

Pointers and Arrays

Pointers and Arrays

- When an array is declared,
 - The compiler allocates sufficient amount of storage to contain all the elements of the array in contiguous memory locations
 - The **base address** is the location of the first element (**index 0**) of the array
 - The compiler also defines the array name as a **constant pointer** to the first element

Example

- Consider the declaration:

```
int x[5] = {1, 2, 3, 4, 5};
```

- Suppose that each integer requires 4 bytes
- Compiler allocates a contiguous storage of size $5 \times 4 = 20$ bytes
- Suppose the starting address of that storage is 2500

<u>Element</u>	<u>Value</u>	<u>Address</u>
x[0]	1	2500
x[1]	2	2504
x[2]	3	2508
x[3]	4	2512
x[4]	5	2516

Contd.

- The array name `x` is the starting address of the array
 - Both `x` and `&x[0]` have the value `2500`
 - `x` is a constant pointer, so cannot be changed
 - `X = 3400`, `x++`, `x += 2` are all illegal
- If `int *p` is declared, then
 - `p = x;` and `p = &x[0];` are equivalent
- We can access successive values of `x` by using `p++` or `p--` to move from one element to another

- Relationship between `p` and `x`:

`p` = `&x[0]` = 2500

`p+1` = `&x[1]` = 2504

`p+2` = `&x[2]` = 2508

`p+3` = `&x[3]` = 2512

`p+4` = `&x[4]` = 2516

In general, `*(p+i)` gives the value of `x[i]`

- C knows the type of each element in array `x`, so knows how many bytes to move the pointer to get to the next element

Example: function to find average

```
int main()
{
    int x[100], k, n;

    scanf ("%d", &n);

    for (k=0; k<n; k++)
        scanf ("%d", &x[k]);

    printf ("\nAverage is %f",
            avg (x, n));
    return 0;
}
```

```
float avg (int array[], int size)
{
    int *p, i , sum = 0;

    p = array;

    for (i=0; i<size; i++)
        sum = sum + *(p+i);

    return ((float) sum / size);
}
```

The pointer p can be subscripted also just like an array!

```
int main()
{
    int x[100], k, n;

    scanf ("%d", &n);

    for (k=0; k<n; k++)
        scanf ("%d", &x[k]);

    printf ("\nAverage is %f",
            avg (x, n));
    return 0;
}
```

```
float avg (int array[], int size)
{
    int *p, i , sum = 0;

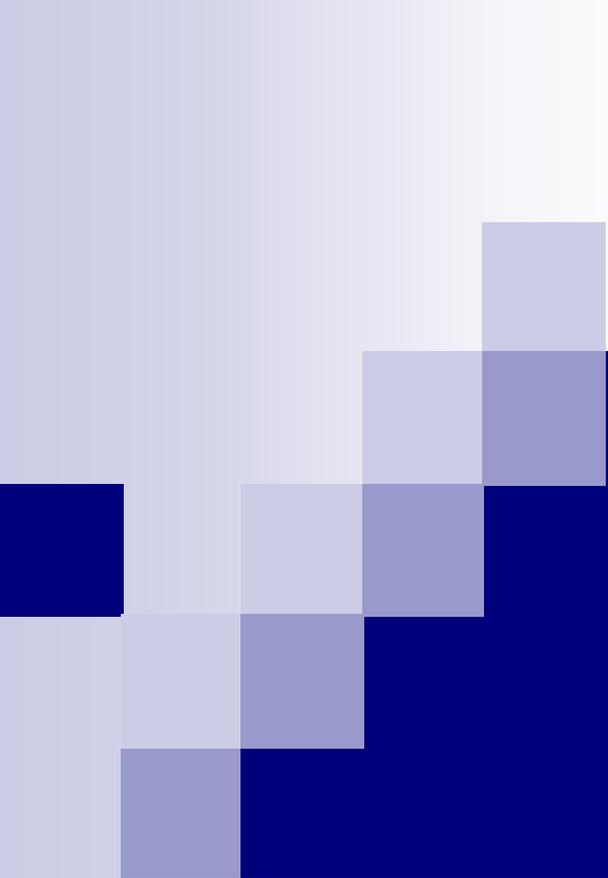
    p = array;

    for (i=0; i<size; i++)
        sum = sum + p[i];

    return ((float) sum / size);
}
```

Important to remember

- **Pitfall:** An array in C does not know its own length, & bounds not checked!
 - Consequence: While traversing the elements of an array (either using [] or pointer arithmetic), we can accidentally access off the end of an array (access more elements than what is there in the array)
 - Consequence: We must pass the array and its size to a function which is going to traverse it, or there should be some way of knowing the end based on the values (Ex., a -ve value ending a string of +ve values)
- Accessing arrays out of bound can cause strange problems
 - Very hard to debug
 - Always be careful when traversing arrays in programs



Pointers to Structures

Pointers to Structures

- Pointer variables can be defined to store the address of structure variables
- Example:

```
struct student {  
    int roll;  
    char dept_code[25];  
    float cgpa;  
};  
struct student *p;
```

- Just like other pointers, p does not point to anything by itself after declaration
 - Need to assign the address of a structure to p
 - Can use & operator on a struct student type variable
 - Example:

```
struct student x, *p;  
scanf("%d%s%f", &x.roll, x.dept_code, &x.cgpa);  
p = &x;
```

- Once `p` points to a structure variable, the members can be accessed in one of two ways:
 - `(*p).roll, (*p).dept_code, (*p).cgpa`
 - Note the `()` around `*p`
 - `p -> roll, p -> dept_code, p -> cgpa`
 - The symbol `->` is called the **arrow** operator
- Example:
 - `printf("Roll = %d, Dept.= %s, CGPA = %f\n", (*p).roll, (*p).dept_code, (*p).cgpa);`
 - `printf("Roll = %d, Dept.= %s, CGPA = %f\n", p->roll, p->dept_code, p->cgpa);`

Pointers and Array of Structures

- Recall that the name of an array is the address of its **0-th element**
 - Also true for the names of arrays of structure variables
- Consider the declaration:

```
struct student class[100], *ptr ;
```

Pointers and Array of Structures

- Recall that the name of an array is the address of its **0-th element**
 - Also true for the names of arrays of structure variables
- Consider the declaration:

```
struct student class[100], *ptr ;
```

- The name `class` represents the address of the 0-th element of the structure array
 - `ptr` is a pointer to data objects of the type `struct student`
- The assignment
`ptr = class;`
will assign the address of `class[0]` to `ptr`
- Now `ptr->roll` is the same as `class[0].roll`. Same for other members
- When the pointer `ptr` is incremented by one (`ptr++`) :
 - The value of `ptr` is actually increased by `sizeof(struct student)`
 - It is made to point to the next record
 - Note that `sizeof` operator can be applied on any data type

```

struct student {
    char name[20];
    int roll;
};
int main()
{
    struct student class[50], *p;
    int i, n;
    scanf("%d", &n);
    for (i=0; i<n; i++)
        scanf("%s%d", class[i].name, &class[i].roll);
    p = class;
    for (i=0; i<n; i++) {
        printf("%s %d\n", class[i].name, class[i].roll);
        printf("%s %d\n", (*(p+i)).name, (*(p+i)).roll);
        printf("%s %d\n", (p+i)->name, (p+i)->roll);
        printf("%s %d\n", p[i].name, p[i].roll);
    }
}

```

Output

```

3
Ajit 1001
Abhishek 1005
Riya 1007
Ajit 1001
Ajit 1001
Ajit 1001
Abhishek 1005
Abhishek 1005
Abhishek 1005
Abhishek 1005
Riya 1007
Riya 1007
Riya 1007
Riya 1007

```

A Warning

- When using structure pointers, be careful of operator precedence
 - Member operator “.” has higher precedence than “*”
 - `ptr -> roll` and `(*ptr).roll` mean the same thing
 - `*ptr.roll` will lead to error
 - The operator “->” enjoys the highest priority among operators
 - `++ptr -> roll` will increment `ptr->roll`, not `ptr`
 - `(++ptr) -> roll` will access `(ptr + 1)->roll` (for example, if you want to print the roll no. of all elements of the class array)
- When not sure, use (and) to force what you you want

Practice Problems

- Look at all problems you have done earlier on arrays (including arrays of structures). Now rewrite all of them using equivalent pointer notations

- Example: If you had declared an array

```
int A[50]
```

Now do

```
int A[50], *p;
```

```
p = A;
```

and then write the rest of the program using the pointer `p` (without using `[]` notation)