STRUCTS
PASSING STRUCTS TO FUNCTIONS

Problem Solving with Computers-I

C++ structures (lab05)

A **`struct`** is a data structure composed of simpler data types.

```
struct Point {
    double x; //member variable of Point
    double y; //member variable of Point
};
```

Think of Point as a new data type

```
Point p1;                  // Declare a variable of type Point
Point p1 = { 10, 20};      //Declare and initialize
```

C++ structures (lab05)

- A **`struct`** is a data structure composed of simpler data types.

```
struct Point {
    double x; //member variable of Point
    double y; //member variable of Point
};
```

- Access the member variables of p1 using the dot '.' operator

```
Point p1;
p1.x = 5;
p1.x = 10;
```

- Access via a pointer using the -> operator

```
Point* q = &p1;
(*q).x = 5;
(*q).x = 10;
q->x = 30;
```

Which of the following is/are incorrect statement(s) in C++?

```
struct Point {
    double x;
    double y;
};
```

```
struct Box {
    Point ul; // upper left corner
    double width;
    double height;
};
```

A. `ul.x = 10;`

B. `Box b1 = {{500, 800}, 10, 20};`

C. Both are incorrect

D. Both statements are correct

Passing structs to functions

- Write a function that prints the x and y coordinates of a `Point`
- Write a function that takes takes two Points as input and checks if they are approximately equal

Passing structs to functions by reference

- Write a function that takes a `Point` as parameter and initializes its x and y coordinates

Arrays of structs

- Write a struct to represent a student (first name, last name, perm, major, gpa over 4 years)
- Initialize a single instance of this struct
- Write a function that takes a student as parameter and prints the following:

  Name: First last

  Major:

  Average GPA:

- Use the function to create a list of students and print their average gpa

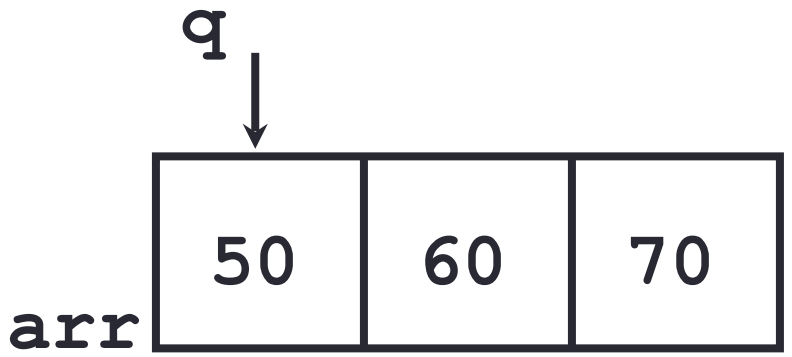
Pointer Diagrams

```
int ar[]={20, 30, 50, 80, 90};
int *p = arr;
p = p + 1;
*p = *p + 1;
```

Draw the array ar after the above code is executed

```
void IncrementPtr(int *p){
    p++;
}

int arr[3] = {50, 60, 70};
int *q = arr;
IncrementPtr(q);
```



Which of the following is true after **`IncrementPtr(q)`** is called in the above code:

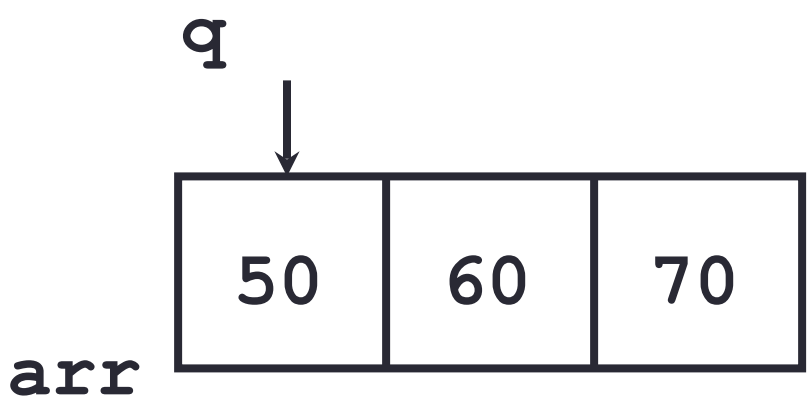
A. ‘q’ points to the next element in the array with value 60

B. ‘q’ points to the first element in the array with value 50

How should we implement `IncrementPtr()`, so that 'q' points to 60 when the following code executes?

```
void IncrementPtr(int **p){
    p++;
}

int arr[3] = {50, 60, 70};
int *q = arr;
IncrementPtr(&q);
```



A. `p = p + 1;`

B. `&p = &p + 1;`

C. `*p= *p + 1;`

D. `p= &p+1;`

Pointer pitfalls

- Dereferencing a pointer that does not point to anything results in undefined behavior.
- On most occasions your program will crash
- Segmentation faults: Program crashes because code tried to access memory location that either doesn’t exist or you don’t have access to

Two important facts about Pointers

1) A pointer can only point to one type –(basic or derived) such as `int`, `char`, a `struct`, another pointer, etc

2) After declaring a pointer: `int *ptr;`

   `ptr` doesn't actually point to anything yet.

   We can either:

   - make it point to something that already exists, OR
   - allocate room in memory for something new that it will point to

Pointer Arithmetic

- What if we have an array of large structs (objects)?
  - C++ takes care of it: In reality, `ptr+1` doesn't add `1` to the memory address, but rather adds the size of the array element.
  - C++ knows the size of the thing a pointer points to – every addition or subtraction moves that many bytes: 1 byte for a char, 4 bytes for an int, etc.

Next time

- Dynamic memory allocation