Programming Languages

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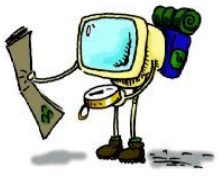
Roadmap

- Object Oriented Programming
- Key Features
  - Encapsulation
  - Inheritance
  - Data Abstraction
  - Polymorphism
- Initialization & Finalization
- Static vs Dynamic Method Binding



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Object Oriented Programming

- Object: any object in real world or an instance of a class in a program
- Object oriented: languages and programming techniques based on objects (classes) instead of procedures or functions
- Objects Capable of:
  - receiving messages
  - processing data
  - sending messages
    - via object specific functions called "methods"
- Each object can be viewed as:
  - an independent little machine with a distinct role or responsibility

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Object Oriented Programming

Goals:

- Reduce conceptual load (minimize amount of detail programmer must think at one time)
- Provide fault containment (prevent programmer from using a program component in appropriate ways)
- Provide independence between program components (modify internal implementation without changing external code or vice versa)

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Object Oriented Programming

Key Features:

1. Encapsulation
2. Inheritance
3. Data Abstraction
4. Polymorphism

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1. Encapsulation

- type of privacy applied to some data and methods in a class
- hides irrelevant details from the user
- ensures object can be changed only through established channels
  - eg. the class's public methods - interface
- clients of the interface perform operations purely through the interface, so if the implementation changes, the clients do not have to change
  - eg. queue implementation, sorting

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2. Inheritance

- Mechanism for creating subclasses
- Provides a way to define a subclass as a
  - specialization
  - subtype
  - extension to a more general class
    - eg. human → man, animal → dog, fruit → apple
- Subclasses
  - acquire all of data and methods of the its superclass
  - it can add or change data or methods
  - is-a relationship
    - eg. a man is a human, a dog is an animal, apple is a fruit
    - fruit is a generalization of apple, and apple is an instantiation of fruit
- Intended to help reuse of existing code with little or no modification
  - eg. man and woman objects can share most of the required code

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3. Data Abstraction

- Mechanism to reduce details so that one can focus on a few concepts at a time
- Separation between the *abstract* properties of a data type and the *concrete* details of its implementation
  - eg. list data type

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4. Polymorphism

- Two or more classes reacting differently to the same message
- The programmer does not need to know the exact type of the object in advance, so this behavior can be implemented at run time (*dynamic binding*).
- The different objects involved need to present a compatible interface to the clients (the calling routines). That is, there must be public methods with the same name and the same parameter sets in all the objects.

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4. Polymorphism (cont.)

- Polymorphism allows client programs to be written based only on the abstract interfaces of the objects
- The original client program does not even need to be recompiled (only relinked) in order to make use of new types exhibiting new (but interface-conformant) behavior

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Object Initialization

- Constructors: initialize an object automatically at the beginning of its lifetime
- In C++, compiler ensures that an appropriate constructor is called for every elaborated object:

```
1) foo b;              // calls foo:foo()
2) foo b(10, 'x');     // calls foo:foo(int, char)
3) foo a;
   bar b;
   …
   foo c(a);           // calls foo:foo(foo&)
   foo d(b);           // calls foo:foo(bar&)

   // single argument constructors are called "copy constructor"
```

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Object Initialization

```
4) foo a;
   bar b;
   …
   foo c = a;          // calls foo:foo(foo&)
   foo d = b;          // calls foo:foo(bar&)
```

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Object Finalization

- When an object is destroyed, the destructor of that class is called → Garbage collection
- In case of a derived class
  - 1. call destructor of the derived class
  - 2. call destructors of base classes (in reverse order of derivation)

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Static vs Dynamic Binding

- class person {…}
- class student : public person {…}
- class professor : public person {…}

- student s;
- professor p;

- void person::print_label(); //polymorphic

```
s.print_label();        //calls person::print_label(s)
p.print_label();        //calls person::print_label(p)
```

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Static vs Dynamic Binding

Suppose:

- student::print_label();
- professor::print_label();

```
s.print_label();        //calls student::print_label(s)
p.print_label();        //calls professor::print_label(p)
```

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Static vs Dynamic Binding

Suppose:

- person *x = &s;
- person *y = &p;

```
x->print_label();       // ??
y->print_label();       // ??
```

x, y: person
s: student
p: professor

Does the choice depend on the type of x & y, or on the type of object they refer?

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Static vs Dynamic Binding

- First option (use type of the object making the call): static method binding
- Second option (use type of the object referred): dynamic method binding

- Dynamic method binding is central to object-oriented programming!

- C++ uses static binding by default. You need to use "virtual" keyword to use dynamic binding

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