

CS19001: Programming and Data Structures Laboratory

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http://cse.iitkgp.ac.in/~aritrah/course/lab/PDS/Autumn2018/CS19101_PDS-Lab_Autumn2018.html

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Tutorial

Pointers and Dynamic Memory Allocation

Pointers

VARIABLE that stores memory address

```
void main(){
    int i;
    int *ptr; //pointer to an int

    i = 4; /* store the value 4 into the
    memory location associated with i */
    ptr = &i; /* store the address of i
    into the memory location associated
    with ptr */
    *ptr = *ptr + 1;
    printf(    %d\ n    , i);    //i=5
}
```

More examples

- argument for scanf()

```
scanf("%d %d", &data1, &data2);
```

Pass address of variable where you want result stored

- Declarations: (all have same meaning)

```
int* x, y;
```

```
int *x, y;
```

```
int *x; int y;
```

The * operator binds to the variable name, not the type

Relationship between Arrays and Pointers

An array name is essentially a pointer to the first element in the array

```
char data[10];  
/* data = addr where first element  
is located = &data[0] */  
char *cptr;  
cptr = data; /* points to data[0] */
```

Pointers and Arrays

```
char data[10];  
/* data = addr where first element  
is located = &data[0] */
```

data	&data[0]
(data + n)	&data[n]
*data	data[0]
*(data + n)	data[n]

Pointers and Arrays

```
int main(void) {  
int a[N] = {84, 67, 24, ...};  
/*  
&a[0] = a+0 = D000  
&a[1] = a+1 = D004  
&a[2] = a+2 = D008  
  
a[0] = *a      = 84  
a[1] = *(a+1) = 67  
a[2] = *(a+2) = 24  
*/  
  
return 0;  
}
```

Passing Pointers as Function Arguments

Alter variables outside a function's own scope

```
void swap(int *first, int *second);
int main(){
    int a = 4, b = 7;
    printf("pre-swap: a=%d, b=%d\n", a, b)
    swap(&a, &b);
    printf("post-swap: a=%d, b =%d\n", a, b)
    return 0;
}

void swap(int *first, int *second){
    int temp;
    temp = *first;
    *first = *second;
    *second = temp;
}
```

Passing Pointers as Function Arguments

```
void swap(int *first, int *second);
int main(){
    int a = 4, b = 7;
    printf("pre-swap: a=%d, b=%d\n", a, b)
    swap(&a, &b);
    printf("post-swap: a=%d, b =%d\n", a, b)
    return 0;
}

void swap(int *first, int *second){
    int temp;
    temp = *first;
    *first = *second;
    *second = temp;
}
```

The address-of operator (&) is used to pass the address of the two variables rather than their values

Passing Array as Function Argument

```
#define N 64
int average(int b[], int n) {
    int i, sum; // same as int *b
    //receives the value D000 from main
    for (i = 0; i < n; i++)
        sum += b[i];
    return sum / n;
}
int main(void) {
    int a[N] = {84, 67, 24, ..., 89, 90};
    printf("%d\n", average(a, N));
    return 0; //passes &a[0] = D000
}
```

Advantage? working with subarray

```
#define N 64
int average(int b[], int n) {
    int i, sum; // same as int *b
    //receives the value D000 from main
    for (i = 0; i < n; i++)
        sum += b[i];
    return sum / n;
}
int main(void) {
    int a[N] = {84, 67, 24, ..., 89, 90};
    printf("%d\n", average(a+5, 10));
    return 0; //passes &a[5] = D020
}
```

- compute average of a[5] through a[14]

Dynamic memory allocation

```
#include <stdio.h>
#include <stdlib.h>
int max(int a[], int c, int *b);
int main(){
    int i, j, m, *a;
    printf("enter number of elements\n");
    scanf("%d",&i);
    a=(int *)malloc(i * sizeof(int));
    for(j=0;j<i;j++){
        printf("enter element no. %d:",j);
        scanf("%d", &a[j]);
    }
    m=max(a, i, &j); // next slide
    printf("Max value is %d stored in a[%d]\n",m,j);
    return 0;
}
```

Returning multiple values

```
int max(int *a, int i, int *j)
{
    int k, max=-32767;
    for (k=0; k<i; k++)
    {
        if (a[k]>max)
        {
            max=a[k];
            *j=k;
        }
    }
    return(max);
}
```

Programming Assignments

Complete and submit during lab

Assignment 1: [Mind-Your-Words]

- Initialize a 2-d character array comprising 20 rows and 30 columns. Read up 20 words from the keyboard and store them.
- Lexicographically sort the 2-d array and print all the words in that order.
- Display the number of words that are of length between 1-2 letters, 3-5 letters, larger than 5 letters.
- Find and display the distribution (percentage) of the letters a to z in proper format by considering all the words together.
- Find all duplicate words, remove them, bring the succeeding words forward and display the updated sorted list of words.

Assignment 2: [Target Standard Deviation]

Recall that (for five data points a, b, c, d, e)

- Arithmetic mean $AM = \frac{(a+b+c+d+e)}{5}$

- Standard deviation $SD = \sqrt{\frac{a^2+b^2+c^2+d^2+e^2}{5} - (AM)^2}$

Implement a C function

```
int standard_dev(int a[ ], int i, int k, double m, int *n)
```

which takes as argument a pointer to an integer sequence of length i . The function computes how many k length subsequences exist in the overall i length sequence for which the standard deviation (SD) is $\geq m$ and returns the value. The function writes the starting index of the k length subsequence whose SD is maximum to the memory location pointed to by n .

Assignment 2: [Target Standard Deviation]

Write a main() which

- declares an integer pointer, asks the user for an input size (i), dynamically allocates memory to the pointer, takes as input i integers and stores in the allocated memory.
- requests the user to provide values for k (subsequence size) and m (SD value).
- reports back the no. of k length subsequences for which the standard deviation (SD) is $\geq m$ and the starting index of the k length subsequence whose SD is maximum.

Assignment 3: [String Orientation]

Implement the following C functions

- `int string_order(char *s)` which takes as input a character pointer 's' and returns '1' if 's' is pointing to a string which is alphabetically ordered. The function assumes that the string contains all characters in lower case.
- `int sub_string_order(char *s, int k)` which takes as input a character pointer 's' and an integer k , finds out how many alphabetically ordered substrings of size k exist in the string pointed to by 's' and returns the value.

Assignment 3: [String Orientation]

Write a main() which

- declares a character pointer, asks the user for a string size (n), dynamically allocates memory to the pointer and takes a lowercase string as input (properly terminated by a null character).
- requests the user to specify an integer $k \leq n$.
- reports back the no. of alphabetically ordered substrings of size k in the user input string.

Thank You