

CSCA48 Final Review

Unit 1

- was developed by Dennis M. Ritchie in early 1970's
- unlike python, C does not have an interactive mode.

comments: /* */ or //

data type: unlike python, once associated a data type with specific variable, the type cannot be changed.

int char (one character)
double/float void (no data type attached)

Basic Structure:

importing a library, we use the '#include<>' statement

#include<stdlib.h> — standard C library

#include<stdio.h> — standard input/output library

main() {

int x;

double y;

char one-character;

program - statement - 1; Every statement ends in ;

program - statement - 2;

f1(1, 2, 3); — a sample function call }

few notes on printf()

printf("... formatting string...", var1, var2, ..., varN, separator);

Formatting options:

%d — Prints a decimal (integer) number

%f — Prints a float point number

%c — Prints a single character

%s — Prints a string

%g — Prints a floating point number using scientific notation

%p — Prints a pointer (this will be formatted as a hexadecimal value)

\n — New line

\t — Print a 'tab'

\% — Print a '%' symbol

\\ — Print a '\' symbol

e.g. printf("My variables are: %d, %f, %s\n", a, b, c);

My variables are: 10, 3.1415, Hello world

eg int x=3.14
printf("%d", x);
output: 190300824

ex.

```
int i, j; // We can declare variables  
// line, separator  
for (i=0; i<10; i=i+1)  
{  
    for (j=0; j<i; j=j+1)  
    {  
        printf("%d, ", j);  
    }  
    printf("\n");  
}
```

output:

```
0,  
0, 1,  
0, 1, 2,  
:  
0, 1, 2, ..., 8,
```

|| logical or
&& logical and
! logical not

Unit 2

- Declaring a variable does not initialize it or set it to 0
- Memory is assigned based on what there is a box of right size that is empty (might contain junk)
(different data types need different amount of space)

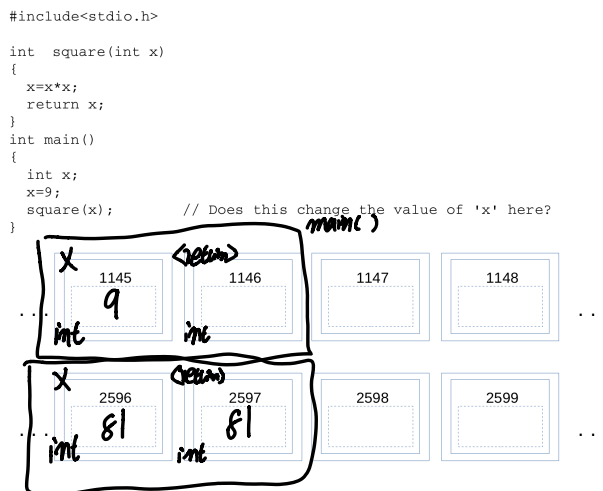
function declaration:

```
int square(int x)
{
}
```

when function call done its job, memory releases.

- each function has its own space and cannot be directly accessed by any other code.
- Passing argument makes a copy.

Ex



local variable vs global variables



```
int x= 6;
float y= 9.1;
printf("%f", x)
printf("%d", y)
```

resulte ??? ?

This is Not type case

```
int x=3;
float y;
y=x;
printf("%f", y)
```

resulte 3.000000
6 0s

This is type case

```
float x=9.9999;
int y;
y=x;
printf("%d", y)
```

resulte 9

This is a type case
(dropping the fractional part)

int my_array[10] // an array of 10 integer values

where my_array[0] is the first entry

my_array[9] is the last entry

reserves consecutive box and the size is fixed and same type

print a str without strcpy

```
char a_string[1024];
```

```
a_string[0]='H';
a_string[1]='e';
a_string[2]='l';
a_string[3]='l';
a_string[4]='o';
a_string[5]='\0';
```

```
printf("%s\n", a_string);
```

Will produce:

Hello

print a str with strcpy

```
#include<stdio.h>
#include<string.h> // - This is the C library for string management
```

```
int main()
{
    char a_string[1024];
```

```
char a_string[1024];
```

```
// Let's initialize a string - we can do that with the strcpy() function
strcpy(a_string, "This is a message for those learning C\n");
```

```
// Let's now concatenate another string to what we already have
strcat(a_string, "Don't forget to practice using strings!\n");
```

```
// Let's print out what we have stored
```

```
printf("%s\n", a_string);
}
```

```
...\\a.exe
```

```
This is a message for those learning C
Don't forget to practice using strings!
```

strcpy

strcat

strlen()

strncpy()

Pointer

```
#include<stdio.h>

int main()
{
    int my_int;
    int *p=NULL;    // A pointer to an int!

    my_int=10;
    printf("My int is: %d\n",my_int);

    my_int=15;
    printf("My int is: %d\n",my_int);

    p=&my_int;
    *(p)=21;
    printf("My int is: %d\n",my_int);
}
```

If you compile and run the above, you get:

```
\a.out
My int is: 10
My int is: 15
My int is: 21
```

pointer to arrays

```
#include<stdio.h>

void square_array(int array[10])
{
    int j;

    for (j=0; j<10; j=j+1)
    {
        array[j]=array[j]*array[j];
    }
}

int main()
{
    int my_array[10];
    int i;

    for (i=0; i<10; i=i+1)
    {
        my_array[i]=i;
    }

    square_array(my_array); Passing a pointer

    for (i=0; i<10; i=i+1)
    {
        printf("%d squared equals %d\n",i,my_array[i]);
    }
}
```

pointer arithmetic (since memory box is consecutive)

```
#include<stdio.h>

int main()
{
    int array[10];
    int *p=NULL;

    p=&array[0];    // Get address of the first entry in the array

    *(p+0)=5;       // Set the contents of array[0] to 5
    *(p+4)=10;      // Set the contents of array[4] to 5

    printf("array[0] is %d, array[4] is %d\n",array[0],array[4]);
}
```

in array, the name of the array is equivalent to a pointer to the first entry in the array

You should always make sure that:

- Pointers are initialized to *NULL* when you declare them - this will save you no end of trouble as you can check whether the pointer has actually been assigned to something or not.
- Every function that receives a pointer as a parameter **must check** that the input pointer is not *NULL*. You can not access a *NULL* pointer and trying to do so will crash your program.
- When using pointers and offsets to access data, you must ensure the offsets used are within bounds for the array you're indexing into.

Unit 3

```
#define MAX_STRING_LENGTH 1024
```

two compound data type cannot be compared

Getting User input

— Numeric types (ints and floats)

```
int x, y;  
float pi;
```

```
{ scanf("%d %d %f", &x, &y, &pi);  
  getchar ;
```

usually come together

— strings

```
char stringy[1024];
```

```
fgets(stringy, 1024, stdin);
```

name max number standard input

in the case, fgets read 1023 chars since the last should be '\0'

List Abstract Data Type (List ADT)

- Declaring a new (empty) list
 - Adding items to an existing list
 - Removing items from a list
 - Searching for a specific data item
- since it does not specify how the operations are implemented.

Creating node on-demand is called dynamic memory allocation

```

/*
CSC A48 - Unit 3 - Containers, ADTs, and Linked Lists

This program implements a linked list of restaurant reviews.
The program allows the user to enter as many reviews as needed,
to print the existing reviews, and when finished, it releases
all memory allocated to the list before exiting.

(c) 2018 - F. Estrada & M. Ahmadzadeh.
*/

```

```

#include<stdio.h> standard input output .h
#include<stdlib.h> standard library .h
#include<string.h>

```

```

#define MAX_STRING_LENGTH 1024

```

```

typedef struct Restaurant_Score
{
    char restaurant_name[MAX_STRING_LENGTH];
    char restaurant_address[MAX_STRING_LENGTH];
    int score;
}

```

Review; Type

```

typedef struct Review_List_Node
{
    Review rev;
    struct Review_List_Node *next;
}

```

Review_Node; Type

```

Review_Node *new_Review_Node(void) no input and returns a pointer.
{
    Review_Node *new_review=NULL;           // Pointer to the new node

    new_review=(Review_Node *)calloc(1, sizeof(Review_Node));
                                type case                                type

    // Initialize the new node's content with values that show
    // it has not been filled. In our case, we set the score to -1,
    // and both the address and restaurant name to empty strings ""
    // Very importantly! Set the 'next' pointer to NULL

    new_review->rev.score=-1;
    strcpy(new_review->rev.restaurant_name,"");
    strcpy(new_review->rev.restaurant_address,"");
    new_review->next=NULL;
    return new_review;
}

```

calloc C ?
1. find available place
2. reverse space
3. wipes-out junk
4. return pointer

*} initialize
(wipes-out junk)*

```

Review_Node *insert_at_head(Review_Node *head, Review_Node *new_node)
{
    // This function adds a new node at the head of the list.
    // Input parameters:
    //     head : The pointer to the current head of the list
    //     new_node: The pointer to the new node
    // Returns:
    //     The new head pointer

    new_node->next=head;
    return new_node;
}

void print_reviews(Review_Node *head)
{
    Review_Node *p=NULL; // Traversal pointer

    p=head;              // Initialize the traversal pointer to
                          // point to the head node
    while (p!=NULL)
    {
        // Print out the review at this node
        printf("*****\n");
        printf("Restaurant Name: %s\n",p->rev.restaurant_name);
        printf("Restaurant Address: %s\n",p->rev.restaurant_address);
        printf("Restaurant Score: %d\n",p->rev.score);
        printf("*****\n");
        // Update the traversal pointer to point to the next node
        p=p->next;
    }
}

void delete_list(Review_Node *head)
{
    Review_Node *p=NULL;
    Review_Node *q=NULL;

    p=head;
    while (p!=NULL)
    {
        q=p->next;
        free(p);
        p=q;
    }
}

```

```

Review_Node *delete_by_name(Review_Node *head, const char name_key[])
{
    // This function removes the node from the link list that contains the
    // review with a matching restaurant name.

    Review_Node *tr=NULL;
    Review_Node *pre=NULL;

    if (head==NULL) return NULL;    // Empty linked list!

    // Set up the predecessor and traversal pointers to point to the first
    // two nodes in the list.
    pre=head;
    tr=head->next;

    // Check if we have to remove the head node
    if (strcmp(head->rev.restaurant_name, name_key)==0)
    {
        free(pre);    // Delete the first node in the list
        return tr;    // Return pointer to the second node (new head!)
    }

    while(tr!=NULL)
    {
        if (strcmp(tr->rev.restaurant_name, name_key)==0)
        {
            // Found the node we want to delete
            pre->next=tr->next;    // Update predecessor pointer
            free(tr);            // remove node
        }
        tr=tr->next;
        pre=pre->next;
    }
}

Review_Node *search_by_name(Review_Node *head,\
                           const char name_key[MAX_STRING_LENGTH])
{
    // Look through the linked list to find a node that contains a
    // review for a restaurant whose name matches the 'name_key'
    // If found, return a pointer to the node with the review. Else
    // return NULL.

    Review_Node *p=NULL; // Traversal pointer

    p=head;
    while (p!=NULL)
    {
        if (strcmp(p->rev.restaurant_name,name_key)==0)
        {
            // Found the key!
            return p;
        }
        p=p->next;
    }
    return NULL;    // The search key was not found!
}

```

```

int main()
{
    Review_Node *head=NULL;
    Review_Node *one_review=NULL;
    char name[MAX_STRING_LENGTH];
    char address[MAX_STRING_LENGTH];
    int score;
    int choice=1;

    while (choice!=4)
    {
        printf("Please choose one of the following:\n");
        printf("1 - Add a new review\n");
        printf("2 - Print existing reviews\n");
        printf("3 - Update review for one restaurant\n");
        printf("4 - Exit this program\n");

        scanf("%d",&choice);
        getchar();

        if (choice==1)
        {
            // Get a new review node
            one_review=new_Review_Node();

            // Read information from the terminal to fill-in this review
            printf("Please enter the restaurant's name\n");
            fgets(name, MAX_STRING_LENGTH, stdin);
            printf("Please enter the restaurant's address\n");
            fgets(address, MAX_STRING_LENGTH, stdin);
            printf("Please enter the restaurant's score\n");
            scanf("%d",&score);
            getchar();

            // Fill-in the data in the new review node
            strcpy(one_review->rev.restaurant_name,name);
            strcpy(one_review->rev.restaurant_address,address);
            one_review->rev.score=score;

            // Insert the new review into the linked list
            head=insert_at_head(head,one_review);
        }
        else if (choice==2)
        {
            print_reviews(head);
        }
        else if (choice==3)
        {
            printf("Which restaurant's score do you want to update?\n");
            fgets(name,MAX_STRING_LENGTH,stdin);
            one_review=search_by_name(head,name);
            if (one_review==NULL)
            {
                printf("Sorry, that restaurant doesn't seem to be in the
list\n");
            }
            else
            {
                printf("Please enter the new score for the restaurant\n");
                scanf("%d",&one_review->rev.score);
                getchar();
            }
        }

        // User chose #3 - Release memory and exit the program.
        delete_list(head);
        return 0;
    }
}

```

Bitwise operation

- only integers
- $\&$ and $\begin{array}{c} 11 \\ 10 \\ 10 \\ 10 \\ 11 \end{array}$
- $|$ or $\begin{array}{c} 11 \\ 10 \\ 10 \\ 11 \end{array}$
- $\wedge$ exclusive or $\begin{array}{c} 10 \\ 01 \\ 11 \end{array}$ $\begin{array}{c} 11 \\ 00 \end{array}$
- $\ll$ shift
- $\gg$
- $\sim$ $\sim \begin{array}{c} 10010 \\ 01101 \end{array}$

Unit 4

Bubble sort: $O(N^2)$

Quick sort: average $O(N \log N)$ worst $O(N^2)$

Bst_Node *BST_insert(root, new_review)

```
{
    if (root == NULL) return new_review;
    if (strcmp(new_review->rev.name, root->rev.name) < 0)
    {
        root->left = insert(root->left, new_review);
    }
    else
    {
        root->right = insert(root->right, new_review);
    }
    return root;
}
```

BST-Node * BST_search(BST-Node *root, name[1024])

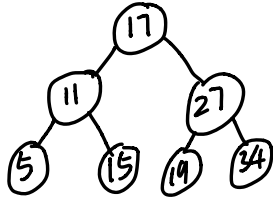
```
{  
    if (root == NULL) return NULL;  
    if (strcmp(root->key.name, name) == 0)  
    {  
        return root;  
    }  
    if (strcmp(name, root->key.name) < 0)  
    {  
        return BST_search(root->left, name);  
    }  
    else  
    {  
        return BST_search(root->right, name);  
    }  
}
```

BST-Node * find_successor(BST-Node * right-child)

```
{  
    BST-Node* p = NULL;  
    p = right-child->left;  
    while (p->right != NULL)  
    {  
        p = p->right;  
    }  
    return p;  
}
```

BST_Node *BST_delete (BST_Node *root, char name[24])

```
{
    BST_Node * tmp = NULL;
    if (root == NULL) return NULL;
    if (strcmp (root->rev.name, name) == 0)
    {
        if (root->left == NULL && root->right == NULL)
        {
            free (root);
            return NULL;
        }
        else if (root->right == NULL)
        {
            tmp = root->left;
            free (root);
            return tmp;
        }
        else if (root->left == NULL)
        {
            tmp = root->right;
            free (root);
            return tmp;
        }
        else
        {
            tmp = find_successor (root->right);
            root->rev.name = tmp->rev.name;
            root->right = BST_delete (root->right, tmp->rev.name);
            return root;
        }
    }
    if (strcmp (name, root->rev.name) < 0)
        root->left = BST_delete (root->left, name);
    else
        root->right = BST_delete (root->right, name);
    return root;
}
```



in-order 5 11 15 17 19 27 34 from left to right →
 pre-order 17 11 5 15 27 19 34 ↓ created a copy
 post-order 5 15 11 19 34 27 17 ↑ delete a BST

Unit 5

	Adjacency list	Adjacency matrix
PROS	space efficient when large V small E	No need to traversal, easy access
CONS	traversal list might be slow	Not space efficient
check 2 node connect	$O(V)$	$O(1)$
insert node	$O(1)$	$O(V^2)$
remove node	$O(E)$	$O(V^2)$
insert edge	$O(1)$	$O(1)$
remove edge	$O(V)$	$O(1)$

Sort an array

① split 1st one every time *heap sort*

N split and N merge results $O(N^2)$

② random *quick sort*

$O(N \log N)$: $\log N$ split N merge or $O(N^2)$

③ half *merge sort*

$O(N \log N)$:

DFS and BFS

Unit 6

good property

- Modularity (individual module; easy to debug; easy to understand)
- Reusability (high chances to be reused)
- Extensibility (easy to extend)
- Maintainability (be organized)
- Correctness (thoroughly tested)
- Efficiency (good algorithm)
- Openness (when possible, contribute)
- Privacy and security

Object Oriented Programming

data in class : member variables

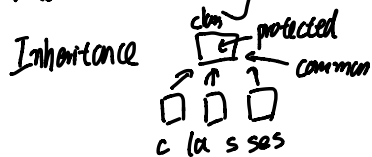
functions in class: class methods

```
typedef struct ListNodeStruct
{
    char string[1024];
    struct ListNodeStruct *next;
} ListNode;

class StringList
{
    // Member variables
private:
    ListNode *head;
    int list_length;

    // Class methods
public:
    StringList()
    {
        head=NULL;
        list_length==0;
    }
    ~StringList();
    void insert_string(char string[1024]);
    void delete_string(char string[1024]);
    ListNode search(char string[1024]);
    void clear_list();
    int get_length();
private:
    void set_length(int l);
};
```

Method Overloading (multiple version)



polymorphism

```

BST_Node *insert(root, new_node)
{
    if (root == NULL) return new_node;
    if (strcmp(new_node->rev_name, root->rev_name) <= 0)
        root->left = insert(root->left, new_node);
    else
        root->right = insert(root->right, new_node);
    return root;
}
  
```

```

BST_Node* search(root, name[100])
{
    if (root == NULL) return NULL;
    if (strcmp(root->rev_name, name) == 0)
        return root;
    if (strcmp(name, root->rev_name) < 0)
        return search(root->left, name);
    else
        return search(root->right, name);
}
  
```

```

BST_Node *find-successor(right-children)
{
    BST_Node *p = NULL;
    p = right-children;
    while (p->left != NULL)
        p = p->left;
    return p;
}
  
```

```

BST_Node *delete (root, name[1024])
{
    BST_Node *tmp = NULL;
    if (root == NULL) return NULL;

    if (strcmp (root->rev.name, name) == 0)
        if (root->left == NULL && root->right == NULL)
            free (root);
            return NULL;
        else if (root->left == NULL)
            tmp = root->right;
            free (root);
            return tmp;
        else if (root->right == NULL)
            tmp = root->left;
            free (root);
            return tmp;
        else
            tmp = find_successor (root->right);
            strcpy (root->rev.name, tmp->rev.name);
            :
            root->right = delete (root->right, tmp->rev.name);
            return root;

    if (strcmp (name, root->rev.name) < 0)
        root->left = delete (root->left, name);
    else
        root->right = delete (root->right, name);

    return root;
}

```

void in_order (root)

```

in_order (root->left);
printf "...";
in_order (root->right);

```