ORACLE

# Forward To Java 18 and Beyond!

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# Important Notes

- Ask questions
- Reach out:
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- Link to slides 👉 https://github.com/wkorando/forward-to-java-18-and-beyond





- https://dev.java
- https://inside.java
- Inside Java Podcast
- #SipOfJava
- https://youtube.com/java
- Inside Java Newscast
- #JEPCafé

# Agenda

- Key Language Changes in 11-17
- Themes of Language Changes
- The Future of Java




# Let's Review:
# Key language changes in 11-17




# Key Language Changes

- Updates to `switch`
- Pattern matching for `instanceof`
- Records
- Sealed classes




# Project Amber

http://openjdk.java.net/projects/amber/

“The goal of Project Amber is to explore and incubate smaller, productivity-oriented Java language features…”

Other changes delivered under Amber:

Local Variable Type Inference (var)

Text Blocks




# Switch Updates

Added in Java 14
JEP 361




# Switch Updates

```
switch(d){
    case 1:
     System.out.println("Sunday");
     break;
    case 2:
     System.out.println("Monday");
     break;
    case 3:
     System.out.println("Tuesday");
     break;
    case 4:
     System.out.println("Wednesday");
     break;
    case 5:
     System.out.println("Thursday");
     break;
    case 6:
     System.out.println("Friday");

    case 7:
     System.out.println("Saturday");
     break;
}
```




# Switch Updates

```
switch(d){
    case 1 -> System.out.println("Sunday");
    case 2 -> System.out.println("Monday");
    case 3 -> System.out.println("Tuesday");
    case 4 -> System.out.println("Wednesday");
    case 5 -> System.out.println("Thursday");
    case 6 -> System.out.println("Friday");
    case 7 -> System.out.println("Saturday");
}
```

# Switch Updates

```
String day = switch(d){
     case 1 -> "Sunday";
     case 2 -> "Monday";
     case 3 -> "Tuesday";
     case 4 -> "Wednesday";
     case 5 -> "Thursday";
     case 6 -> "Friday";
     case 7 -> "Saturday";
     default -> throw new IllegalArgumentException();
}
```

# Switch Updates

```
String day = switch(d){
     case 1 -> "Sunday";
     case 2 -> "Monday";
     case 3 -> "Tuesday";
     case 4 -> "Wednesday";
     case 5 -> "Thursday";
     case 6 -> {
       System.out.println("Ladies and Gentlemen, the Weekend");
       yield "Friday";
     }
     case 7 -> "Saturday";
     default -> throw new IllegalArgumentException();
}
```




# Switch Updates

```
String day = switch(d){
    case 1:
        yield "Sunday";
    case 2:
        yield "Monday";
    case 3:
        yield "Tuesday";
    case 4:
        yield "Wednesday";
    case 5:
        yield "Thursday";
    case 6:
        yield "Friday";
    case 7:
        yield "Saturday";
    default:
        throw new IllegalArgumentException();
}
```




# Switch Updates

```
enum DaysOfWeek {
    SUNDAY, MONDAY, TUESDAY, WEDNESDAY, THURSDAY, FRIDAY, SATURDAY;
}

DaysOfWeek dayOfWeek = [someDayOfWeek]

String day = switch(dayOfWeek){
     case SUNDAY -> "Sunday";
     case MONDAY -> "Monday";
     case TUESDAY -> "Tuesday";
     case WEDNESDAY -> "Wednesday";
     case THURSDAY -> "Thursday";
     case FRIDAY -> "Friday";
     case SATURDAY -> "Saturday";
}
```




# Switch Updates

```
enum DaysOfWeek {
   SUNDAY, MONDAY, TUESDAY, WEDNESDAY, THURSDAY, FRIDAY, SATURDAY;
}

String day = switch(dayOfWeek){
    case SUNDAY :
        yield "Sunday";
    case MONDAY :
        yield "Monday";
    case TUESDAY :
        yield  "Tuesday";
    case WEDNESDAY:
        yield "Wednesday";
    case THURSDAY:
        yield "Thursday";
    case FRIDAY:
        yield "Friday";
    case SATURDAY:
        yield "Saturday";
};
```




# Pattern Matching for Instanceof

Added in Java 16
JEP 394




# Pattern Matching for Instanceof

```
Object actuallyAString = "I'm actually a string!";

if(actuallyAString instanceof String) {//Test if actuallyAString is a String
    String nowImAString = //Assign actuallyAString to a variable
    (String) actuallyAString; //Convert actuallyAString to a String

    System.out.println(nowImAString);
}
```




# Pattern Matching for Instanceof

```
Object actuallyAString = "I'm actually a string!";

if(actuallyAString instanceof String nowImAString) {
    System.out.println(nowImAString);
}
```

Predicate

Pattern Variable




# Pattern Matching for Instanceof

```
Object actuallyAString = "I'm actually a string!";

if(actuallyAString instanceof String nowImAString) {
    System.out.println(nowImAString);
}

System.out.println(nowImAString); //Compiler error, nowImAString not in scope

boolean isAString = (actuallyAString instanceof String nowImAString);

System.out.println(nowImAString); //Compiler error, nowImAString not in scope
```

In scope where compiler knows pattern variable is set




# Records

Added in Java 16
JEP 395




# Records

```
String firstName1 = "Billy";
String lastName1 = "Korando";
String title1 = "Java Developer Advocate";
String twitterHandle1 = "@BillyKorando";

String firstName2 = "Sharat";
String lastName2 = "Chander";
String title2 = "Java Developer Advocate";
String twitterHandle2 = "@Sharat_Chander";

class Person{
    private String firstName;
    private String lastName;
    private String title;
    private String twitterHandle;
    public Person(String firstName, String lastName, String title, String twitterHandle) {
        this.firstName = firstName;
        this.lastName = lastName;
        this.title = title;
        this.twitterHandle = twitterHandle;
    }
    @Override
    public int hashCode() {
        final int prime = 31;
        int result = 1;
        result = prime * result + ((firstName == null) ? 0 : firstName.hashCode());
        result = prime * result + ((lastName == null) ? 0 : lastName.hashCode());
        result = prime * result + ((title == null) ? 0 : title.hashCode());
        result = prime * result + ((twitterHandle == null) ? 0 : twitterHandle.hashCode());
        return result;
    }
    @Override
    public boolean equals(Object obj) {
        if (this == obj)
            return true;
        if (obj == null)
            return false;
        if (getClass() != obj.getClass())
            return false;
        Person other = (Person) obj;
        if (firstName == null) {
            if (other.firstName != null)
                return false;
        } else if (!firstName.equals(other.firstName))
            return false;
        if (lastName == null) {
            if (other.lastName != null)
                return false;
        } else if (!lastName.equals(other.lastName))
            return false;
        if (title == null) {
            if (other.title != null)
                return false;
        } else if (!title.equals(other.title))
            return false;
        if (twitterHandle == null) {
            if (other.twitterHandle != null)
                return false;
        } else if (!twitterHandle.equals(other.twitterHandle))
            return false;
        return true;
    }
    @Override
    public String toString() {
        return "Person [firstName=" + firstName + ", lastName=" + lastName + ", title=" + title
                + ", twitterHandle=" + twitterHandle + "]";
    }
}

var persons = Stream.of(new Person(firstName1, lastName1, title1, twitterHandle1),
new Person(firstName2, lastName2, title2, twitterHandle2));

persons.forEach(System.out::println);
```

# Records

```
String firstName1 = "Billy";
String lastName1 = "Korando";
String title1 = "Java Developer Advocate";
String twitterHandle1 = "@BillyKorando";

String firstName2 = "Sharat";
String lastName2 = "Chander";
String title2 = "Java Developer Advocate";
String twitterHandle2 = "@Sharat_Chander";

record Person(String firstName, String lastName, String title, String twitterHandle) {}

var persons = Stream.of(new Person(firstName1, lastName1, title1, twitterHandle1),
        new Person(firstName2, lastName2, title2, twitterHandle2));

persons.forEach(System.out::println);
```

# Records

- Transparent modeling of data as data

```
record Person(String firstName, String lastName, String title, String twitterHandle) {}
```

- Superclass always `java.lang.Record`
- Cannot be extended, abstract, and implicitly final
- All fields are final (shallowly immutable)
- Cannot declare instance fields, field initializers, instance initializers
- Accessors, `hashCode()`, `toString()`, `equals()`, automatically generated, but can be overwritten
- Fundamentally just a class

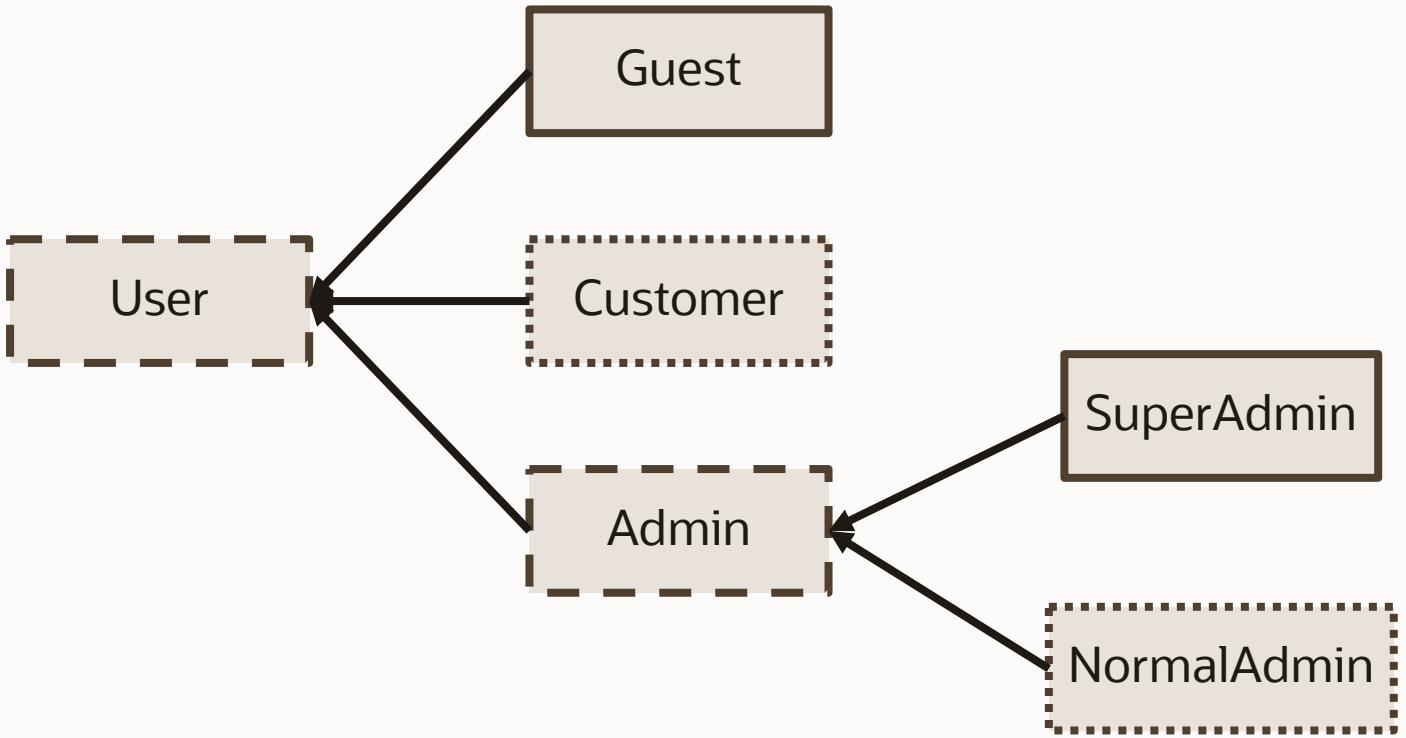



# Sealed Classes

Added in Java 17
JEP 409




# Sealed Classes



# Sealed Classes

```
public abstract sealed class User
permits Admin, Customer, Guest{

}

public sealed class Admin
extends User permits SuperAdmin, NormalAdmin{

}

public final class Guest extends User {

}

public non-sealed class Customer extends User {

}
```




# Sealed Classes & Records

```
public sealed interface User{}

public record Admin(...) implements User{}
public record Guest(...) implements User{}
public record Customer(...) implements User{}
```




# Themes

1. More expressive
   - Meaning can be derived more easily from code
2. Safer
   - Compiler warnings
   - Address some security issues (serialization)
   - Fewer concerns with nulls
3. Reducing verbosity/ceremony
   - Not *just* about typing, but reducing opportunities for bugs




# “Making it easier to program in plain data”

**Brian Goetz – Java Language Architect**
https://www.youtube.com/watch?v=krmW1wcFvcE





# The Future of Java

# Near Future




# Pattern Matching for Switch

Currently in Preview 2
JEP 420




# Pattern Matching for Switch

```
return switch (o) {
      case Integer i -> String.format("int %d", i);
      case Long l    -> String.format("long %d", l);
      case Double d  -> String.format("double %f", d);
      case String s  -> String.format("String %s", s);
      default        -> o.toString();
};
```




# Pattern Matching for Switch

```
switch (s) {
    case Triangle t && (t.calculateArea() > 100) ->
        System.out.println("Large triangle");
    case Triangle t ->
        System.out.println("Small triangle");
    default ->
        System.out.println("Non-triangle");
}
```




# Pattern Matching for Switch

```
switch (s) {
    case null          -> System.out.println("Oops");
    case "Foo", "Bar" -> System.out.println("Great");
    default            -> System.out.println("Ok");
}
```




# Pattern Matching for Switch

```
public sealed interface User{}

public record Admin(...) implements User{}
public record Guest(...) implements User{}
public record Customer(...) implements User{}

User u = ...

User someUser = switch(u){
    case Admin a -> ...;
    case Guest g -> ...;
    case Customer c -> ...;
}
```




# Pattern Matching for Switch

```
public sealed interface User{}

public record Admin(...) implements User{}
public record Guest(...) implements User{}
public record Customer(...) implements User{}

User u = ...

switch(u){  //Error not exhaustive!
    case Admin a -> ...;
    case Customer c -> ...;
}
```




# Record Patterns and Array Patterns

Currently in candidate status
JEP 405




# Record Patterns and Array Patterns

```
record Point(int x, int y) {}
enum Color { RED, GREEN, BLUE }
record ColoredPoint(Point p, Color c) {}
record Rectangle(ColoredPoint upperLeft, ColoredPoint lowerRight) {}

static void printColorOfUpperLeftPoint(Rectangle rectangle) {
    if(rectangle != null){
        ColoredPoint ul = rectangle.ul();
        if (ul != null) {
            Color c = ul.c();
            System.out.println(c);
        }
    }
}
```

# Record Patterns and Array Patterns

```
record Point(int x, int y) {}
enum Color { RED, GREEN, BLUE }
record ColoredPoint(Point p, Color c) {}
record Rectangle(ColoredPoint upperLeft, ColoredPoint lowerRight) {}

static void printColorOfUpperLeftPoint(Rectangle rectangle) {
    if(rectangle instaceof Rectangle r){
        ColoredPoint ul = r.ul();
        if (ul != null) {
            Color c = ul.c();
            System.out.println(c);
        }
    }
}
```




# Record Patterns and Array Patterns

```
record Point(int x, int y) {}
enum Color { RED, GREEN, BLUE }
record ColoredPoint(Point p, Color c) {}
record Rectangle(ColoredPoint upperLeft, ColoredPoint lowerRight) {}

static void printColorOfUpperLeftPoint(Rectangle rectangle) {
    if(rectangle instaceof Rectangle(ColoredPoint ul, ColoredPoint lr){
        Color c = ul.c();
        System.out.println(c);
    }
}
```




# Record Patterns and Array Patterns

```
record Point(int x, int y) {}
enum Color { RED, GREEN, BLUE }
record ColoredPoint(Point p, Color c) {}
record Rectangle(ColoredPoint upperLeft, ColoredPoint lowerRight) {}

static void printColorOfUpperLeftPoint(Rectangle rectangle) {
    if(rectangle instaceof Rectangle(ColoredPoint(Point p, Color c), ColoredPoint lr){
        System.out.println(c);
    }
}
```




# Record Patterns and Array Patterns

```
String[] someStrings = new String[]{
"foo",
"bar"};

if(someStrings instanceof String[]{String s1, String s2}){
    System.out.println(s1);
    System.out.println(s2);
}
```




# Record Patterns and Array Patterns

```
String[][] multiDimensionalArray ...

if(multiDimensionalArray instanceof
    String[][]{{var s1, var s2},{var s3, var s4}}){
      ...
}
```




# Record Patterns and Array Patterns

```
record Point(int x, int y) {}
enum Color { RED, GREEN, BLUE }
record ColoredPoint(Point p, Color c) {}
record Rectangle(ColoredPoint upperLeft, ColoredPoint lowerRight) {}

static void printColorOfUpperLeftPoint(Rectangle rectangle) {
    if(rectangle instaceof Rectangle(ColoredPoint(Point p, Color c), ColoredPoint lr){
        System.out.println(c);
    }
}
```




# A Bit Further Out Future




# Enhanced Arrays

```
int[] someNums = {...};
int n = someNums.length;

if(someNums instanceof int[]{[n-2] -> int x, [n-1] -> int y}){
    System.out.println("Sum of last two elements: " + (x+y));
}
```




# Don’t Care Patterns

```
void int getXfromPoint(Object o) {
    if (o instanceof Point(var x, _)){
        return x;
    }
    return -1;
}
```

# Don’t Care Patterns

```
void int getXfromPoint(Object o) {
    if (o instanceof Point(var x)){
        return x;
    }
    return -1;
}
```




# Destructuring Patterns

```
int eval(Expr n) {
    return switch(n) {
        case IntExpr(int i) -> i;
        case NegExpr(Expr n) -> -eval(n);
        case AddExpr(Expr left, Expr right) -> eval(left) + eval(right);
        case MulExpr(Expr left, Expr right) -> eval(left) * eval(right);
        default -> throw new IllegalArgumentException(n);
    };
}
```




# Pattern Matching in foreach Loops

```
for (Entry e : map.entrySet()){
        System.out.printf("%s: %s%n", e.key(), e.value());
```




# Pattern Matching in foreach Loops

```
for (Map.Entry(var key, var value) : map.entrySet())
        System.out.printf("%s: %s%n", key, value);
```




# Other Active JDK Projects




# JDK Projects

Project Loom
https://openjdk.java.net/projects/loom/

Adding Virtual Threads to the JVM to improve parallelization

Project Valhalla
https://openjdk.java.net/projects/valhalla/

Improvements to value types, generics, better aligning memory usage with modern hardware, and more

Project Panama
https://openjdk.java.net/projects/panama/

Improving foreign (non-Java) APIs




# Early Access Builds

https://jdk.java.net/18/
https://jdk.java.net/loom/
https://jdk.java.net/panama/
https://jdk.java.net/valhalla/




# Thank you

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**Email: billy.korando@oracle.com**

**Slides: https://github.com/wkorando/forward-to-java-18-and-beyond**





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