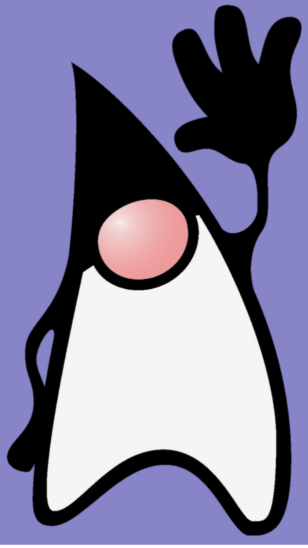
Java

switch – since Java 14



switch

- arrow instead of colon
- no break needed

```
switch (k) {
    case 1 -> System.out.println("one");
    case 2 -> System.out.println("two");
    case 3 -> System.out.println("many");
}
```

```
return switch (day) {
    case "mon", "tue", "wed", "thu", "fri" ->
        System.out.println("Working day");
    case "sat", "sun" ->
        System.out.println("Weekend");
};
```

- multiple values

switch expression

- switch as an expression

```
    static boolean isWeekend(String day) {
        return switch (day) {
            case "mon", "tue", "wed", "thu", "fri" -> false;
            case "sat", "sun" -> true;
            default -> throw new
                IllegalArgumentException("oops!");
        };
    }
```

- expression value

- requires all possibilites

- must complete with a value or exception

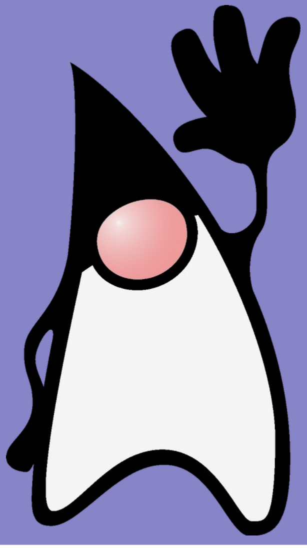
switch expression

```
static boolean isWeekend(String day) {
    return switch (day) {
        case "mon", "tue", "wed", "thu", "fri" -> false;
        case "sat", "sun" -> true;
        default -> {
            System.out.printf("unknown day: %s%n", day);
            yield false;
        }
    };
}
```

- resulting value in a block of code

Java

Enum



Enumerations

- “enum” without enum

```
public static final int COLOR_BLUE = 0;
public static final int COLOR_RED = 1;
public static final int COLOR_GREEN = 2;
```

- possible problems
  - type (un)safety
  - no namespace
  - constants hard-compiled in clients
  - only numbers when printed

Enum

```
public enum Color { BLUE, RED, GREEN }
...
public Color clr = Color.BLUE;
```

- “normal” class
  - can have fields, methods, even the main method
  - subclass of `java.lang.Enum`
  - for each value – single instance
    - public static final field
    - protected constructor

„Enum without enum“

- how to implement enum without enum
  - (and how enums are in principle implemented)

```
class Color {
  private int ordinal;

  public static final Color RED = new Color(0);
  public static final Color GREEN = new Color(1);
  public static final Color BLUE = new Color(2);

  private Color(int o) {
    ordinal = o;
  }
  ...
}
```

java.lang.Enum

```
public abstract class Enum <E extends Enum<E>> { ... }
```

- methods
  - `String name()`
  - `int ordinal()`

- each enum has the method `values()`
  - returns an array with all enum's values

```
public Colors clr = Colors.BLUE;
System.out.println(clr);   →  BLUE
```

Fields and methods

```
public enum Planet {
  MERCURY (3.303e+23, 2.4397e6),
  VENUS (4.869e+24, 6.0518e6),
  EARTH (5.976e+24, 6.37814e6),
  ...

  private final double mass;
  private final double radius;

  Planet(double mass, double radius){
    this.mass = mass;
    this.radius = radius;
  }

  double surfaceGravity() {
    return G * mass / (radius * radius);
  }
}
```

Fields and methods

- example

```
public enum Operation {
    PLUS, MINUS, TIMES, DIVIDE;

    double eval(double x, double y){
        return switch (this) {
            case PLUS -> x + y;
            case MINUS -> x - y;
            case TIMES -> x * y;
            case DIVIDE -> x / y;
        };
    }
}
```

Fields and methods

- abstract methods
- particular implementations with each of the values

```
public enum Operation {
  PLUS { double eval(double x, double y) { return x+y; }},
  MINUS { double eval(double x, double y) { return x-y; }},
  TIMES { double eval(double x, double y) { return x*y; }},
  DIVIDE { double eval(double x, double y) { return x/y;}};

  abstract double eval(double x, double y);
}
```

enum

- cannot be extended
  - ~~`enum MoreColors extends Colors`~~
  - ~~`enum Colors extends AnotherClass`~~

- why?

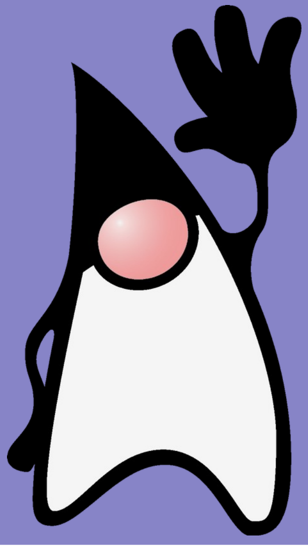
```
enum Color { Red, Green }
```

↓

```
final class Color extends java.lang.Enum<Color> {
  public static final Color Red;
  public static final Color Green;
  ...
}
```

Java

Variable number of arguments



...

- „three dots“
- only as the last argument
- either an array or list of arguments can be passed
- in the method, available as an array

```
void argtest(Object... args) {
  for (int i=0;i <args.length; i++) {
    System.out.println(args[i]);
  }
}
argtest("Hello", "how", "are", "you");
argtest(new Object[] {"Hello", "how", "are", "you"});
```

- methods printf
  - `System.out.printf("%s %d\n", user, total);`

Test

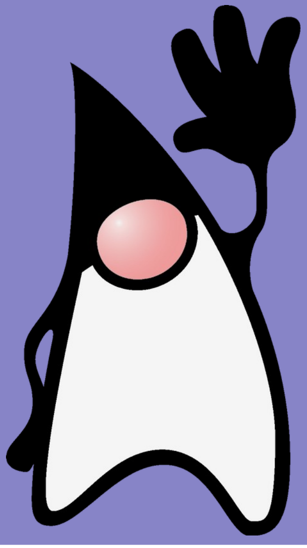
- Are the calls equivalent?

```
argtest("Hello", "how", "are", "you");
argtest(new Object[] {"Hello", "how", "are", "you"});
argtest((Object) new Object[] {"Hello", "how", "are", "you"});
```

a) Yes, all of them
b) Only 1. and 2.
c) Only 2. and 3.
d) Each of them will print something different

Java

Annotations



Annotations

- (metadata)
- since Java 5
- allow attaching information to elements of code (to classes, methods, fields,...)
  - in general, can be used in the same places as visibility modifiers
    - but also elsewhere
- written as **@NameOfAnnotation**
- own annotations can be created
  - can be specified, where can be used, how can be used,....
- predefined annotations in the package java.lang
  - @Deprecated
  - @Override
  - @SuppressWarnings
  - ...

Annotations

- can have arguments

```
@Deprecated(since="1.2", forRemoval=true)
```

  - arguments can have default values
    - i.e., can be used without argument value

```
@Deprecated
```

- where can be used
  - classes, fields, methods …
  - method arguments, packages
  - type usage
  - can restricted in the annotation definition

Predefined annotations

- @Override
  - marks a method that overrides the method from a parent
  - in a case that nothing is overridden => the compiler will not compile the class
  - usage is optional (but strongly recommended)

✓
```
class A {
  public void foo() {}
}
class B extends A {
  @Override
  public void foo() {}
}
```

✓
```
interface Ice {
  void foo();
}
class C implements Ice {
  @Override
  public void foo() {}
}
```

✗
```
class D {
  public void foo() {}
}
class E extends D {
  @Override
  public void bar() {}
}
```

Predefined annotations

- @Deprecated
  - marks API that programmers are discouraged from using
    - replacement of the javadoc tag @deprecated
  - if used => warning when compiled
  - arguments
    - `String since`
      - default `""`
    - `boolean forRemoval`
      - default `false`

Predefined annotations

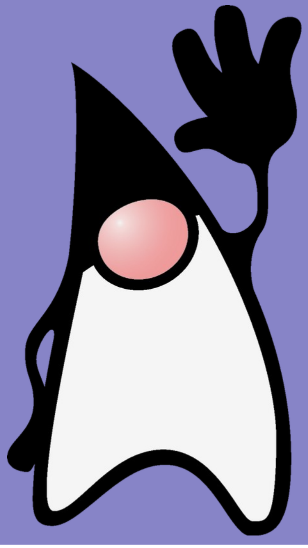
- @SuppressWarnings
  - suppress warnings during compilation
  - argument – kinds of suppressed warnings
    - String[] value

    - supported kinds depend on a compiler
    - always available kinds
      - unchecked – warning for “improper” usage of generics
      - deprecation – warning when deprecated elements are used

  - e.g. @SuppressWarnings(“unchecked“)
    @SuppressWarnings({“unchecked“, “deprecation“})

Java

Lambda expressions



Motivation

- event handling in GUI
- a comparator implementation
- a thread implementation
- …
  - commonly using an anonymous inner class

always an interface with a single method

```
interface Comparator<T> {
  int compare(T o1, T o2);
}
```

```
class Arrays {
  ...
  void sort(T[] a, Comparator<T> c);
}
```

```
Arrays.sort(array, new Comparator<AClass> () {
  public int compare(AClass o1, AClass o2) {
    return o1.x - o2.x;
}});
```

Motivation

- the previous example using a lambda expression

```
Arrays.sort(array, (o1, o2) -> o1.x - o2.x );
```

- informally:
  an lambda expression ~ a block of code with parameters

- since Java 8

Functional interface

- where can be the lambda expressions use?

  where an object of **an interface with a single abstract method** is expected

  = functional interface

- a lambda expression = an instance of a functional interface

- but

  a lambda expression does not contain information about which functional interface it is implementing

Functional interface

```
interface Predicate<T> {
  default Predicate<T> and(Predicate<? super T> other) {}
  static <T> Predicate<T> isEqual(Object targetRef) {}
  default Predicate<T> negate() {}
  default Predicate<T> or(Predicate<? super T> other) {}
  boolean test(T t);
}
```

- is it functional interface?

yes
only a single **abstract** method

Type of a lambda expression

- the same lambda expression can be assigned to different interfaces

```
Runnable r = () -> {};
AutoCloseable r = () -> {};



public interface Runnable {
  void run();
}

public interface AutoCloseable {
  void close();
}
```

Type of a lambda expression

- lambda expressions are objects

```
Runnable r = () -> {};
Object o = r;
```

- but
  lambda expressions cannot be (directly) assigned to the Object type

~~`Object r = () -> {};`~~

  - as Object is not a functional interface

Lambda expression syntax

- a comma-separated list of parameters in parentheses
  - types can be omitted
    - since Java 11, **`var`** can be used
  - parentheses can be omitted if there is only one parameter
- “arrow” `->`
- body
  - single expression
    - return can be omitted
    - no braces
      - cannot be omitted if return is used
  - block
    - in curly braces

Examples of lambda expressions

- `(int x, int y) -> x + y`
- `(x, y) -> x – y`
- `(var x, var y) -> x – y`
- `() -> 42`
- `(String s) -> System.out.println(s)`
- `x -> 2 * x`
- `c -> { int s = c.size(); c.clear(); return s; }`

Functional interface

- @FunctionalInterface
  - annotation
  - to mark a functional interface
    - usage is not mandatory
      - similarly to @Override

References to methods

- `String::valueOf`
  - a reference to a static method
  - equivalent to: `x -> String.valueOf(x)`

- `Object::toString`
  - a reference to a non-static method
  - ekvivalent to: `x -> x.toString()`

- `x::toString`
  - a reference a method of a particular object
  - equivalent to: `() -> x.toString()`

- `ArrayList::new`
  - a reference to a constructor
  - equivalent to: `() -> new ArrayList<>()`

Lambda expressions

- lambda expressions do not add a new scope of variable visibility

~~Path first = Paths.get("/usr/bin");~~
~~Comparator<String> comp = (first, second) ->~~
~~Integer.compare(first.length(), second.length());~~

- `this` in a lambda expression refers to `this` of a method, in which the lambda expression is created

```
public class Application {
   public void doWork() {
      Runnable runner = () ->
                          {System.out.println(this.toString());};
   }
}
```

Lambda expr. compilation

```
public class AClass {
  ...
  public void foo(AClass[] array) {
    Arrays.sort(array, new Comparator<AClass> () {
      public int compare(AClass o1, AClass o2) {
        return o1.x - o2.x;
    }});
  }
}
```

```
javac AClass.java

  =>  AClass.class
      AClass$1.class
```

- but

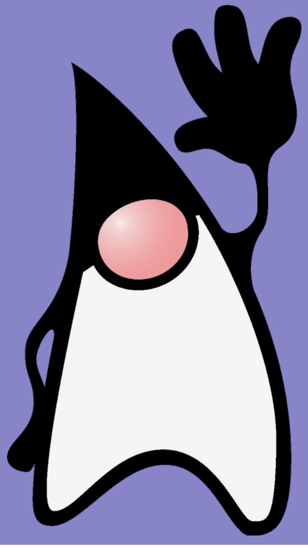
```
public class AClass {
  ...
  public void foo(AClass[] array) {
    Arrays.sort(array, (o1, o2) -> o1.x - o2.x);
  }
}
```

```
javac AClass.java

  =>  AClass.class
```

Java

java.lang.Object



Methods

- clone
- equals
- ~~finalize~~
- getClass
- hashCode
- notify
- notifyAll
- toString
- wait

equals

- boolean equals(Object obj)
  - be aware about the signature
  - defined with the parameter type **Object**
  - if overridden the parameter **Object** must be kept
  - example

```
class Complex {
  long x,y;
  public boolean equals(Object obj) {
    if (obj instanceof Complex) {
      Complex c = (Complex) obj;
      if (c.x == x && c.y == y) {
        return true;
      }
    }
    return false;
  }
}
```

equals

- ideal to declare the method with @Override
  - `@Override public boolean equals(Object obj)`
- if defined with another type, the method is **overloaded** but not overridden

```
class Complex {
  long x,y;
  public boolean equals(Complex obj) {
    ...
  }
}
```

  - the class contains **two** method equals

instanceof pattern matching

- the previous equals example

```
if (obj instanceof Complex) {
    Complex c = (Complex) obj;
    if (c.x .....

}
```

- since Java 16 – instanceof pattern matching

declaration here

```
if (obj instanceof Complex c) {
    if (c.x .....

}
```

no cast needed

hashCode

- `int hashCode()`
- hash code of the object
- used e.g. in the `java.util.HashMap` and others
- for the same object must always return the same value
  - the value need not to be the same in different runs of a program
- if two objects are equals (by the *equals* method), then the hashCode must be the same value
- two different objects need not to have a different hashCode
  - but it is desirable

clone

- `Object clone() throws CloneNotSupportedException`
- creates a copy of the object
- must hold
  ```
  x.clone() != x
  ```
- should hold
  ```
  x.clone().equals(x)
  ```
- the class must implement the interface Cloneable
  - otherwise the method throws CloneNotSupportedException
- arrays “implement” the Cloneable
- shallow copy of objects
  - i.e. fields are not cloned
  - for different behavior, the method should be overridden

clone

- overriding clone
  - typical implementation
    - but not mandatory

```
protected Object clone() {
  Object clonedObj = super.clone();
  ....
  return clonedObj;
}
```

toString

- returns textual representation of an object
- default
  - `getClass().getName() + '@' + Integer.toHexString(hashCode())`
- should be overridden

```
class MyClass { .... }
...
MyClass o = new MyClass();
System.out.println(o);  // toString() is called
```

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