# Announcements

- FINAL EXAM Monday May 21, 1:30pm
- Review Session
  - Wednesday May 16, 7-9pm

# Recitation 12

Root Finding, Sorting, Stacks, Queues

# Outline

- Linked Lists
- Sorting
- Queues

# Object References

Let's start with a class called "Node"

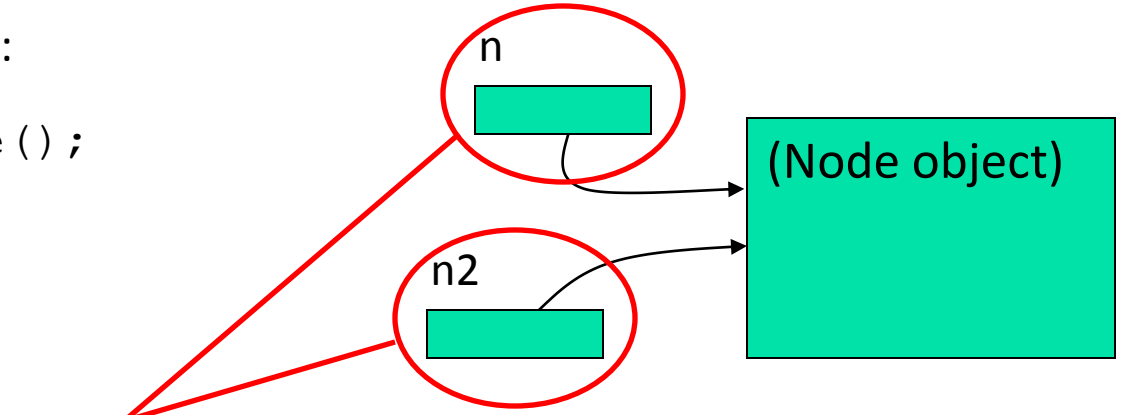
Node.java

```
class Node{

}
```

To create an instance of Node:

```
Node n = new Node();
Node n2 = n;
```




These are **object references**. Notice how there is only ONE object, and each reference "**refers**" to it.

# *Fun* with References

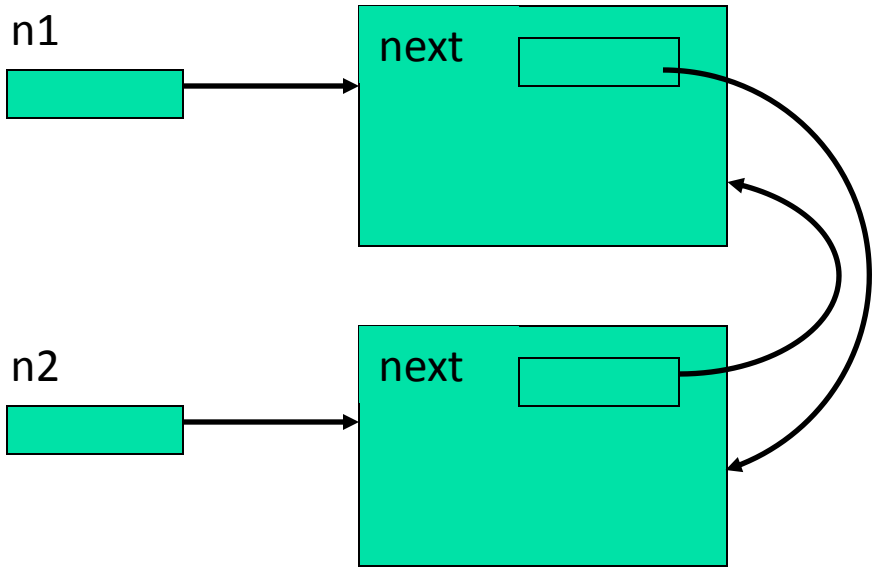
Let's add to our Node class

Node.java

```
class Node{
        Node next;
}
```

Now, let's use the following code:

```
Node n1 = new Node();
Node n2 = new Node();
n2.next = n1;
n1.next = n2;
```



# Serious Work with References

Let's add a data member to store some information.

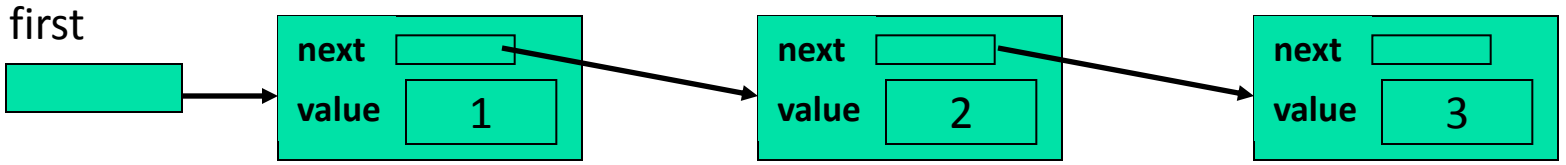
(It could be a primitive type or an object reference… or anything else you want)

Node.java

```
class Node{
        Node next;
        int value;
}
```

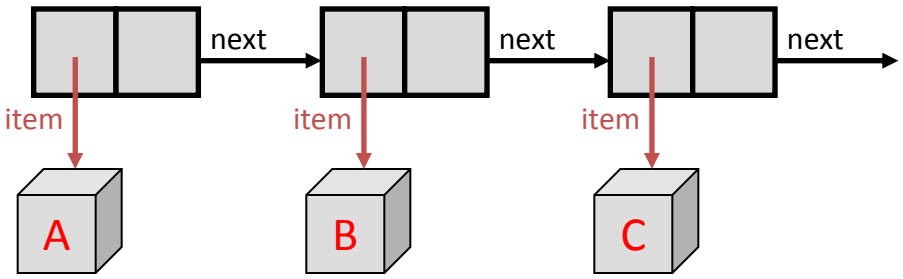
Now, let's use the following code:

```
Node first =  new Node();
first.value=1;
first.next =  new Node();
first.next.value=2;
first.next.next =  new Node();
first.next.next.value = 3;
```

# Linked Lists

- A linked list is made of a series of `Node`s, each with:
  - an associated **item** object
  - a reference to the **next** node of the list
- Simplified "double-box" picture:




- Traverse the list by following each node's "next" reference

# SLinkedList

For convenience, create a class with references to the first & last nodes, with methods, so we don't have to re-write the manipulation code each time.

Our original `Node` class

```
public class SLinkedList implements List{

    private int length = 0;
    private Node first = null;
    private Node last = null;

    private static class Node {
        Object item;
        Node next;
        Node( Object o, Node n ){ item = o; next = n; }
    }

    public int size() {/*code…*/}
    public boolean isEmpty() {/*code…*/}
    public boolean contains(Object o) {/*code…*/}
    public void clear() {/*code…*/}
    // various add() and remove() methods…
}
```

# What's so great about Linked Lists?

## BIG Pros:

- A Linked List can grow dynamically.
  (To resize an array you have to create a new, larger array, and copy everything over)
- A linked list does NOT need contiguous memory.
  (A Java 1-D array has to occupy contiguous memory. When storing large amounts of data, finding back-to-back-to-back… memory can be impossible)

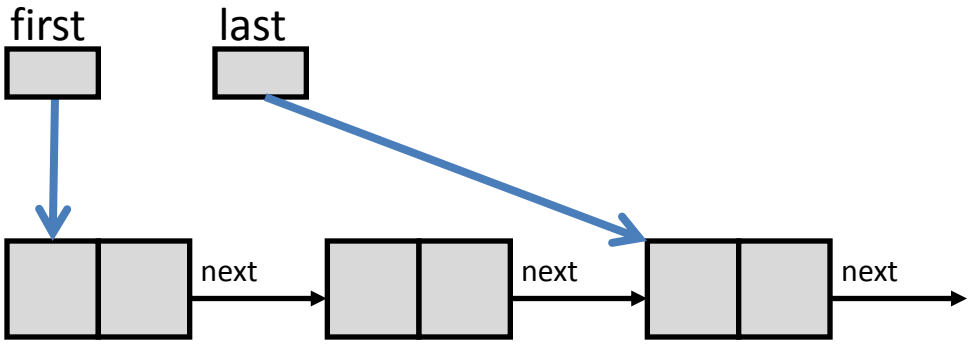
## Cons:

- The references add overhead.
- Access is slower than an array.
- The code to maintain a Linked List can be complex.
- Depending on how the 'links' (references) are structured, you may only be able to traverse one way…

# Linked List: Tips

- Always think of special cases
  - What if your list is empty?
  - What if there is only one element?

- Always draw a diagram!



# Sorting

- Sortable objects implement Comparable<Object> or have Comparator defined
- Comparable:
  - Define compareTo()
  - For `object.compareTo(other)`:
    - returns 1 if `other` higher ranked than `object`
    - returns 0 if equally ranked
    - returns -1 otherwise

# Sorting

- Comparator:
  - New class `Object1Object2Comparator`
  - Implements `Comparator<Object>`
  - Must define `compare()`. For `compare(a, b)`:
    - returns 1 if `b` higher ranked than `a`
    - return 0 if equally ranked
    - returns -1 otherwise

# Sorting Exercise

- Sort restaurants by rating (high to low) then distance (close to far)

```
public class Restaurant {
          String name;
          int rating;
          double distance;

          public Restaurant(String n, int r, double d){
                    name = n;
                    rating = r;
                    distance = d;
          }

          public String toString(){
                    return name + ": " + rating + "/5.0, " + distance + " meters away.";
          }
}
```

# Stacks and Queues

- Structures store, manage data
- For data with an inherent order
  - Think of structures like a line to get into a movie
- Stacks: people are added and removed from same end of line
  - Last person in an elevator is the first person out of the elevator
- FIFO Queue: people added to back of line, removed from front
  - *First In First Out*, the way you expect a ticket line to work

# Stacks

- Single end
- LIFO: Last In First Out
  - push(): add an element
  - pop(): remove top element
- Applications:
  - Simulation: robots, machines
  - Recursion: pending function calls
  - Reversal of data

# Stack Interface

```
import java.util.*;          // For exception

public interface Stack
{
    public boolean isEmpty();
    public void push( Object o );
    public Object pop() throws
              EmptyStackException;
    public void clear();
}
```

# Queues

- Two ends
- FIFO: First In First Out
  - push(): add an element to top
  - pop(): remove bottom element
- Applications:
  - Simulation: lines
  - Ordered requests: device drivers, routers, …
  - Searches

# Queue Interface

```
import java.util.*;

public interface Queue
{
    public boolean isEmpty();
    public void add( Object o );
    public Object remove() throws
      NoSuchElementException;
    public void clear();
}
```

# Exercise

- What is the final output?
  - Add {2, 4, 6, 8} to a stack #1
  - Remove three items from stack, place in queue
  - Remove two items from queue, place in stack #2
  - Remove one item from stack #2, place in queue
  - Remove one item from stack #1, place in stack #2

**Queue:**
**{6, 4}**

**Stack #2:**
**{2, 8}**

# Exercise

- Write a class to store a queue in a linked list
  - What happens when you remove the last object?
  - What happens when you try to remove an object from an empty list?

```
public interface Queue {

     public void enqueue(int item);              // add to end
     public int dequeue() throws Exception; // remove from front
}
```

1.00 / 1.001 / 1.002 Introduction to Computers and Engineering Problem Solving

Spring 2012