Polymorphism

Abstract Classes, Abstract Methods, Override Methods

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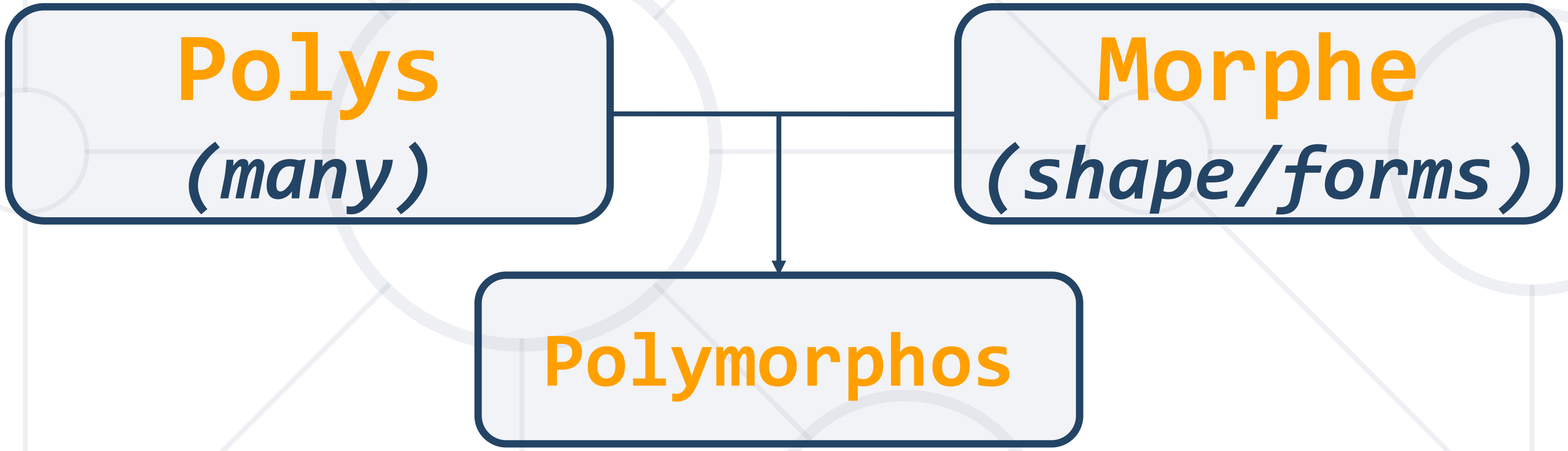
Polymorphism

What is Polymorphism?

- From the Greek



- Such as a word having several different meanings based on the context
- Often referred to as the third pillar of OOP, after encapsulation and inheritance

Polymorphism in OOP

- The ability of an **object** to take on **many forms**

```
public interface Animal {}
public abstract class Mammal {}
public class Person extends Mammal implements Animal {}
```

```
Person IS-A Person
```

```
Person IS-AN Animal
```

```
Person IS-A Mammal
```

```
Person IS-AN Object
```

Reference Type and Object Type

```java
public class Person extends Mammal implements Animal {}
Animal person    = new Person();
Mammal personOne = new Person();
Person personTwo = new Person();
```

Reference Type

Object Type

- **Variables** are saved in a **reference** type
- You can use only **reference methods**
- If you need an **object method** you need to **cast it or override it**

Keyword – Instanceof

- Check if an **object** is an **instance** of a specific **class**

```
Mammal george = new Person();
Person peter = new Person();
```

```
if (george instanceof Person) {
  ((Person) george).getSalary();
}
```

Check object type of person

```
if (peter.getClass() == Person.class) {
  ((Person) peter).getSalary();
}
```

Cast to object type and use its methods

Types of Polymorphism

- **Runtime** polymorphism

```
public class Shape {}
public class Circle extends Shape {}
public static void main(String[] args) {
  Shape shape = new Circle();
}
```

Method overriding

- **Compile time** polymorphism

```
int sum(int a, int b, int c){}
double sum(Double a, Double b){}
```

Method overloading

Compile Time Polymorphism

- Also known as **Static Polymorphism**

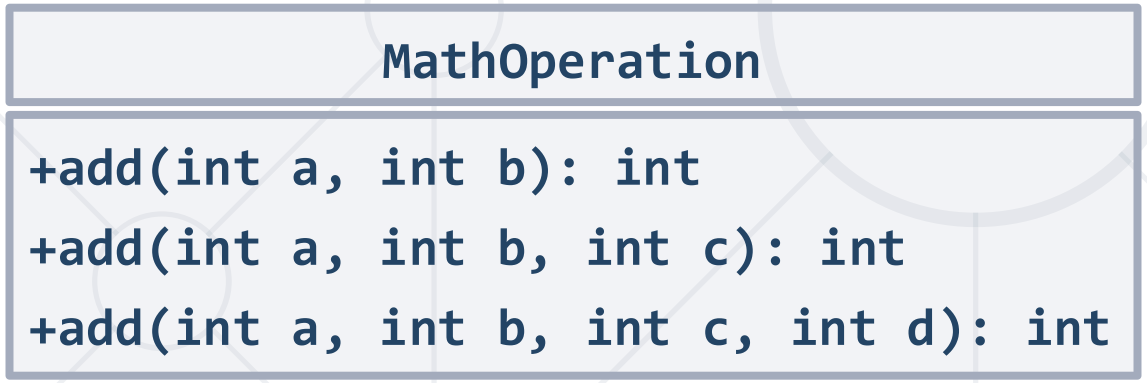
```
static int myMethod(int a, int b) {}
static Double myMethod(Double a, Double b) {}
```

Method overloading

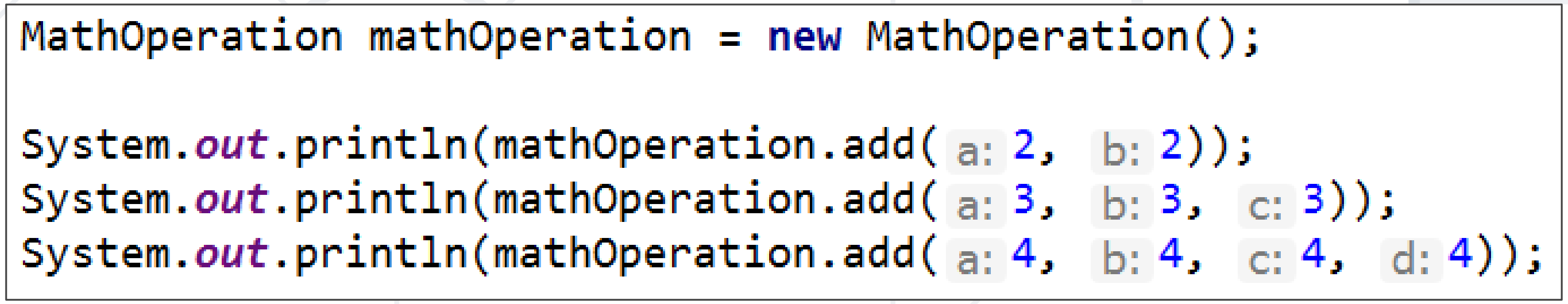
- Argument lists could **differ** in
  - Number of parameters
  - The data type of parameters
  - The sequence of Data type parameters

Problem: MathOperation

- Create a class **MathOperation**, which should have method **add()**
- Must be invoked with **two**, **three** or **four integers**

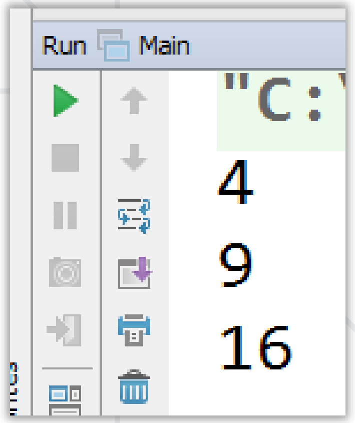


MathOperation
+add(int a, int b): int +add(int a, int b, int c): int +add(int a, int b, int c, int d): int



```
MathOperation mathOperation = new MathOperation();

System.out.println(mathOperation.add( a: 2,  b: 2));
System.out.println(mathOperation.add( a: 3,  b: 3,  c: 3));
System.out.println(mathOperation.add( a: 4,  b: 4,  c: 4,  d: 4));
```



```
"C:
4
9
16
```

Check your solution here: https://judge.softuni.bg/Contests/1592/Polymorphism-Lab

Solution: MathOperation

```java
public class MathOperation {
  public int add(int a, int b) {
    return a + b;
  }
  public int add(int a, int b, int c) {
    return a + b + c;
  }
  public int add(int a, int b, int c, int d) {
    return a + b + c + d;
  }
}
```

Rules for Overloading Method

- **Overloading** can take place in the **same class** or its **subclass**
- **Constructors** in Java can be **overloaded**
- Overloaded methods must have a **different argument list**
- The overloaded method should always be part of the same class (can also take place in a subclass), with the **same name** but **different parameters**
- They may have the **same** or **different return types**

Runtime Polymorphism

- Using of **override** method

```
public static void main(String[] args) {
  Rectangle rect = new Rectangle(3.0, 4.0);
  Rectangle square = new Square(4.0);

  System.out.println(rect.area());
  System.out.println(square.area());
}
```

Method overriding

Runtime Polymorphism

- Also known as **Dynamic Polymorphism**

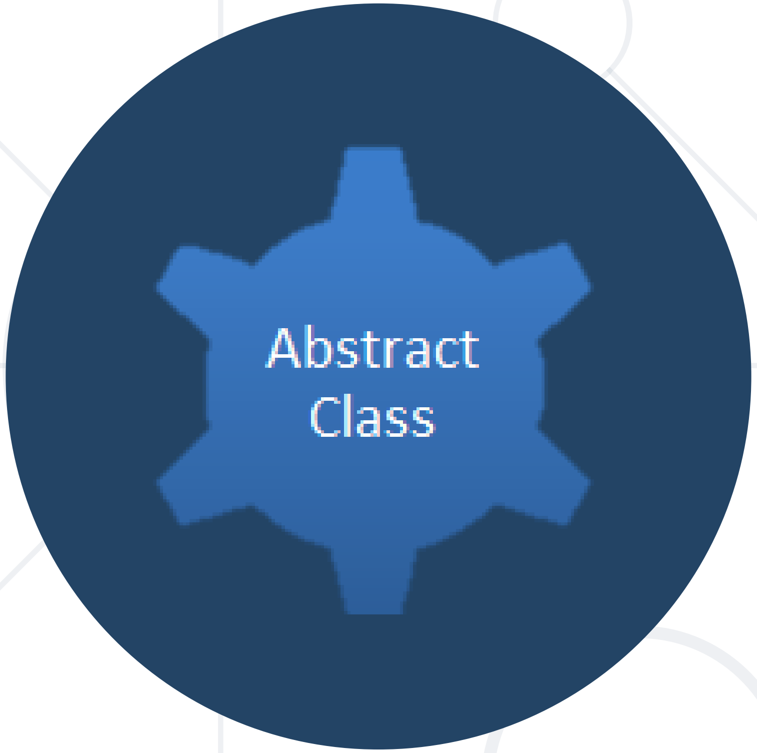
```java
public class Rectangle {
  public Double area() {
    return this.a * this.b;
  }
}
```

```java
public class Square extends Rectangle {
  @Override
  public Double area() {
    return this.a * this.a;
  }
}
```

Method overriding

Rules for Overriding Method

- **Overriding** can take place in **sub-class**
- The **argument list** must be the **same** as that of the **parent method**
- The overriding method must have the **same return type**
- **Access modifier** cannot be more **restrictive**
- **Private**, **static**, and **final** methods can **NOT** be overridden
- The overriding method **must not** throw new or broader **checked exceptions**



Abstract Classes

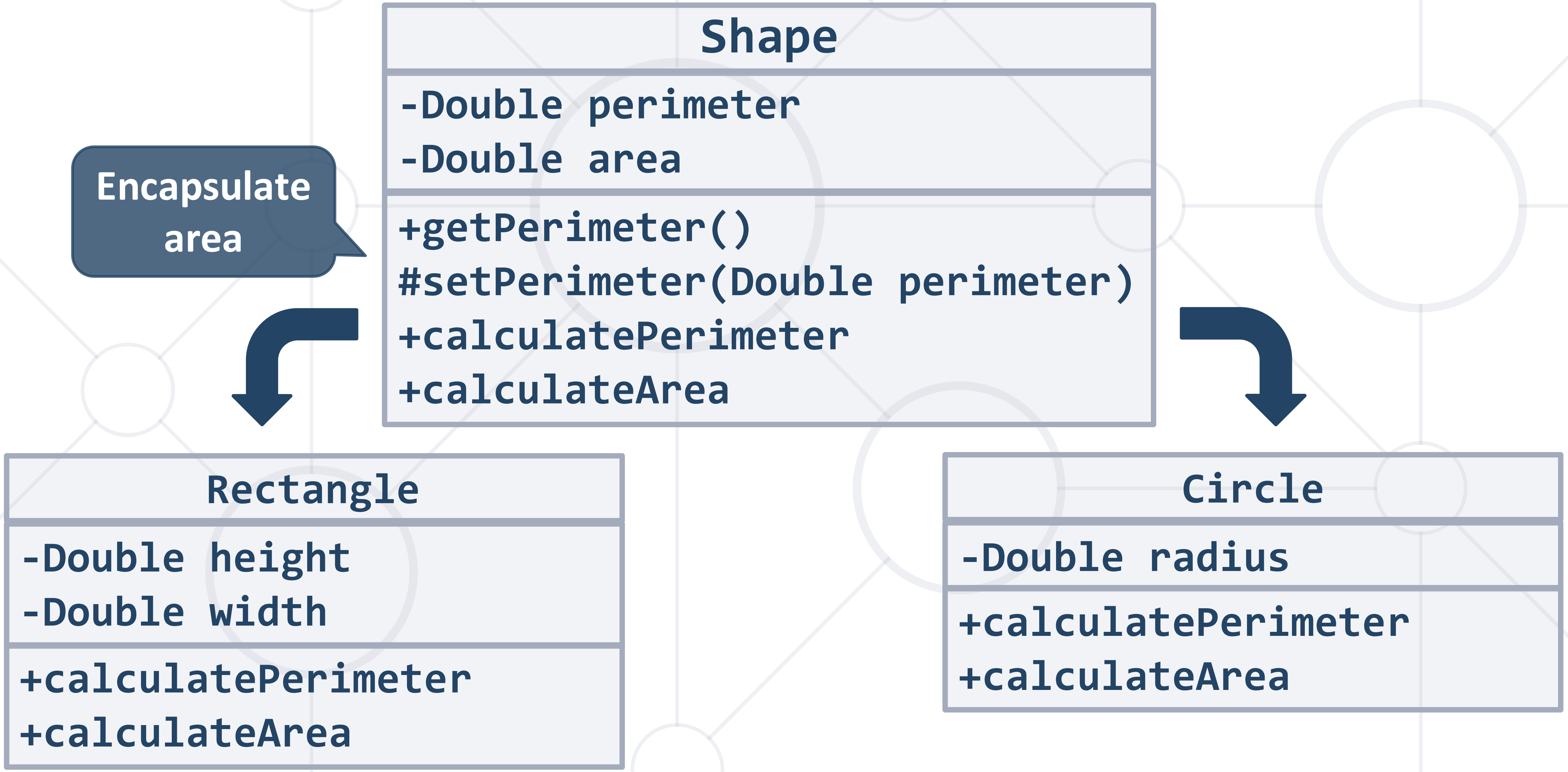
Abstract Classes

- An abstract class **can NOT be instantiated**

```
public abstract class Shape {}
public class Circle extends Shape {}
Shape shape = new Shape(); // Compile time error
Shape circle = new Circle(); // polymorphism
```

- An **abstract** class may or may not include **abstract methods**
- If it has at least one abstract method, it must be declared **abstract**
- To use an **abstract class**, you need to **inherit it**

Problem: Shapes



Solution: Shapes

```java
public abstract class Shape {
  private Double perimeter;
  private Double area;
  protected void setPerimeter(Double perimeter) {
    this.perimeter = perimeter;
  }
  public Double getPerimeter() { return this.perimeter; }
  protected void setArea(Double area) {this.area = area; }
  public Double getArea() { return this.area; }
  protected abstract void calculatePerimeter();
  protected abstract void calculateArea();
}
```

Solution: Shapes

```
public class Rectangle extends Shape {
  //TODO: Add fields
  public Rectangle(Double height, Double width) {
    this.setHeight(height); this.setWidth(width);
    this.calculatePerimeter(); this.calculateArea(); }
  //TODO: Add getters and setters
  @Override
  protected void calculatePerimeter() {
    setPerimeter(this.height * 2 + this.width * 2); }
  @Override
  protected void calculateArea() {
    setArea(this.height * this.width); } }
```

Solution: Shapes

```
public class Circle extends Shape {
  private Double radius;
  public Circle (Double radius) {
    this.setRadius(radius);
    this.calculatePerimeter();
    this.calculateArea();
  }
  public final Double getRadius() {
    return radius;
  }

  //TODO: Finish encapsulation
  //TODO: Override calculate Area and Perimeter
}
```

Summary

- Polymorphism - Definition and Types
- Override Methods
- Overload Methods
- Abstraction
  - Classes
  - Methods

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