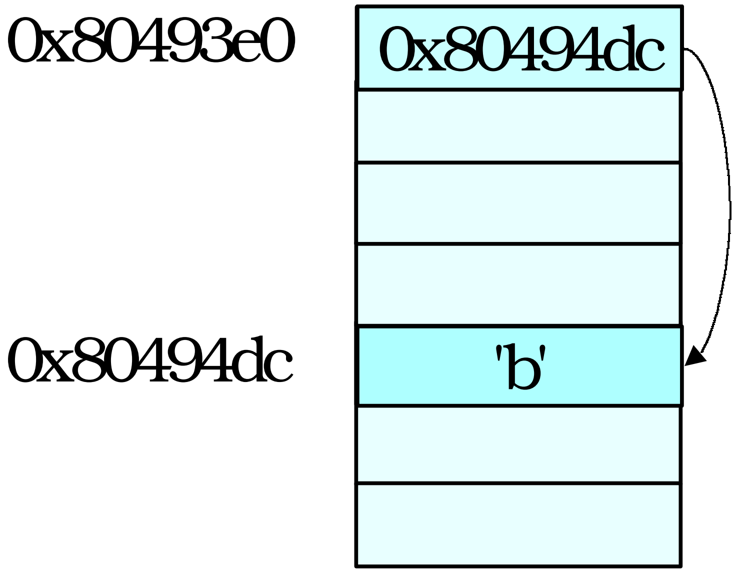
Pointers and Arrays

- Recall the pointer syntax:
- `char *cptr;`
  - declares a pointer to a char
  - allocates space to store a pointer (to a char)
- `char c = 'a';`
- `cptr = &c;`
  - `cptr` gets the value of the address of c
  - the value stored at the memory location referred to by `cptr` is the address of the memory location referred to by `c`;
- `*cptr = 'b';` – dereference `cptr`
  - the address stored at `cptr` identifies the memory location where `'b'` will be stored.

Pointers and Arrays

```
char *cptr;
char c = 'a';
cptr = &c;
*cptr = 'b';
```



0x80493e0

0x80494dc

0x80494dc

'b'

Symbol Table

cptr	0x80493e0
c	0x80494dc

Arrays vs. Pointers

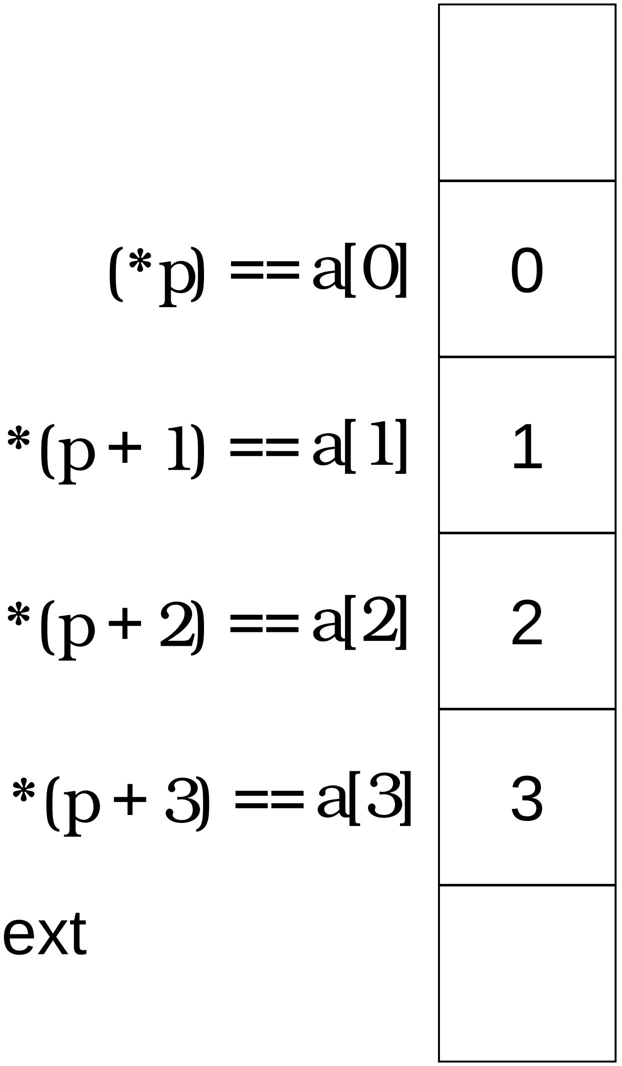
- An array name in expression context decays into a pointer to the zero’th element.
- E.g.

```
int a[3] = {1, 3, 5};
int *p = a;  p = &a[0];
p[0] = 10;
printf("%d %d\n", a[0], *p);
```

Example

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

for(i = 0; i < 4; i++) {
  printf("%d\n", *(p + i));
}
```



$(*p) == a[0]$ 0

$*(p+1) == a[1]$ 1

$*(p+2) == a[2]$ 2

$*(p+3) == a[3]$ 3

Why does adding 1 to p move it to the next spot for an int, when an int is 4 bytes?

Pointer Arithmetic

- Pointer arithmetic respects the type of the pointer.
- E.g.,

```
int i[2] = {1, 2};      char c[2] = {'a','z'};
int *ip;                char *cp;
ip = i;                 cp = c;
*(ip + 1) += 2;         *(cp + 1) = 'b';
```

(really adds 4 to `ip`)   (really adds 1 to `cp`)

- C knows the size of what is being pointed at from the *type* of the pointer.

Pointer Arithmetic

- The array access operator [ ] is really only a shorthand for pointer arithmetic + dereference
- These are equivalent in C:

```
a[i]  ==  *(a + i)
```

- C translates the first form into the second.
  - pointers and arrays are nearly the same in C!

Passing Arrays as Parameters

```
int main()
{
   int i[3] = {10, 9, 8};
   printf("sum is %d\n", sum(i)); /*??*/
   return 0;
}
int sum( What goes here? ) {
}
```

- What is being passed to the function is the name of the array which decays to a pointer to the first element – a pointer of type int.

Passing Arrays as Parameters

```
int sum( int *a ) {
   int i, s = 0;
   for(i = 0; i < ??; i++)
      s += a[i];  /* this is legal */
   return s;
}
```

`sizeof(a)==4` since `a` is just a pointer here

- How do you know how big the array is?
- Remember that arrays are not objects, so knowing where the zero’th element of an array is does not tell you how big it is.
- Pass in the size of the array as another parameter.

Array Parameters

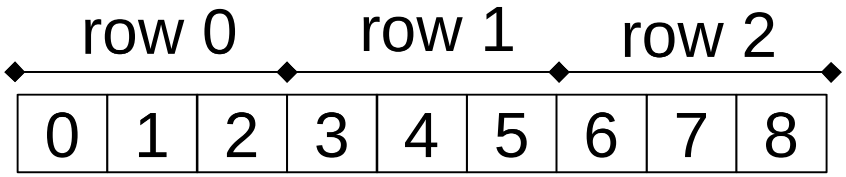
```
int sum(int *a, int size)
```

- Also legal is:
  `int sum(int a[], int size)`
- Many advise against using this form.
  - You really are passing a pointer-to-int not an array.
  - You still don't know how big the array is.
  - Outside of a formal parameter declaration `int a[];` is illegal

⇨ `int a;` and `int a[10];` are completely different things

Multi-dimensional arrays

- Remember that memory is a sequence of bytes.



row 0 row 1 row 2

0 1 2 3 4 5 6 7 8

```
int a[3][3] = { {0, 1, 2},
                {3, 4, 5},
                {6, 7, 8}};
```

- Arrays in C are stored in row-major order
- row-major access formula

```
x[i][j] == *(x + i * n + j)
```

where n is the row size of x

But use array notation!

Summary

- The name of an array can also be used as a pointer to the zero’th element of the array.
- This is useful when passing arrays as parameters.
- Use array notation rather than pointer arithmetic whenever you have an array.