THE RULE OF THREE
LINKED LISTS

Problem Solving with Computers-II

Linked Lists

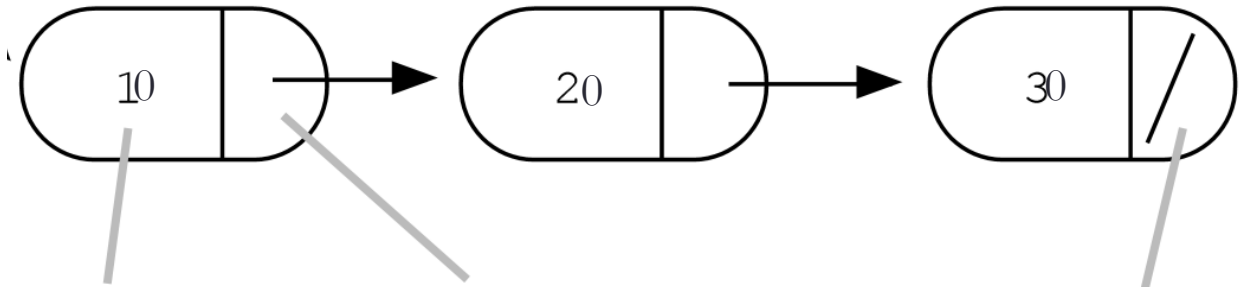
Array

Stack

Heap

The overall list is built by connecting the nodes together by their next pointers. The nodes are all allocated in the heap.

Linked List



Each node stores one data element (int in this example).

Each node stores one next pointer.

The next field of the last node is NULL.

Questions to ask about any data structure:

- **What operations does the data structure support?**

  A linked list supports the following operations:

  1. Insert (a value to the head)
  2. Append (a value to the tail)
  3. Delete (a value)
  4. Search (for a value)
  5. Min
  6. Max
  7. Print all values

- **How do you implement each operation?**
- **How fast is each operation?**

Linked List Abstract Data Type (ADT)

```
class LinkedList {
public:
    LinkedList();
    ~LinkedList();
    // other public methods


private:
    struct Node {
        int info;
        Node* next;
    };
    Node* head;
    Node* tail;
};
```

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

The questions we ask are:

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

```
void test_append_0(){
      LinkedList ll;
      ll.append(10);
       ll.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

Why do we need to write a destructor for LinkedList?

A. To free LinkedList objects
B. To free Nodes in a LinkedList
C. Both A and B
D. None of the above

Behavior of default copy constructor

```
void test_copy_constructor(){
   LinkedList l1;
   l1.append(1);
   l1.append(2);
   LinkedList l2{l1};
   // calls the copy c'tor
   l1.print();
   l2.print();
}
```

Assume:

destructor: overloaded

copy constructor: default

What is the output?

A. Compiler error

B. Memory leak

C. Segmentation fault

D. All of the above

E. None of the above

Behavior of default copy assignment

l1 : 1 -> 2- > 5 -> null

```
void default_assignment_1(LinkedList& l1){
   LinkedList l2;
   l2 = l1;
}
```

* What is the behavior of the default assignment operator?

Assume:

* **Overloaded destructor**
* **Default copy constructor**
* **Default copy assignment**

Behavior of default copy assignment

```
void test_default_assignment_2(){
    LinkedList l1, l2;
    l1.append(1);
    l1.append(2)
    l2 = l1;
    l2.print()
}
```

What is the result of running the above code?
A. Prints 1 , 2
B. Segmentation fault
C. Memory leak
D. A &B
E. A, B and C

Assume:

* **Overloaded destructor**
* **Default copy constructor**
* **Default copy assignment**

Behavior of default copy assignment

```
void test_default_assignment_3(){
    LinkedList l1;
    l1.append(1);
    l1.append(2)
    LinkedList l2{l1};
    l2.append(10);
    l2.append(20);
    l2 = l1;
    l2.print()
}
```

What is the result of running the above code?

A. Prints 1 , 2

B. Segmentation fault

C. Memory leak

D. A &B

E. A, B and C

Assume:

* **Overloaded destructor**
* **Overloaded copy constructor**
* **Default copy assignment**

Overloading Operators

Overload relational operators for LinkedLists

==

!=

and possibly others

```
void test_equal(const LinkedList & lst1, const LinkedList &lst2){
    if (lst1 == lst2)
        cout<<“Lists are equal”<<endl;
    else
        cout<<“Lists are not equal”<<endl;

}
```

Overloading Arithmetic Operators

Define your own addition operator for linked lists:

```
LinkedList l1, l2;

//append nodes to l1 and l2;

LinkedList l3 = l1 + l2 ;
```

Overloading input/output stream

Wouldn’t it be convenient if we could do this:

```
LinkedList list;
cout<<list; //prints all the elements of list
```

Next time

- Binary Search Trees