Arrays

‘primitive’ arrays v. vectors (1)

allocate new, 10 elements

```
int a[10];
```

```
vector<int> v(10);
// or:
vector<int> v;
v.resize(10);
```

‘primitive’ arrays v. vectors (1)

allocate new, 10 elements

```
int a[10];
```

```
vector<int> v(10);
// or:
vector<int> v;
v.resize(10);
```

access (no bounds checking)

```
int foo = a[3];
a[4] = 17;
```

```
int foo = v[3];
v[4] = 17;
```

‘primitive’ arrays v. vectors (1)

allocate new, 10 elements

```
int a[10];
```

```
vector<int> v(10);
// or:
vector<int> v;
v.resize(10);
```

access (no bounds checking)

```
int foo = a[3];
a[4] = 17;
```

```
int foo = v[3];
v[4] = 17;
```

access (with bounds checking)

```
/* no equivalent */
```

```
int foo = v.at(3);
v.at(4) = 17;
```

‘primitive’ arrays v. vectors (2)

copy

```
int a[10]; int b[10];
...
// a = b does NOT work
for (int i = 0;
     i < 10; ++i)
    a[i] = b[i];
```

```
vector<int> a;
vector<int> b;
...
a = b;
```

‘primitive’ arrays v. vectors (3)

equality

```
int a[10]; int b[10];
...

// a == b does NOT work
  // instead: checks if
  // a, b are same array
  // (not same values)

bool isEqual = true;
for (int i = 0; i < 10; ++i)
    isEqual = (isEqual &&
        a[i] == b[j]);
```

```
vector<int> a;
vector<int> b;
...

bool isEqual = (a == b);
```

arrays, pointers, and memory (1)

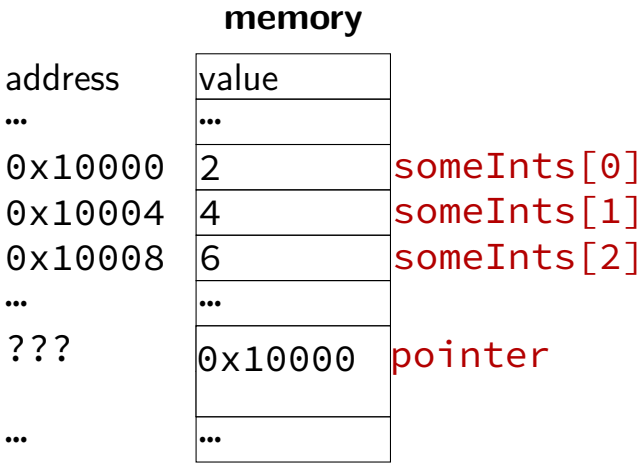
```
int someInts[3] = {2, 4, 6};
int *pointer = someInts;
```

memory

address	value
…	…
0x10000	2
0x10004	4
0x10008	6
…	…
???	0x10000
…	…

arrays, pointers, and memory (1)

```
int someInts[3] = {2, 4, 6};
int *pointer = someInts;
```



arrays, pointers, and memory (2)

```
int someInts[3] = {2, 4, 6};

cout << "someInts is: " << someInts << endl;
cout << "&someInts[0] is: " << &someInts[0] << endl;
cout << "&someInts[1] is: " << &someInts[1] << endl;
cout << "someInts[1] is: " << someInts[1] << endl;
```

---

example output:

```
someInts is: 0x7ffda5455b44
&someInts[0] is: 0x7ffda5455b44
&someInts[1] is: 0x7ffda5455b48
someInts[1] is: 4
```

arrays, pointers, and memory (2)

```
int someInts[3] = {2, 4, 6};

cout << "someInts is: " << someInts << endl;
cout << "&someInts[0] is: " << &someInts[0] << endl;
cout << "&someInts[1] is: " << &someInts[1] << endl;
cout << "someInts[1] is: " << someInts[1] << endl;
```

example output: array implicitly converted to pointer to first element

```
someInts is: 0x7ffda5455b44
&someInts[0] is: 0x7ffda5455b44
&someInts[1] is: 0x7ffda5455b48
someInts[1] is: 4
```

arrays, pointers, and memory (2)

```
int someInts[3] = {2, 4, 6};

cout << "someInts is: " << someInts << endl;
cout << "&someInts[0] is: " << &someInts[0] << endl;
cout << "&someInts[1] is: " << &someInts[1] << endl;
cout << "someInts[1] is: " << someInts[1] << endl;
```

arrays elements always at adjacent addresses
(4 bytes apart = ints are 4 bytes)

example output:

```
someInts is: 0x7ffda5455b44
&someInts[0] is: 0x7ffda5455b44
&someInts[1] is: 0x7ffda5455b48
someInts[1] is: 4
```

arrays, pointers, and memory (2)

```
int someInts[3] = {2, 4, 6};

cout << "someInts is: " << someInts << endl;
cout << "&someInts[0] is: " << &someInts[0] << endl;
cout << "&someInts[1] is: " << &someInts[1] << endl;
cout << "someInts[1] is: " << someInts[1] << endl;
```

general rule:

```
(long) &array[i] == (long) array-addr + sizeof(array-elem) * i
```

```
someInts is: 0x7ffda5455b44
&someInts[0] is: 0x7ffda5455b44
&someInts[1] is: 0x7ffda5455b48
someInts[1] is: 4
```

arrays as function parameters

```
void someFunc(int ptrToArray[], int size) { /* code */ }
int main() {
    int someInts[3];
    someFunc(someInts, 3);
    return 0;
}
```

is exactly equivalent to:

```
void someFunc(int *ptrToArray, int size) { /* code */ }
int main() {
    int someInts[3];
    someFunc(someInts, 3);
    return 0;
}
```

arrays as function parameters

```
void someFunc(int ptrToArray[], int size) { /* code */ }
int main() {
    int someInts[3];
    so
    re
}
```

`ptrToArray` is always a pointer
example: `sizeof(ptrToArray) == sizeof(int*)`
(even though `sizeof(someInts) == 3 * sizeof(int)`)

is exactly equivalent to:

```
void someFunc(int *ptrToArray, int size) { /* code */ }
int main() {
    int someInts[3];
    someFunc(someInts, 3);
    return 0;
}
```

arrays of arrays

AKA multidimensional arrays

```
int m[2][3];
int n[2][3] = { {1,2,3}, {4,5,6} };
```

arrays of arrays

AKA multidimensional arrays

```
int m[2][3];
int n[2][3] = { {1,2,3}, {4,5,6} };

// "row" 1
n[0][0] == 1
n[0][1] == 2
n[0][2] == 3

// "row" 2
n[1][0] == 4
n[1][1] == 5
n[1][2] == 6
```

array of array storage

"row-major" order

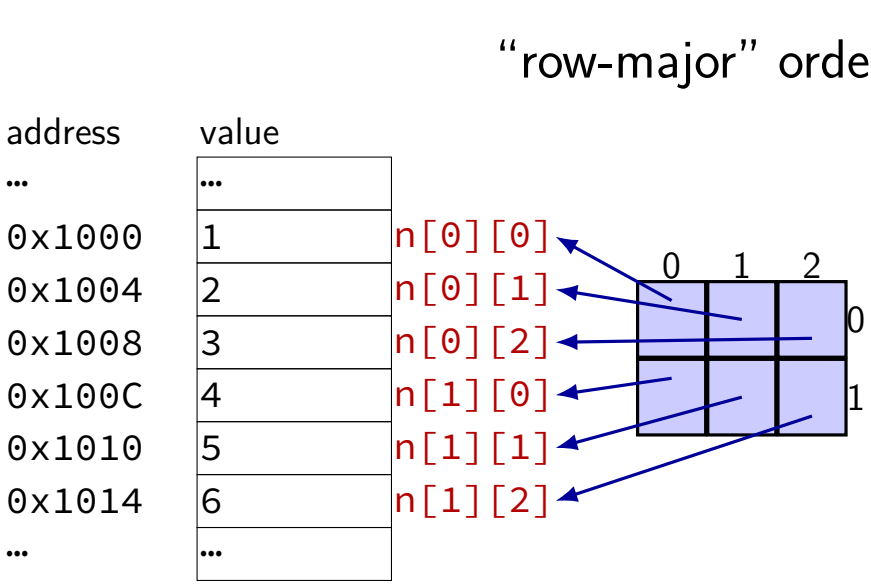
address	value
…	…
0x1000	1
0x1004	2
0x1008	3
0x100C	4
0x1010	5
0x1014	6
…	…

array of array storage

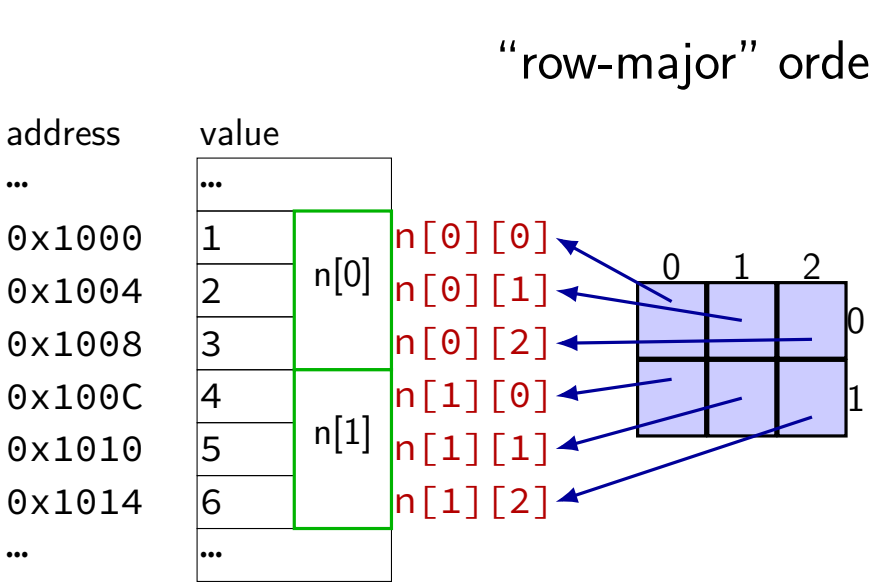
"row-major" order

address	value	
…	…	
0x1000	1	n[0][0]
0x1004	2	n[0][1]
0x1008	3	n[0][2]
0x100C	4	n[1][0]
0x1010	5	n[1][1]
0x1014	6	n[1][2]
…	…	

array of array storage



array of array storage



pointers to array

(we will not test you on this)

```
int m[2][3] = { {1,2,3}, {4,5,6} }

// p1 is a "pointer to array of 3 ints"
    // yes, this syntax is really confusing
    // and generally not worth using
int (*p1)[3];
p1 = m;   // p1 contains address of m[0]
cout << p1 << endl;
    // OUTPUT: 0x... --- address of m[0][0]
cout << p1[1] << endl;
    // OUTPUT: 0x... --- address of m[1][0]

cout << p1[1][1] <<endl;
    // OUTPUT: 5
```

command line parameters

```
int main (int argc, char* argv[]) { ... }
// same as:
int main (int argc, char **argv) { ... }
```

`argc` — number of arguments + 1

`argv` — array of *pointers* to C-style strings

- `argv[0]` — program name
- `argv[1]`, `argv[2]`, ...— arguments

what about `int main() { ... }`?

- okay, but can't get arguments

```
int main(int argc, char **argv) {
    ... // argv == 0x10000
}
```

memory

address	value
…	…
0x10000–7	0x20000
0x10008–F	0x2003A
…	…
0x20000	'.'
0x20001	'/'
0x20002	'a'
0x20003	'.'
0x20004	'o'

address	value
0x20005	'u'
0x20006	't'
0x20007	'\0'
…	…
0x2003A	'a'
0x2003B	'r'
0x2003C	'g'
0x2003C	'1'
0x2003D	'\0'
…	…

```
int main(int argc, char **argv) {
    ... // argv == 0x10000
}
```

memory

address	value	
…	…	
0x10000–7	0x20000	argv[0]
0x10008–F	0x2003A	argv[1]
…	…	
0x20000	'.'	argv[0][0]
0x20001	'/'	argv[0][1]
0x20002	'a'	argv[0][2]
0x20003	'.'	argv[0][3]
0x20004	'o'	argv[0][4]
0x20005	'u'	argv[0][5]
0x20006	't'	argv[0][6]
0x20007	'\0'	argv[0][7]
…	…	
0x2003A	'a'	argv[1][0]
0x2003B	'r'	argv[1][1]
0x2003C	'g'	argv[1][2]
0x2003C	'1'	argv[1][3]
0x2003D	'\0'	argv[1][4]
…	…	

C strings to strings

given a `char *c_style_string` (like `argv[i]`)

output:

```
cout << c_style_string
```

convert to C++-style string called `s`:

```
string s(c_style_string)
string s; s = c_style_string;
```

command line parameters

```
int main (int argc, char* argv[]) {
    // The 0th command line parameter is the program name.
    cout << "This program is called '" << argv[0]
         << "'" << endl;
    cout << "The following are the command "
         << "line parameters you specified: " << endl;
    // for loop starts at 1 to avoid printing
    // name of program (again)
    for ( int i = 1; i < argc; i++ ) {
        // we can convert the C-style strings into
        // C++-style strings, and then print them:
        string s(argv[i]);
        cout << "\t" << s << endl;
    }
    return 0;
}
```

command line parameters

```
int main (int argc, char* argv[]) {
    // The 0th command line parameter is the program name.
    cout << "This program is called '" << argv[0]
         << "'" << endl;
    cout << "The following are the command "
         << "line parameters you specified: " << endl;
    // for loop starts at 1 to avoid printing
    // name of program (again)
    for ( int i = 1; i < argc; i++ ) {
        // we can convert the C-style strings into
        // C++-style strings, and then print them:
        string s(argv[i]);
        cout << "\t" << s << endl;
    }
    return 0;
}
```

command line parameters

```
int main (int argc, char* argv[]) {
    // The 0th command line parameter is the program name.
    cout << "This program is called '" << argv[0]
         << "'" << endl;
    cout << "The following are the command "
         << "line parameters you specified: " << endl;
    // for loop starts at 1 to avoid printing
    // name of program (again)
    for ( int i = 1; i < argc; i++ ) {
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        cout << "\t" << s << endl;
    }
    return 0;
}
```