

# Inheritance

Polymorphism, Subtyping, Reuse

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Lecture #8 out of 8

90 minutes

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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)

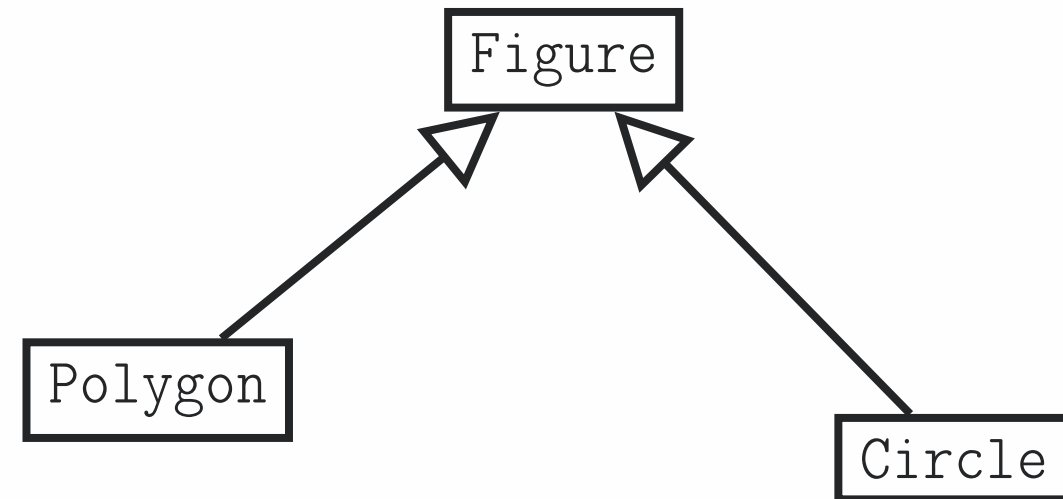


“Functions that use pointers or references to base classes must be able to use objects of derived classes without knowing it”

— 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)

```
1 class StackOfStrings {  
2     void push(String str) // ...  
3     String pop() // ...  
4  
5 class StackOfIntegers {  
6     void push(Integer num) // ...  
7     Integer pop() // ...  
8  
9 var s1 = new StackOfStrings();  
10 s1.push("Hello, world!");  
11  
12 var s2 = new StackOfIntegers();  
13 s2.push(42);
```

```
1 class <T> Stack<T> {  
2     void push(T item) // ...  
3     T pop() // ...  
4 }  
5  
6 var s1 = new Stack<String>();  
7 s1.push("Hello, world!");  
8  
9 var s2 = new Stack<Integer>();  
10 s2.push(42);
```

## Ad Hoc Polymorphism (Method Overloading)

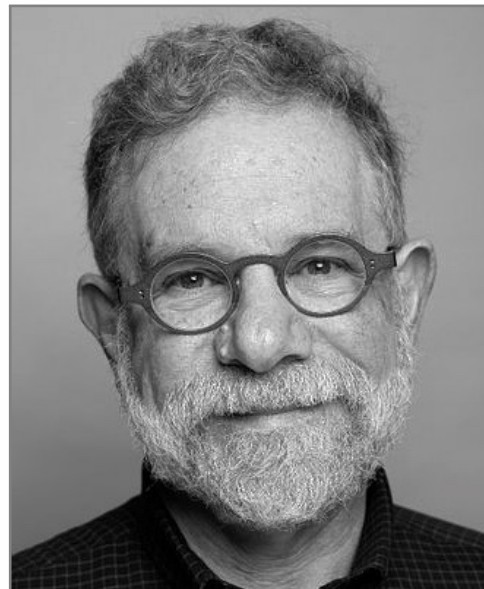
```
1 class Cart {  
2     void add(int pid) // ...  
3     void addString(String pid) {  
4         this.add(Integer.parseInt(pid));  
5     }  
6 }  
7  
8 var c = new Cart();  
9 c.add(42);  
10 c.addString("17");  
11 c.addString("Hello, world!");
```

```
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!");
```



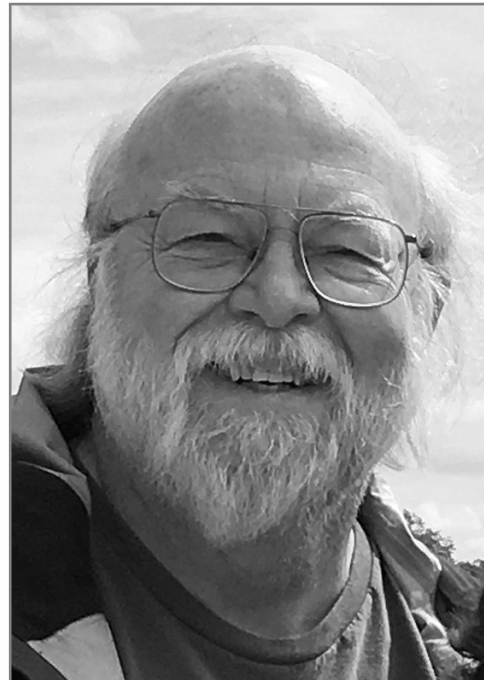
Chapter #2:

## Implementation Inheritance



“The `extends` keyword is evil; maybe not at the Charles Manson level, but bad enough that it should be shunned whenever possible.”

— Allen Holub, [Why extends is evil](#), [InfoWorld](#), 2003

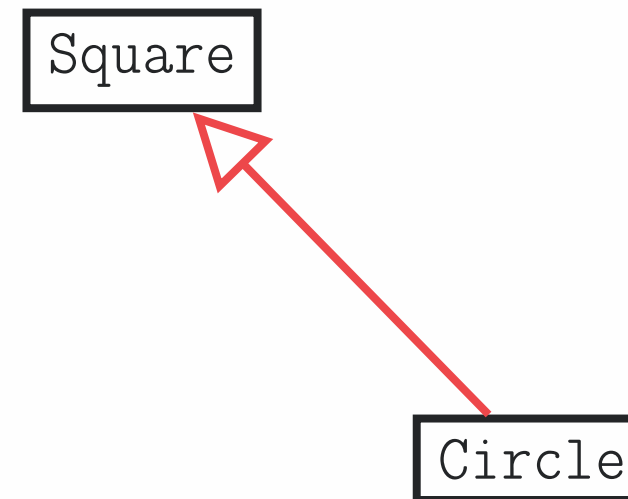


“Someone asked him: “If you could do Java over again, what would you change?” “I’d leave out classes,” he replied”

— James Gosling

## 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`.

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.

## 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:

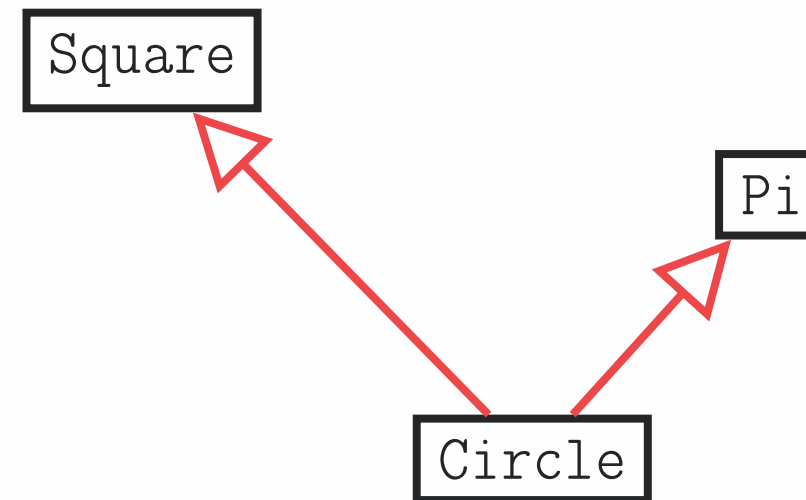
```
1 final class Square
2     private float width;
3     float surface()
4         return width * width;
5
6 final class Circle
7     private Square s;
8     Circle(float radius)
9         this.s = new Square(radius);
10    float surface()
11        return 3.14 * s.surface();
```



All classes, without exceptions, should be either `final` or `abstract`

## Multiple inheritance

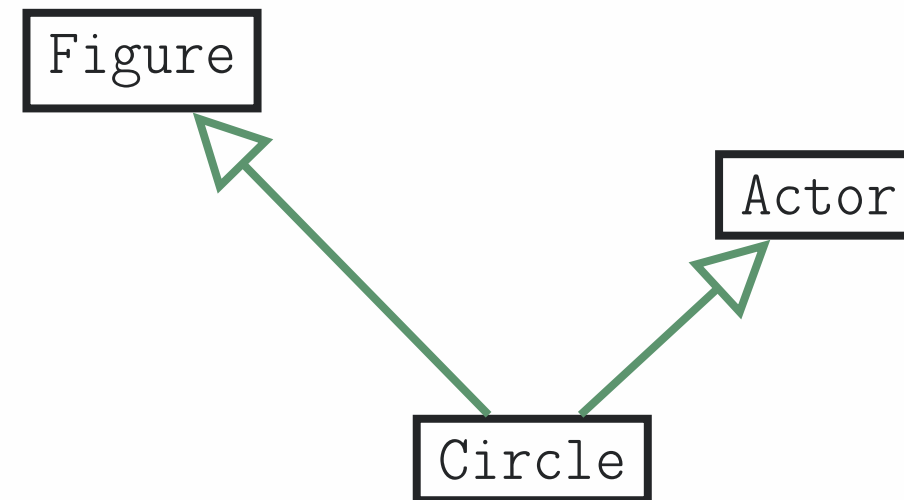
```
1 class Pi
2     float value()
3         return 3.1415926;
4
5 class Square
6     private float width;
7     float surface()
8         return width * width;
9
10 class Circle extends Square, Pi
11     Circle(float r): Square(r), Pi() {}
12     virtual float surface()
13         return Pi.value()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

```
1 public class Parser {
2     private File file;
3     public synchronized void setFile(File f) {
4         file = f;
5     }
6     public synchronized File getFile() {
7         return file;
8     }
9     public String getContent() throws IOException {
10         FileInputStream i = new FileInputStream(file);
11         String output = "";
12         int data;
13         while ((data = i.read()) > 0) {
14             output += (char) data;
15         }
16         return output;
17     }
18     public String getContentWithoutUnicode()
19         throws IOException {
20         FileInputStream i = new FileInputStream(file);
```

```
21         String output = "";
22         int data;
23         while ((data = i.read()) > 0) {
24             if (data < 0x80) {
25                 output += (char) data;
26             }
27         }
28         return output;
29     }
30     public void saveContent(String content) {
31         FileOutputStream o = new FileOutputStream(file);
32         try {
33             for (int i = 0; i < content.length(); i += 1) {
34                 o.write(content.charAt(i));
35             }
36         } catch (IOException e) {
37             e.printStackTrace();
38         }
39     }
40 }
```

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)