COMP2521: Recursion (Linked List)

Term: 20T1

[Credits: Lecture slides from COMP1511 (18s2)]

Recursion

- **Recursion** is a programming pattern where a function calls ***itself***
- For example, we define *factorial* as below,

  n! = 1*2*3* … *(n-1)*n
- We can ***recursively*** define *factorial* function as below,

  f(n) = 1 , if (n=0)

  f(n) = n * f(n-1) , for others

Pattern for a Recursive function

- Base case(s)
  - Situations when we **do not** call the same function (no recursive call), because the problem can be solved easily without a recursion.
  - All recursive calls eventually lead to one of the base cases.
- Recursive Case
  - We **call** the **same function** for a problem with ***smaller size***.
  - Decrease in a problem size eventually leads to one of the base cases.

```
// return sum of list data fields: using recursive call

int sum(struct node *head) {
    if (head == NULL) {
        return 0;
    }
    return head->data + sum(head->next);
}
```

Base case

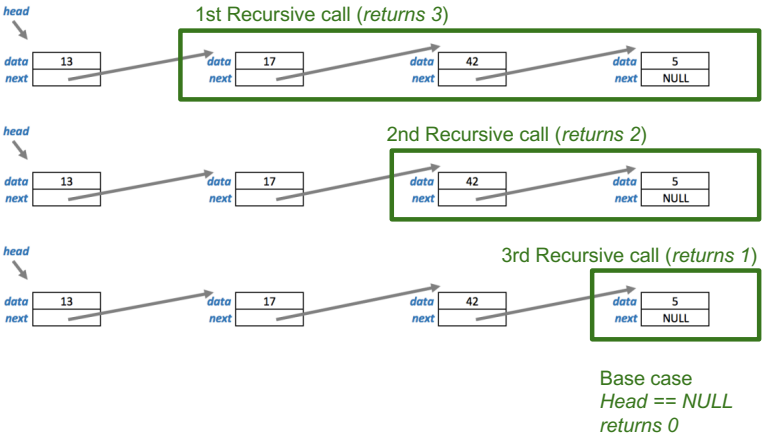
Recursive case, Recursive call for a smaller problem (size-1)

Linked List with Recursion

```
// return count of nodes in list

int length(struct node *head) {
    if (head == NULL) {
        return 0;
    }
    return 1 + length(head->next);
}
```

Recursive call

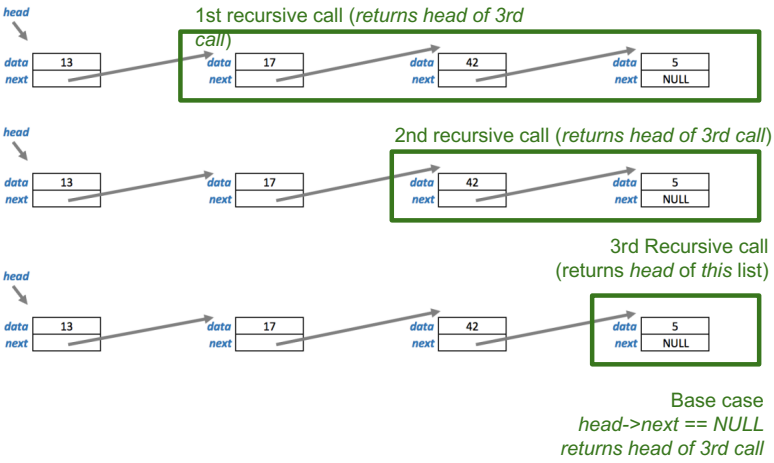


Base case
Head == NULL
returns 0

Last Node using Recursion

```
struct node *last(struct node *head) {
    // list is empty
    if(head == NULL) {
        return NULL;
    }
    // found the last node! return it.
    else if (head->next == NULL) {
        return head;
    }
    // return last node from the rest of the list
    // using a recursion
    else {
        return last(head->next);
    }

}
```



Find Node using Recursion

```
// return pointer to first node with specified data value
// return NULL if no such node

struct node *find_node(struct node *head, int data) {
    // empty list, so return NULL
    if (head == NULL) {
        return NULL;
    }
    // Data at "head" is same as the "data" we are searching,
    // Found the node! so return head.
    else if (head->data == data) {
        return head;
    }
    // Find "data" in the rest of the list, using recursion,
    // return whatever answer we get from the recursion
    else {
        return find_node(head->next, data);
    }

}
```

Recursive call

Delete From List using Recursion

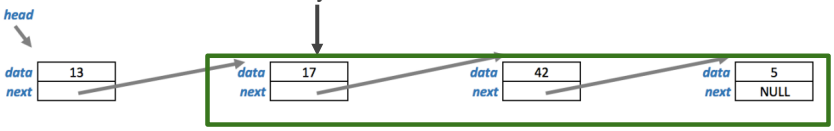
```
// Delete a Node from a List: Recursive
struct node *deleteR(struct node *list, int value) {
   if (list == NULL) {
      fprintf(stderr, "warning: value %d is not in list\n", value);

   } else if (list->data == value) {
      struct node *tmp = list;
      list = list->next;        // remove first item
      free(tmp);

   } else {
      list->next = deleteR(list->next, value);
   }
   return list;
}
```

Recursive call

Say we want to delete value == 17



1st recursive call (node to delete is same as "head" of this call, *returns updated list, pointing to node with 42)*

Linked List with Recursion

```
// Insert a Node into an Ordered List: recursive
struct node *insertR(struct node *list, int value) {
   if (list == NULL || list->data >= value) {

      struct node *newHead = create_node(value, NULL);
      newHead->next = list;
      return newHead;

      // Alternatively, in one line
      // return create_node(value, list) ;
   }

   list->next = insertR(list->next, value);

   return list;
}
```

Recursive call

Print Python List using Recursion

Recursive function

Recursive call

```c
// print contents of list in Python syntax

void print_list(struct node *head) {
    printf("[");
    if (head != NULL) {
        print_list_items(head);
    }
    printf("]");
}

void print_list_items(struct node *head) {
    printf("%d", head->data);
    if (head->next != NULL) {
        printf(", ");
        print_list_items(head->next);
    }
}
```