Inheritance

Polymorphism, Subtyping, Reuse

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Lecture #8 out of 8
90 minutes

- Polymorphism
- Implementation Inheritance
- Quiz
- Read and Watch

Chapter #1:

Polymorphism

Liskov Substitution Principle

"If for each object o_1 of type S there is an object o_2 of type T such that for all programs P defined in terms of T, the behavior of P is unchanged when o_1 is substituted for o_2, then S is a subtype of T"

— Barbara Liskov, Keynote Address: Data Abstraction and Hierarchy, Addendum to the Proceedings on Object-oriented Programming Systems, Languages and Applications, 1987

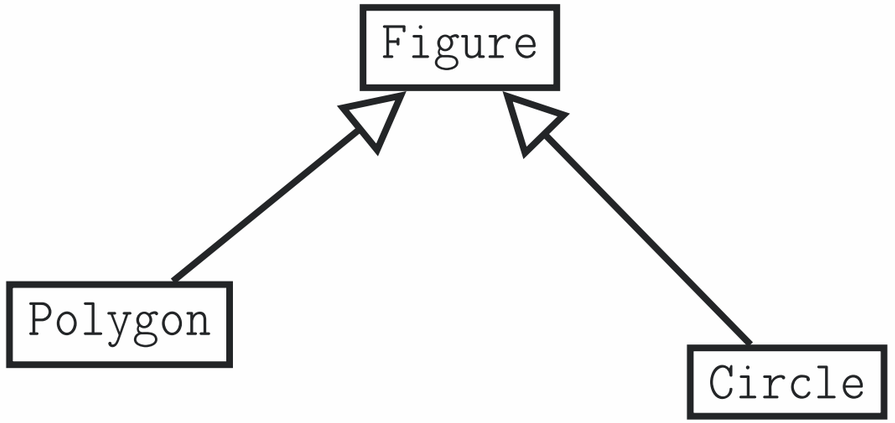
SOLID (the “L” part)

“Functions that use pointers or references to base classes must be able to use objects of derived classes without knowing it”

— Robert C. Martin, Design Principles and Design Patterns discussing, 2000

Subtyping

```
1  interface Figure
2    float surface();
3
4  interface Circle extends Figure
5    float perimeter();
6
7  interface Polygon extends Figure
8    int sides();
9
10 void paint(Figure f)
11   float s = f.surface();
12   // ...
```



Circle $\sqsubseteq$ Figure

Circle <: Figure

Parametric Polymorphism (Generics)

```
class StackOfStrings {
  push(String str) // ...
  String pop() // ...

class StackOfIntegers {
  push(Integer num) // ...
  Integer pop() // ...

var s1 = new StackOfStrings();
s1.push("Hello, world!");

var s2 = new StackOfIntegers();
s2.push(42);
```

```
class <T> Stack<T> {
  push(T item) // ...
  T pop() // ...
}

var s1 = new Stack<String>();
s1.push("Hello, world!");

var s2 = new Stack<Integer>();
s2.push(42);
```

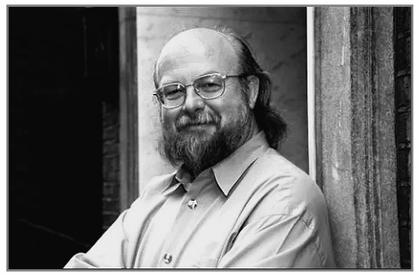
Ad Hoc Polymorphism (Method Overloading)

```
1  class Cart {
2    void add(int pid) // ...
3    void addString(String pid) {
4      this.add(Integer.parseInt(pid));
5    }
6  }
7
8  var c = new Cart();
9  c.add(42);
10 c.addString("17");
11 c.addString("Hello, world!");
```

```
1  class Cart {
2    void add(int pid) // ...
3    void add(String pid) {
4      this.add(Integer.parseInt(pid));
5    }
6  }
7
8  var c = new Cart();
9  c.add(42);
10 c.add("17");
11 c.add("Hello, world!");
```

Chapter #2:

Implementation Inheritance



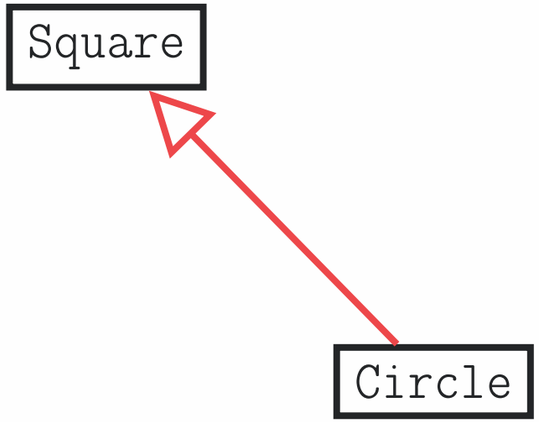
“Someone asked him: “If you could do Java over again, what would you change?” “I’d leave out classes,” he replied”

— James Gosling

> Inheriting means “receive (money, property, or a title) as an heir at the death of the previous holder.” Who is dead, you ask? An object is dead if it allows other objects to inherit its encapsulated code and data.

Code reuse

```
1  class Square
2    private float width;
3    float surface()
4      return width * width;
5
6  class Circle extends Square
7    Circle(float radius)
8      super(radius);
9    @Override float surface()
10     return 3.14 * super.surface();
```



Here, the `Circle` is not a `Square`. It merely reuses the code that was negligently left open in the `Square`.

Composition over inheritance

Implementation Inheritance:

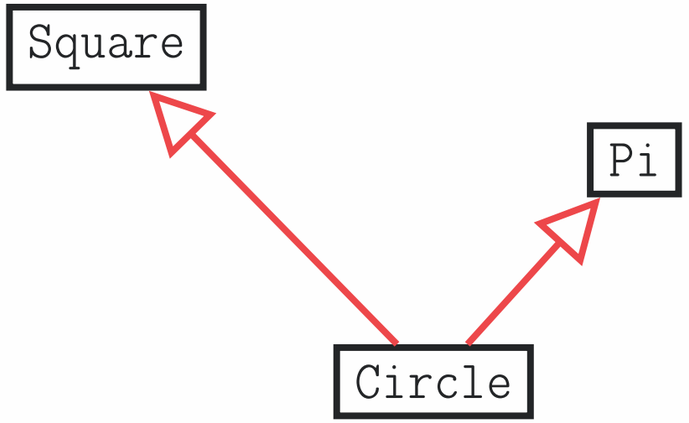
```
1  class Square
2    private float width;
3    float surface()
4      return width * width;
5
6  class Circle extends Square
7    Circle(float radius)
8      super(radius);
9    @Override float surface()
10     return 3.14 * super.surface();
```

Composition:

```
1  final class Square
2    private float width;
3    float surface()
4      return width * width;
5
6  final class Circle
7    private Square s;
8    Circle(float radius)
9      this.s = new Square(radius);
10   float surface()
11     return 3.14 * s.surface();
```

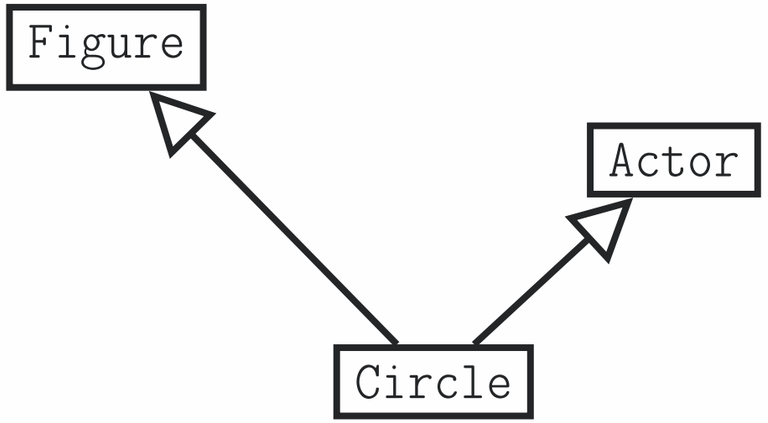
Multiple inheritance

```
1  class Pi
2    float value()
3      return 3.1415926;
4
5  class Square
6    private float width;
7    float surface()
8      return width * width;
9
10 class Circle extends Square, Pi
11   Circle(float r): Square(r), Pi() {}
12   virtual float surface()
13     return Pi.value() * Square.surface();
```



Multiple super types

```
1  interface Actor
2    void move(int dx, int dy);
3
4  interface Figure
5    float surface();
6
7  class Circle implements Figure, Actor
8    Circle(float r)
9    @Override float surface()
10     // ...
11   @Override void move(int dx, int dy)
12     // ...
```



Chapter #3:

Quiz

I show this code to job interview candidates, asking them to find as many defects in it as they can: yegor256/quiz (Java).

How many problems you can find in this code?

Chapter #4:

Read and Watch

Why extends is evil by Allen Holub (2003)

Inheritance Is a Procedural Technique for Code Reuse by me (2016)

Inheritance vs. Subtyping (Webinar #24) by me (2017)