Introduction to Problem Solving and Programming

Structures, Enumerations

Structures

- The last major language facility in *C* to be introduced in this course.

- Essential for building up "interesting" data structures — e.g.,
  - Data structures of multiple values of different kinds
  - Data structures of unspecified size

Definition — *Structure*

- A collection of one or more variables, typically of different types, grouped together under a single name for convenient handling

- Known as **`struct`** in *C*

What is a Structure?

- Structure is the collection of variables of different types under a **single name** for better handling.
- **For example:** You want to store the information about person about his/her name, citizenship number and salary.
- Keyword struct is used for creating a structure.

Using Structures

- Define the structure.
- Declare/Initialize instances of the structure.
- Access members of an instance of the structure.

Syntax of Structure

```
struct structure_name
{ data_type member1;
  data_type member2;
          .
          .
data_type memeber; };
```

struct

- Defines a new *type*
  - i.e., a new kind of data type that compiler regards as a unit
- E.g.,

```
struct motor {
  float volts;        //voltage of the motor
  float amps;         //amperage of the motor
  int phases;         //# of phases of the motor
  float rpm;  //rotational speed of motor
};          //struct motor
```

Structure Variable Declaration

- When a structure is defined, it creates a user-defined type but, no storage is allocated.
- For the structure of person, variable can be declared as:

Structure Variable Declaration

```
struct person
{ char name[50];
  int cit_no;
  float salary;
};
```

Inside main function:

struct person p1, p2, p[20];

```
struct  person
 { char name[50];
   int cit_no;
   float salary;
 }p1 ,p2 ,p[20];
```

Accessing Members of a Structure

- There are two types of operators used for accessing members of a structure:

1. Member operator(.)
2. Structure pointer operator(->) (will be discussed in structure and pointers)

Accessing Members of a Structure -1

- Any member of a structure can be accessed as: structure_variable_name.member_name
- Suppose, we want to access salary for variable p2. Then, it can be accessed as:

p2.salary

struct

- Defines a new *type*
- E.g.,

```
struct motor {
  float volts;
  float amps;
  int phases;
  float rpm;
};          //struct motor
```

Name of the type

struct

- Defines a new *type*
- E.g.,

```
struct motor {
  float volts;
  float amps;
  int phases;
  float rpm;
};          //struct motor
```

Members of the **struct**

Declaring `struct` variables

```
struct motor p, q, r;
```

- Declares and sets aside storage for three variables – **`p`**, **`q`**, and **`r`** – each of type **`struct motor`**

```
struct motor M[25];
```

- Declares a 25-element array of **`struct motor`**; allocates 25 units of storage, each one big enough to hold the data of one **`motor`**

Accessing Members of a `struct`

- Let

```
struct motor p;
struct motor q[10];
```

- Then

`p.volts`	— is the voltage
`p.amps`	— is the amperage
`p.phases`	— is the number of phases
`p.rpm`	— is the rotational speed
`q[i].volts`	— is the voltage of the `i`th motor
`q[i].rpm`	— is the speed of the `i`th motor

Operations on `struct` (continued)

- Remember:–
  - Passing an argument by value is an instance of *copying* or *assignment*
  - Passing a return value from a function to the caller is an instance of *copying* or *assignment*
- E.g,:–

```
struct motor f(struct motor g) {
  struct motor h = g;
  ...;
  return h;
}
```

Initialization of a `struct`

- Let
```
struct motor {
          float volts;
          float amps;
          int phases;
          float rpm;
};               //struct motor
```
- Then
```
struct motor m = {208, 20, 3, 1800};
```
initializes the `struct`

Typedef

- Definition:– a **`typedef`** is a way of *renaming* a type
- E.g.,

```
typedef struct motor Motor;

Motor m, n;
Motor r[25];
Motor function(const Mo
```

E.g., **`typedef`**, lets you leave out the word “**`struct`**”

Keyword typedef

- Programmer generally use **typedef** while using structure in C language. For example:

```
typedef struct complex
{ int imag;
float real; } comp;
                    Inside main:
                    comp c1,c2;
```

- Here, typedef keyword is used in creating a type **comp** (which is of type as struct complex). Then, two structure variables c1 and c2 are created by this comp type.

Structure and Function

- In C, structure can be passed to functions by two methods:

1. Passing by value (passing actual value as argument)
2. Passing by reference (passing address of an argument)

Passing Structure by Value

```
#include <stdio.h>
struct student{
char name[50];
int roll;};

void Display(struct student stu);

int main()
{
    struct student s1;
    printf("Enter student's name: ");
    scanf("%s",&s1.name);
    printf("Enter roll number:");
    scanf("%d",&s1.roll);
    Display(s1);
    return 0;
}
void Display(struct student stu)
{
    printf("Output\nName: %s",stu.name);
    printf("\nRoll: %d",stu.roll);
}
```

Output

```
Enter student's name: Kevin

Enter roll number: 149
```

Output

```
Name: Kevin

Roll: 149
```

Pointer to Structure

- We can use pointer to struct:
  - `struct MyPoint {int x, int y};`
  - `struct MyPoint point, *ptr;`
  - `point.x = 0;`
  - `point.y = 10;`
  - `ptr = &point;`
  - **`ptr->x = 12;`** <u>same as</u> **`(*ptr).x`**
  - **`ptr->y = 40;`** <u>same as</u> **`(*ptr).y`**

Example – 9 (pointer to struct)

```
#include <stdio.h>
struct inven
{      char  code;
       float cost;
       int   pieces ; } ;
void read (struct inven *in);
void write (struct inven out);
int main()
{
    struct inven part;
    read (&part);
    write (part);
    return 0;
}
```

Example - 9 (pointer to struct) -cont

```
void read (struct inven *in)
{  printf ("\n Enter Product Data. \n") ;
   printf (" Enter part code: ");      scanf  ("%c",&in->code);
   printf (" Enter part cost: ");      scanf  ("%f",&in->cost);
   printf (" Enter no of pieces: ");  scanf  ("%d",&in->pieces);
}
void write (struct inven out)
{        printf (" part code: %c    \n", out.code);
         printf (" part cost: %f    \n", out.cost);
         printf (" no of pieces: %d \n", out.pieces);
         }
```

Example – 10 (pointer to struct)

```
#include <stdio.h>
struct inven
{       char  code;
        float cost;
        int   pieces ;
       void(*read)(struct ineven*);
       void(*write)(struct ineven);
} ;
void read (struct inven *in);
void write (struct inven out);
```

```
int main()
{
            struct inven part;
            part.read = read;
            part.write = write;
            part.read (&part);
            part.write (part);
            return 0;
}
```

Example – 10 (pointer to struct) – cont

```
void read (struct inven *in)
{  printf ("\n Enter Product Data. \n") ;
   printf (" Enter part code: ");     scanf  ("%c",&in->code);
   printf (" Enter part cost: ");     scanf  ("%f",&in->cost);
   printf (" Enter no of pieces: ");  scanf  ("%d",&in->pieces);
}
void write (struct inven out)
{        printf (" part code: %c   \n", out.code);
         printf (" part cost: %f   \n", out.cost);
         printf (" no of pieces: %d \n", out.pieces);
         }
```

Enumeration -1

- Is a set of named integer **constants** that specifies all the legal values that a variable of its type can have.

```
enum color {red, white, blue}
color C;
C = red;
C = white;
```

Enumeration -2

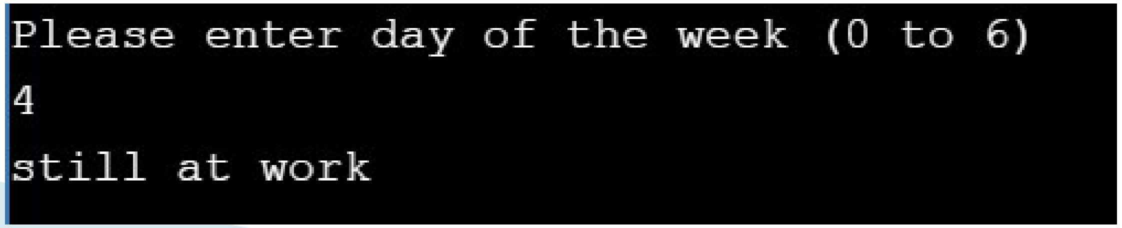
- The key point to understand about an enumeration that each of the symbols stands for an integer value and can be used in any integer expression.

Enumeration -3

```
#include <stdio.h>
int main()
{
    enum
    Days{Sunday,Monday,Tuesday,Wednesday,Thursday,Friday,Saturday};

    enum Days TheDay;
    int j = 0;
    printf("Please enter day of the week (0 to 6)\n");
    scanf("%d",&j);
    TheDay = j;

    if(TheDay == Friday || TheDay == Saturday)
        printf("It is the weekend\n");
    else
        printf("still at work\n ");
    return 0;
}
```



```
Please enter day of the week (0 to 6)
4
still at work
```

Example

- Define a struct student that holds:
    - Name
    - GPA
    - Term
  - Enter the information for 5 students
  - Write a function that calculates the average GPA

Questions?