N

THE GOOD, BAD AND UGLY ABOUT POINTERS

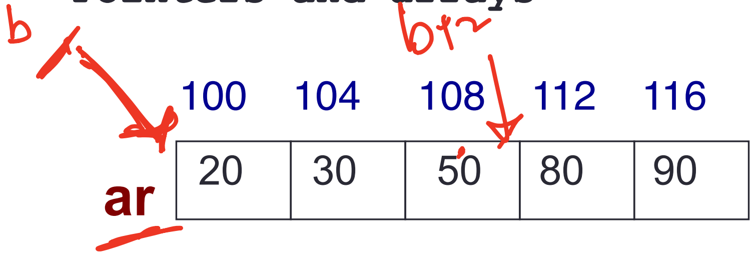
Problem Solving with Computers-I

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

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

The good: Pointers pass data around efficiently

Pointers and arrays



- `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

Passing arrays to functions

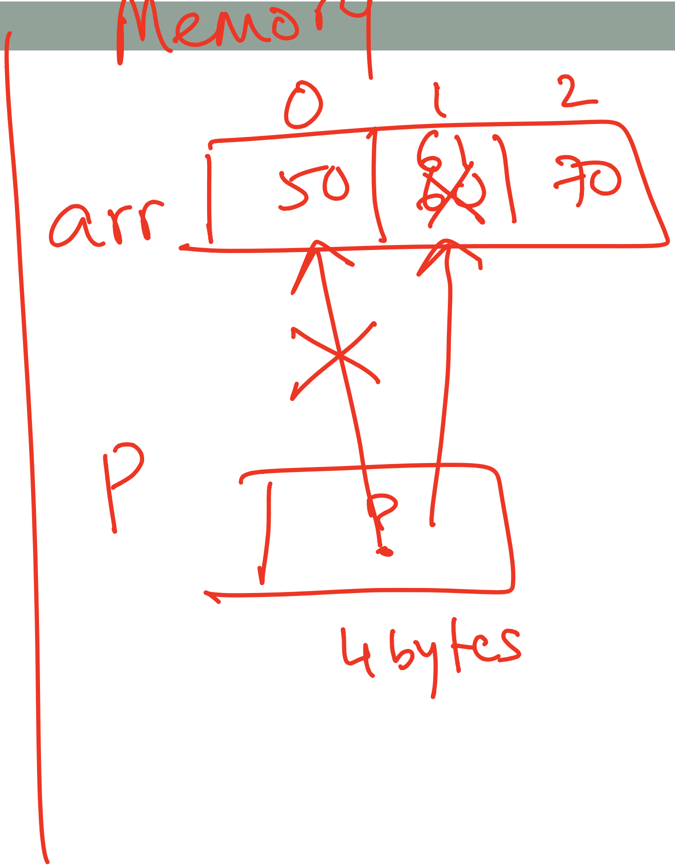
$ar[2] \equiv *(ar+2)$

$b[2] \equiv *(b+2);$

Pointer Arithmetic

```
int arr[]={50, 60, 70};
int *p;
p = arr;
p = p + 1;
*p = *p + 1;
```

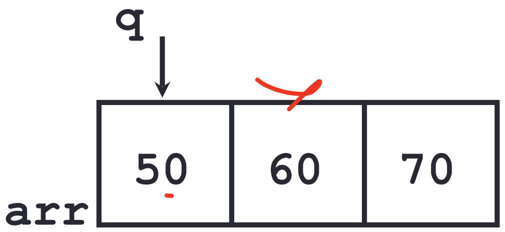
p[0] = p[0]+1



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

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

int *q;
q = arr;



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);
```

✓ → Address of q

A. `p = p + 1;`

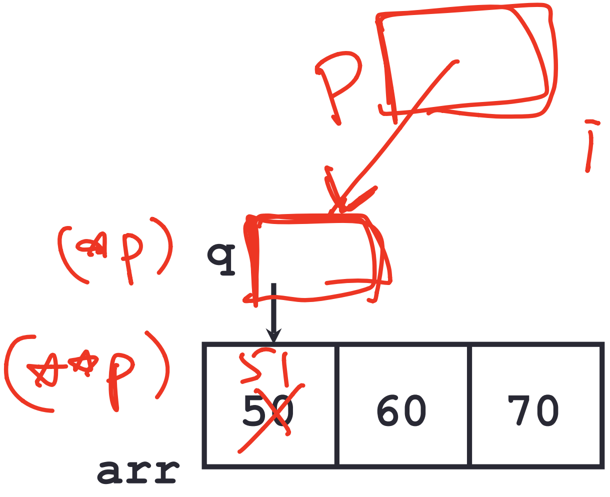
B. `&p = &p + 1;`

[✓ C.] `*p= *p + 1;`

D. `p= &p+1;`

$**p = **p + 1;$

$50+1$



Review of homework 7, problem 4

```
void printRecords(UndergradStudents records [], int numRecords);
int main(){
    UndergradStudents ug[3];
    ug[0] = {"Joe", "Shmoe", "EE", {3.8, 3.3, 3.4, 3.9} };
    ug[1] = {"Macy", "Chen", "CS", {3.9, 3.9, 4.0, 4.0} };
    ug[2] = {"Peter", "Patrick", "ME", {3.8, 3.0, 2.4, 1.9} };
    printRecords(ug, 3);
}
```

Expected output

```
These are the student records:
ID# 1, Shmoe, Joe, Major: EE, Average GPA: 3.60
ID# 2, Chen, Macy, Major: CS, Average GPA: 3.95
ID# 3, Peter, Patrick, Major: ME, Average GPA: 2.77
```

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.

The bad? Using pointers needs work!

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

The ugly: memory errors!

"*The overwhelming majority of program bugs and computer crashes stem from problems of memory access... Such memory-related problems are also notoriously difficult to debug. Yet the role that memory plays in C and C++ programming is a subject often overlooked…. Most professional programmers learn about memory entirely through experience of the trouble it causes.*"

…. Frantisek Franek

(Memory as a programming concept)

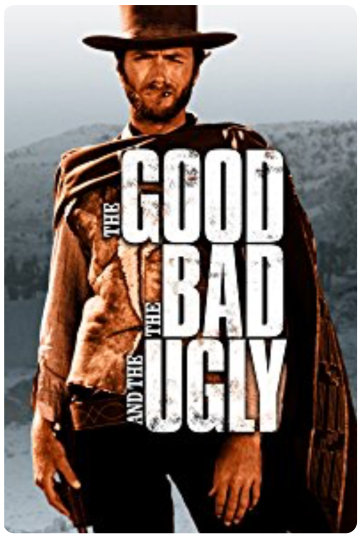
Pointer pitfalls and memory errors

- **Segmentation faults**: Program crashes because it attempted to access a memory location that either doesn't exist or doesn't have permission to access
- Examples
  - Out of bound array access
  - Dereferencing a pointer that does not point to anything results in undefined behavior.

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

for(int i=0; i<=3; i++){
   cout<<arr[i]<<endl;
}
```

```
int x = 10;
int* p;
cout<<*p<<endl;
```


THE GOOD
THE BAD
AND THE UGLY

Next time

- C++ Memory Model
- Dynamic memory allocation