C Structures

1. Objective

- What is C structure?
- When to use structures.
- Syntax of a structure.
- How to declare variable of type structure?
- Fields of a structure and how to initialize them.
- How to manipulate structure type

2. Structure Definition

- A Structure is a collection of related data items, possibly of different types.
- Structures are also called records.
- A structure type in C is called **struct**.
- Unlike arrays, a struct is composed of data of different types.
- You use structures to group data that belong together.
- Examples:
    - Student information:
        - student id,
        - last name,
        - first name
        - major,
        - gender,
        - …

    - Bank account information:
        - account number,
        - account type
        - account holder
            - first name
            - last name
        - balance
- Data elements in a structure are called **fields** or **members**
- Complex data structures can be formed by defining arrays of structs.

3. Struct Syntax

- Syntax of the structure type::

```
typedef  struct{
        type1 id1;
        type2 id2;
        …
} struct_name;
```

Required

- Example:
    - The following structure has three fields:

```
typedef struct  {
         int day;
         int month;
         int year;
    } eventDate;

typedef struct {
        char name[20];
        int age;
    } person;

struct telephone {
   char name[30];
   int number;
};
```

- How to declare variable of type structure?
  - Create a variable, var1, using this structure:

```
    typedef  struct{
        type1 id1;
        type2 id2;
        …
    } struct_name ;

sturct_name var1;
```

  - **Examples**:

```
    person p1;
    person p2;
```

4. Manipulating Structure Types

- **How to access a field in a structure**:
  - Use the **direct component selection operator**, which is a **period**.
  - The **direct component selection operator** has the **highest priority** in the operator precedence.
  - Examples:

```
person p1;
p1.name;
p1.age;
```

- **Structure assignment**:
  - The copy of an entire structure can be easily done by the assignment operator.
  - Each component in one structure is copied into the corresponding component in the other structure.

- Examples:
  - Given the following structure:

```
typedef struct  {
        int day;
        int month;
        int year;
    } eventDate;
```

```
eventDate ev1;

ev1.day = 2; ev1.month = 11; ev1.year = 
2017;
eventDate ev2 = { 20, 10, 2017};
```

  - Given the following structure

```
typedef struct {
       char name[20];
       int age;
    } person;
```

```
person p1 ={ “Mary”, 24};
person p2;
strcpy(p2.name, "Paul
p2.age = 27;
```

5. Arrays of Structures

- We can also declare an array of structures.
- Recall the syntax of an array:

```
type array_name[size];
```

type can any C type including struct type.

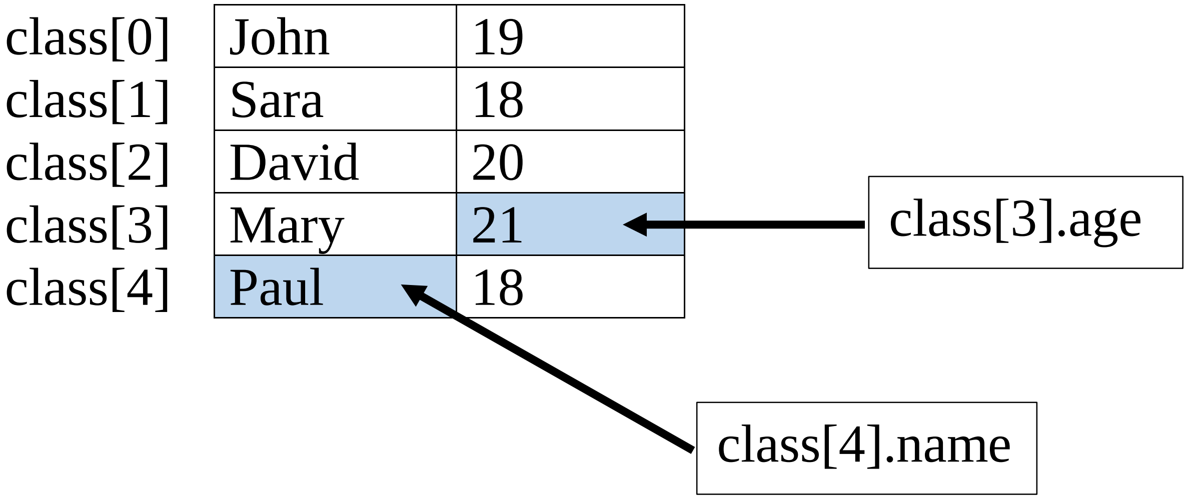
- The array of structures can be simply manipulated as **arrays** of simple data types.
- Example:

```
typedef struct {
        char name[20];
        int age;
} person;

person class[5];

strcpy(class[0].name, “John”);
class[0].age = 19;
strcpy(class[1].name, “Sara”);
class[1].age = 18;
```

.name	.age



class[0]	John	19
class[1]	Sara	18
class[2]	David	20
class[3]	Mary	21
class[4]	Paul	18

class[3].age

class[4].name

- Application: Bank Account
  - We would like to write a C program that stores customers at a bank.
  - Here are the different steps:
    - Step 1: design your structure

```
typedef struct {
        int account number;
        char account_type[20];
        char account_holder_name[40];
        double balance;
} bank_account;
```

    - Step 2: declare the array of structs

```
bank_customer    bank_customers[100];
```

- Step 3: Initialization

```
bank_customers[0].account_number = 1001;
strcpy(bank_customers[0].account_type,
"Checking");
strcpy(bank_customers[0].account_holder_nam
e, "John Paul");
bank_customers[0].balance = 2100.50;
```

- Full Program:

```
//gcc 5.4.0

#include  <stdio.h>

int main(void)
{
   typedef struct {
      int account_number;
      char account_type[20];
      char account_holder_name[40];
      double balance;
   } bank_customer;
```

```
    bank_customer    bank_customers[5];

    bank_customers[0].account_number = 1001;
    strcpy(bank_customers[0].account_type, "Checking");
    strcpy(bank_customers[0].account_holder_name, "John
Paul");
    bank_customers[0].balance = 2100.50;

    for(int i=0;i<5;++i){

        printf("Account Number: %d\nAccount Type:
%s\nACcount Holder Name: %s\nbalance: %.2lf\n-----------
--\n",

bank_customers[i].account_number,bank_customers[i].acco
unt_type, bank_customers[i].account_holder_name,
bank_customers[i].balance);
    }
}
```

6. Hierarchical structure

- A hierarchical structure is a structure containing components which are also structures.
- Let us review the description of the bank account of a customer:
    - Here is the initial definition:

```
typedef struct {
        int account number;
        char account_type[20];
        char account_holder_name[40];
        double balance;
} bank_account;
```

    - Now, let us break the name of a customer into:
        - First name
        - Last name
    - Let us define a name structure as follows:

```
typedef struct {
        char first_name[20];
        char last_name[20];
} customer_name;
```

- Here is the updated program:

```
//gcc 5.4.0
#include  <stdio.h>
#include  <string.h>
int main(void)
{
   typedef struct {
      char first_name[20];
      char last_name[20];
   } customer_name;

   typedef struct {
      int account_number;
      char account_type[20];
      customer_name account_holder_name;
      double balance;
   } bank_customer;


   bank_customer    bank_customers[5];

   bank_customers[0].account_number = 1001;
   strcpy(bank_customers[0].account_type, "Checking");

strcpy(bank_customers[0].account_holder_name.first_name
, "John");

strcpy(bank_customers[0].account_holder_name.last_name,
"Paul");
```

```
    bank_customers[0].balance = 2100.50;

    bank_customers[1].account_number = 1002;
    strcpy(bank_customers[1].account_type, "Checking");

strcpy(bank_customers[1].account_holder_name.first_name
, "Mary");

strcpy(bank_customers[1].account_holder_name.last_name,
"Paul");
    bank_customers[1].balance = 30100.50;

    for(int i=0;i<5;++i){
        printf("Account Number: %d\nAccount Type:
%s\nACcount Holder fist Name: %s\nCcount Holder Last
Name: %s\nbalance: %.2lf\n-------------
\n",bank_customers[i].account_number,bank_customers[i].a
ccount_type,
bank_customers[i].account_holder_name.first_name,
bank_customers[i].account_holder_name.last_name,
bank_customers[i].balance);
    }
}
```

7. Function with a Structure Input Parameter

- When a structure variable is passed as an input argument to a function, all its component values are copied into the local structure variable.
- Example:

```
#include <stdio.h>

struct student
{
        int id;
        char name[20];
        char grade;
};

void func(struct student stud);

int main()
{
        struct student astud;

        astud.id=9401;
        strcpy(astud.name, "Joe");
        astud.grade = 'A';

        func(astud);
        return 0;
}
```

```
void func(struct student astud)
{
        printf(" Id is: %d \n", astud.id);
        printf(" Name is: %s \n", astud.name);
        printf(" Grade is: %c \n", astud.grade);
}
```

8. Questions/Practice

- Write a C program that implement complex numbers (see solution below)
- Write a C program that implement fractions (Lab)
- Modify the last program in section 7 to include the address of a student as a separate structure. The address should include the following:
    - Address as an array of 30 characters
    - City as a an array of 20 characters
    - Zipcode as an integer.

9. Partial Solution

- Complex numbers:

```
//gcc 5.4.0

#include  <stdio.h>

typedef struct {
   double realpart;
   double imaginarypart;
} complex;

complex addcomp (complex a, complex b){
   complex addc;
   addc.realpart = a.realpart + b.realpart;
   addc.imaginarypart = a.imaginarypart + b.imaginarypart;

   return (addc);
}
complex subcomp (complex a, complex b){
   complex addc;
   addc.realpart = a.realpart - b.realpart;
   addc.imaginarypart = a.imaginarypart - b.imaginarypart;

   return (addc);
}

int main(void) {
   complex c1;
   complex c2;
   complex c3;
   c1.realpart = 2.3;
   c2.realpart = 2.3;
   c1.imaginarypart = 2.3;
   c2.imaginarypart = 2.3;
   c3 = addcomp(c1, c2);
   printf("%.2lf+%.2lfi + %.2lf+%.2lfi = %.2lf+%.2lfi\n",
c1.realpart, c1.imaginarypart,c2.realpart,
c2.imaginarypart,c3.realpart, c3.imaginarypart);
   c1.imaginarypart = 2.3;
   c2.imaginarypart = 2.3;
   c3 = subcomp(c1, c2);
   printf("%.2lf+%.2lfi - %.2lf+%.2lfi = %.2lf+%.2lfi\n",
c1.realpart, c1.imaginarypart,c2.realpart,
c2.imaginarypart,c3.realpart, c3.imaginarypart);
   return 0;
}
```