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Advanced Programming

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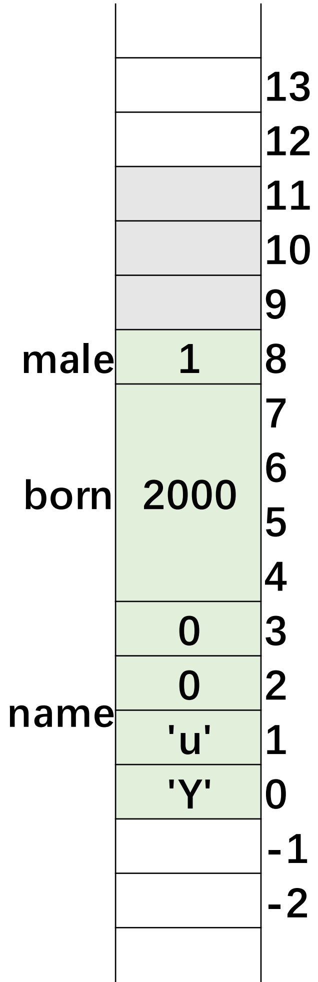
Classes and Objects

Structures

- A `struct` in **C** is a type consisting of a sequence of data members.
- Some functions/statements are needed to operate the data members of an object of a `struct` type.

```
struct Student
{
    char name[4];
    int born;
    bool male;
};

struct Student stu;
strcpy(stu.name, "Yu");
stu.born = 2000;
stu.male = true;
```



Classes

- You should be very careful to manipulated the data members in a `struct` object.
- Can we improve `struct` to a better one?
- Yes, it is `class`! We can put some member functions in it.

Safer solution!

firstclass.cpp

```
class Student
{
  public:
    char name[4];
    int born;
    bool male;
    void setName(const char * s)
    {
        if (s == NULL){...}
        size_t len = sizeof(name) - 1;
        strncpy(name, s, sizeof(name));
        name[len] = '\0';
    }
    void setBorn(int b) { ... }
```

```
Student yu;
yu.setName("Yu");
```

Access Specifiers

- You can protect data members by access specifier private.
- Then data member can only be accessed by well designed member functions.

access-attribute.cpp

```
Student yu;
yu.born = 2001;
```

```
class Student
{
  private:
    char name[4];
    int born;
    bool male;
  public:
    void setName(const char * s)
    {
        ...
    }
    void setBorn(int b)
    {
        ...
```

Member Functions

- A member function can be defined inside or outside class.

inline function

```
class Student
{
  private:
    char name[4];
    int born;
    bool male;
  public:
    void setName(const char * s)
    {
        strncpy(name, s, sizeof(name));
    }
    void setBorn(int b)
    {
        born = b;
    }
    void setGender(bool isMale);
    void printInfo();
};
```

```
inline void Student::setGender(bool isMale)
{
    male = isMale;
}
void Student::printInfo()
{
    cout << "Name: " << name << endl;
    cout << "Born in " << born << endl;
    cout << "Gender: " << (male ? "Male" : "Female") << endl;
}
```

File Structures

- The source code can be placed into multiple files

student.hpp

```
#pragma once
class Student
{
 private:
  char name[4];
  int born;
  bool male;
 public:
  void setName(const char * s)
  {
    // ...
  }
  void setBorn(int b)
  {
    // ...
  }
  void setGender(bool isMale);
  void printInfo();
};
```

student.cpp

```
#include "student.hpp"
void Student::setGender(bool isMale)
{
   male = isMale;
}
void Student::printInfo()
{
   cout << "Name: " << name << endl;
   cout << "Born in " << born << endl;
   cout << "Gender: " << (male ? "Male" : "Female") << endl;
}
```

main.cpp

```
#include "student.hpp"
int main()
{
   Student yu;
   yu.setName("Yu");
   yu.setBorn(2000);
```

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Constructors and Destructors

Constructors

- Different from `struct` in C, a constructor will be invoked when creating an object of a `class`.
  - ➢ `struct` in C: allocate memory
  - ➢ `class` in C++: allocate memory & invoke a constructor
- But ... No constructor is defined explicitly in previous examples.
  - ➢ The compiler will generate one with empty body

Constructors

```
class Student
{
  private:
    // ...
  public:
    Student()
    {
        name[0] = 0;
        born = 0;
        male = false;
    }
    Student(const char * initName, int initBorn, bool isMale)
    {
         setName(initName);
         born = initBorn;
         male = isMale;
    }
};
```

- The same name with the class.
- Have no return value

Constructors

- The members can also be initialized as follows

```
Student(const char * initName): born(0), male(false)
{
   setName(initName);
}
```

constructor.cpp

Destructors

- The destructor will be invoked when the object is destroyed.
- Be formed from the class name preceded by a tilde (~)
- Have no return value, no parameters

```
class Student
{
   // ...
  public:
   Student()
   {
      name = new char[1024]{0};
      born = 0;
      male = false;
      cout << "Constructor: Person()" << endl;
   }
   ~Student()
   {
      delete [] name;
   }
};
```

destructor.cpp

Destructors

```
Student * class1 = new Student[3]{
        {"Tom", 2000, true},
        {"Bob", 2001, true},
        {"Amy", 2002, false},
    };
```

- What is the difference between the following two lines?

```
delete class1;

delete []class1;
```

array.cpp

this Pointer

Why is `this` needed?

- How does a member function know which name?

```
Student yu  = Student{"Yu", 2000, true};
Student amy = Student{"Amy", 2000, true};
yu.setName("yu");
amy.setName("Amy");
```

```
name: "Yu"
born: 2000
male: true
```

```
name: "Amy"
born: 2001
male: false
```

```
void setName(const char * s)
{
    strncpy(name, s, 1024);
}
```

this Pointer

- All methods in a function have a `this` pointer.
- It is set to the address of the object that invokes the method.

```
void setBorn(int b)
{
    born = b;
}
```

```
void setBorn(int b)
{
    this->born = b;
}
```

```
void setBorn(int born)
{
    this->born = born;
}
```

this.cpp

`const` and `static` Members

const Variables

- Statements for constants

```
#define VALUE 100

const int value = 100;
const int * p_int;
int const * p_int;

int * const p_int;

void func(const int *);
void func(const int &);
```

const Members

- const member variables behavior similar with normal const variables
- const member functions promise not to modify member variables.

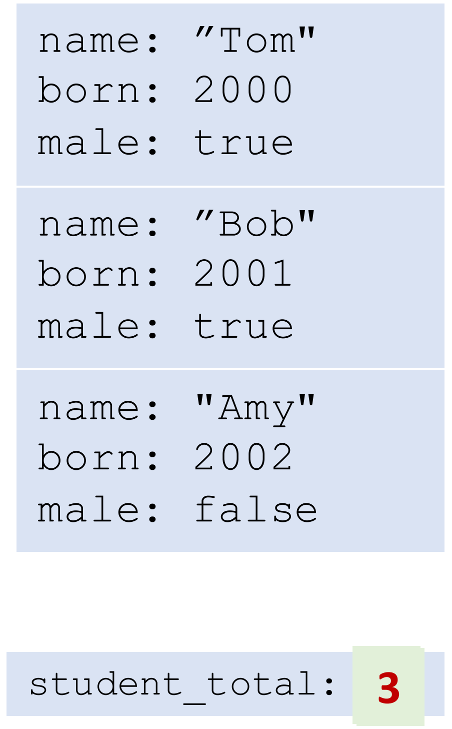
```
class Student
{
  private:
    const int BMI = 24;
    // ...
  public:
    Student()
    {
        BMI = 25;//can it be modified?
        // ...
    }
    int getBorn() const
    {
        born++; //Can it be modified?
        return born;
    }
};
```

const.cpp

static members

- static members are not bound to class instances.

```
class Student
{
 private:
  static size_t student_total; // declaration only
 public:
  Student()
  {
    student_total++;
  }
  ~Student()
  {
    student_total--;
  }
  static size_t getTotal() {return student_total;}
};
// definition it here
size_t Student::student_total = 0;
```



```
name:  ”Tom"
born:  2000
male:  true

name:  ”Bob"
born:  2001
male:  true

name:  "Amy"
born:  2002
male:  false

student_total: 3
```

static.cpp