More Classes

C++ Object Oriented Programming
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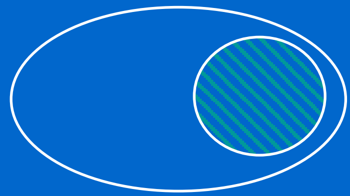
Contents

- Object composition and constructors
- Initialization of object within object
- Returning pointers
- **this** pointer
- Exploiting implicit references
- Class conversion
- Static data members
- Static member functions

Object Component

- Sometimes you would like to use a well designed object as a component to help accomplishing the task
- In that case, we have an **object within another object**



- Example:

```
class Person {
public:
   Person(const char *name);
   ~Person();
   char *getName() const;
private:
   char *m_name;
};

class SaleDept {
public:
   SaleDept(const char *manager,
                  const char *clerk);
   void listMembers() const;
private:
   Person m_manager;
   Person m_clerk;
};
```

```
void main() {
   SaleDept *saleDept;
   saleDept =
      new SaleDept("Jamie", "Paul");
   myRoom->listMembers();
   delete saleDept;
}
SaleDept::SaleDept(
          const char *managerName,
          const char *clerkName) {
}
```

NOT working!!

error C2512: 'Person' :
no appropriate default
constructor available

Solving The Initialization Problem

- First try: illegal syntax, calling Person ctor within SaleDept ctor, i.e.

```
SaleDept::SaleDept(const char *managerName, const char *clerkName) {
    m_manager(managerName);
    m_clerk(clerkName);
}
```

- Second try: not a good one, require default ctor, extra CPU time, depending on some uncertain factors

```
SaleDept::SaleDept(const char *managerName, const char *clerkName) {
    m_manager = Person(managerName);
    m_clerk = Person(clerkName);
}
```

- Third try: a safe and syntactically legal solution, but undesirable

```
class Person {
   ....
   Person(); // empty ctor
   void setName(const char *name);
};
```

- Correct solution: using initialization list

```
SaleDept::SaleDept(const char *managerName, const char *clerkName)
      : m_manager(managerName), m_clerk(clerkName) {
}
```

Returning Pointers

- The function getName() violates *data encapsulation*

```
class Person {
public:
    Person(const char *name);
    ~Person();
    char *getName() const;
private:
    char *m_name;
};
```

- Why? Consider the following code: looks OK

```
void SaleDept::listMembers() const {
    cout << m_manager.getName() << " is the manager of the sale department and "
            <<  m_clerk.getName() << " is the clerk.\n";
}
```

- What would happen if it were written like this

```
void SaleDept::listMembers() const {
    char *tempString = m_manager.getName();
    tempString[0] = '#';
    cout << tempString << " is the manager of the sale department and "
            <<  m_clerk.getName() << " is the clerk.\n";
}
```

Interfering the integrity of the private data of Person class

Solution to Data Encapsulation Problem

- Simple solution provided by the grammar to prevent **incidental** breaking of the encapsulation

unintentional

```
class Person {
public:
    Person(const char *name);
    ~Person();
    const char *getName() const;
private:
    char *m_name;
};
```

Won't be able to mutate the content of m_name within this member function

```
const char *Person::getName() const {
    return m_name;
}
```

```
void SaleDept::listMembers() const {
    const char *tempString = m_manager.getName();
    // tempString[0] = '#';   // compiler rejects this statement
    cout << tempString << " is the manager of the sale department and "
          <<  m_clerk.getName() << " is the clerk.\n";
}
```

- Other solutions? use a string object

this pointer

- In the first C++ translator, by Stroustrup, C++ functions is translated to pure C functions. How can a function access some variables (those member variables) not defined in that function? Ex.

```
class Grades {
public:
    Grades(int score);
    int getScore();
private:
    int m_score;
};
int Grades::getScore() {
    return m_score;
}
```

```
void main() {
    Grades student1(95), student2(85), student3(45);
    cout << student1.getScore();
    cout << student2.getScore();
    cout << student3.getScore();
}
```

which variable is this referring to

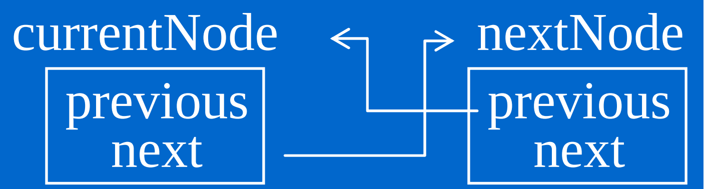
- The compiler generates an *implicit* reference to the object which called the function and passes it into the function as an argument.
- Explicitly referencing the object

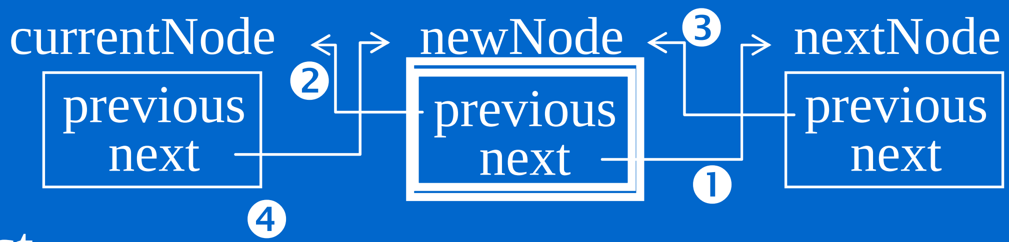
```
int Grades::getScore() {
    return this->m_score;
}
```

The primary purpose of ***this*** pointer

- The *this* pointer is most commonly used when objects need to be linked to other objects

```
class LinkedList {
public:
   void insert(LinkedList *newNode);
private:
   LinkedList *previous;
   LinkedList *next;
};
```





- We want to insert a new node into the list after another object with **currentObject–>insert(newObject);**
- The actual way to achieve the goal is using this pointer

```
void LinkedList::insert(LinkedList *newNode) {
   newNode–>next = next;        // implicitly referring the member of current object
   newNode–>previous = this;  // or next->previous
   next–>previous = newNode;
   next = newNode;
}
```

Exploiting Implicit References

- Suppose we want to add a function to class **Grades** that checks if two objects contain the same score
- Here is the call in main()

```
if (grade1.equal(grade2))
   cout << "same scores";
else
   cout << "different scores";
```

- Here is the function

```
bool Grades::equal(Grades &secondScore) {
   return m_score == secondScore.m_score;
}
```

- Do not ignore implicit dereferencing

```
bool Grades::equal(Grades &firstScore, Grades &secondScore) {
   return firstScore.m_score == secondScore.m_score;
}
```

Note how clumsy the call is to this function

```
if (grade1.equal(grade1, grade2))
   ….
```

Type Conversion Constructor

- Suppose we would like to convert raw minutes to Time object

```
class Time {
public:
    Time();
    Time(int hours, int minutes, int seconds);
    Time(int rawMinutes);
private:
    int m_hours;
    int m_minutes;
    int m_seconds;
    void normalize();
};
Time::Time(): m_seconds(0), m_minutes(0), m_hours(0) {
}
Time::Time(int hours, int minutes, int seconds)
    : m_hours(hours), m_minutes(minutes), m_seconds(seconds) {
    normalize();
}
Time::Time(int rawMinutes): m_seconds(0), m_minutes(rawMinutes), m_hours(0) {
    normalize();
}
```

```
void Time::normalize() {
    m_minutes += m_seconds / 60;
    m_seconds = m_seconds % 60;
    m_hours += m_minutes / 60;
    m_minutes = m_minutes % 60;
    m_hours = m_hours % 24;
}
```

Type Conversion Constructor

- Usage:

```
void main() {
    int x = 125;
    Time object;
    object = Time(125);  // temporary object, assignment operator
    object = 125;
    object = x;
    object = (Time) x;
}
```

implicit invocation of type conversion ctor, construct a temporary object, assignment operator

Class Conversion

```
class Celsius;  // forward declaration
class Fahrenheit {
public:
   Fahrenheit(int temperature);
   Fahrenheit(Celsius &cTemperature);
   int getTemperature() const;
   void display() const;
private:
   int m_temperature;
};

class Celsius {
public:
   Celsius(int temperature);
   Celsius(Fahrenheit &fTemperature);
   int getTemperature() const;
   void display() const;
private:
   int m_temperature;
};
```

```
Fahrenheit::Fahrenheit(Celsius &cTemperature) {
   int celsiusTemperature = cTemperature.getTemperature();
   m_temperature = (int)(9.0 * celsiusTemperature / 5 + 32.5);
}
```

Usage:

```
   Fahrenheit room(75);
   Celsius zimmer(18);
   Celsius c_room(room);
   Fahrenheit f_zimmer(zimmer);
   room = zimmer;
```

Static Data Members

- Suppose we want to give each object of the Student class a unique ID
- Using a global variable is one method

```
int gIDNumber = 0;
class Student {
public:
    Student();
    int getID() const;
private:
    int m_id;
};
```

- The constructor

```
Student::Student():m_id(gIDNumber++) {
}
```

- Problems:
  - If other programs manipulate this global variable, the count would be incorrect
  - It would be better if a name like gStudentIDNumber is used

Static Data Members (cont'd)

- Better solution with static data member

```
class Student {
public:
   Student();
   int getID() const;
private:
   static int lastIDNumber;
   int m_id;
};
```

- A class declaration is not a variable, you must define the static variable in the global scope

```
int Student::lastIDNumber = 0;
```

this can be put anywhere in the program, but it must be in the *.cpp file and only occurs once

- The constructor

```
Student::Student():m_id(lastIDNumber++) {
}
```

- Also used for specific constant definition. Ex. Integer::INT_MAX

Static Member Functions

- A static function can only access static data member

```
class Student {
public:
   Student();
   int getID() const;
private:
   static int lastIDNumber;
   int m_id;
   static int getNewID();
   static int incrementNewID();
};
```

- The keyword static is not repeated in the function definition

```
int Student::getNewID() {
   return lastIDNumber;
}
```

```
int Student::incrementNewID() {
   return lastIDNumber++;
}
```

- The constructor might take this form

```
Student::Student():m_id(getNewID()) {
   incrementNewID()
}
```

Static Member Functions (cont'd)

- If the static member function is public, it can be accessed without reference to a particular object, ex.

  Integer::convertFromInt(10);

- Static member function does not have the implicit *this* pointer because it is not invoked with any object.
- Sometimes use static member functions to implement callback functions that do not allow any implicit argument.