CSC 211: Computer Programming

Structs

Michael Conti

Department of Computer Science and Statistics
University of Rhode Island

Spring 2024

THINK BIG  WE DO℠

Original design and development by Dr. Marco Alvarez

Structures

- Definition is generally outside any function
  - new 'data type' will be available to all code that follows
- Structures can be declared in the same way as basic data types
- Can also use { } notation for initialization
- Use the **dot operator** for accessing data members

Structures

```
struct structureName {
    member1;
    member2;
    member3;
    .
    .
    .
    memberN;
};
```

Structures in C++ are user defined data types which are used to store multiple items (members) of possibly different data types

Example

```
// defining the struct
struct Point {
    int x;
    int y;
};

int main() {
    // creating a variable
    struct Point p1;
}
```

Initializing …

```
// defining the struct
struct Point {
    int x;
    int y;
};

int main() {
    // initializing (follows order)
    struct Point p1 = { 10, 20 };
}
```


The dot operator

```
#include <iostream>

struct Point {
    int x;
    int y;
};

int main() {
    struct Point p1 = { 10, 20 };
    p1.x += 5;
    std::cout << p1.x << ' ' << p1.y << '\n';
}
```


The dot operator

```
#include <iostream>

struct Point {
    int x;
    int y;
};

int main() {
    struct Point p1 = { 10, 20 };
    struct Point p2 = { 30, 40 };
    struct Point p3 = { 50, 60 };
    p1.x += 5; p2.y += 10; p3.y += 15;
}
```


DISPLAY 10.2 Member Values

```
1   struct CDAccount
2   {
3       double balance;
4       double interestRate;
5       int term; //months until maturity
6   };
7   int main( )
8   {
9      CDAccount account;
10          ...
11
12
13     account.balance = 1000.00;
14
15
16     account.interestRate = 4.7;
17
18
19     account.term = 11;
20
21
22
```

	account.balance	account.interestRate	account.term
CDAccount account;	?	?	?
account.balance = 1000.00;	1000.00	?	?
account.interestRate = 4.7;	1000.00	4.7	?
account.term = 11;	1000.00	4.7	11

from: Problem Solving with C++, 10th Edition, Walter Savitch

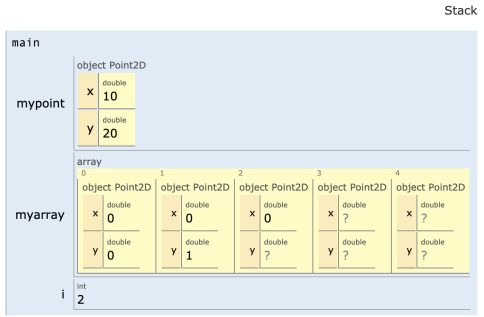
Array of structures

```cpp
#include <iostream>

struct Point2D {
    double x;
    double y;
};

int main() {

    Point2D mypoint;
    Point2D myarray[5];

    mypoint.x = 10;
    mypoint.y = 20;

    for (int i = 0 ; i < 5 ; i ++) {
        myarray[i].x = 0;
        myarray[i].y = i;
    }
}
```


pythontutor.com

C++ (gcc 4.8, C++11)
EXPERIMENTAL! known limitations

```cpp
1  struct Point2D {
2    double x;
3    double y;
4  };
5
6  int main() {
7    struct Point2D mypoint;
8    struct Point2D myarray[5];
9
10   mypoint.x = 10;
11   mypoint.y = 20;
12
13   for (int i = 0 ; i < 5 ; i++) {
14     myarray[i].x = 0;
15     myarray[i].y = i;
16   }
17
18 }
```



Arrays and Structures

- When using arrays as structs member, the index goes at the end
  - student.grades[i]
- When using structs as arrays elements, the index goes after the struct name
  - students[i].finalGrade

Functions

```cpp
// defining the struct
struct Point {
    int x;
    int y;
};

void distance(Point P1,Point P2);
```

Passing structures to functions

- A struct can be passed as a parameter either by value or by reference

```
void printPoint(Point &somePoint){
    std::cout << somePoint.x;
    std::cout << somePoint.y;
};
```

- A function can return a value of type struct

```
Point incrementPoint(Point somePoint){
    somePoint.x+=1;
    somePoint.y+=1;
    return somePoint;
};
```


Passing structures to functions

DISPLAY 10.1 A Structure Definition

```
1   //Program to demonstrate the CDAccount structure type.
2   #include <iostream>
3   using namespace std;
4   //Structure for a bank certificate of deposit:
5   struct CDAccount
6   {
7       double balance;
8       double interestRate;
9       int term; //months until maturity
10  };
11
12
13  void getData(CDAccount& theAccount);
14  //Postcondition: theAccount.balance and theAccount.interestRate
15  //have been given values that the user entered at the keyboard.
16
17
18  int main( )
19  {
20      CDAccount account;
21      getData(account);
22
23      double rateFraction, interest;
24      rateFraction = account.interestRate / 100.0;
25      interest = account.balance * rateFraction * (account.term / 12.0);
26      account.balance = account.balance + interest;
27
28      cout.setf(ios::fixed);
29      cout.setf(ios::showpoint);
30      cout.precision(2);
31      cout << "When your CD matures in "
32           << account.term << " months,\n"
33           << "it will have a balance of $"
34           << account.balance << endl;
35      return 0;
36  }
38  //Uses iostream:
39  void getData(CDAccount& theAccount)
40  {
41      cout << "Enter account balance: $";
42      cin >> theAccount.balance;
43      cout << "Enter account interest rate: ";
44      cin >> theAccount.interestRate;
45      cout << "Enter the number of months until maturity\n"
46           << "(must be 12 or fewer months): ";
47      cin >> theAccount.term;
48  }
```

from: Problem Solving with C++, 10th Edition, Walter Savitch

Be careful of same member names

```
// defining the struct
struct Point {
    int x;
    int y;
};

struct Character {
    int x;
    int y;
    std::string name;
};
```

Compiler can keep track but it's harder for humans

Structs and Pointers

```
struct Books {
   std::string title;
   std::string author;
   std::string subject;
   int book_id;
};
```

Pointers and Structs

- You can define pointers to structures in very similar way as you define pointer to any other variable

```
struct Books *struct_pointer;
struct Books Book1;
```

- Now, you can store the address of a structure variable in the above defined pointer variable.

```
struct_pointer = &Book1;
```


Structs and Pointers

```
void printBook( struct Books *book ) {
   std::cout << "Book title : " << (*book).title;
   std::cout << "Book author : " << (*book).author;
   std::cout << "Book subject : " << (*book).subject;
   std::cout << "Book id : " << (*book).book_id;
}

struct Books {
   std::string title;
   std::string author;
   std::string subject;
   int book_id;
};
```

```
int main(){
   struct Books Book1;

   Book1.title = "Learn C++ Programming"
   Book1.author = "Chand Miyan"
   Book1.subject = "Computer Science"

    printBook( &Book1 );
}
```


Example

- Write a Student struct that contains
  - Name
  - StudentID
  - Major
- Implement functions:
  - void buildStudent(Student &someStudent)
    - Initialize member variables of student Struct
  - void changeMajor(Student &someStudent);
    - Change the major of a student structure
  - void printStudent(Student &someStudent);
    - Prints out all member variables of student structure