Algorithms

History, State, Behavior, Enemies of OOP

Yegor Bugayenko

Lecture #1 out of 8
80 minutes

The slidedeck was presented by the author in this YouTube Video

Pre-Test

History

Original Intent

Object Thinking vs. Algorithms

Enemies of Object Thinking

Post-Test

WARNING!

In the pursuit of academic enlightenment within this course, it is paramount to caution that the doctrines disseminated may present a potentially hazardous venture if employed in real-life software projects. This inherent risk arises from the potential incongruity with the broadly accepted canon of object-oriented programming and recognized best programming practices. If one remains resolute in their decision to adapt their coding methodologies to align with the principles propagated in this course, it would be prudent to employ a certain degree of foresight. A humorous, yet sincere suggestion, would be to secure alternate employment prior to a possible premature termination of one's current professional engagement.

Chapter #1:
Pre-Test

[quiz]

https://github.com/yegor256/quiz

```
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     // Read the content of the file
11     // and return it.
12   }
13   public String getContentWithoutUnicode() throws IOException {
14     // Read the file and filter out symbols
15     // that are not UTF-8 compliant.
16   }
17   public void saveContent(String content) {
18     // Save the "content" to the file.
19   }
20 }
```

Chapter #2:
History

Who started it?

Ivan Sutherland's seminal **Sketchpad** <u>application</u> was an early inspiration for OOP, created between 1961 and 1962 and published in his Sketchpad Thesis in 1963. Any object could become a "master," and additional instances of the objects were called "occurrences". Sketchpad's masters share a lot in common with JavaScript's prototypal inheritance.

(c) Wikipedia

Who invented Objects, Classes, and Inheritance?

Simula was developed in 1965 at the Norwegian Computing Center in Oslo, by Ole-Johan Dahl and Kristen Nygaard. Like Sketchpad, Simula featured objects, and eventually introduced classes, class inheritance, subclasses, and virtual methods. (c) Wikipedia

Simula-67: Sample Code

```
1  Class Figure;
2    Virtual: Real Procedure area Is Procedure area;;
3  Begin
4  End;
5  Figure Class Circle (c, r);
6    Real c, r;
7  Begin
8    Real Procedure area;
9    Begin
10     area := 3.1415 * r * r;
11   End;
12 End;
```

Who coined the "OOP" term?

Smalltalk was created in the 1970s at Xerox PARC by Learning Research Group (LRG) scientists, including Alan Kay, Dan Ingalls, Adele Goldberg, Ted Kaehler, Diana Merry, and Scott Wallace. (c) Wikipedia

Smalltalk: Sample Code

```
1  Object subclass: Account [
2      | balance |
3      Account class >> new [
4          | r |
5          r := super new. r init. ^r
6      ]
7      init [ balance := 0 ]
8  ]
9  Account extend [
10      deposit: amount [ balance := balance + amount ]
11 ]
12 a := Account new
13 a deposit: 42
```

[Sketchpad Objects Simula-67 OOP Smalltalk Stroustrup C++ Languages Features]

"Everyone will be in a favor of OOP. Every manufacturer will promote his products as supporting it. Every manager will pay lip service to it. Every programmer will practice it (differently). And no one will know just what it is."

— Tim Rentsch. Object Oriented Programming. *ACM SIGPLAN Notices*, 17(9): 51–57, 1982. doi:10.1145/947955.947961

Who made it all popular?
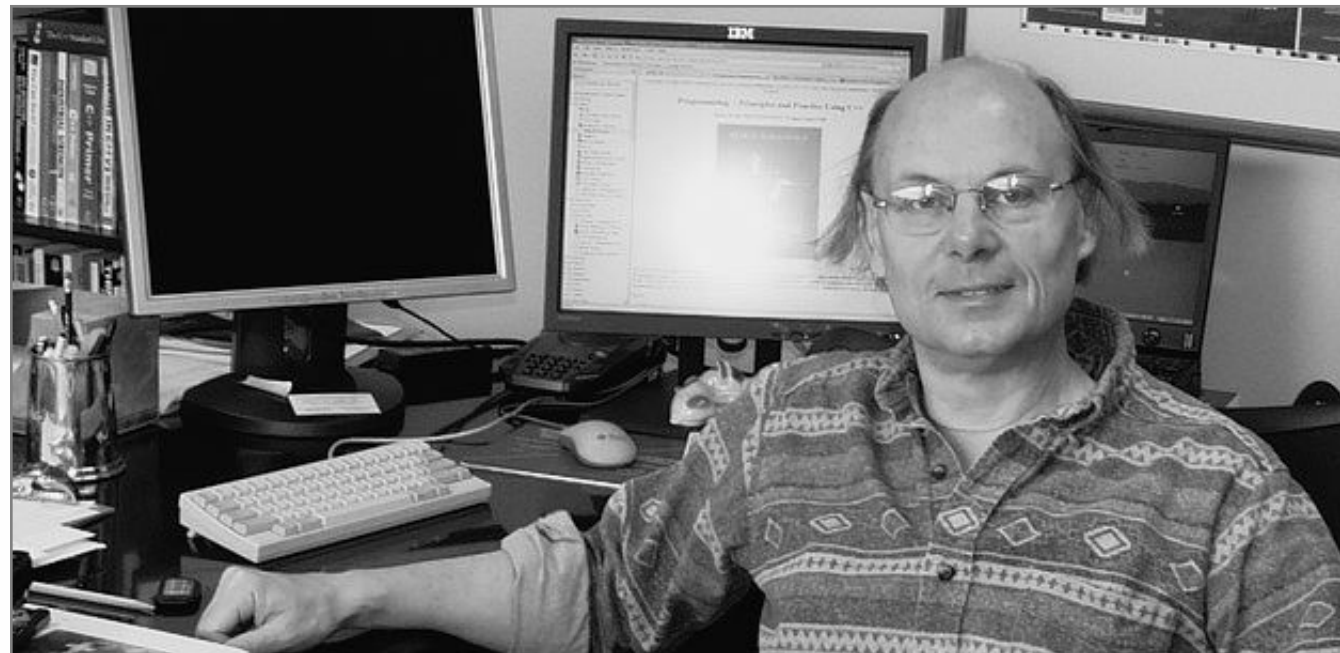
C++ was created by Danish computer scientist Bjarne Stroustrup in 1985, by enhancing the C language with Simula-like features. C was chosen because it was general-purpose, fast, portable and widely used.

You may enjoy watching this one-hour dialog of Dr. Stroustrup and me.

C++: Sample Code

```
1 class Figure {
2   virtual float area() = 0;
3 };
4 class Circle : public Figure {
5   Circle(float c, float r) : c(c), r(r) {};
6   float area() { return 3.1415 * r * r; };
7 private:
8   float c, r;
9 };
```

[Sketchpad Objects Simula-67 OOP Smalltalk Stroustrup C++ Languages Features]

OLE LEHRMANN MADSEN

"There are as many definitions of OOP as there are papers and books on the topic."

— Ole Lehrmann Madsen and Birger Møller-Pedersen. What Object-Oriented Programming May Be — And What It Does Not Have to Be. In *Proceedings of the European Conference on Object-Oriented Programming*, pages 1–20. Springer, 1988. doi:10.1007/3-540-45910-3_1

"I made up the term 'object-oriented,' and I can tell you I didn't have C++ in mind."

— Alan Kay. The Computer Revolution Hasn't Happened yet, 1997

There was an interesting debate between Alan Kay and a few readers of my blog, in the comments section under this blog post: Alan Kay Was Wrong About Him Being Wrong [Bugayenko, 2017].

What happened later?

C++ was released in 1985. And then...

Erlang 1986

Eiffel 1986

Self 1987

Perl 1988

Haskell 1990

Python 1991

Lua 1993

JavaScript 1995

Ruby 1995

Java 1995

Go 2009

PHP3 1998

C# 2000

Rust 2010

Swift 2014

EO 2016

[Sketchpad Objects Simula-67 OOP Smalltalk Stroustrup C++ Languages Features]

"There is no uniformity or an agreement on the set of features and mechanisms that belong in an OO language as the paradigm itself is far too general."

— Oscar Nierstrasz. A Survey of Object-Oriented Concepts, 1989

Incomplete list of OOP features, ... so far:

Polymorphism	Monads	Access Modifiers	NULL Safety
Nested Objects	Algebraic Types	Pattern Matching	Streams
Traits	Annotations	Enumerated Types	Buffers
Templates	Interfaces	Namespaces	Iterators
Generics	Constructors	Modules	Generators
Invariants	Destructors	Type Aliases	Aspects
Classes	Lifetimes	Decorators	Anonymous Objects
NULL	Volatile Variables	Lambda Functions	Anonymous Functions
Exceptions	Synchronization	Type Inference	Reflection
Operators	Macros	Properties	Type Casting
Methods	Inheritance	Value Types	Lazy Evaluation
Static Blocks	Overloading	Multiple Inheritance	Garbage Collection
Virtual Tables	Tuple Types	Events	Immutability
Coroutines	Closures	Callbacks	
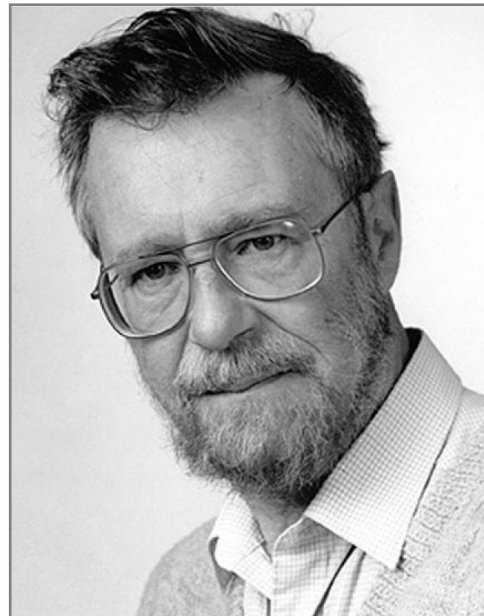
"Object oriented programs are offered as alternatives to correct ones... Object-oriented programming is an <u>exceptionally bad idea</u> which could only have originated in California."

— Edsger W. Dijkstra, 1989

"C++ is a horrible language... C++ leads to really, really bad design choices... In other words, the only way to do good, efficient, and system-level and portable C++ ends up to limit yourself to all the things that are basically available in C."

— Linus Torvalds, 2007
Creator of Linux

[Sketchpad Objects Simula-67 OOP Smalltalk Stroustrup C++ Languages Features]

"OO seems to bring at least as many problems to the table as it solves"

— Jeff Atwood, 2007
Co-founder of Stack Overflow

"I think that large object-oriented programs struggle with increasing complexity as you build this large object graph of mutable objects. You know, trying to understand and keep in your mind what will happen when you call a method and what will the side effects be."

— Rich Hickey, 2010
Creator of Clojure

The **complexity** of object-oriented code remains its primary drawback

"Reading an OO code you can't see the big picture and it is often impossible to review all the small functions that call the one function that you modified."

— Asaf Shelly. Flaws of Object Oriented Modeling. https://jttu.net/shelly2015flaws, 2015. [Online; accessed 15-03-2016]

[Sketchpad Objects Simula-67 OOP Smalltalk Stroustrup C++ Languages Features]

> Thus, we don't know anymore what exactly is object-oriented programming, and whether it helps us write better code.

You can find more quotes in this blog post of mine: What's Wrong With Object-Oriented Programming? [Bugayenko, 2016]

Chapter #3:
Original Intent
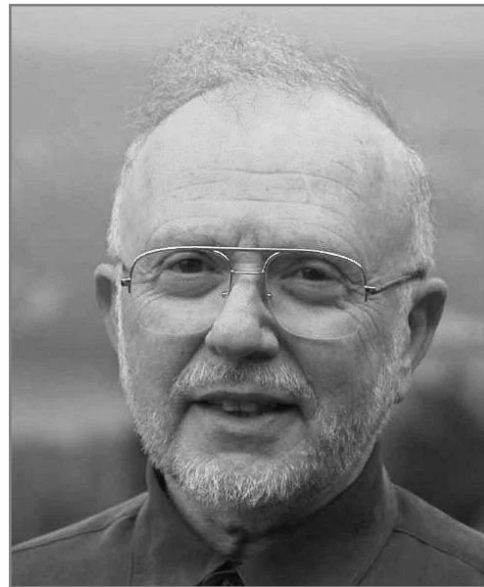
"It is almost always incorrect to begin the decomposition of a system into modules on the basis of a flowchart. We propose instead that one begins with a list of difficult design decisions or design decisions which are likely to change. Each module is then designed to hide such a decision from the others."

— David Lorge Parnas. On the Criteria to Be Used in Decomposing Systems into Modules. *Communications of the ACM*, 15(12):1053–1058, 1972. doi:10.1145/361598.361623
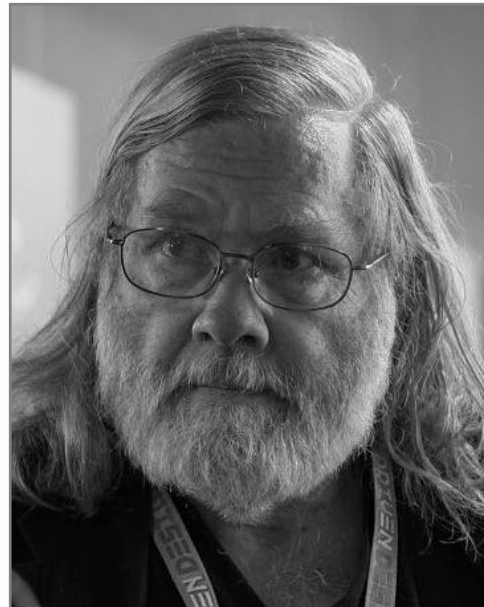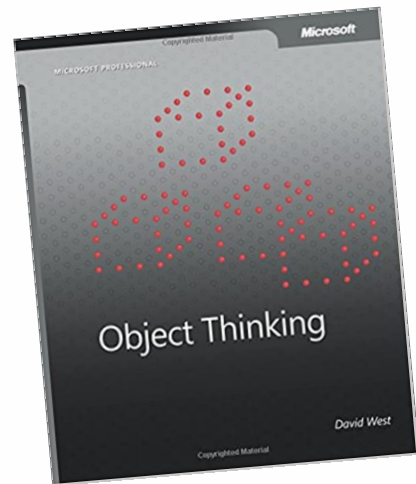
"The contemporary mainstream understanding of objects (which is not behavioral) is but a pale shadow of the original idea and antithetical to the original intent."

— David West. *Object Thinking*. Pearson Education, 2004. doi:10.5555/984130

You may enjoy watching our conversation with Dr. David West, video-recorded and published on YouTube: part I and part II.
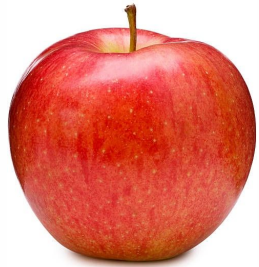
A system is a composition of objects that are abstractions, which hide data and expose behavior*

* This is how I understand the original intent.

1) What is an "abstraction"?

- Color: red

- Weight: 120g
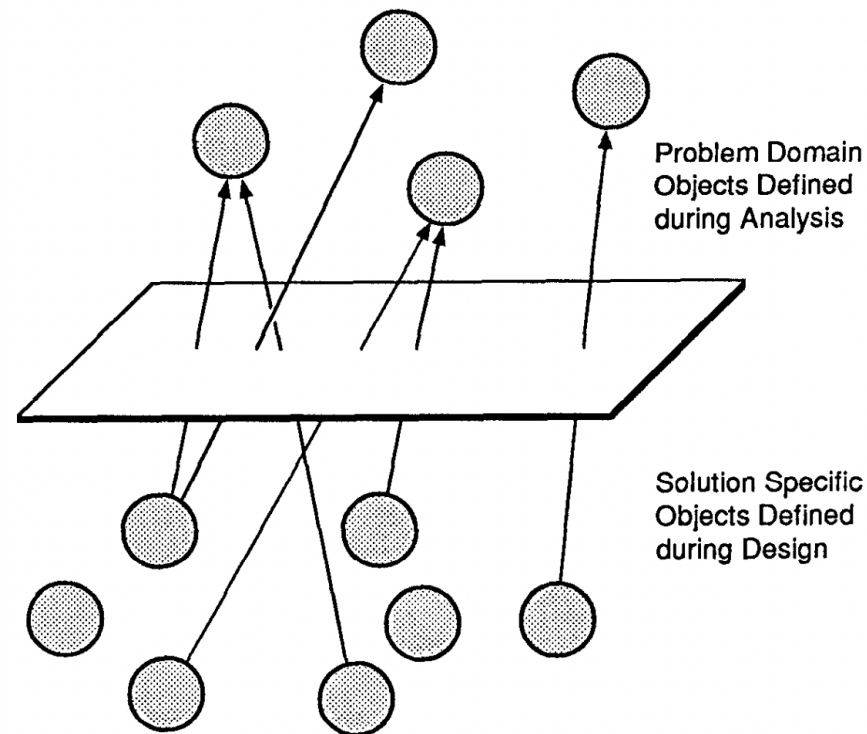
- Price: $0.99

```
1  var file = {
2      path: '/tmp/data.txt',
3      read: function() { ... },
4      write: function(txt) { ... }
5  }
```

We deal with an abstraction as if it was a real thing, but eliminating unnecessary details. We do `file.read()` instead of "open file handler for data.txt, read byte by byte, store in byte buffer, wait for the end of file, and return the result."

Problem Domain Objects Defined during Analysis

Solution Specific Objects Defined during Design

"Object-oriented design is first concerned with entities—things. These things may be tangible objects such as traffic lights, chairs, or airplanes. The entities may be abstract concepts such as roles, interactions, or incidents. From a design perspective, objects model the entities in the application domain."

[Abstraction Rectangle Levels Rectangle Rectangle Function State FigureUtils Composition]
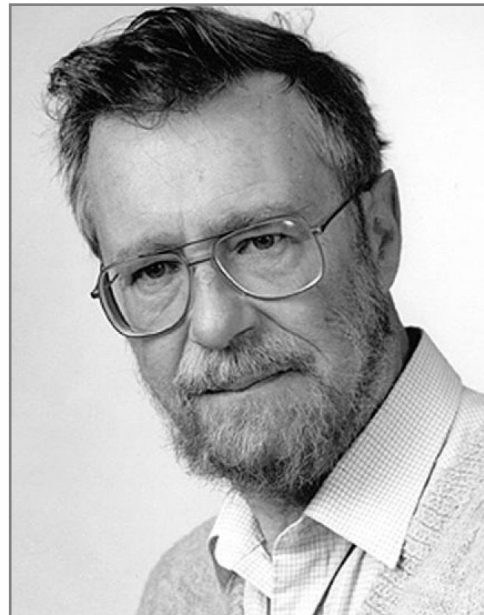
"The effective exploitation of his powers of abstraction must be regarded as one of the most vital activities of a competent programmer… By suitable application of our powers of abstraction, the intellectual effort required to conceive or to understand a program need not grow more than proportional to program length."

— Edsger W. Dijkstra. The Humble Programmer. *Communications of the ACM*, 15(10):859–866, 1972. doi:10.1145/355604.361591

How many abstractions are needed?

```
1  int area(x1, y1, x2, y2) {
2    int w = x2 - x1;
3    if (w < 0) { w = w * -1; }
4    int h = y2 - y1;
5    if (h < 0) { h = h * -1; }
6    return w * h;
7  }
```

```
1  int distance(left, right) {
2    int d = right - left;
3    if (d < 0) { d = d * -1; }
4    return d;
5  }
6
7  int area(x1, y1, x2, y2) {
8    return distance(x2, x1)
9      * distance(y2, y1);
10 }
```

There are two abstractions at the right snippet ("area" and "distance"),
while only one abstraction at the left one (just "area").
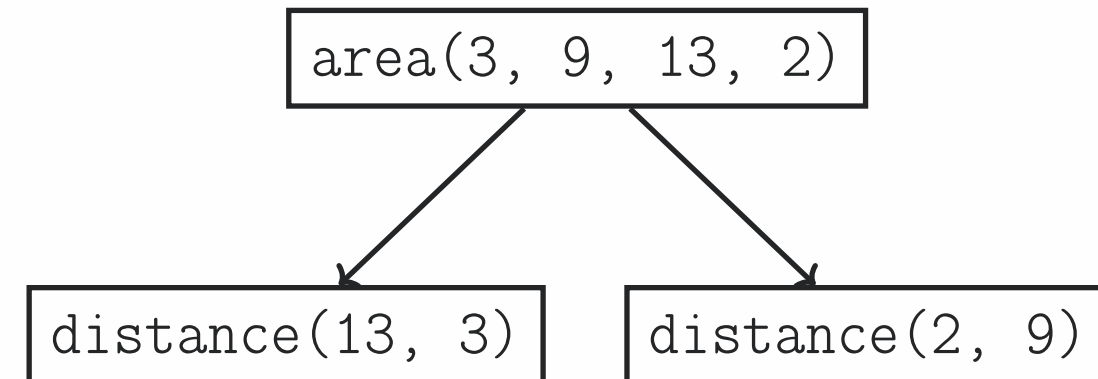
Levels of Abstraction

```
1  int distance(left, right) {
2    int d = right - left;
3    if (d < 0) { d = d * -1; }
4    return d;
5  }
6
7  int area(x1, y1, x2, y2) {
8    return distance(x2, x1)
9      * distance(y2, y1);
10 }
```

area(3, 9, 13, 2)

distance(13, 3)   distance(2, 9)

Higher level abstractions must not know and/or rely on semantics of lower
level abstractions.

2) What is "data hiding"?

```
1  f = new File("/tmp/data.txt");
2  // The data escapes the object! :(
3  p = f.getPath();
4  FileUtils.deleteFile(p);
```

```
1  f = new File("/tmp/data.txt");
2  // The boolean data escapes too :)
3  done = f.delete();
4  assert(done);
```

Obviously, some data must escape your objects.

3) What is "Behavior Exposing"?

This is so called "anemic" object:

```
1  var user = {
2    login: 'jeff',
3    password: 'swordfish',
4    age: 32
5  }
6  function print(u) {
7    console.log('Hello, ${u.login},
8       you are ${u.age} today!');
9  }
10 print(user);
```

This object is "alive":

```
1  var user = {
2    login: 'jeff',
3    password: 'swordfish',
4    age: 32,
5    print: function() {
6       console.log('Hello, ${this.login},
7          you are ${this.age} today!');
8    }
9  }
10 user.print();
```

An Object as a Function

```
1  int distance(left, right) {
2    int d = right - left;
3    if (d < 0) { d = d * -1; }
4    return d; }
5  int area(x1, y1, x2, y2) {
6    return distance(x2, x1)
7      * distance(y2, y1); }
```

```
1   class Distance {
2     private int r; private int l;
3     Distance(a, b) { l = a; r = b; }
4     int value() {
5       int d = r - l;
6       if (d < 0) { d = d * -1; }
7       return d; } }
8   int area(x1, y1, x2, y2) {
9     return new Distance(x2, x1).value()
10      * new Distance(y2, y1).value(); } }
```

The Java object `Distance` on the right snippet is semantically equivalent to the C function `distance()` on the left one.

Identity, State, Behavior

```
1  class Circle {
2    private float radius;
3    Circle(float r) {
4      radius = r; }
5    float getRadius() {
6      return radius; }
7    void setRadius(float r) {
8      radius = r; }
9    float area() {
10     return 3.14 * radius * radius; }
11 }
```

```
1  // Identity:
2  c1 = new Circle(42.0);
3  c2 = new Circle(42.0);
4  c1 != c2;
5  // State:
6  c1 = new Circle(42.0);
7  c2 = new Circle(42.0);
8  c1.getRadius() == c2.getRadius();
9  // Behavior:
10 c1 = new Circle(42.0);
11 c2 = new Circle(-42.0);
12 c1.area() == c2.area();
```

State vs. Behavior

```
1  class Circle {
2    private float r;
3    void setR(float r) { this.r = r; }
4    float getR() { return this.r; }
5  }
6  class FigureUtils {
7    static float area(Circle c) {
8      return 3.14 * c.getR() * c.getR();
9    }
10 }
11 Circle c = new Circle();
12 c.setR(42.0);
13 float s = FigureUtils.area(c);
```

```
1  class Circle {
2    private float r;
3    Circle(float r) { this.r = r; }
4    float area() {
5      return 3.14 * this.r * this.r;
6    }
7  }
8  Circle c = new Circle(42.0);
9  float s = c.area();
```

How to decide what is state and what is behavior?

4) What is "composition"?

```
1  canvas = new Canvas();
2  canvas.addCircle(new Circle(42));
3  canvas.draw();
```

```
1  canvas = new Canvas();
2  circle = new Circle(42);
3  circle.drawOn(canvas);
```

What is composition? What is the "right" composition?

Chapter #4:

Object Thinking vs. Algorithms

[While Buffer Loop Loop Composition]

While-Do loop

```
1  buffer = []
2  while true
3    c = STDIN.readchar
4    break if c == "\n"
5    if buffer.length > 3
6      STDOUT.puts buffer.join
7      buffer = []
8    end
9    buffer << c
10 end
```

```
1  $ echo 'Hello, world!' | ruby a.rb
2  Hell
3  o, w
4  orld
```

[While Buffer Loop Loop Composition]

Buffer abstraction

```
1  buffer = []
2  while true
3    c = STDIN.readchar
4    break if c == "\n"
5    if buffer.length > 3
6      STDOUT.puts buffer.join
7      buffer = []
8    end
9    buffer << c
10 end
```

```
1  class Buffer
2    def initialize; @data = []; end
3    def push(c)
4      if @data.length > 3
5        STDOUT.puts @data.join
6        @data = []
7      end
8      @data << c
9    end
10 end
11 buffer = Buffer.new
12 while true
13   c = STDIN.readchar
14   break if c == "\n"
15   buffer.push c
16 end
```

[While Buffer Loop Loop Composition]

Loop abstraction

```ruby
1  class Buffer
2    def initialize; @data = []; end
3    def push(c)
4      if @data.length > 3
5        STDOUT.puts @data.join
6        @data = []
7      end
8      @data << c
9    end
10 end
11 buffer = Buffer.new
12 while true
13   c = STDIN.readchar
14   break if c == "\n"
15   buffer.push c
16 end
```

```ruby
1  class Buffer
2    # the same
3  end
4  class Pull
5    def initialize(b); @buf = b; end
6    def again
7      c = STDIN.readchar
8      return false if c == "\n"
9      @buf.push c
10     true
11   end
12 end
13 buffer = Buffer.new
14 pull = Pull.new(buffer)
15 while pull.again; end
```

[While Buffer Loop Loop Composition]

Loop abstraction

```
1  class Buffer
2    # the same
3  end
4  class Pull
5    def initialize(b); @buf = b; end
6    def again
7      c = STDIN.readchar
8      return false if c == "\n"
9      @buf.push c
10     true
11   end
12 end
13 buffer = Buffer.new
14 pull = Pull.new(buffer)
15 while pull.again; end
```

```
1  class Buffer
2    # the same
3  end
4  class Pull
5    # the same
6  end
7  class Pulls
8    def initialize(p); @pull = p; end
9    def fetch
10     while @pull.again; end
11   end
12 end
13 Pulls.new(Pull.new(Buffer.new)).fetch
```

[While Buffer Loop Loop Composition]

Object composition

```
 1  class Buffer
 2    def initialize; @data = []; end
 3    def push(c)
 4      if @data.length > 3
 5        STDOUT.puts @data.join
 6        @data = []
 7      end
 8      @data << c
 9    end
10  end
11
12  class Pull
13    def initialize(b); @buf = b; end
14    def again
15      c = STDIN.readchar
16      return false if c == "\n"
17      @buf.push c
18      true
19    end
20  end
21
22  class Pulls
23    def initialize(p); @pull = p; end
24    def fetch
25      while @pull.again; end
26    end
27  end
28
29  Pulls.new(
30    Pull.new(
31      Buffer.new
32    )
33  ).fetch
```

Chapter #5:

Enemies of Object Thinking

What makes us think as algorithms

Static Methods

Anemic Objects (Getters)

Mutability (Setters)

Workers ("-er" Suffix)

NULL References

Type Casting (Reflection)

Inheritance

Chapter #6:

Post-Test

https://github.com/yegor256/hangman

Bibliography

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