Array and its relationship to pointer

Jinyang Li

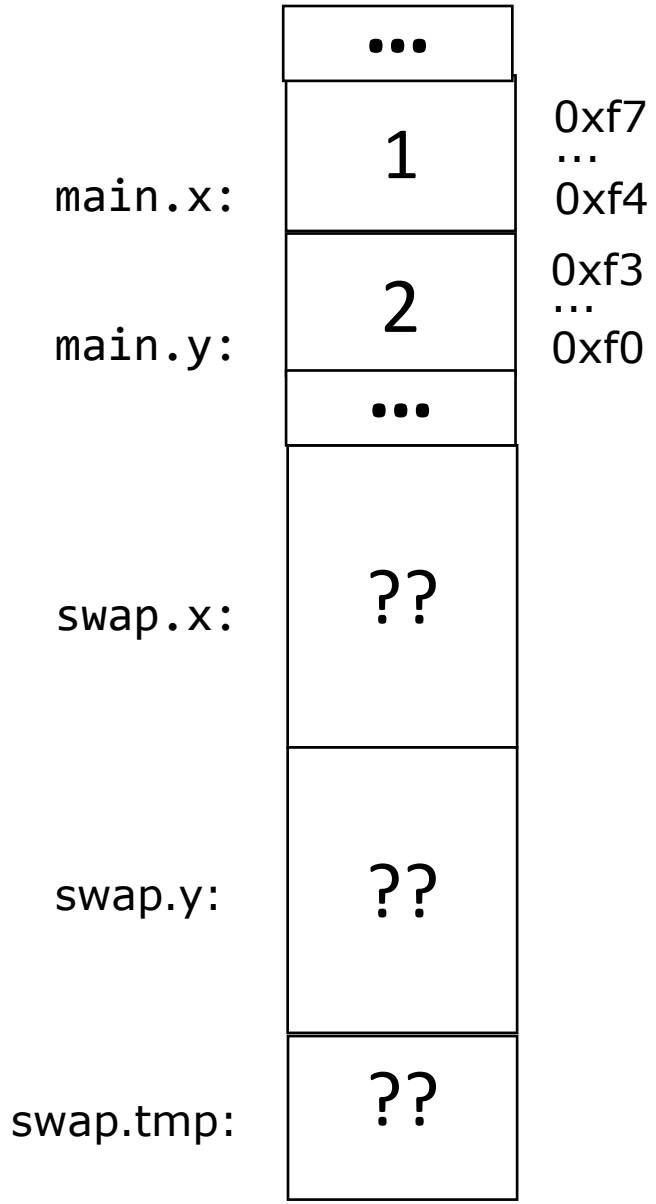
Lesson plan

- Passing pointers to function
- Arrays
  - 2 access methods

Pass pointers to function

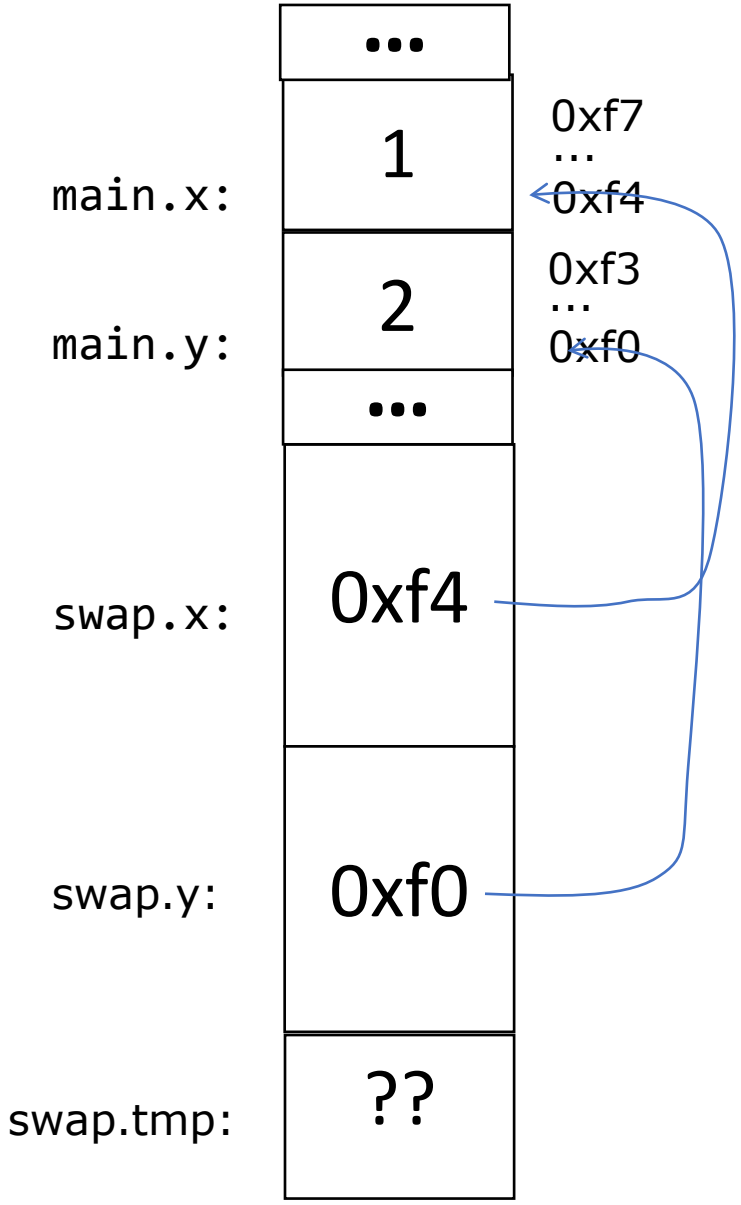
```
void swap(int* x, int* y)
{
    int tmp = *x;
        *x = *y;
        *y = tmp;
}
int main()
{
        int x = 1;
        int y = 2;
        swap(&x, &y);

        printf("x:%d,
y:%d",x,y);
}
```

Size and value of x, y, tmp
in swap upon function entrance?



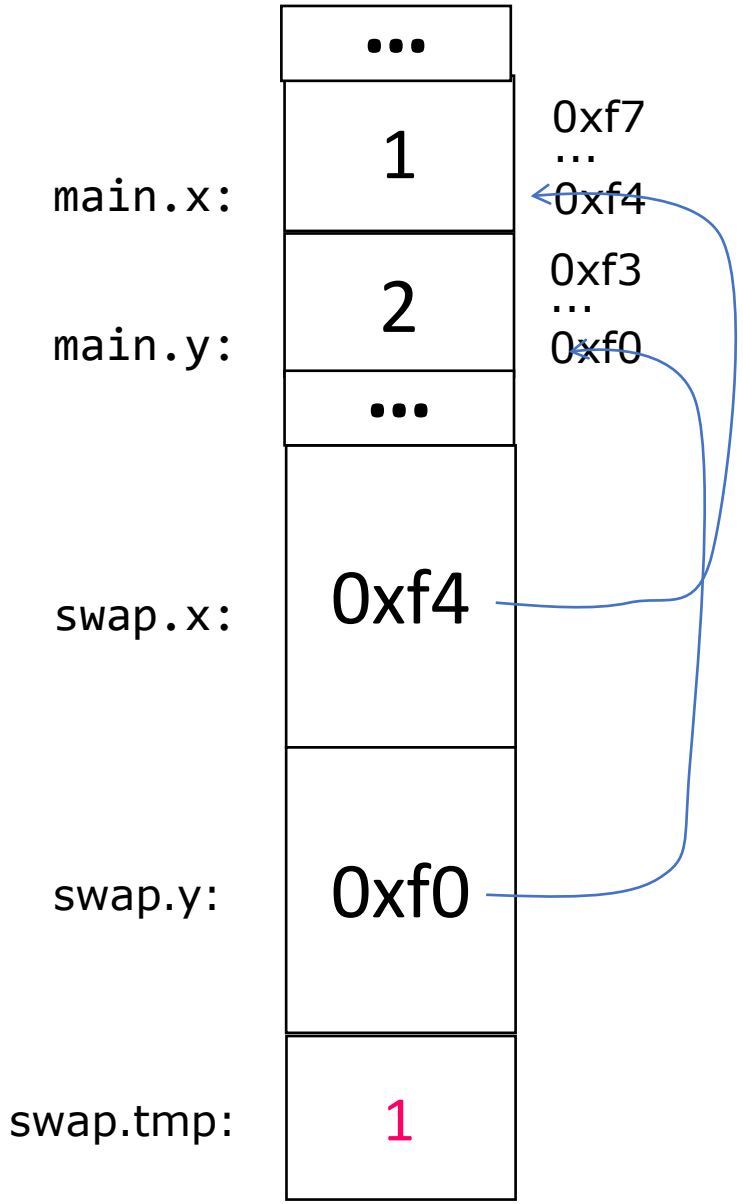
Pass pointers to function

```
void swap(int* x, int* y)
{
    int tmp = *x;
        *x = *y;
        *y = tmp;
}
int main()
{
        int x = 1;
        int y = 2;
        swap(&x, &y);

        printf("x:%d,
y:%d",x,y);
}
```



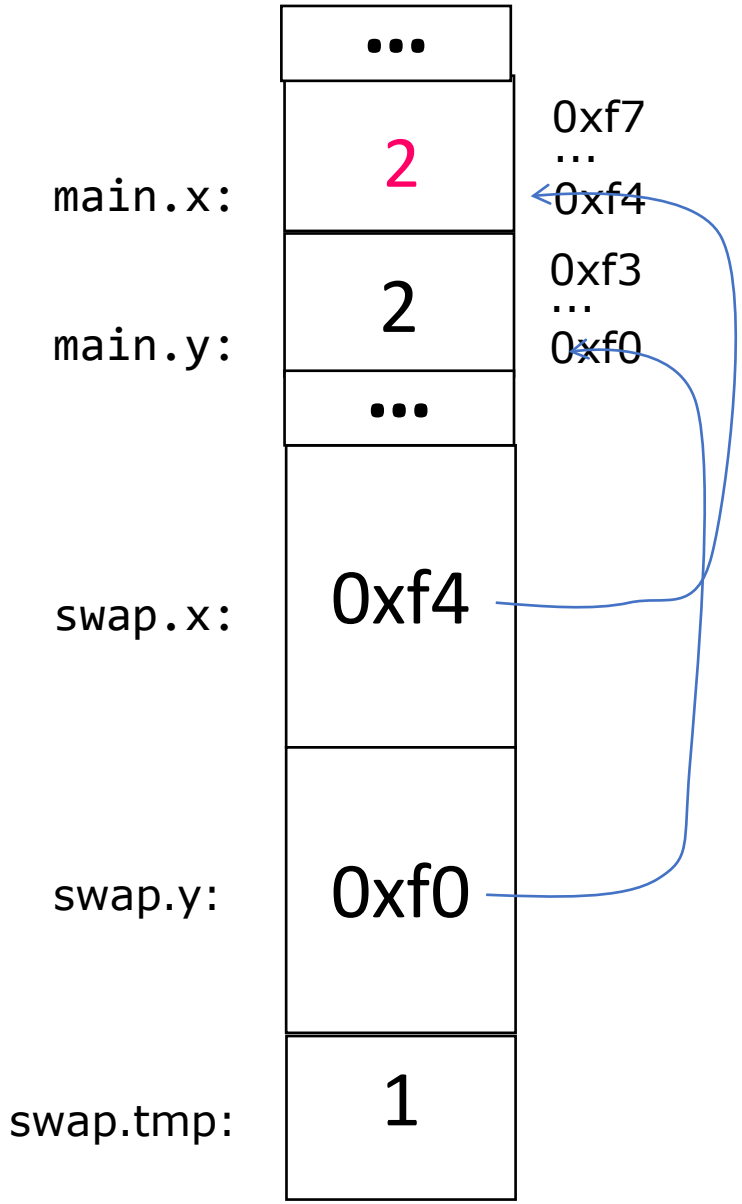
Pass pointers to function

```
void swap(int* x, int* y)
{
    int tmp = *x;
        *x = *y;
        *y = tmp;
}
int main()
{
        int x = 1;
        int y = 2;
        swap(&x, &y);

        printf("x:%d,
y:%d",x,y);
}
```



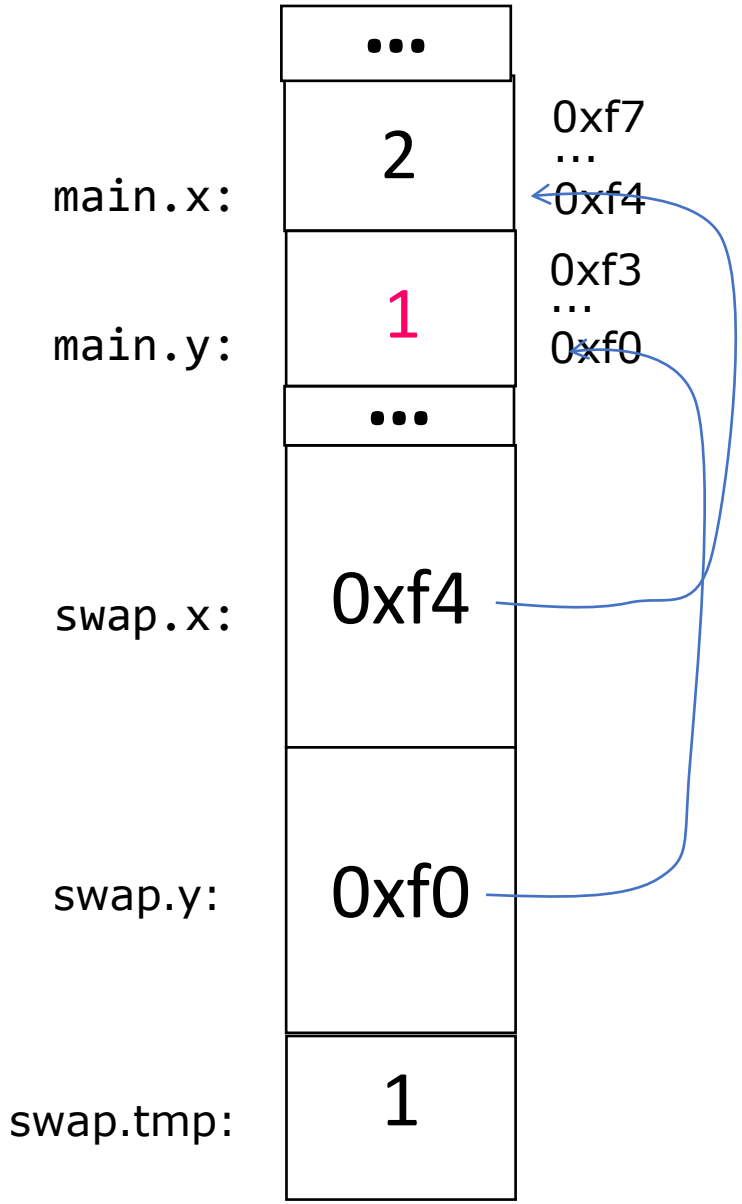
Pass pointers to function

```
void swap(int* x, int* y)
{
    int tmp = *x;
        *x = *y;
        *y = tmp;
}
int main()
{
       int x = 1;
       int y = 2;
       swap(&x, &y);

       printf("x:%d,
y:%d",x,y);
}
```



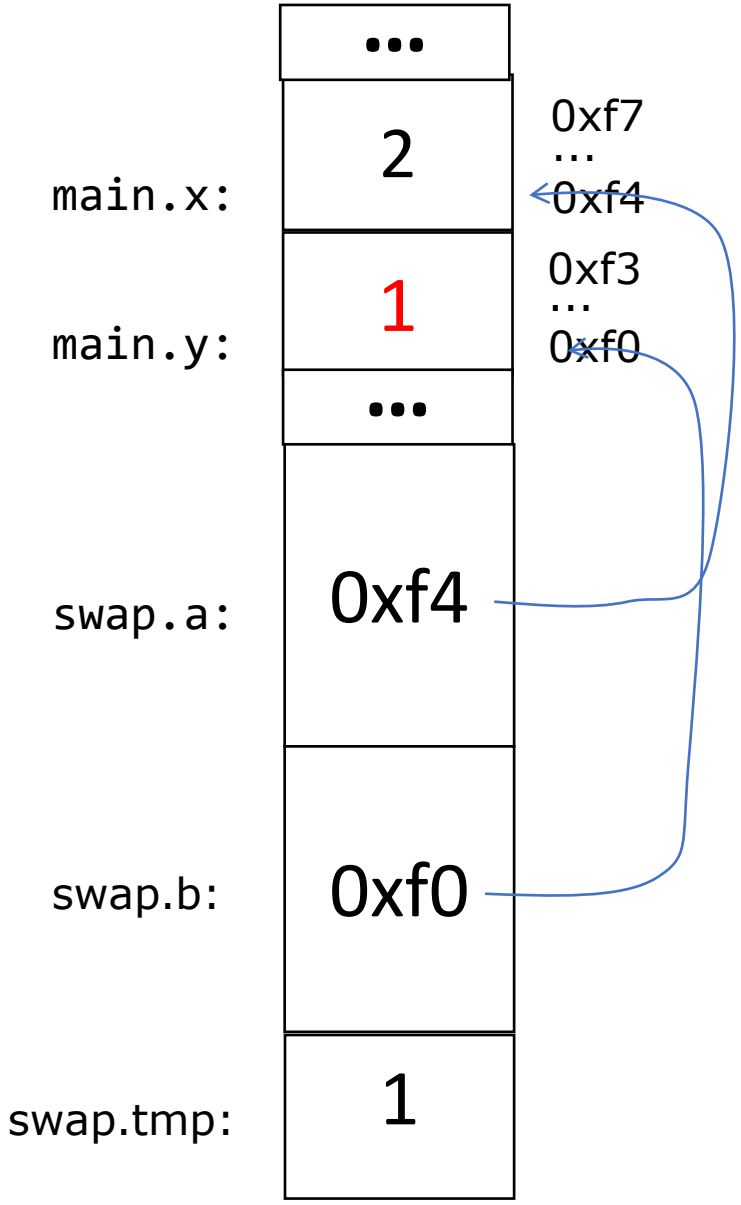
Pass pointers to function

```
void swap(int* x, int* y)
{
    int tmp = *x;
        *x = *y;
        *y = tmp;
}
int main()
{
       int x = 1;
       int y = 2;
       swap(&x, &y);

       printf("x:%d,
y:%d",x,y);
}
```



Pass pointers to function

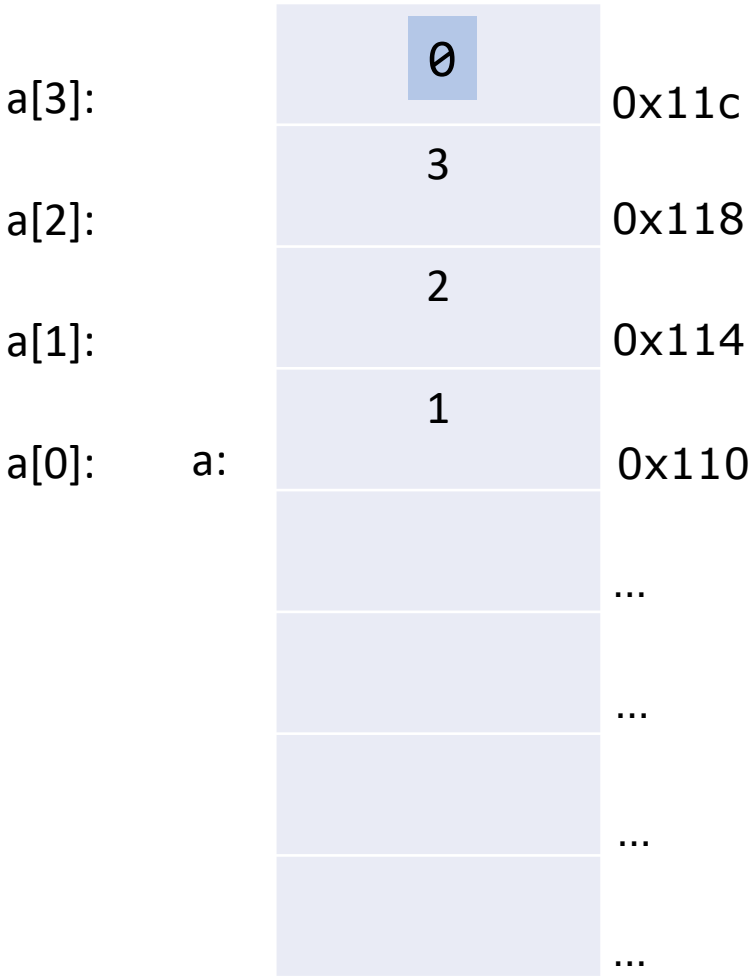
```
void swap(int* a, int* b)
{
    int tmp = *a;
        *a = *b;
        *b = tmp;
}
int main()
{
       int x = 1;
       int y = 2;
       swap(&x, &y);

       printf("x:%d,
y:%d",x,y);
}
```



Arrays

Array is a collection of contiguous objects with the same type

Array

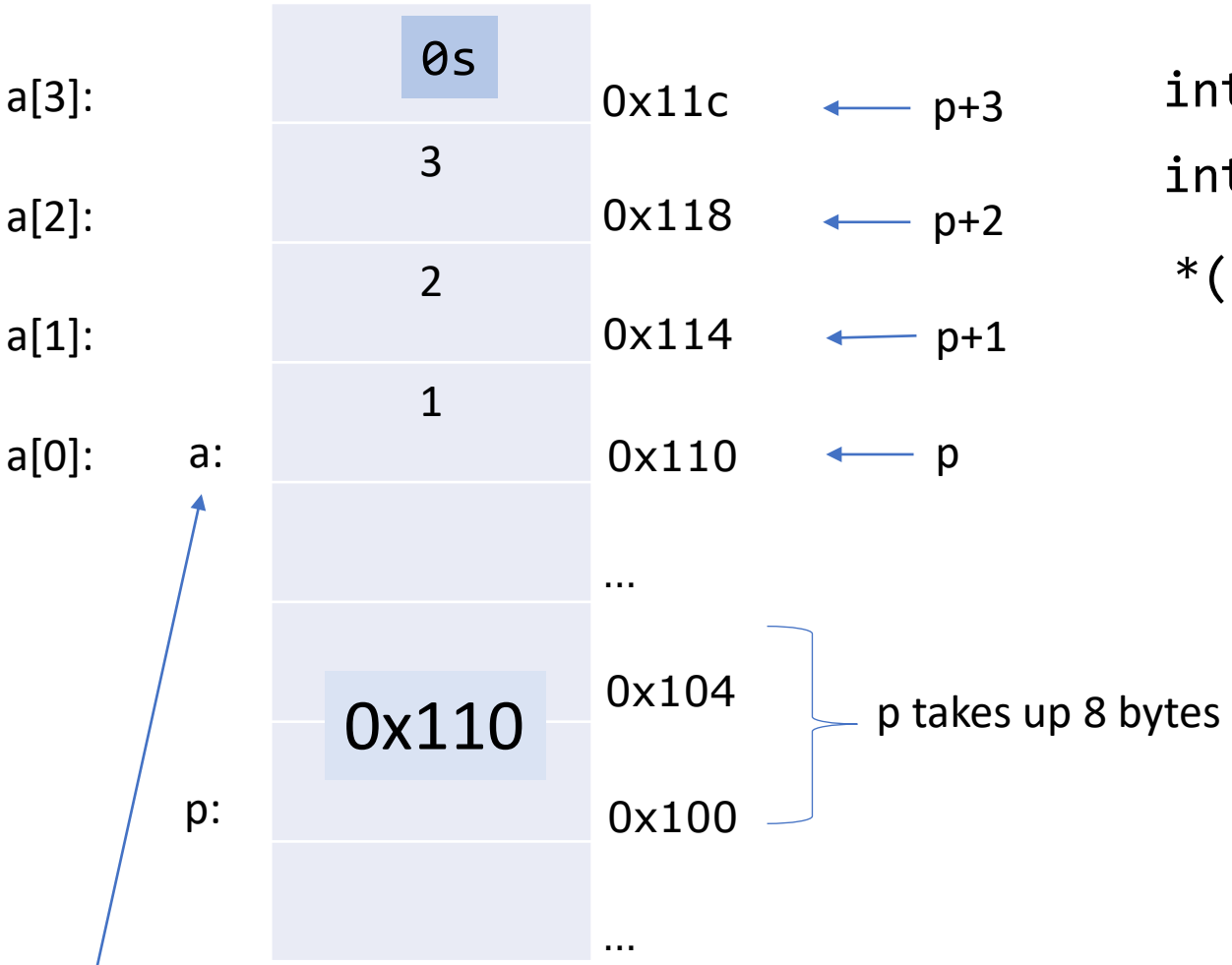



```
int a[4] = {1, 2, 3, 4};

a[3] = 0;
```

Method-1: access using index

There's no meta-data (e.g. capacity, length) associated/stored with the array

Array access using pointer




```
int a[4] = {1, 2, 3, 4};
int *p = a;
*(p+3)=0;
```

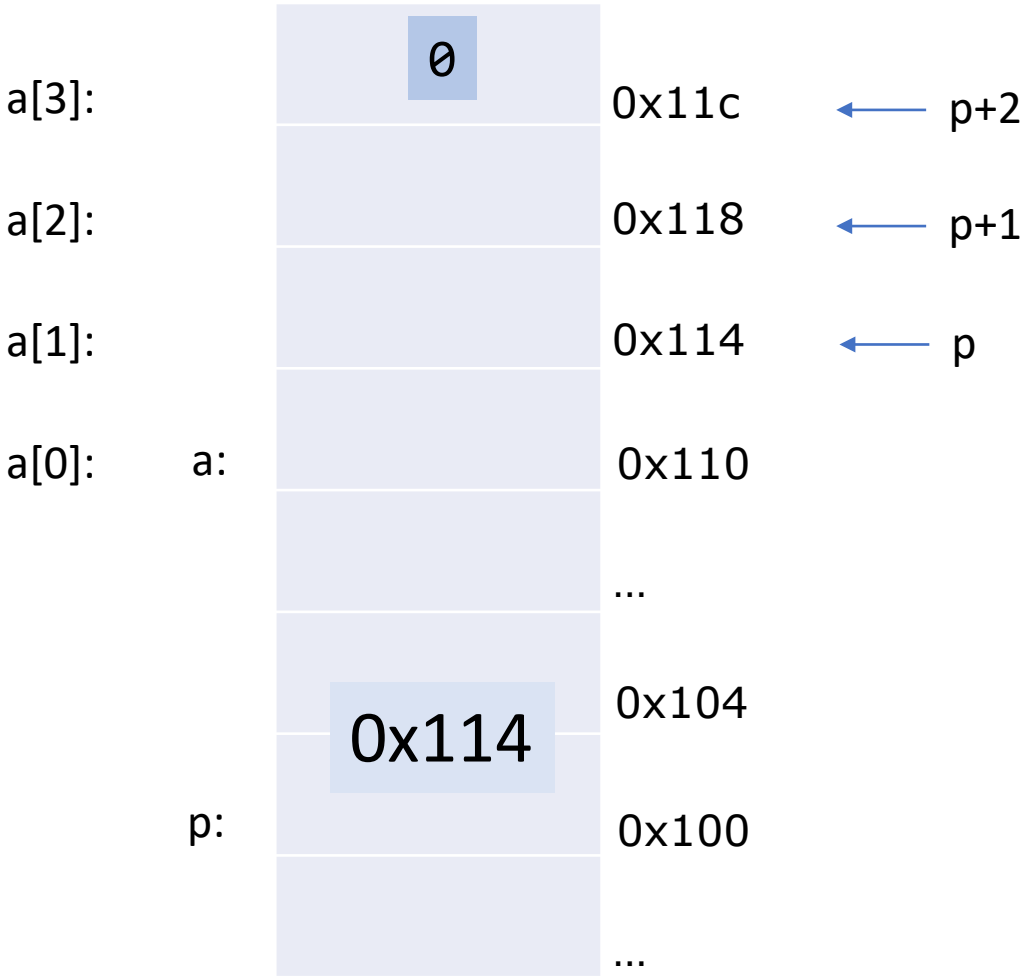
Method-2: access using pointer (arithmetic)

- `p+i` points to the i-th element after the one pointed to by p
  - i.e. `p+i` is calculated as: p's value + sizeof(*p) * i
- `p-i` points to the i-th element before the one pointed to by p

Built-in function sizeof returns size (in bytes) of the object representing a given expression or type

a (array name) is aliased to be the memory address of the first element.
a is effectively a constant, not a variable, cannot be changed

Array access using pointer

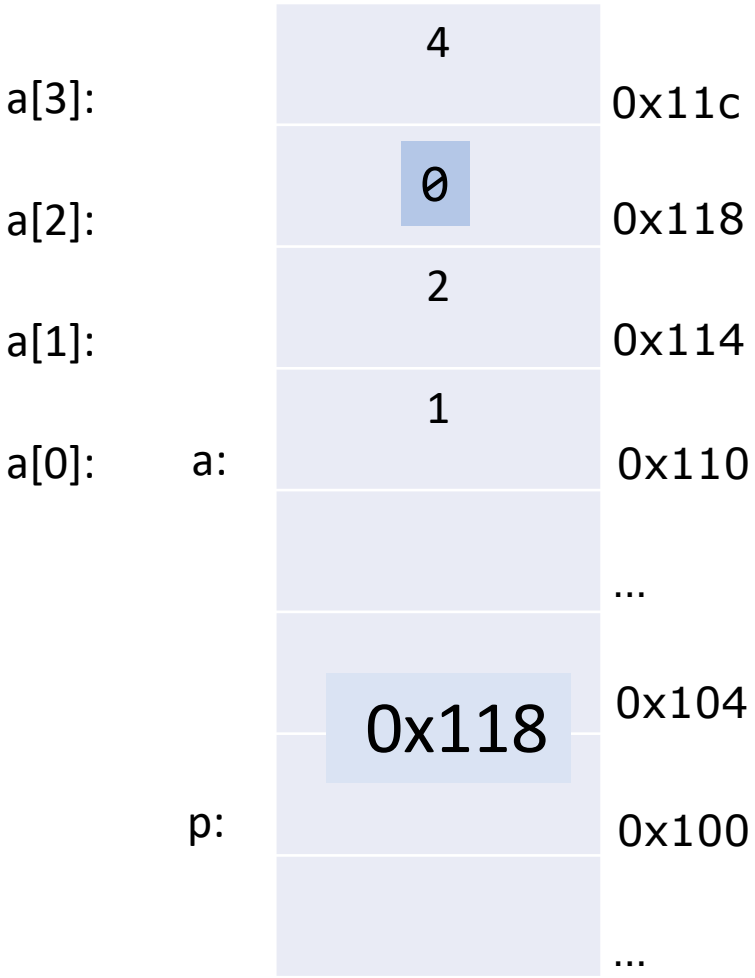



```
int a[4];
int *p = &a[1];
*(p+2)=0;
```

`&a[i]` is syntactically equivalent to: `a+i`

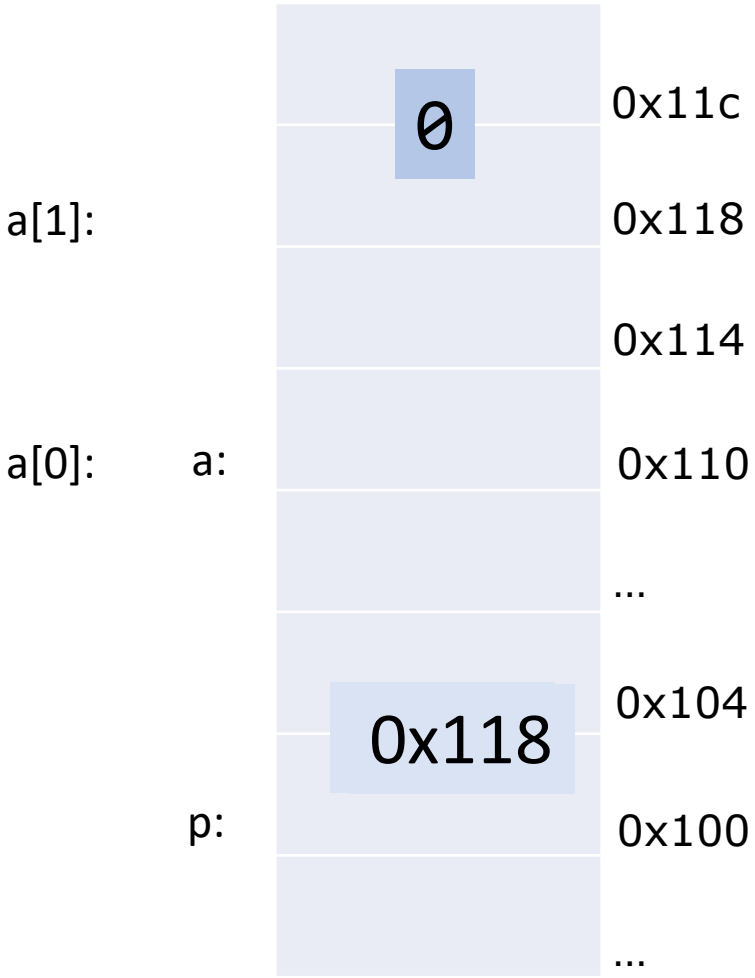
`*(p+i)` is syntactically equivalent to: `p[i]`

Array access using pointer




```
int a[4] = {1, 2, 3, 4};
int *p = &a[3];
 p--;
 *p=0;
```

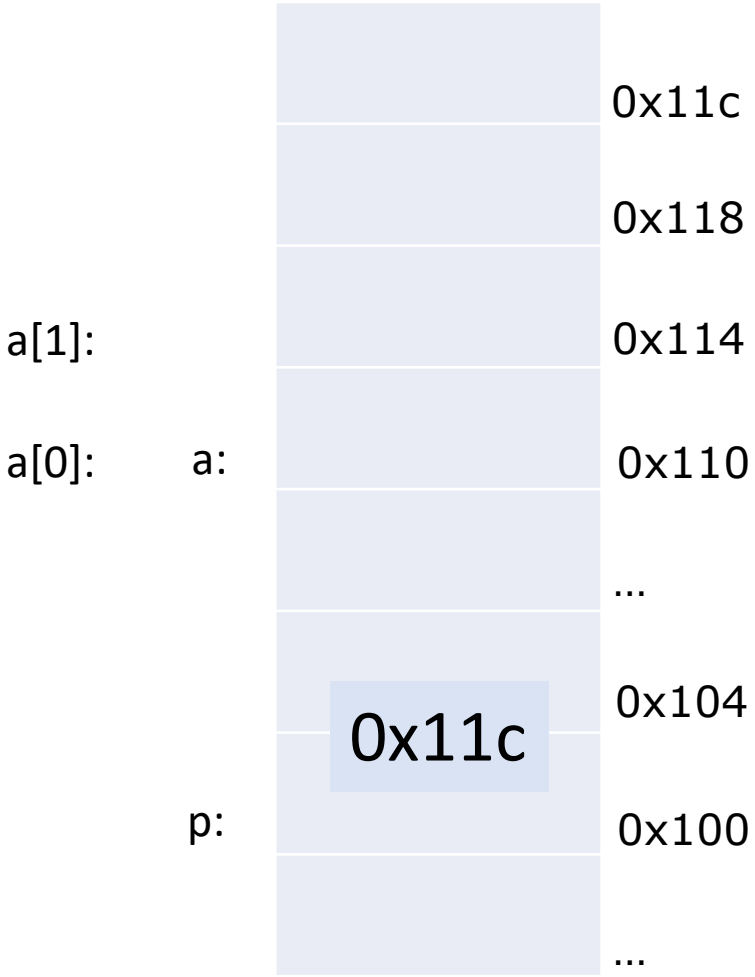
Array access using pointer



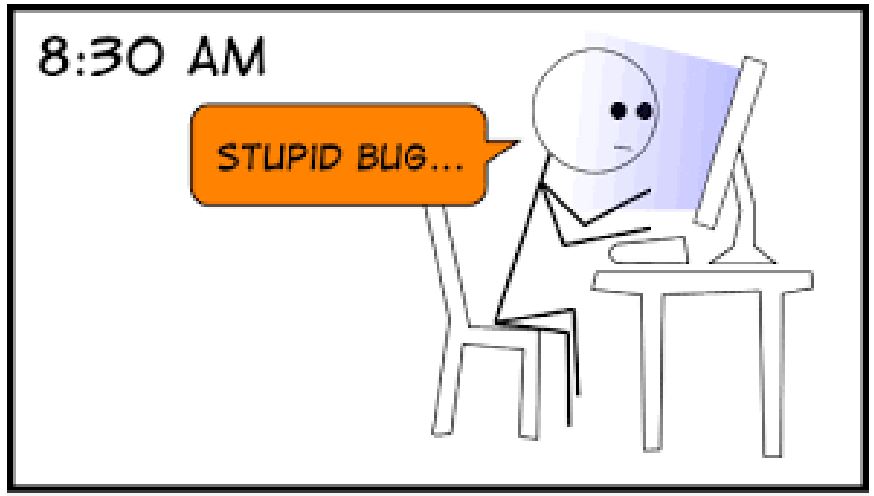

```
char *a[2];

char ** p = &a[0];

 p++;

*p=NULL;
```

Equivalent to:
p = a

Out-of-bound access results in (potentially silent) memory error




```
int a[2];
int *p = a;

 p += 3;

 *p=0;
```



Breakout time!

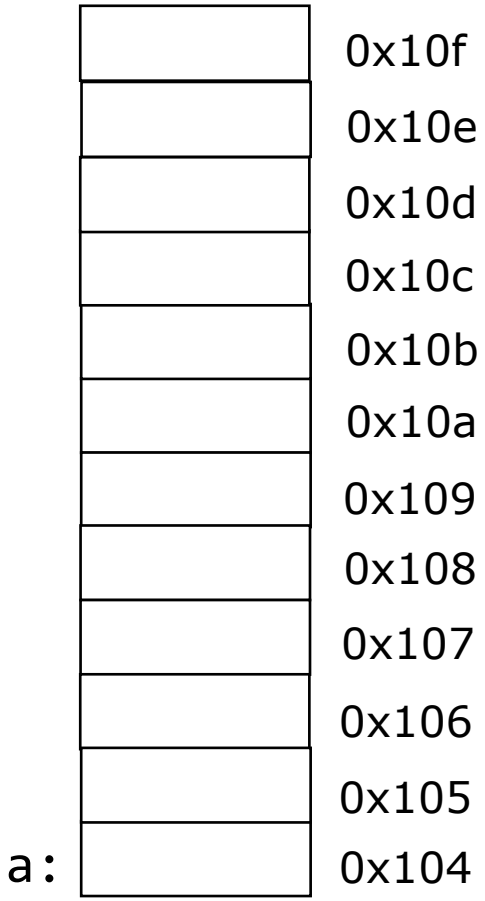
Pass array to function via pointer

```
// multiply every array element by 2
void multiply2(int *a) {
   for (int i = 0; i < ???; i++) {
      a[i] *= 2;
   }
}

int main() {
   int a[2] = {1, 2};
   multiply2(a);
   for (int i = 0; i < 2; i++) {
       printf("a[%d]=%d", i, a[i]);
   }
}
```

Pass array to function via pointer

```
// multiply every array element by 2
void multiply2(int *a, int n) {
   for (int i = 0; i < n; i++) {
      a[i] *= 2; // (*(a+i)) *= 2;
   }
}

int main() {
   int a[2] = {1, 2};
   multiply2(a, 2);
   for (int i = 0; i < 2; i++) {
       printf("a[%d]=%d", i, a[i]);
   }
}
```

Pointer casting




```
int a = 0x12345678;
char *cp = (char *)&a;

// What is *cp?

cp++;

// What is *cp?
```

Assume 64-bit small endian machine

Another example use of pointer casting

```
unsigned int extract_float_bit_pattern(float f)
{

     unsigned int i = *(unsigned int *)&f;

     return i;


}
```

Summary

- Arrays: equivalence of pointer arithmetic and array access
  - `p+i` same as `&p[i]`
  - `*(p+i)` same as `p[i]`
  - Value of `p+i` is computed as `p+sizeof(*p)*I`
- Pass pointers to functions
- Pointer casting

function *sizeof*

sizeof(`type`)

- Returns size in bytes of the object representation of type

sizeof(expression)

- Returns size in bytes of the type that would be returned by expression, if evaluated.

function *sizeof*

sizeof()	result (bytes)
sizeof(int)	
sizeof(long)	
sizeof(float)	
sizeof(double)	
sizeof(int *)	

64 bits machine

function *sizeof*

sizeof()	result (bytes)
sizeof(int)	4
sizeof(long)	8
sizeof(float)	4
sizeof(double)	8
sizeof(int *)	8

64 bits machine

function *sizeof*

expr	sizeof()	result (bytes)
int a = 0;	sizeof(a)	
long b = 0;	sizeof(b)	
int a = 0; long b = 0;	sizeof(a + b)	
char c[10];	sizeof(c)	
int arr[10];	sizeof(arr)	
	sizeof(arr[0])	
int *p = arr;	sizeof(p)	

64 bits machine

function *sizeof*

expr	sizeof()	result (bytes)
int a = 0;	sizeof(a)	4
long b = 0;	sizeof(b)	8
int a = 0; long b = 0;	sizeof(a + b)	8
char c[10];	sizeof(c)	10
int arr[10];	sizeof(arr)	10 * 4 = 40
	sizeof(arr[0])	4
int *p = arr;	sizeof(p)	8

64 bits machine