Announcements

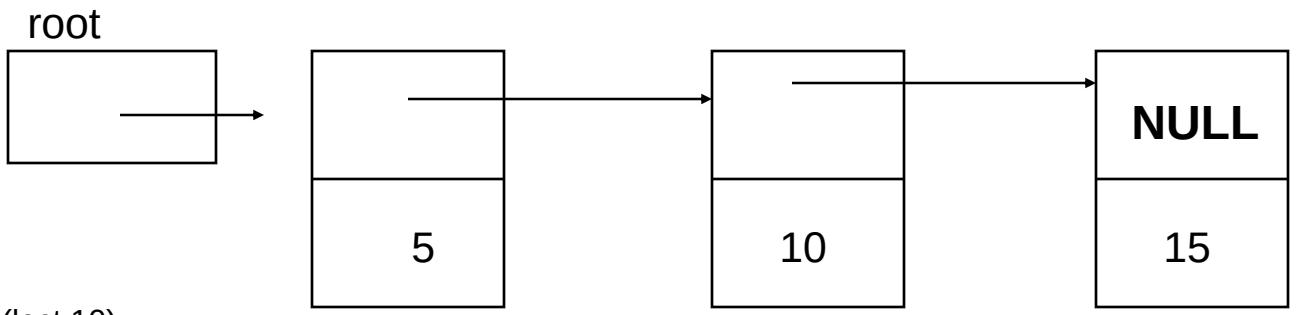
- Exam #1
  - Thursday, March 8, 6:00 – 7:30 in Armory 0126
- Program #2
  - Due today
- Reading
  - Chapter 12, 10.2

Linked Data Structures

- Like classes with refs to same class in Java
- Have pointers to a struct of the same type
- Example Declaration:

```
typedef struct NODE {
        struct NODE *next;
        int value;
} Node;
Node * root;
```

- next and root are pointers to Nodes

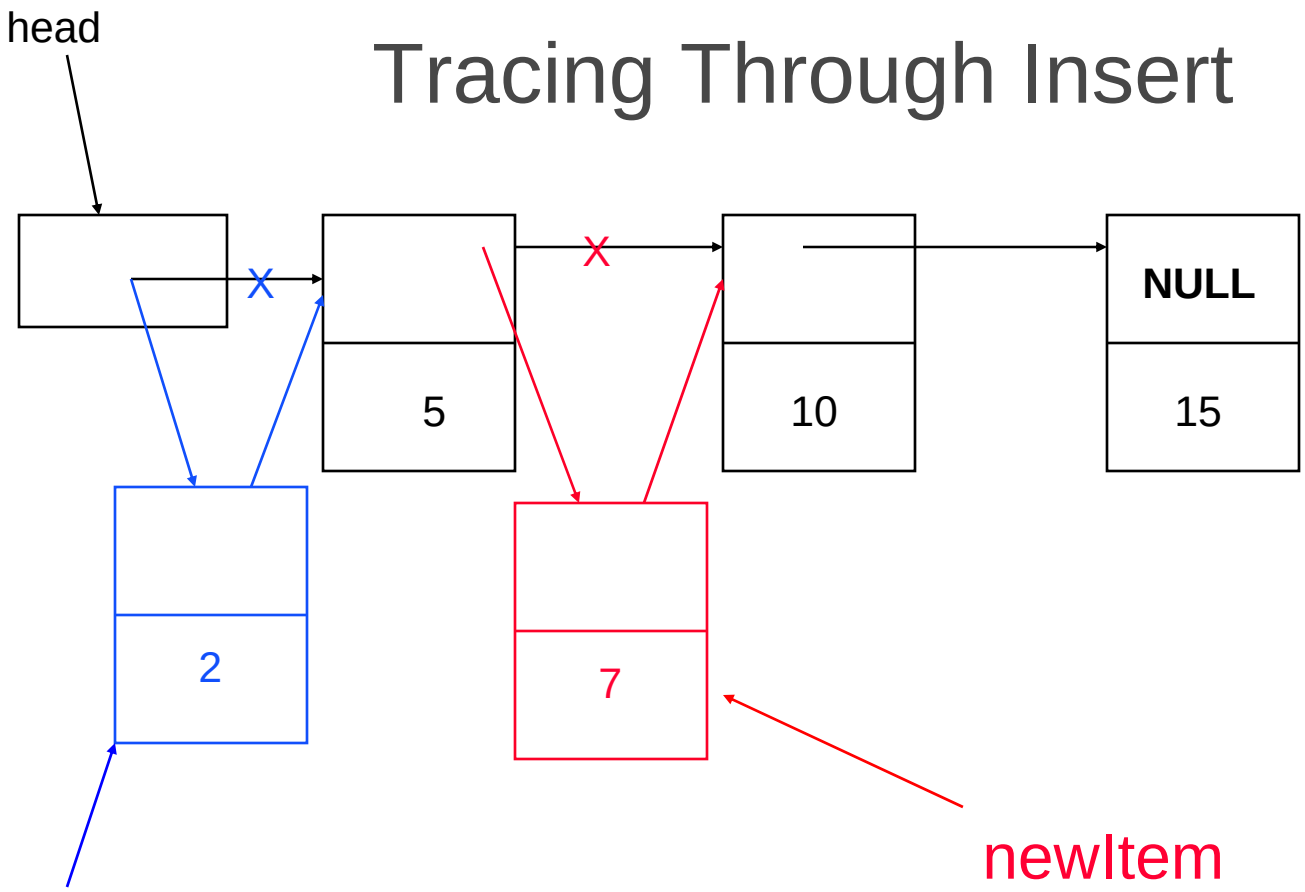


Finding a value in a Linked Structure

```
Node  *find(Node *current, int val) {
        while (current && current->value != val)  {
            current = current->next;
        }
        return current;
}
```

```
int IsIn(Node *current, int val) {
        while ((current != NULL) && ((current->value) != val))  {
            current = current->next;
        }
        if (current) {
            return 1;
        } else {
            return  0;
        }
}
```

Tracing Through Insert

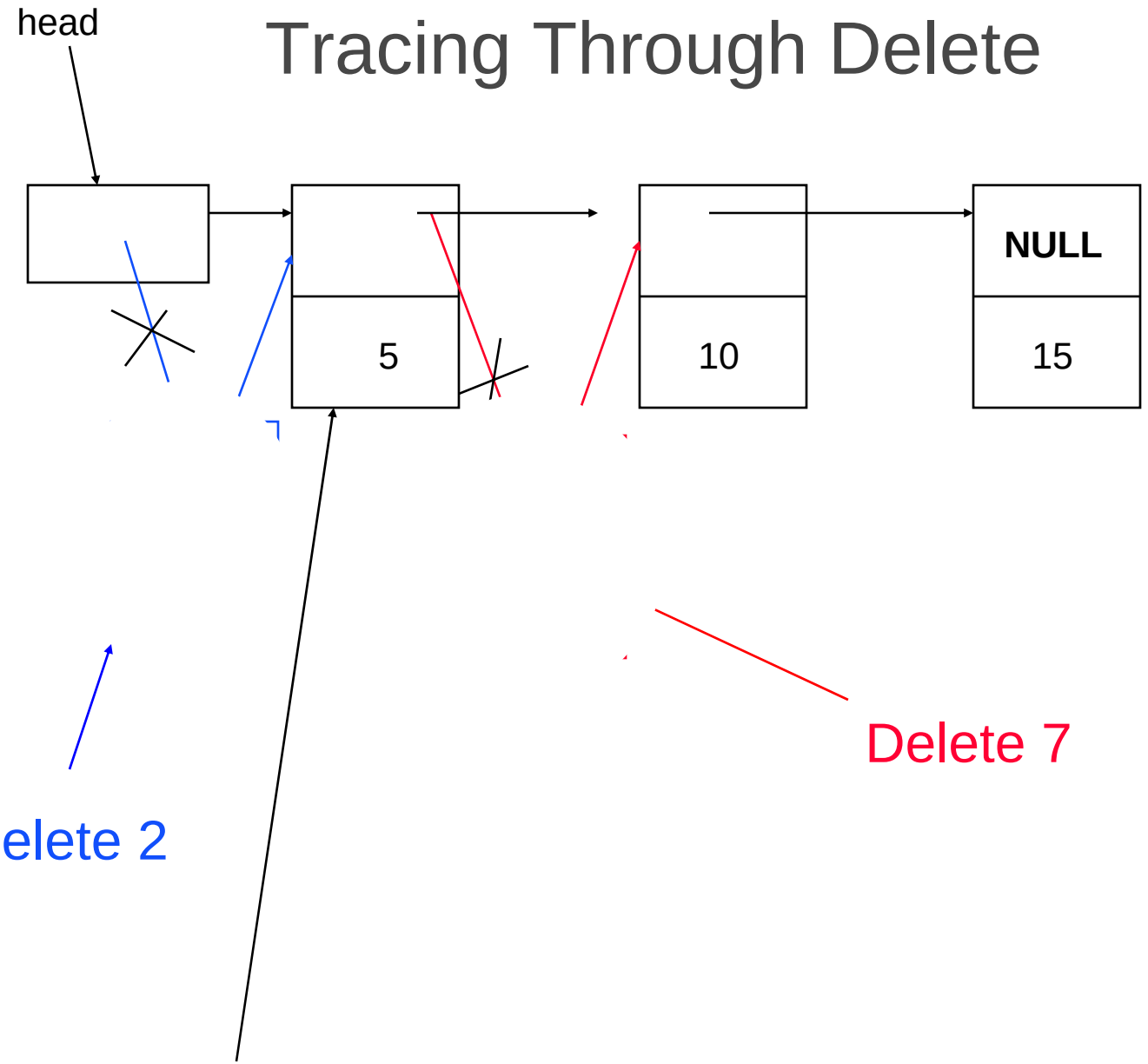


Inserting Into a Linked List

```
int insert(Node **head, int new_value) {
        Node *current = *head;
        Node *pred = NULL;
        Node *newItem;
        while (current && current->value < new_value)  {
            pred = current;
            current = current->next;
        }
        newItem = (Node *) malloc(sizeof(Node));
        if (!newItem) return -1;
        newItem->value = new_value;
        newItem->next = current;

        if (!pred) {
            *head = newItem;
        } else {
            pred->next = newItem;
        }
        return 0;
}
```

Tracing Through Delete



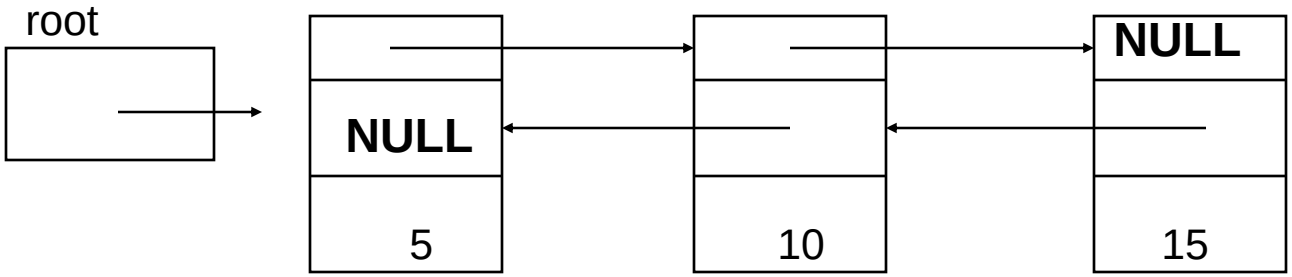
Deleting From A Single Linked List

```
int delete(Node **head, int new_value) {
        Node *pred = NULL;
        Node *current = *head;
        while (current && (current->value != new_value))  {
            pred = current;
            current = current->next;
        }
        if (!current) {
            return -1;        /* not found */
        }
        if (pred) {
            pred->next = current->next;
        } else {
            *head = current->next;  /* deleted first item */
        }
        free (current);
        return 0;
}
```

Doubled Linked Lists

- Each nodes
  - contains a value
  - a pointer the next **and** previous element
- Typical Declaration:

```
typedef struct NODE {
    struct NODE *next;
    struct NODE *prev;
    int value;
} Node;
```



Insert into a doubly Linked list

- Think about 4 cases:
  - **Middle of the list**
    - **Update previous element's next pointer**
      - **new node's previous pointer set to this node**
    - **Update next element's previous pointer**
      - **new node's next point set to that node**
  - **End of the list**
    - **Update previous element's next pointer**
      - **new node's previous pointer set to this node**
      - **new node's next pointer set to NULL**
  - **Start of the list**
    - **Update head of list**
    - **Update old head of list's previous element**
      - **new node's next pointer set to this node**
      - **new node's previous pointer set to NULL**
  - **An initially empty list**
    - **Update head of the list**
      - **new node's next and previous pointer both NULL**

Inserting Into A Doubly Linked List

```
int insert(Node **head, int new_value) {
        Node *pred = NULL, *newItem;
        Node *current = *head;
        while (current && current->value < new_value)  {
            pred = current;
            current = current->next;
        }
        newItem = (Node *) malloc(sizeof(Node));
        if (!newItem) return -1;
        newItem->value = new_value;
        newItem->next = current;
        newItem->prev = pred;
        if (!pred) {
            *head = newItem;
        } else {
             pred->next = newItem;
        }
        if (current) {
           current->prev = newItem;
        }
}
```

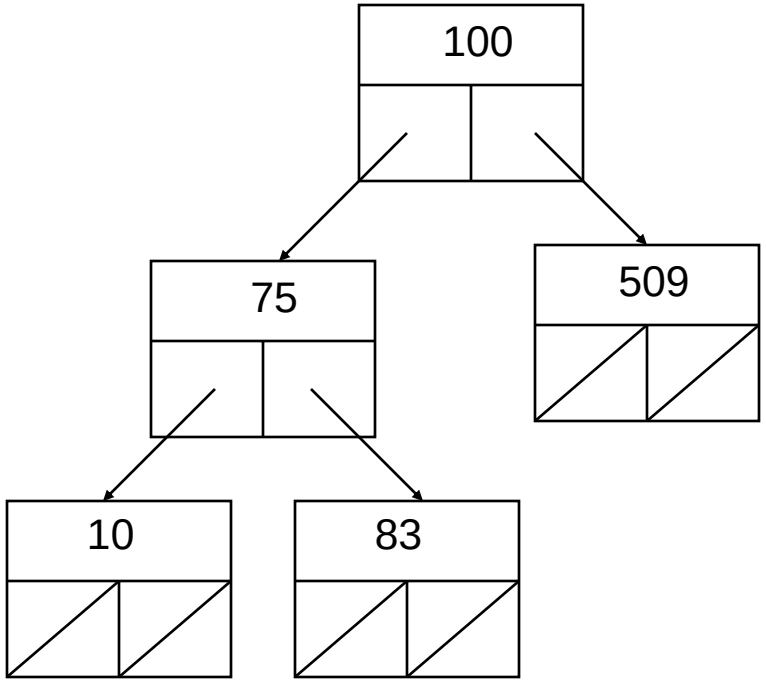
Deleting from a Doubly Linked List

```
int delete(Node **head, int new_value) {
        Node *pred = NULL;
        Node *current = *head;
        while (current && (current->value != new_value))  {
              pred = current;
              current = current->next;
        }
        if (!current)     return -1;   /* not found */
        if (pred) {
            pred->next = current->next;
        } else {
           *head = current->next;  /* deleted first item */
        }
        if (current->next) {
            current->next->prev = pred;
        }
        free (current);
        return 0;
}
```

Binary Trees

- Each node
  - contains a value
  - a pointer a left child and a right child
- Typical Declaration:

```
typedef struct NODE {
    struct NODE *left;
    struct NODE *right;
    int value;
} Node;
```



Lookup In A Binary Search Tree

- If the element is less than the current node
  - Look in the left child tree
- If the element is greater than current node
  - Look in the right child tree
- Example:

```
int Lookup(Node *root, int value) {
    if (!root) return -1;
    if (root->value == value) {
        return 1;
    } else if (root->value > value) {
        return Lookup(root->left, value);
    } else {
        return Lookup(root->right, value);
    }
}
```

Insert Into a Binary SearchTree

```
int insert(Node **root, int value)
{
    Node *new;
    if (!(*root)) {
        new = (Node *) malloc(sizeof(Node));
        if (!new) return -1;
        *root = new;
        new->left = new->right = NULL;
        new->value = value;
        return 0;
    } else if ((*root)->value > value) {
            return insert(&((*root)->left), value);
    } else {
            return insert(&((*root)->right), value);
    }
}
```