

POINTERS

Problem Solving with Computers-I

C++

```
#include <iostream>
using namespace std;

int main()
{
    cout << "Hola Facebook!";
    return 0;
}
```

GitHub



How far along are you with lab04

- A. Almost done
- B. I am on track to finish
- C. I am stuck and don't know how to proceed
- D. Haven't started

Why learn pointers?



Pass by value: What is printed by this code?

```
void swapValue(int x, int y){  
    int tmp = x;  
    x = y;  
    y = tmp;  
}
```

```
int main() {  
    int a=30, b=40;  
    cout<<a<<" "<<b<<endl;  
    swapValue( a, b);  
    cout<<a<<" "<<b<<endl;  
}
```

A.

30 40

30 40

B.

30 40

40 30

C. Something else

Passing parameters by value

Pointers

- **Pointer:** A variable that contains the address of another variable
- Declaration: `type * pointer_name;`

```
int* p; // Just like all uninitialized variables this will have a  
junk value
```

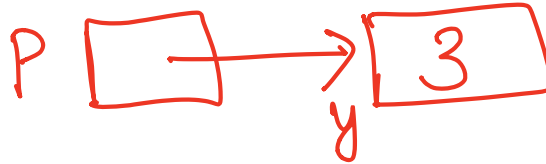
```
int* p = 0; //Declare and initialize
```

How to make a pointer **point to** something

```
int *p;  
int y = 3;
```



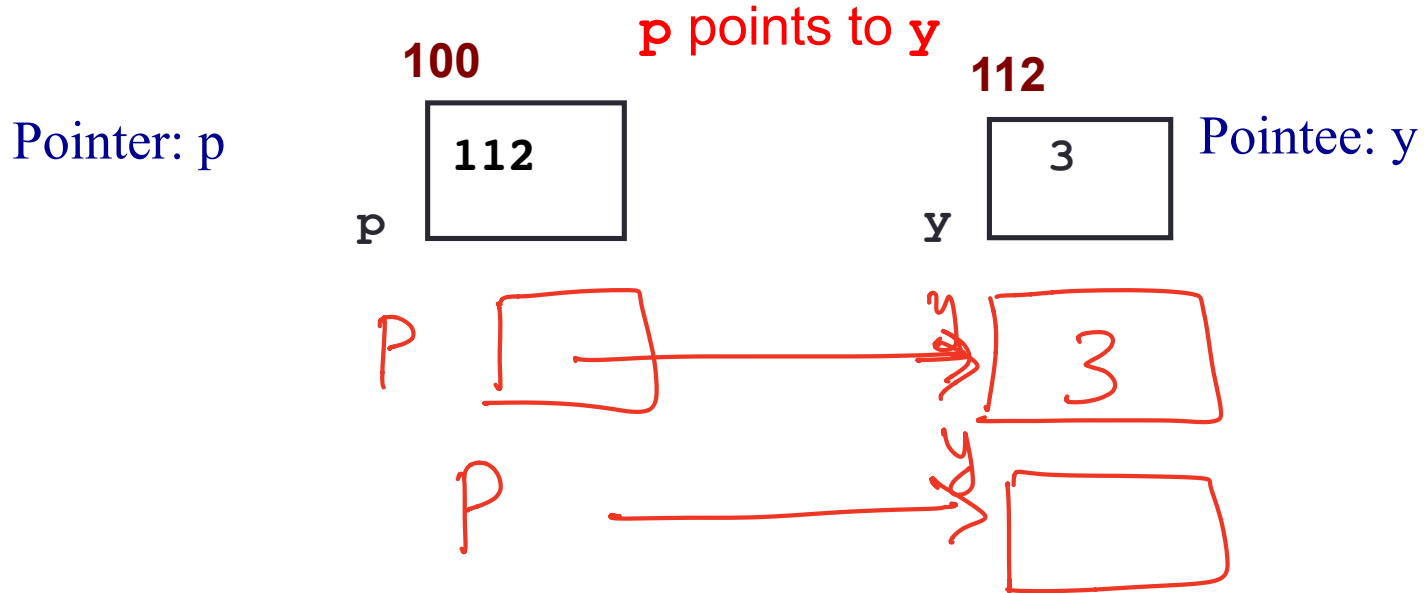
$p = \&y;$ → Gets the location of y



To access the location of a variable, use the address operator '&'

Pointer Diagrams:

Diagrams that show the relationship between pointers and pointees



You can change the value of a variable using a pointer !

```
int *p, y;
```

```
y = 3;
```

```
p = &y;
```

```
cout << *p ;
```

de-referencing operator
This means "get the data p is pointing to"
In this case "y"

```
*p = 5;
```

Use dereference * operator to left of pointer name

Tracing code involving pointers

```

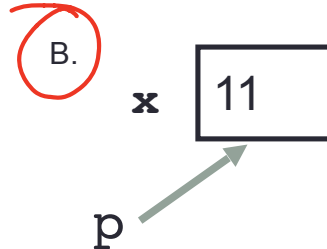
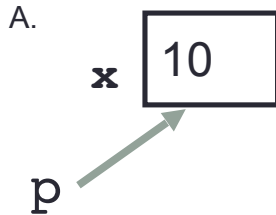
int *p;
int x=10;
p = &x;


*p

 = *p + 1;
  
```



Q: Which of the following pointer diagrams best represents the outcome of the above code?



C. Neither, the code is incorrect

Two ways of changing the value of a variable

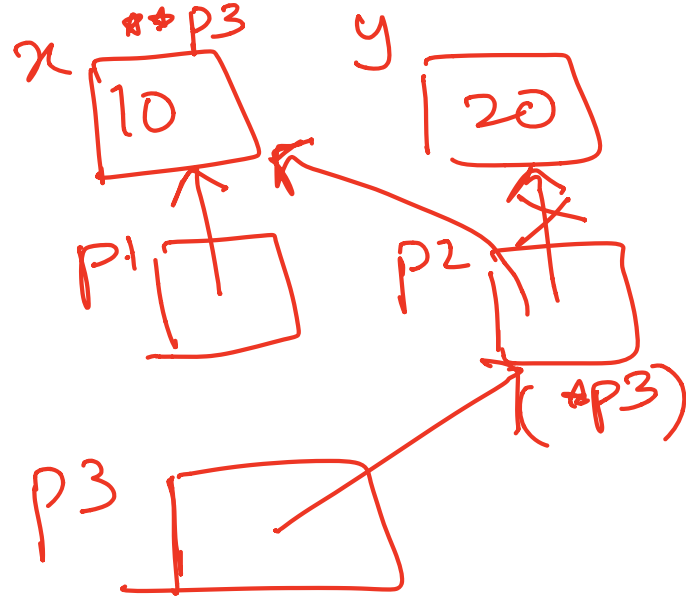


Change the value of y directly:

Change the value of y indirectly (via pointer p):

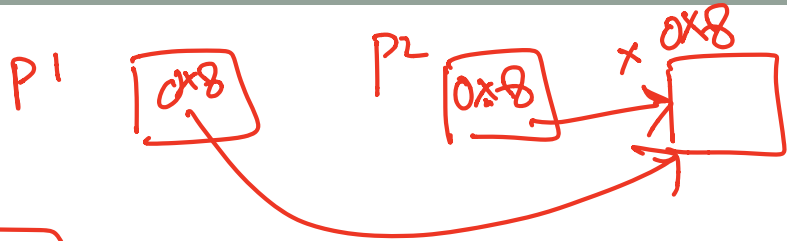
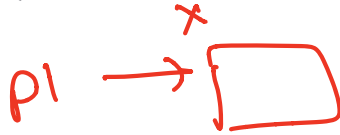
Pointer assignment and pointer arithmetic: Trace the code

```
int x=10, y=20;  
int *p1 = &x, *p2 = &y;  
p2 = p1;  
int **p3;  
p3 = &p2;
```

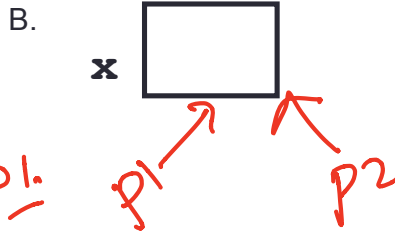
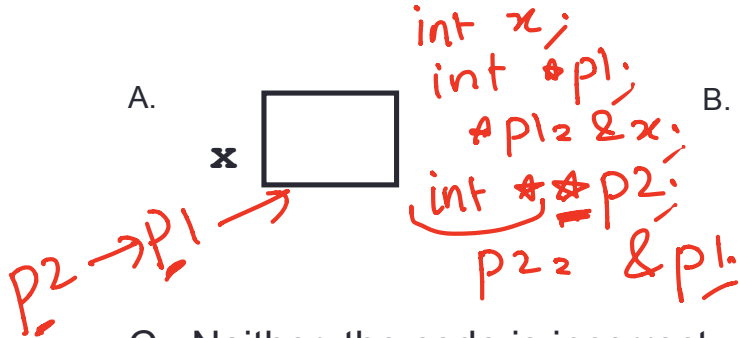


Pointer assignment

```
int *p1, *p2, x;
p1 = &x;
p2 = p1;
```



Q: Which of the following pointer diagrams best represents the outcome of the above code?



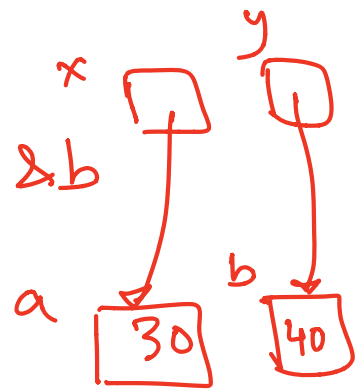
C. Neither, the code is incorrect

Swap values revisited: Pass by address

```
void swapValue(int* x, int* y){  
    int tmp = *x;  
    *x = *y;  
    *y = tmp;  
}
```

→ swap the values of variables that x & y are pointing to. (In this case a, b)

```
int main() {  
    int a=30, b=40;  
    swapValue(&a, &b);  
    cout<<a<<" "<<b<<endl;  
}
```



Arrays and pointers

	100	104	108	112	116
ar	20	30	50	80	90

- `ar` is like a pointer to the first element
- `ar[0]` is the same as `*ar`
- `ar[2]` is the same as `*(ar+2)`
- Use pointers to pass arrays in functions
- Use *pointer arithmetic* to access arrays more conveniently

Pointer Arithmetic

```
int arr[]={50, 60, 70};
```

```
int *p;
```

```
p = arr;
```

```
p = p + 1;
```

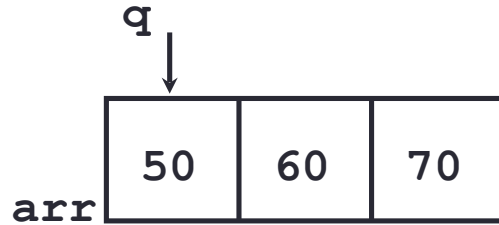
```
*p = *p + 1;
```

(Next lecture)

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

(Next lecture)

```
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:

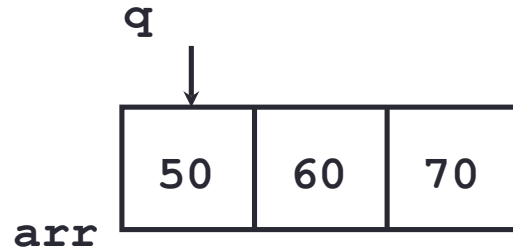
- A. 'q' points to the next element in the array with value 60
- B. 'q' points to the first element in the array with value 50

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);
```

(Next Lecture)



- A. `p = p + 1;`
- B. `&p = &p + 1;`
- C. `*p = *p + 1;`
- D. `p = &p + 1;`

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
 - Null check before dereferencing

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.

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

Why learn pointers?...to get CS jokes



Next time

- References
- Structs
- Pass by reference
- Arrays of structs