CSC 211: Computer Programming

Introduction to Classes

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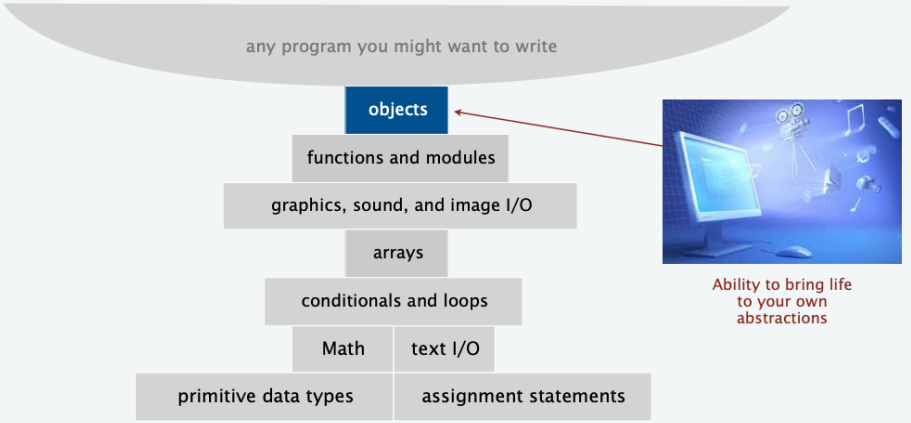
THINK BIG WE DO℠

Original design and development by Dr. Marco Alvarez

Basic building blocks



https://introcs.cs.princeton.edu/java/lectures/keynote/CS.9.CreatingDTs.pdf

Classes

- In object-oriented programming (OOP), a **class** is an extensible "datatype" for creating **objects** ("variables")
- Examples of classes you have already used
  - `std::string, std::istream, std::ostream`
- A class can define **member variables** and behavior (called **member functions** or **methods**)
- When an object is created, the resulting object is also called an **instance of the class**

C++ Classes

- A class in C++ is a user-defined type declared with the keyword **`class`**
- A class can define data members and member functions
  - three levels of access: **private** (default), **protected**, or **public**
- **Private members** are not accessible outside the class
  - only through methods of the class
- **Public members** form an interface to the class and are accessible outside the class

Class declaration

- Similar to structs, however level of access must be specified

```
class MyClass {

    public:

        int myNum;
        string myString;

};
```


Declaration and dot operator

```
#include <iostream>
#include <string>

class MyClass {

    // access specifier
    public:

        // data members
        int myNum;
        std::string myString;
};

int main() {
    // creating an object
    MyClass object;

    // using the dot operator
    object.myNum = 10;
    object.myString  = "My Message";
    std::cout << object.myNum << std::endl;
    std::cout << object.myString << std::endl;

    return 0;
}
```


Methods (member functions)

- Methods must be declared inside the class
  - definition of methods must identify the class they belong to
  - `::` is the **scope resolution operator**

```
class Date {
  public:
    int month;
    int year;
    int day;

    void print();
};
```

declaration

```
void Date::print() {
  std::cout << month << '-'
      << day << '-'
      << year << std::endl;
}
```

definition

Example

```
#include <iostream>

class Date {
    public:
        int month;
        int year;
        int day;

        void print();
};

void Date::print() {
    std::cout << month << '-'
       << day << '-'
       << year << std::endl;
}
```

Must include the object

```
int main() {
    Date today;

    today.day = 12;
    today.month = 07;
    today.year = 2023;

    today.print();

    return 0;
}
```

Improving the class declaration

- Making changes to the internal representation of `Date` requires changes to the entire program
- A better declaration of the class `Date` would allow for changes to the class without requiring changes to the program(s) that use `Date`

don't allow the program to directly reference or access member variables

Example

```
#include <iostream>

class Date {
    public:
        int mymonth;
        int year;
        int day;

        void print();
};

void Date::print() {
    std::cout << month << '-'
       << day << '-'
       << year << std::endl;
}
```

```
int main() {
    Date today;

    today.day = 12;
    today.month = 07;
    today.year = 2023;

    today.print();

    return 0;
}
```

Internal change to date broke this line


```
#include <iostream>

class Date {
    public:
        int month;
        int year;
        int day;

        void set(int m, int d, int y);
        void print();
};
```



```
void Date::print() {
    std::cout << month << '-'
              << day << '-'
              << year << std::endl;
}


void Date::set(int m, int d, int y) {
    month = m;
    day = d;
    year = y;
}
```

When accessing data members or methods inside the class, the object name is not required

```
int main() {
    Date today;

    today.set(07, 12, 2023);
    today.print();

    return 0;
}
```

Now changes to the date class will
not require changes to main (programs that use date)

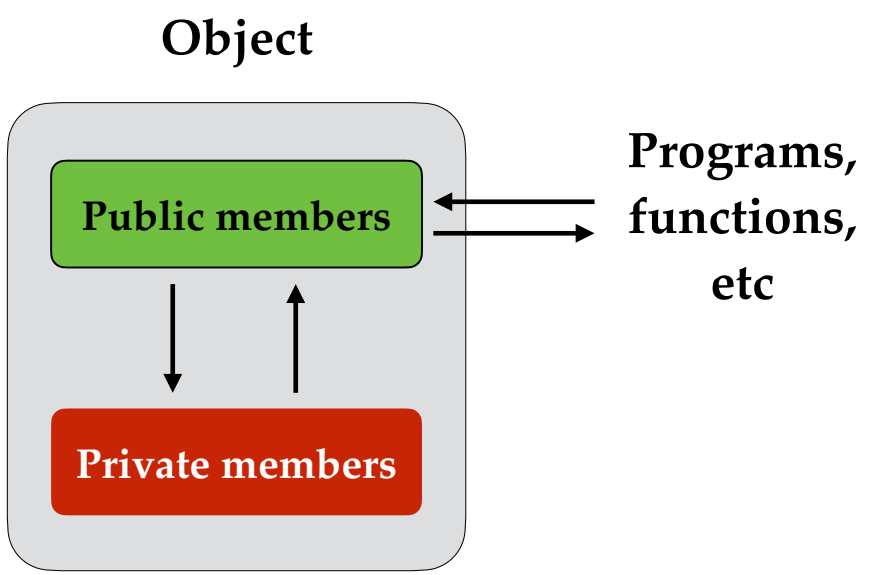
Encapsulation

- **Encapsulation** is one of the most fundamental concepts of OOP
- In OOP, encapsulation is used to hide the values or state of a structured data object inside a class. It is implemented as a:
  - language construct that **facilitates the bundling of data with the methods** (or other functions) operating on that data
  - language mechanism for **restricting direct access** to some of the object's components

https://en.wikipedia.org/wiki/Encapsulation_(computer_programming)

Public vs Private

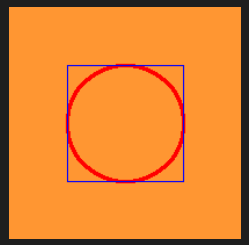
- C++ helps us restrict the program from directly referencing member variables
- Private members of a class can **only be referenced** within member functions
  - otherwise, the compiler gives an error message
- The keyword **`private`** identifies the members of a class that can be accessed only by member functions
- The keyword **`public`** identifies the members of a class that can be accessed from outside the class

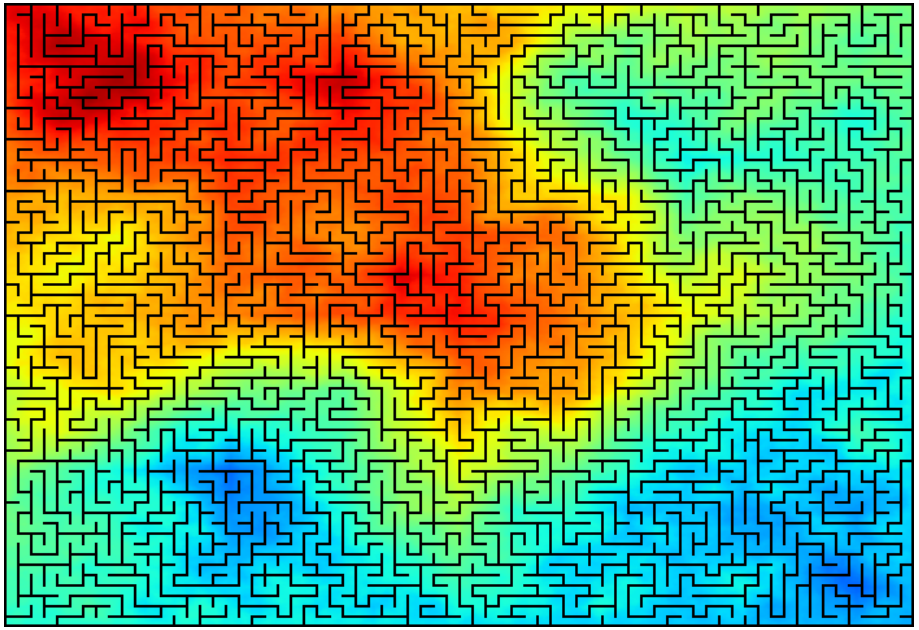


```
class Date {
    private:
        int month;
        int year;
        int day;

    public:
        void set(int m, int d, int y);
        void print();
};
```



```
// https://www.partow.net/programming/bitmap/index.html
#include "bitmap_image.hpp"

int main() {
    bitmap_image image(200,200);

    // set background to orange
    image.set_all_channels(255, 150, 50);

    image_drawer draw(image);

    draw.pen_width(3);
    draw.pen_color(255, 0, 0);
    draw.circle(image.width() / 2, image.height() / 2, 50);

    draw.pen_width(1);
    draw.pen_color(0, 0, 255);
    draw.rectangle(50, 50, 150, 150);

    image.save_image("output.bmp");

    return 0;
}
```





https://www.partow.net/programming/bitmap/index.html

Assignment operator

- Objects and structures can be assigned values using the = operator

```
int main() {
    Date today;
    Date due;

    today.set(07, 12, 2023);
    due = today;
    today.print();
    due.print();

    return 0;
}
```

Exercise

- Implement the following public methods for the class date
  - `add_years`, which adds a number of years to the current date
  - `add_months`, which adds a number of months to the current date
  - `add_days`, which adds a number of days to the current date