Structures

What is a Structure?

- Used for handling a group of logically related data items
  - Examples:
    - Student name, roll number, and marks
    - Real part and complex part of a complex number
- Helps in organizing complex data in a more meaningful way
- The individual structure elements are called members

Defining a Structure

```
struct tag {
        member 1;
        member 2;
        :
        member m;
    };
```

- struct is the required C keyword
- tag is the name of the structure
- member 1, member 2, … are individual member declarations

Contd.

- The individual members can be ordinary variables, pointers, arrays, or other structures (any data type)
  - The member names within a particular structure must be distinct from one another
  - A member name can be the same as the name of a variable defined outside of the structure
- Once a structure has been defined, the individual structure-type variables can be declared as:

```
struct tag var_1, var_2, …, var_n;
```

Example

- A structure definition

```
struct student {
        char name[30];
        int  roll_number;
        int  total_marks;
        char dob[10];
    };
```

- Defining structure variables:

```
struct student  a1, a2, a3;
```

A new data-type

A Compact Form

- It is possible to combine the declaration of the structure with that of the structure variables:

```
struct tag {
        member 1;
        member 2;
        :
        member m;
    }  var_1, var_2,…, var_n;
```

- Declares three variables of type struct tag
- In this form, tag is optional

Accessing a Structure

- The members of a structure are processed individually, as separate entities
  - Each member is a separate variable
- A structure member can be accessed by writing

  variable.member

  where variable refers to the name of a structure-type variable, and member refers to the name of a member within the structure
- Examples:

  a1.name, a2.name, a1.roll_number, a3.dob

Example: Complex number addition

```
void main()
{
        struct  complex
        {
                float  real;
                float  cmplex;
        }  a, b, c;

        scanf ("%f %f", &a.real, &a.cmplex);
        scanf ("%f %f", &b.real, &b.cmplex);

        c.real = a.real + b.real;
        c.cmplex = a.cmplex + b.cmplex;
        printf ("\n %f + %f j", c.real, c.cmplex);
}
```

Operations on Structure Variables

- Unlike arrays, a structure variable can be directly assigned to another structure variable of the same type

  a1 = a2;

  - All the individual members get assigned
- Two structure variables can not be compared for equality or inequality

  if (a1 == a2)…… ⟵ this cannot be done

Arrays of Structures

- Once a structure has been defined, we can declare an array of structures

```
struct student class[50];
```

type name

  - The individual members can be accessed as:

```
class[i].name
class[5].roll_number
```

Arrays within Structures

- A structure member can be an array

```
struct  student
{
    char  name[30];
    int  roll_number;
    int  marks[5];
    char  dob[10];
} a1, a2, a3;
```

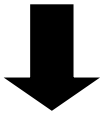
- The array element within the structure can be accessed as:

  a1.marks[2], a1.dob[3],…

Structure Initialization

- Structure variables may be initialized following similar rules of an array. The values are provided within the second braces separated by commas
- An example:

```
struct complex a={1.0,2.0}, b={-3.0,4.0};
```



```
a.real=1.0;   a.imag=2.0;
b.real=-3.0;  b.imag=4.0;
```

Parameter Passing in a Function

- Structure variables can be passed as parameters like any other variables. Only the values will be copied during function invocation

```
void swap (struct complex a, struct complex b)
{
    struct complex tmp;

    tmp=a;
    a=b;
    b=tmp;
}
```

Returning structures

- It is also possible to return structure values from a function. The return data type of the function should be as same as the data type of the structure itself

```
struct complex add(struct complex a, struct complex b)
{
    struct complex tmp;

    tmp.real = a.real + b.real;
    tmp.imag = a.imag + b.imag;
    return(tmp);
}
```

Direct arithmetic operations are not possible with structure variables

Defining data type: using typedef

- One may define a structure data-type with a single name

```
typedef struct newtype {
        member-variable1;
        member-variable2;
              .
        member-variableN;
 } mytype;
```

- mytype is the name of the new data-type
  - Also called an alias for struct newtype
  - Writing the tag name newtype is optional, can be skipped
  - Naming follows rules of variable naming

typedef : An example

```
typedef struct {
        float real;
        float imag;
} _COMPLEX;
```

- Defined a new data type named _COMPLEX. Now can declare and use variables of this type

```
_COMPLEX a, b, c;
```

- Note: typedef is not restricted to just structures, can define new types from any existing type
- Example:
  - typedef int INTEGER
  - Defines a new type named INTEGER from the known type int
  - Can now define variables of type INTEGER which will have all properties of the int type

```
INTEGER a, b, c;
```

The earlier program using typedef

```
typedef struct{
                float real;
                float imag;
        } _COMPLEX;

void swap (_COMPLEX a, _COMPLEX b)
 {
    _COMPLEX tmp;

    tmp = a;
    a = b;
    b = tmp;
 }
```

Contd.

```
void print (_COMPLEX a)
{
    printf("(%f, %f) \n",a.real,a.imag);
}

void main()
{
   _COMPLEX x={4.0,5.0}, y={10.0,15.0};

    print(x); print(y);
    swap(x,y);
    print(x); print(y);
}
```

- Output:

  (4.000000, 5.000000)
  (10.000000, 15.000000)
  (4.000000, 5.000000)
  (10.000000, 15.000000)

- x and y are not swapped! But that has got nothing to do with structures specially . We will see its reason shortly

Structures and Functions

- A structure can be passed as argument to a function
- A function can also return a structure

Example: complex number addition

```
void main()
{
   _COMPLEX a, b, c;
   scanf("%f %f", &a.real, &a.imag);
   scanf("%f %f", &b.real, &b.imag);
   c = add (a, b) ;
   printf("\n %f %f", c,real, c.imag);
}
```

```
_COMPLEX add(_COMPLEX x, _COMPLEX
y)
{
   _COMPLEX t;

   t.real = x.real + y.real;
   t.imag = x.imag + y.imag ;
   return (t) ;
}
```

Exercise Problems

1. Extend the complex number program to include functions for addition, subtraction, multiplication, and division
2. Define a structure for representing a point in two-dimensional Cartesian co-ordinate system
   - Write a function to compute the distance between two given points
   - Write a function to compute the middle point of the line segment joining two given points
   - Write a function to compute the area of a triangle, given the co-ordinates of its three vertices