C++ Arrays, Pointers

Review: Java and C++ are very similar

- **Similar in:**
  - Syntax: Java used syntax similar to C++ to ease adoption
  - Principles: Both are object-oriented languages
  - Execution: Many similarities when run on a machine
    - Compiled down to similar assembly language

- **Different in goals:**
  - Java designed for: safety and portability
  - C++ designed for: performance and control

As a result, C++ exposes aspects of execution that Java hides

What we’ve talked about so far

- **Main function: where everything starts**
  - #include: “” for things you write, <> for things you didn’t
- **Printing things out with std::cout and std::endl**
  - Namespaces, using, scope resolution operator (::)
- **Object declaration**
  - .h (declarations) include guards public/private regions
  - .cpp (function implementation)
- **Constructors**
  - Don’t rely on ~~default~~ automatic constructors; primitives uninitialized
  - Initializer lists: for init-ing children –and– calling other constructors

What we've talked about so far, cont.

- **Allocating objects, two ways:**
  - On the stack: uses same notation as primitives
    - "Deallocated" when they leave scope
  - On the heap: returns a **pointer** to the allocated thing
    - Thing *thing = new Thing();
    - Need to manually delete this memory.
- **Useful tools for looking at memory**
  - & (address of operator)
  - sizeof(thing) says how big "thing" is

"automatic memory"

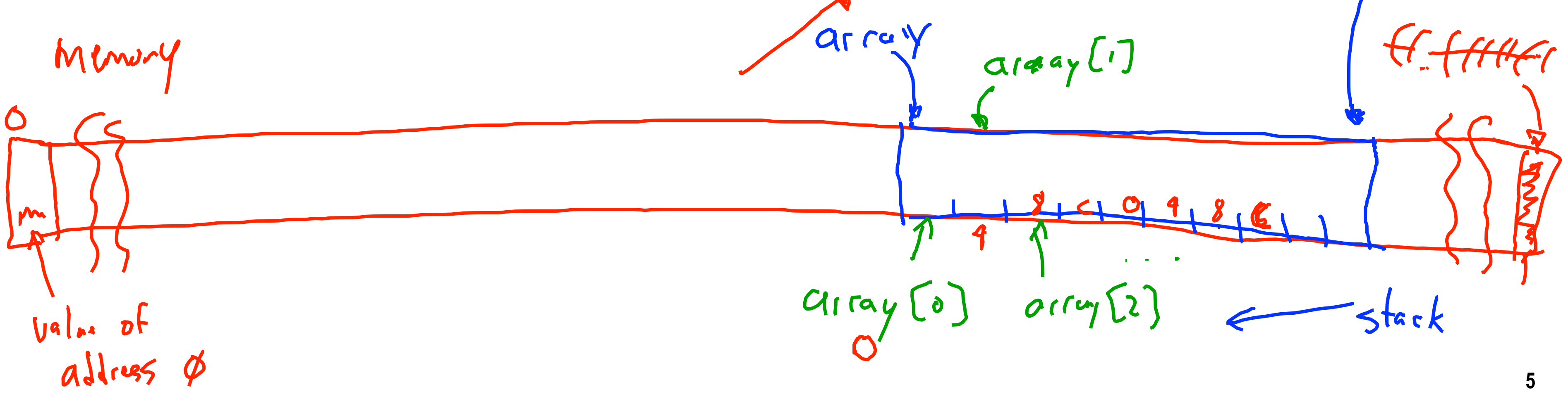
"dynamically allocated"

Arrays in C++ vs. Java (Primitives)

a) 0
b) 4
c) 8
d) c

- **Arrays of primitives in C++ are similar to those in Java**
  - Laid out sequentially
  - Unlike Java, they don't know how big they are
    - They don't prevent you from accessing elements that don't exist
    - It is common in C/C++ to keep an int length with an array

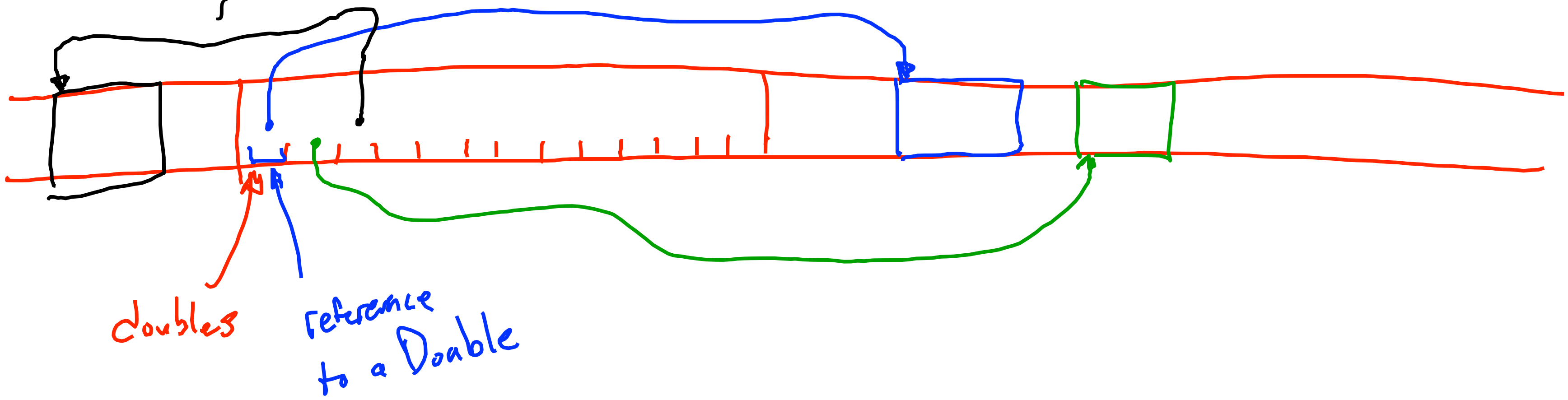
```
int array[10];
cout << sizeof(int) << " " << sizeof(array) << endl;
cout << &array[0] << " " <<  &array[1] << endl;
```



Arrays in C++ vs. Java (Objects)

- **In Java, arrays of objects are arrays of references to objects**
  - We had to do:

```
Double [] doubles = new Double[100];
for (int i = 0; i < doubles.length; i++) {
   doubles[i] = new Double(i);
}
```



  - Also, arrays were objects themselves (heap allocated)

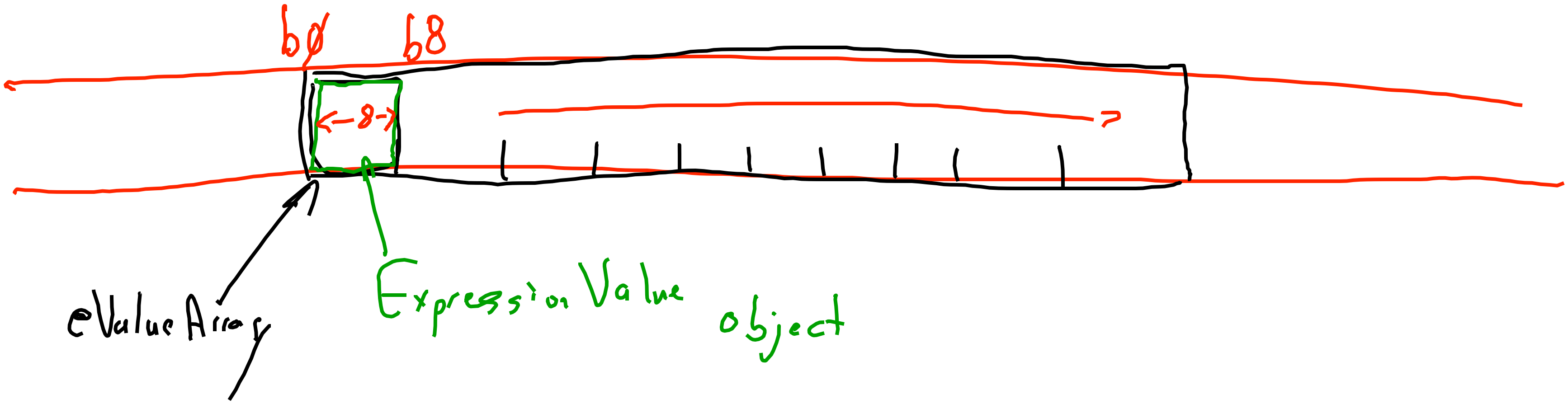
Arrays in C++ vs. Java (Objects)

- **In C++, arrays of objects can be arrays of objects**
  - Allocated in place, just like primitive values

```
ExpressionValue eValueArray[10];
cout << sizeof(ExpressionValue) << " " << sizeof(eValueArray) << endl;
cout << &eValueArray[0] << " " <<  &eValueArray[1] << endl;
```

  - Arrays can be stack or heap allocated
    - If heap allocated, it returns a pointer to the type

```
ExpressionValue *eValueArray2 = new ExpressionValue[10];
```



So let's talk more about pointers

int myInt

- **4 main operations:**
  - **Declaring:** use a * in declaration
    - **int *myIntPointer;**
  - **Assignment:** must match type
    - **myIntPointer = &myInt;** *// & is address of operator*
    - **myIntPointer = new int;** *// new returns a pointer*
  - **Copying:** from one pointer to another
    - **int *myOtherIntPointer = myIntPointer;**
  - **De-referencing:** use * in expression to get to the value

left hand side

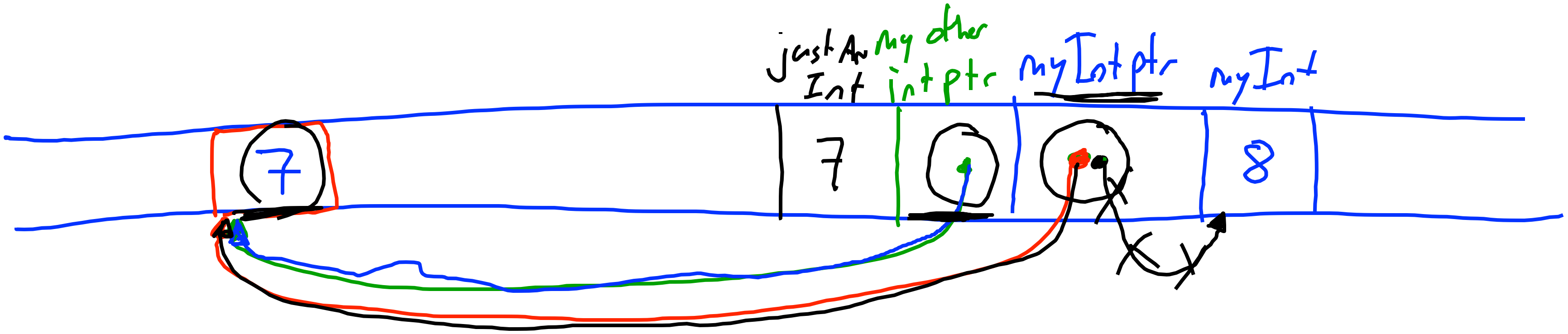
    - ***myOtherIntPointer = 7;** // assigning value pointed to.
    - **int justAnInt = *myIntPointer;** //getting value of thing pointed to

↑ expression

What is happening here? (Draw a picture!)

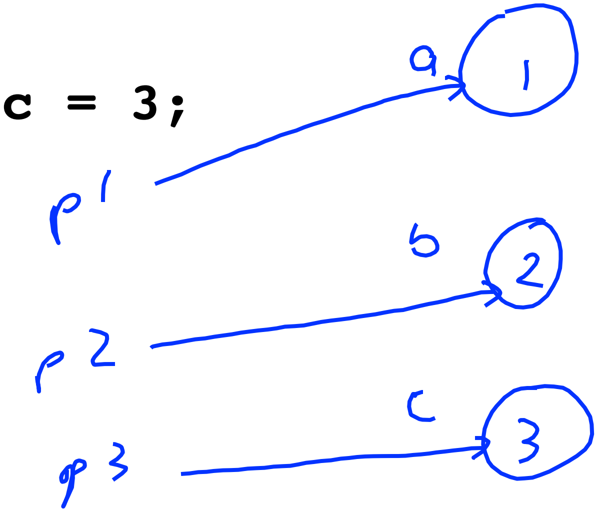
```
int myInt = 8;
int *myIntPointer;
myIntPointer = &myInt;
myIntPointer = new int;
int *myOtherIntPointer = myIntPointer;
*myOtherIntPointer = 7;
int justAnInt = *myIntPointer;
cout << justAnInt << endl;
```

A) 7
B) 8



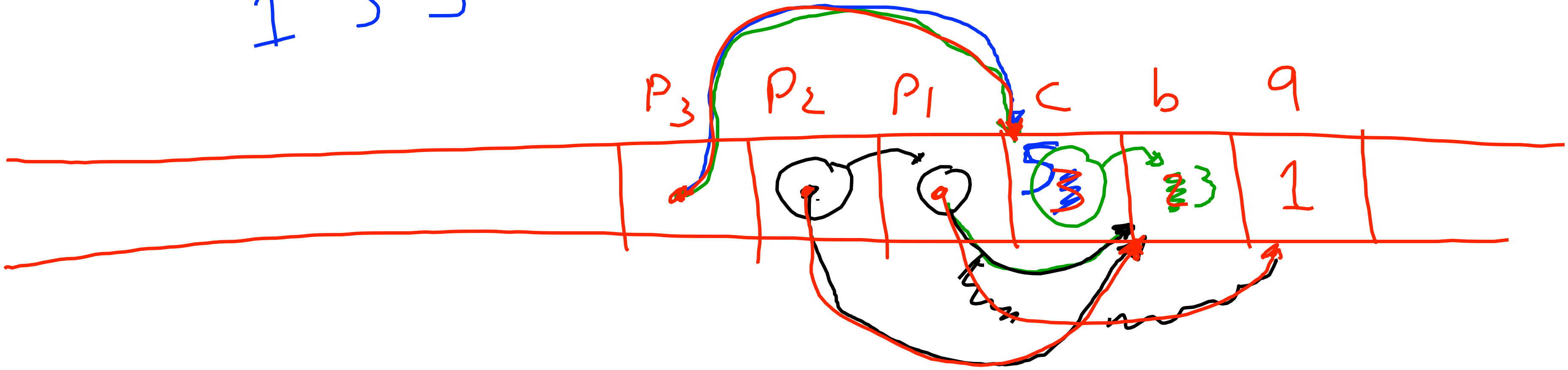
More pointer puzzles

```
int a = 1, b = 2, c = 3;
int *p1 = &a;
int *p2 = &b;
int *p3 = &c;
p1 = p2; ✓
*p1 = *p3; ✓
*p3 = 5; ✓
cout << a << " " << b << " " << c << endl;
```



A) 5 5 5
B) 3 2 5
C) 1 2 5
D) 1 3 5
E) 5 1 3

1 3 5



C++ pointers point to arrays or individuals

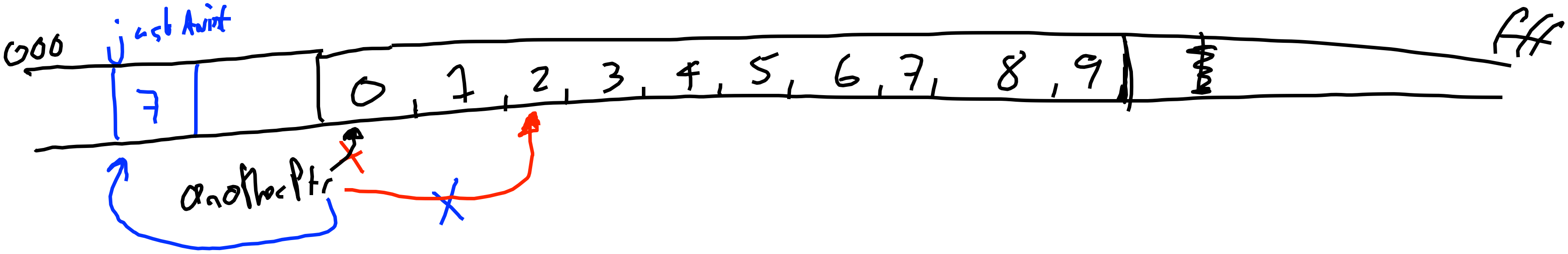
```
int *anotherIntPtr = new int[10];
for (int i = 0; i < 10; i++) { anotherIntPtr[i] = i; }

anotherIntPtr = &(anotherIntPtr[2]);
cout << *anotherIntPtr << endl;

for (int i = 0; i < 8; i++) {
    cout << anotherIntPtr[i] << endl;
}
int justAnInt = 7;
anotherIntPtr = &justAnInt;
cout << *anotherIntPtr << " ";
cout<< anotherIntPtr[0] << endl;
```

2

2 3 4 5 6 7 8 9

addr: anotherIntPtr + 4 × 0

sizeof(int

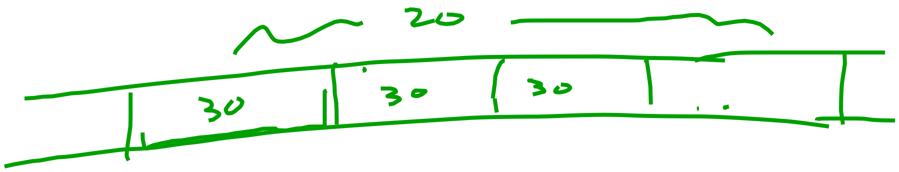


C++ pointers point to arrays or individuals

- **As a result, you need to tell delete if what you are deleting is an array:**
  - Use **delete []** for arrays, **delete** for single things

```
ExpressionValue *eValuePtr = new ExpressionValue();
delete eValuePtr;

ExpressionValue *eValueArray2 = new ExpressionValue[10];
delete [] eValueArray2;
```

x = new int[20][30];



x[3][4]

$x + (3\,\boxed{30} + 4) \cdot 4$

siz