# OPERATOR OVERLOADING (CONTD.) DYNAMIC RESOURCE MANAGEMENT

Problem Solving with Computers-II


# 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 + w;
```

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

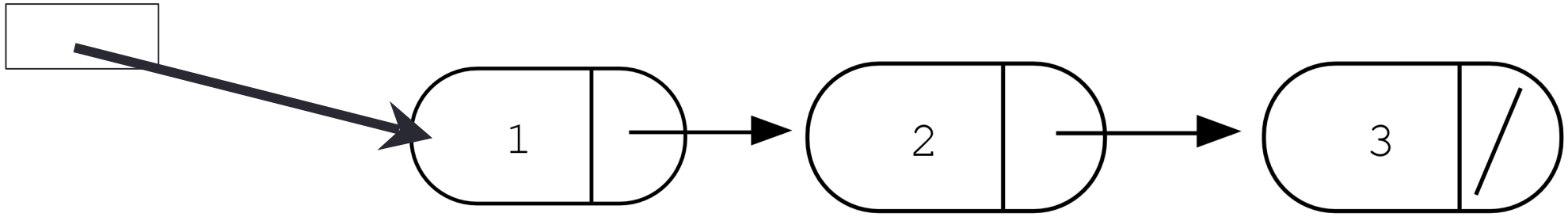
C. Segmentation fault

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

```
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