Week 7

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slides by Leah Bar-On Simmons and Diana Gage

Course Evals

- Thanks to those of you who filled them out!
- I got some good feedback…
  - *“Make the discussion even **more interactive** and not as much of a review of the lecture material…”*
  - *“you could involve everyone by making them physically stand up and look at/write code on the board, talk to others (different people every time) about the material at hand”*

How’s Project 3 Going?

- Any general questions I can answer?
- Specific questions?
  - I can talk with you after class until 11:45am if you need me!

Projects going forward

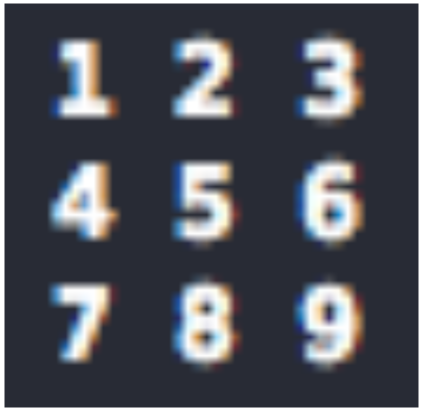
- For project 4 you can also work with a partner!
- After that, there is the Final Project, which is in groups of 4
- Final day to withdraw from course: **11/13**

Discussion Plan

- 2-dimensional arrays review
  - Practice problems
- File Input/Output

2 Dimensional Arrays

- You can visualize these like a matrix, or game board!
  - ALWAYS: arr[row][col]
  - *You'll often see 'col' in place of column*



```
1 2 3
4 5 6
7 8 9
```

Origin (for 2-dim array)

- You choose where your origin will be, and write your functions accordingly
- The origin is at [0][0], but this location is defined by you
- Think about your decision logically, not arbitrarily
  - Think about a Connect 4 board – what makes more sense when pieces are dropped into the board?

Pick your Origin!

```
const int MAX_HEIGHT = 6;                          // max height and width
const int MAX_WIDTH = 6;                           // possible, can be less

int board[MAX_HEIGHT][MAX_WIDTH] = {
    {1, 2, 3, 4},                                  // origin = board[0][0]
    {5, 4, 9, 16},
    {9, 8, 27, 64},                                // we have some empty
    {10, 16, 81, 256}                              // rows and cols!
  };

  for (int row = MAX_HEIGHT - 1; row >= 0; --row) {   // printing out the 2D
    for (int col = 0; col < MAX_WIDTH; ++col) {       // array…
      cout << board[row][col] << ' ';
    }
    cout << endl;
  }
```

Where will the origin be?

Pick your Origin!

OUTPUT:

```
0 0 0 0 0 0
0 0 0 0 0 0
10 16 81 256 0 0
9 8 27 64 0 0
5 4 9 16 0 0
1 2 3 4 0 0

board at (0, 0): 1
```

```
// we printed the
// 2D array to look
// like this
```

Initializing all to 0

- 1-dimensional array:

```
int board[3] = {0};
```

- **2-dimensional array:**

```
int board[3][5] = {0};
```

- Both of these initialize every element in the array to 0
- this only works with 0 – any other number within the curly braces is interpreted as just setting the first element in the array

Initializing directly

```
const int HEIGHT = 3;
const int WIDTH = 4;

int board[HEIGHT][WIDTH] = {
                              {1, 2, 3, 4},
                              {5, 6, 7, 8},
                              {9, 10 , 11, 12}
                           };
```

- You can also initialize all to the same thing, using nested loops

When initializing…

Which of these is **invalid**?

int data[10][2];

int data [4][];

int data [][8];

When initializing…

Which of these is **invalid**?

```
int data[10][2];

int data [4][]; //compile error

int data [][8];
```

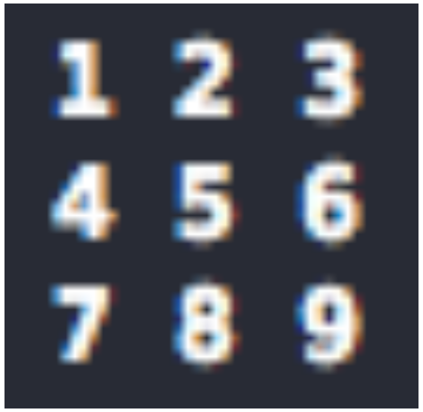
When initializing…

```
int data[10][2];
int data [4][]; //compile error
int data [][8];
```

- With a 2-dimensional array, the compiler absolutely needs to know the **column** (the second parameter) **size** at compile time
- **The row is optional**

How do we iterate through a 2-d array

- What if we want to print every element in as in the picture?

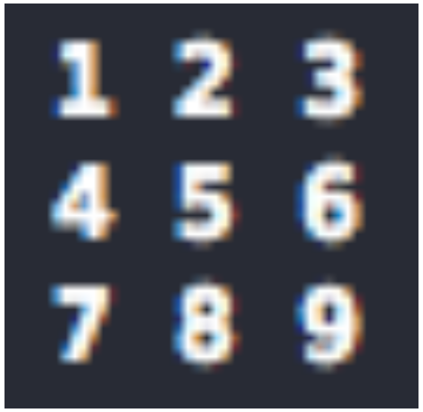


```
1 2 3
4 5 6
7 8 9
```

How do we iterate through a 2-d array

- What if we want to print every element as in the picture. We print each element in each row, and start a new line for each row so it looks like a matrix.

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

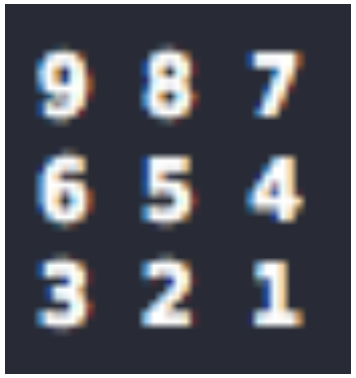


```
1 2 3
4 5 6
7 8 9
```

How do we iterate through a 2-d array

- Now what if we want to print the values **backwards**, keeping the matrix form?

int my_arr[3][3] = { {1, 2, 3}, {4, 5, 6}, {7, 8, 9} };



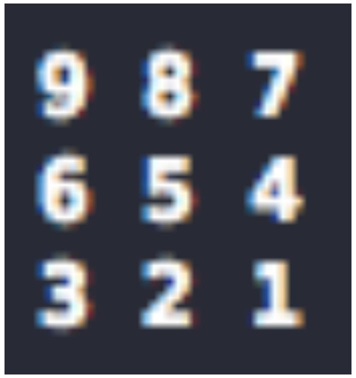
```
9 8 7
6 5 4
3 2 1
```

How do we iterate through a 2-d array

- Now what if we want to print the values **backwards**, keeping the matrix form?

```
int my_arr[3][3] = { {1, 2, 3}, {4, 5, 6}, {7, 8, 9} };

for (int i = 2; i >= 0; --i){
        for (int j = 2; j >= 0; --j){
            cout << my_arr[i][j] << " ";
        }
        cout << endl;
}
```



```
9 8 7
6 5 4
3 2 1
```

How do we iterate through a 2-d array

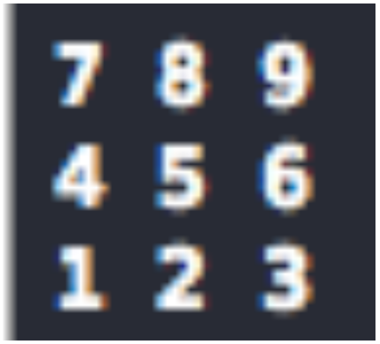
- Now what if we want to **only reverse each column**, not the entire array?
- What is this equivalent to? What will be the net result?

```
int my_arr[3][3] = { {1, 2, 3}, {4, 5, 6}, {7, 8, 9} };
```

How do we iterate through a 2-d array

- Now what if we want to only **reverse each column**, not the entire array?
- What is this equivalent to? What will be the net result? Reversing the order of the rows

int my_arr[3][3] = { {1, 2, 3}, {4, 5, 6}, {7, 8, 9} };



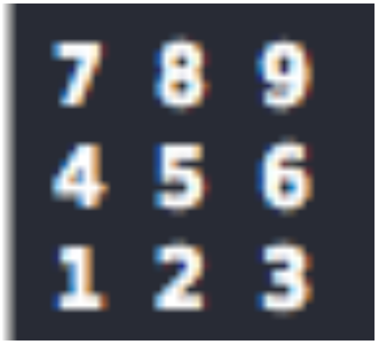
```
7 8 9
4 5 6
1 2 3
```

How do we iterate through a 2-d array

- Now what if we want to only **reverse each column**, not the entire array?

int my_arr[3][3] = { {1, 2, 3}, {4, 5, 6}, {7, 8, 9} };

```
for (int i = 2; i >= 0; --i){
      for (int j = 0; j < 3; ++j){
          cout << my_arr[i][j] << " ";
      }
      cout << endl;
}
```



```
7 8 9
4 5 6
1 2 3
```

File I/O

- Will be key in your next project/some of the final projects!

- Alternative to standard I/O
  - Reading in from keyboard, printing to screen

- File input – reading in from a file
- File output – writing to a file

File I/O

- **#include <fstream>** to have access to these datatypes:
  - Ifstream
  - Ofstream

- With these, you can declare variables so that you can read from/write to files!

<iostream> vs <fstream>

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

int main() {
    int x;


    cin >> x;


}
```

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

int main() {
    int x;
    ifstream input_file;
    input_file.open("filename");
    input_file >> x;
    input_file.close();
}
```

My suggestion: name your ifstream "**fin**"

What about writing to files?

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

int main() {
    int x = 42;
    ofstream output_file;
    output_file.open("filename");
    output_file << x;
    output_file.close();
}
```

My suggestion: name your ofstream "**fout**"

When Reading in From Files:

- **DO NOT** use while (!fin.eof()) {…} to stop reading in

- **INSTEAD:** use these
  - while (fin >> x) {…}
  - while (!fin.fail()) {…}

- Fail bit will be set to **true** when end of file is reached, and/or when fin fails
- **EOF** has *undefined behavior* (varies by compiler)

When Reading in From Files:

- Remember from Project 2 how to deal with clearing a fail state
  - Works the same with fin!
  - **fin.clear()** to clear the fail state, and include a junk variable to get rid of what caused fail state

Next week: Classes!

- Good luck finishing up Project 3 ☺
- Ask me questions!