OPERATOR OVERLOADING (CONTD.) DYNAMIC RESOURCE MANAGEMENT

Problem Solving with Computers-II

```
#include <iostream>
using namespace std;

int main(){
    cout<<"Hola Facebook\n";
    return 0;
}
```

GitHub

Today’s goals

- Operator overloading (contd)
- Dynamic memory and common errors
- We want to understand the what, why, and how of the C++ Big Three:
    - Destructor
    - Copy constructor
    - Copy assignment operator

Overloading the + operator for Complex objects

```
Z = x + y;
```

Goal: We want to apply the + operator to Complex type objects

New method: add()

```
int main(){
  Complex z;
  Complex x(2, 3);
  Complex y(10, -5);
  z = add(x, y);
  z.print();
}
```

Approach 1

```
int main(){
  Complex z;
  Complex x(2, 3);
  Complex y(10, -5);
  z = x.add(y);
  z.print();
}
```

Approach 2

Overloading the + operator for Complex objects

```
z = add(x, y);
```

```
z = x.add(y);
```

```
z = x + y;
```

Goal: We want to apply the + operator to Complex type objects

Overloading the << operator

```
int main(){
  Complex w(10, -5);
  w.conjugate();
  w.print();
}
```

```
int main(){
  Complex w(10, -5);
  w.conjugate();
  cout << w;
}
```

```
Before overloading the << operator
```

```
After overloading the << operator
```

```
cout << w;
```

Select any equivalent C++ statement:

```
w.operator<<(cout);
```

A

```
cout.operator<<(w);
```

B

```
operator<<(cout, w);
```

C

```
operator<<(cout, w);
```

Select the function declaration that does NOT match the above call

A

```
void operator<<(ostream &out,
                const Complex &c);
```

B

```
void Complex::operator<<(ostream &out);
```

C

```
Complex operator<<(ostream &out,
                   Complex c);
```

Operator Overloading

We would like to be able to perform operations on two objects of the class using the following operators:

<<

==

!=

+

-

and possibly others

Dynamic Memory: common errors

- Memory Leak: Program does not free memory allocated on the heap.

- Segmentation Fault: Code tries to access an invalid memory location

C++Big Four: Special functions of any C++ class

- Constructor
- Destructor
- Copy constructor
- Copy assignment operator

The compiler automatically generates default versions for all of these, but you can provide user-defined implementations.

RULE OF THREE

If a class uses dynamic memory, you usually need to provide your implementation of the destructor. If a class implements one (or more) of the following it should probably implement all three:

1. Destructor
2. Copy constructor
3. Copy assignment

- What is the behavior of these defaults?
- What is the desired behavior ?
- How should we over-ride these methods?

```
void test_0(){
      IntList x;
      x.push_front(10);
       x.print();
}
```

Assume:

* **Default destructor**

* **Default copy constructor**

* **Default copy assignment**

What is the result of running the above code?

A. Compiler error

B. Memory leak

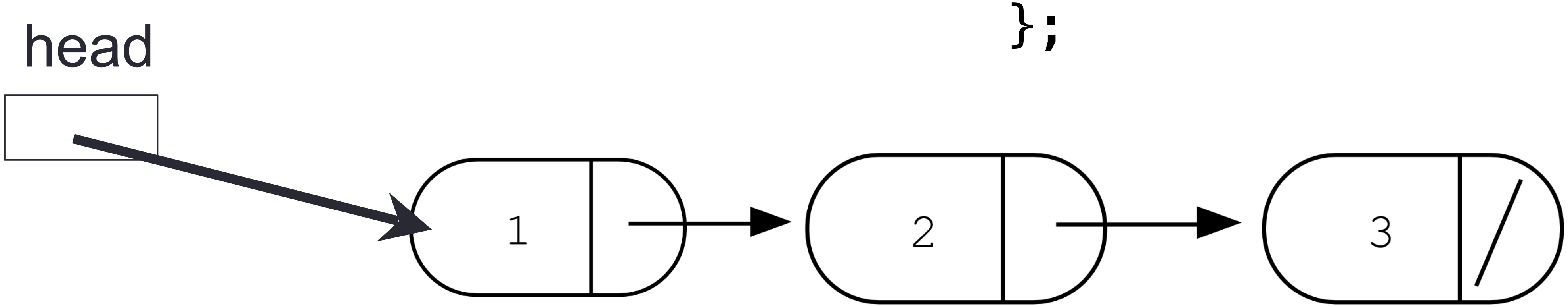
C. Segmentation fault

D. None of the above

Concept Question

```
IntList::~IntList(){
   delete head;
}
```

```
class Node {
    public:
       int data;
       Node *next;
};
```



Which of the following objects are deleted when the destructor of IntList is called?

(A): head pointer

(B): only the first node

(C): A and B

(D): All the nodes of the linked list

(E): A and D

Copy constructor

- Parameterized constructor whose first argument is a class object
- **initializes a (new) object using an existing object**

In which of the following cases is the copy constructor called?

```
A. IntList x;
   IntList y;

B. Complex(1, 2);
   Complex p2(p1);

C. Complex* p1 = new Complex(1, 2);

D. B & C
E. A, B & C
```

Behavior of default copy constructor

```
void test_copy_constructor(){
   IntList x;
   x.push_front(10);
   x.push_front(20);
   IntList y(x);
   // calls the copy c’tor
   x.clear();
   y.print();
}
```

Assume:

destructor: user-defined

copy constructor: default

copy assignment: default

What is the output?

A. No output

B. 20, 10

C. Segmentation fault

Copy assignment (operator=)

- For existing objects x, y, this statement calls the operator= function:

  x = y;

- Default behavior: Copies the member variables of rhs object (y) to lhs object (x)

```
Complex x(1, 2);
Complex y;
y = x;
cout << y;
```

Behavior of default copy assignment

x : 1 -> 2- > 5 -> null

```
void default_assignment_1(IntList& x){
   IntList y;
   y = x;
}
```

```
* What is the behavior of the default assignment operator?
```

Assume:

- * **User-defined destructor**
- * **Default copy constructor**
- * **Default copy assignment**

Behavior of default copy assignment

```
void test_default_assignment_2(){
    IntList x, y;
    x.push_front(10);
    x.push_front(20)
   y = x;
   y.print()
}
```

What is the result of running the above code?
A. Prints 20, 10
B. Segmentation fault
C. Memory leak
D. A &B
E. A, B and C

Assume:

*** User-defined destructor**

*** Default copy constructor**

*** Default copy assignment**

Behavior of default copy assignment

```
void test_default_assignment_3(){
    IntList x;
    x.push_front(10);
    x.push_front(20)
    IntList y(x);
    y.push_front(30);
    y.push_front(40);
    y = x;
    y.print()
}
```

What is the result of running the above code?

A. Prints 20, 10

B. Segmentation fault

C. Memory leak

D. A &B

E. A, B and C

Assume:

* **User-defined destructor**

* **User-defined copy constructor**

* **Default copy assignment**

RULE OF THREE

If a class defines one (or more) of the following it should probably explicitly define all three:

1. Destructor
2. Copy constructor
3. Copy assignment