

# CS 32 Week 1

## Discussion 1B

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# About us

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# Icebreaker Time!

- Preferred name, year, major?
- Where from?
- Favorite programming language?

# Topics

- Overview
- Order of Construction and Destruction, Const Member Functions for class.
- Compiling and Linking, #include guard, Circular Dependency.

# Overview

1. C++ language (continued from CS31).
2. Data structure (how to efficiently store, query, and update data for efficient task-dependent computation).
3. Algorithms (how to write programs to efficiently solve problems for us).

# Order of Construction

1. -----
2. Initialize the data members (built-in: uninitialized; class: default constructor) in order
3. Body of the constructor

# Order of Construction

```
1 class Characters {
2     public:
3         Characters(double x, double y, string name);
4     private:
5         double m_x;
6         double m_y;
7         string m_name;
8 };
9
10 Characters::Characters(double x, double y, string name) {
11     m_x = x;
12     m_y = y;
13     m_name = name;
14 }
15
16 class Game {
17     public:
18         Game(const double& size, const double& x, const double& y, const string& name);
19     private:
20         Characters m_character;
21         double m_size;
22 };
23
24 Game::Game(const double& size, const double& x, const double& y, const string& name) {
25     m_character = Characters(x, y, name);
26     m_size = size;
27 }
```

Will it compile?

# Order of Construction

```
1 class Characters {
2     public:
3         Characters(double x, double y, string name);
4     private:
5         double m_x;
6         double m_y;
7         string m_name;
8 };
9
10 Characters::Characters(double x, double y, string name) {
11     m_x = x;
12     m_y = y;
13     m_name = name;
14 }
15
16 class Game {
17     public:
18         Game(const double& size, const double& x, const double& y, const string& name);
19     private:
20         Characters m_character;
21         double m_size;
22 };
23
24 Game::Game(const double& size, const double& x, const double& y, const string& name) {
25     m_character = Characters(x, y, name);
26     m_size = size;
27 }
```

Wrong!

Characters has no default constructor  
Characters::Characters();

# Order of Construction

```
3 class Characters {
4     public:
5         Characters(double x, double y, string name);
6     private:
7         double m_x;
8         double m_y;
9         string m_name;
10    };
11
12 Characters::Characters(double x, double y, string name) {
13     m_x = x;
14     m_y = y;
15     m_name = name;
16 }
17
18 class Game {
19     public:
20         Game(const double& size, const double& x, const double& y, const string& name);
21     private:
22         Characters m_character;
23         double m_size;
24    };
25
26 Game::Game(const double& size, const double& x, const double& y, const string& name)
27     : m_character(x, y, name)
28 {
29     m_size = size;
30 }
```

Correct!

# Order of Construction

```
1 class Characters {
2     public:
3         Characters(double x, double y, string name);
4     private:
5         double m_x;
6         double m_y;
7         string m_name;
8     };
9
10    Characters::Characters(double x, double y, string name) {
11        m_x = x;
12        m_y = y;
13        m_name = name;
14    }
15
16    class Game {
17        public:
18            Game(const double& size, const double& x, const double& y, const string& name);
19        private:
20            Characters* m_character;
21            double m_size;
22    };
23
24    Game::Game(const double& size, const double& x, const double& y, const string& name)
25    {
26        m_character = new Characters(x, y, name);
27        m_size = size;
28    }
```

Correct!

# Order of Destruction

Reverse the order of construction:

1. Run body of the destructor
2. Data members (class: default destructor) are destructed in reverse order.
3. ---

# Order of Destruction

```
32 class User
33 {
34     public:
35     User(const double* tasks, const int& len);
36     ~User();
37     private:
38     string m_name;
39     int m_age;
40     double* m_tasks;
41     int m_len;
42 }
43 User::User(const double* tasks, const int len) {
44     m_len = len;
45     m_tasks = new double[len];
46     for (int i = 0; i < len; ++i) {
47         m_tasks[i] = tasks[i];
48     }
49 }
50 User::~User() {
51     delete [] m_tasks;
52 }
```

# Const Member Functions

```
56 class Characters {  
57     public:  
58         Characters(double x, double y, string name);  
59         void Move(const double& movex, const double& movey);  
60     private:  
61         double m_x;  
62         double m_y;  
63         string m_name;  
64 };  
65 Characters::Characters(double x, double y, string name) {  
66     m_x = x;  
67     m_y = y;  
68     m_name = name;  
69 }  
70  
71 void Characters::Move(const double& movex, const double& movey) {  
72     cout << "hi" << endl;  
73 }  
74  
75 void Play(const Characters* character, const double& movex, const double& movey) {  
76     character->Move(movex, movey);  
77 }
```

Will it compile?

# Const Member Functions

```
56 class Characters {  
57     public:  
58         Characters(double x, double y, string name);  
59         void Move(const double& movex, const double& movey);  
60     private:  
61         double m_x;  
62         double m_y;  
63         string m_name;  
64 };  
65 Characters::Characters(double x, double y, string name) {  
66     m_x = x;  
67     m_y = y;  
68     m_name = name;  
69 }  
70  
71 void Characters::Move(const double& movex, const double& movey) {  
72     cout << "hi" << endl;  
73 }  
74  
75 void Play(const Characters* character, const double& movex, const double& movey) {  
76     character->Move(movex, movey);  
77 }
```

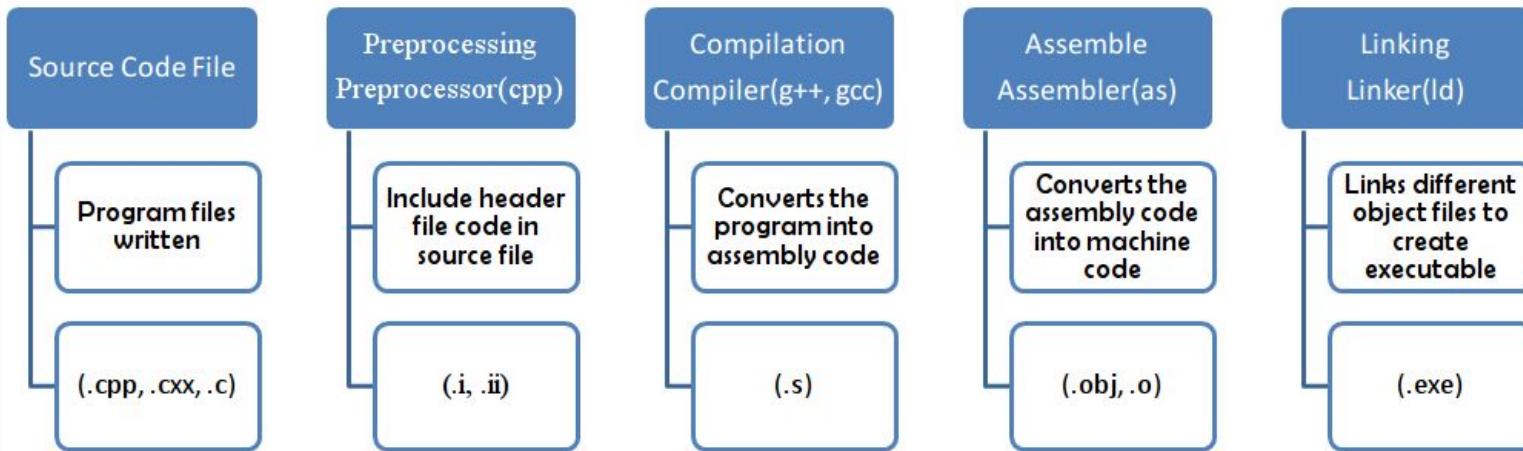
Wrong! Move is not defined to be a constant member function.

# Const Member Functions

```
56 class Characters {  
57     public:  
58         Characters(double x, double y, string name);  
59         void Move(const double& movex, const double& movey) const;  
60     private:  
61         double m_x;  
62         double m_y;  
63         string m_name;  
64     };  
65 Characters::Characters(double x, double y, string name) {  
66     m_x = x;  
67     m_y = y;  
68     m_name = name;  
69 }  
70  
71 void Characters::Move(const double& movex, const double& movey) const{  
72     cout << "hi" << endl;  
73 }  
74  
75 void Play(const Characters* character, const double& movex, const double& movey) {  
76     character->Move(movex, movey);  
77 }
```

Correct!

# Compiling and Linking



# #include guard

To make sure each header file is included once for each source file.

```
“XXX.h”
#ifndef XXX_INCLUDED
#define XXX_INCLUDED
class XXX{
    ...
};

...
#endif
```

# Circular Dependency

```
80 "Characters.h"
81 #ifndef Characters_INCLUDED
82 #define Characters_INCLUDED
83 #include <cstring>
84 #include "Game.h"
85 using namespace std;
86 class Characters {
87     public:
88     Characters(double x, double y);
89     private:
90     double m_x;
91     double m_y;
92     string m_name;
93     Game m_game;
94 };
95 #endif
```

```
98 "Game.h"
99 #ifndef Game_INCLUDED
100 #define Game_INCLUDED
101 #include <cstring>
102 #include <iostream>
103 #include "Characters.h"
104 using namespace std;
105 class Game {
106     public:
107     Game(double size, double x, double y);
108     private:
109     Characters* m_character;
110     double m_size;
111 };
112 #endif
113
114 "main.cpp"
115 #include "Game.h"
116 #include "Characters.h"
117
```

Will it compile?

# Circular Dependency

```
80 "Characters.h"
81 #ifndef Characters_INCLUDED
82 #define Characters_INCLUDED
83 #include <cstring>
84 #include "Game.h"
85 using namespace std;
86 class Characters {
87     public:
88         Characters(double x, double y);
89     private:
90         double m_x;
91         double m_y;
92         string m_name;
93         Game m_game;
94 };
95 #endif
```

```
98 "Game.h"
99 #ifndef Game_INCLUDED
100 #define Game_INCLUDED
101 #include <cstring>
102 #include <iostream>
103 #include "Characters.h"
104 using namespace std;
105 class Game {
106     public:
107         Game(double size, double x, double y);
108     private:
109         Characters* m_character;
110         double m_size;
111     };
112 #endif
113
114 "main.cpp"
115 #include "Game.h"
116 #include "Characters.h"
```

Wrong!

# Circular Dependency

```
--  
80 "Characters.h"  
81 #ifndef Characters_INCLUDED  
82 #define Characters_INCLUDED  
83 #include <cstring>  
84 class Game;  
85 using namespace std;  
86 class Characters {  
87     public:  
88         Characters(double x, double y);  
89     private:  
90         double m_x;  
91         double m_y;  
92         string m_name;  
93     Game m_game;  
94 };  
95 #endif
```

```
98 "Game.h"  
99 #ifndef Game_INCLUDED  
100 #define Game_INCLUDED  
101 #include <cstring>  
102 #include <iostream>  
103 class Characters;  
104 using namespace std;  
105 class Game {  
106     public:  
107         Game(double size, double x, double y);  
108     private:  
109         Characters* m_character;  
110         double m_size;  
111 };  
112 #endif  
113  
114 "main.cpp"  
115 #include "Game.h"  
116 #include "Characters.h"
```

Will it compile?

# Circular Dependency

```
80 "Characters.h"
81 #ifndef Characters_INCLUDED
82 #define Characters_INCLUDED
83 #include <cstring>
84 #include "Game.h"
85 using namespace std;
86 class Characters {
87     public:
88         Characters(double x, double y);
89     private:
90         double m_x;
91         double m_y;
92         string m_name;
93         Game m_game;
94 };
95 #endif
```

```
98 "Game.h"
99 #ifndef Game_INCLUDED
100 #define Game_INCLUDED
101 #include <cstring>
102 #include <iostream>
103 class Characters;
104 using namespace std;
105 class Game {
106     public:
107         Game(double size, double x, double y);
108     private:
109         Characters* m_character;
110         double m_size;
111     };
112 #endif
113
114 "main.cpp"
115 #include "Game.h"
116 #include "Characters.h"
```

Correct!

# g32

1. Connect to a Campus WiFi. Use a VPN if you are not connected to a campus WiFi.

E.g. AnyConnect, openconnect.

2. Send your files to the seasnet server [username@cs32.seas.ucla.edu](mailto:username@cs32.seas.ucla.edu)

Windows: winscp

Mac single file: \$scp path\_to\_the\_file [username@cs32.seas.ucla.edu](mailto:username@cs32.seas.ucla.edu):path\_to\_be\_saved

Mac directory: \$scp -r path\_to\_dir [username@cs32.seas.ucla.edu](mailto:username@cs32.seas.ucla.edu):path\_to\_be\_saved

3. Connect to the cs32 server.

Windows: Putty

Mac: \$ssh [username@cs32.seas.ucla.edu](mailto:username@cs32.seas.ucla.edu)

4. Compile, build, and test your program.

\$g32 files.cpp -o exe\_name

./exe\_name

# Copy Constructor

```
145 class User
146 {
147     public:
148         User(const double* tasks, const int& len);
149         User(const User& other);
150         User& operator=(const User& rhs);
151         void swap(User& other);
152         ~User();
153     private:
154         string m_name;
155         int m_age;
156         int m_len;
157         double* m_tasks;
158     };
159 User::User(const User& other)
160 {
161     m_len = other.m_len;
162     m_age = other.m_age;
163     m_name = other.m_name;
164     m_tasks = new double[m_len];
165     for (int i = 0; i < m_len; ++i)
166         m_tasks[i] = other.m_tasks[i];
167 }
```

Most of the time, a copy constructor passes by constant reference.

```
211 User b(...);
212 User a(b);
213 User a = b;
```

# Assignment Operator

By default, “=” copies everything, which may cause memory leak and malfunctioning when the class has pointers as its data member. We define “=” as a member function.

```
30 class User
31 {
32     public:
33     User(const double* tasks, const int& len);
34     User(const User& other);
35     User& operator=(const User& rhs);
36     ~User();
37 private:
38     string m_name;
39     int m_age;
40     int m_len;
41     double* m_tasks;
42 }
43
44 User& User::operator=(const User& rhs) {
45     //check if assign u to u: u = u
46     if (this != & rhs) {
47         m_age = rhs.m_age;
48         m_name = rhs.m_name;
49         m_len = rhs.m_len;
50         delete [] m_tasks;
51         m_tasks = new double[m_len];
52         for (int i = 0; i < m_len; ++i) {
53             m_tasks[i] = rhs.m_tasks[i];
54         }
55     }
56 }
```

Aliasing: two different variables have the same reference (e.g.  $u = u$ ).  
Always be cautious of aliasing!

This is the traditional way. Not widely used. Why?

```
216 User a(...);
217 User b(...);
218 a = b;
```

# Assignment Operator

```
173 class User
174 {
175     public:
176         User(const double* tasks, const int& len); //constructor
177         User(const User& other); //copy constructor
178         User& operator=(const User& rhs); //assignment operator
179         void swap(User& other); //swap
180         ~User();
181     private:
182         string m_name;
183         int m_age;
184         int m_len;
185         double* m_tasks;
186     };
187     void User::swap(User& other) {
188         std::swap(m_name, other.m_name);
189         std::swap(m_age, other.m_age);
190         std::swap(other.m_tasks, m_tasks);
191         std::swap(m_len, other.m_len);
192     }
193     User& User::operator=(const User& rhs) {
194         //check if assign u to u: u=u
195         if (this != &rhs) {
196             User temp(rhs); //copy
197             swap(temp);
198         }
199         return *this;
200     }
```

This is the modern way to assign.  
It makes sure there's enough resource  
for assignment by creating a copy of  
the rhs and swap it with lhs.

```
216 User a(...);
217 User b(...);
218 a = b;
```