  
    return switch(this) {  
        case PEGI12 -> 12;  
        case PEGI16 -> 16;  
        case PEGI18 -> {  
            System.out.println("DEBUG");  
            yield 18; // "returns" from the switch not the method  
        }  
        default:  
            throw new AssertionError(...);  
    };  
}
```

InstanceOf + Type pattern

instanceof is enhanced to specify a local variable as last parameter

```
int price(Item item) {  
    if (item instanceof VideoGame videoGame) {  
        return videoGame.rating().year() * 50;  
    }  
    if (item instanceof ActionFigure actionFigure) {  
        return actionFigure.universe().equals("Marvel")? 30: 20;  
    }  
    if (item instanceof Box box) {  
        return 5 + box.items().stream().mapToInt(item -> price(item)).sum();  
    }  
    throw new AssertionError("oops");  
}
```

instanceof and equals

The binding (local variable) is also accessible after a &&

```
class VideoGame {  
    final String name;  
    final PEGI rating;  
    ...  
    public boolean equals(Object o) {  
        return o instanceof VideoGame &&  
            && rating == videoGame.rating  
            && name.equals(videoGame.name);  
    }  
}
```

Sealed type and permits

A sealed types list all its direct subtypes

```
sealed interface Item permits VideoGame, Box {}  
final class VideoGame implements Item { ... }  
final class ActionFigure implements Item { ... }  
final class Box implements Item { ... }
```

A subtype must be either **final**, **sealed** or **non-sealed**

Sealed type

All subtypes must have a *stable* name and declared in the same package (or module)

- A lambda is not a valid subtype
- A local class is not a valid subtype (may be relaxed)

“permits” is not necessary if the sealed type and all its subtypes are in the same file

Record

Unmodifiable Named Tuple

```
record VideoGame(String name, PEGI rating) {}
```

“name” and “rating” are components of the record

- No more fields are allowed

Accessors name() and rating() are generated
(they do not follow the getter convention)

Canonical Constructor

A record has an overridable constructor that takes all the components

```
record VideoGame(String name, PEGI rating) {  
    VideoGame(String name, PEGI rating) {  
        Objects.requireNonNull(name);  
        Objects.requireNonNull(rating);  
        this.name = name;  
        this.rating = rating;  
    }  
}
```

Canonical Compact constructor

There is a syntactic sugar version of the canonical constructor

```
record VideoGame(String name, PEGI rating) {  
  VideoGame { // the compiler insert the parameters  
    Objects.requireNonNull(name);  
    Objects.requireNonNull(rating);  
  
    // all the lines "this.foo = foo;" are added by the compiler  
  }  
}
```

Equals/hashCode/toString()

equals/hashCode and toString are generated

Technically the compiler generates the header and the JDK implement them (less bytecodes)

```
assertEquals(  
    Set.of(new VideoGame("naruto", PEGI16)),  
    Set.of(new VideoGame("naruto", PEGI16)));
```

More on records

Final class that extends `java.lang.Record`

- It can implement interfaces

Auto-serializable (if it implements `Serializable`)

- Do not bypass the constructor when deserializing

Reflection: `Class.getRecordComponents()` returns a `RecordComponent(String name, Class<?> type)`

- `GetName()`, `getType()`, `getAccessor()`

Demo Java 18

(with `--enable-preview`)

Switch and null

By default a switch does not accept null

```
String s = ...  
switch(s) {  
    case null -> ...  
    case "foo", "bar" -> ...  
    default -> ...  
}
```

If a “case null” is present, switch accepts null

Switch and null (2)

“default” by default does not accept null

```
String s = ...  
switch(s) {  
    case "foo", "bar" -> ...  
    case null, default -> ...  
}
```

but “case null” can be combined with “default”

Switch statement + enum

A switch statement on an enum does not ask for exhaustiveness (backward compatibility issue)

Adding a “case null” makes it exhaustive

```
switch(rating) {  
    case null - > throw null; // make the switch exhaustive  
    case PEGI12 -> ...  
    case PEGI16 -> ...  
    case PEGI18 -> ...  
} // can not fall-through anymore
```

Switch on type pattern

Even the switch statement must be exhaustive

```
void foo(Item item) {  
    switch(item) {  
        case VideoGame videoGame -> ...  
        case ActionFigure actionFigure -> ...  
        case Box box -> ...  
    }  
}
```

Switch on type pattern (2)

“case” on a subtype should appear first (like try/catch)

```
int price(Item item) {  
    return switch(item) {  
        case Item i -> ...  
        case VideoGame videoGame -> ... // not reachable  
    };  
}
```

Java 19

Switch on record pattern

Guard on switch case

Record Pattern

Match and de-structure

```
int price(Item item) {  
    return switch(item) {  
        case VideoGame(String name, PEGI rating) -> ...  
        case ActionFigure(int id, String universe) -> ...  
        case Box(List<Item> items) -> ...  
    };  
}
```

The type patterns inside a record pattern match null

Record Pattern syntax

A record pattern has an optional binding for the record itself

RecordType(c₀Type c₀, ...) name?

```
int price(Item item) {  
    return switch(item) {  
        case VideoGame(String name, PEGI rating) videoGame -> ...  
        ...  
    };  
}
```

Record Pattern (2)

Also works with instanceof

```
class VideoGame {  
    final String name;  
    final PEGI rating;  
    ...  
    public boolean equals(Object o) {  
        return o instanceof VideoGame(String name2, PEGI rating2)  
            && rating == rating2  
            && name.equals(name2);  
    }  
}
```

Guarded case

A case can add an additional boolean expression using “when”

```
void foo(Item item) {  
  switch(item) {  
    case VideoGame(String name, PEGI rating)  
      when rating == PEGI18 -> ...  
    case VideoGame videoGame -> ...  
    ...  
  }  
}
```

A case with a guard must appear before the case without a guard

Future

Future of pattern matching

De-constructor on class

- Allow class to export values without breaking encapsulation

Pattern on List, Map, Set, etc

- Requires a real syntax for List, Set, Map first

User defined Pattern methods

- Users can create their own patterns

Pattern assignment

- de-structuring while assigning

De-constructor on class

Export values for pattern matching without getters (*experimental syntax*)

```
class Point {  
  final int x;  
  final int y;  
  ...  
  
  public (int, int) deconstructor {  
    return match x, y; // always match  
  }  
}
```

```
switch(item) {  
  case Point(int x, int y) -> ...
```

Concise syntax for collections

Add new syntax for usual collections (*experimental syntax*)

- Non mutable (equivalent to List.of(), Set.of(), Map.of())
- Use target typing (may require a new kind of cast)

```
List<String> list = [ "foo", "bar" ];           // non mutable
```

```
var list2 = new ArrayList<>([ "foo", "bar" ]); // mutable
```

```
var list3 = (List<>) [ "foo", "bar" ];
```

```
Set<String> set = [ "foo", "bar" ];
```

```
Map<String, Integer> map = { "foo": 3, "bar": 4 };
```

Pattern on collections

Pattern on collection has two variants

- Type [value₀, value₁, ...] // size >= 2
- Type [value₀, value₁] // size == 2

```
Collection<String> c = ...
```

```
switch(c) {
```

```
    case List ["foo", ...] - > ...
```

```
    case ArrayList [1, 2] - > ... // does not compile int != String
```

```
    ...
```

```
}
```

+ a syntax for pattern on arrays

User defined pattern method

Use instance methods to define pattern methods (*experimental syntax*)

```
class Optional<T> {  
  final T value;  
  final boolean exist;  
  ...  
  pattern (T) of() { if (exists) match value; else not-match; }  
  pattern () empty() { if (exist) not-match; else match; }  
}  
  
switch(opt) {  
  case Optional.of(T t) - > ...  
  case Optional.empty() - > ...  
} // how to say that this is exhaustive ??
```

Pattern assignment

Use record pattern on the left hand side of an assignment
(*experimental syntax*)

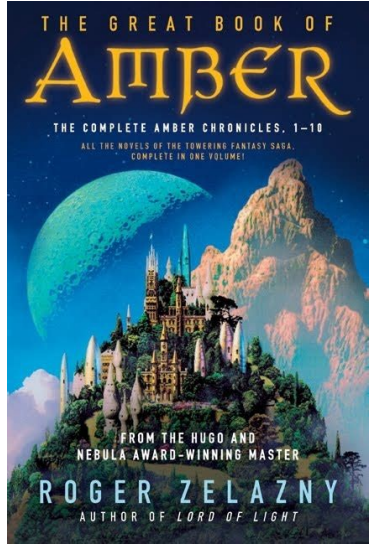
- Assignment conversions should apply

```
record Box<T>(T value) {}
```

```
Box<Integer> box = ...
```

```
Box<>(int v) = p;    // auto-unboxing conversion
```

```
System.out.println(v);
```



Questions ?

<https://github.com/forax/pattern-matching>