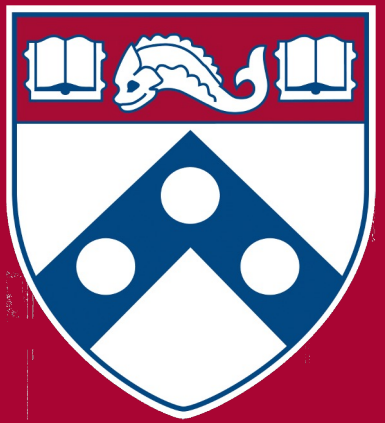
2D Arrays



Overview

- We know how to store data in an ordered sequence using arrays.
- Our ordered collections have only been in one dimension so far, though.
- Sometimes we want to represent data in multiple dimensions
    - Images as grids of pixels, arrays at different points in time, matrices

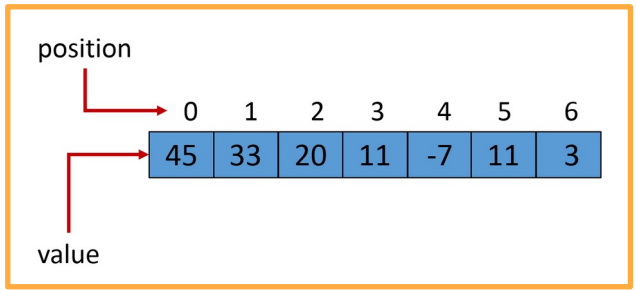
Learning Objectives

After this lecture, you should be able to…

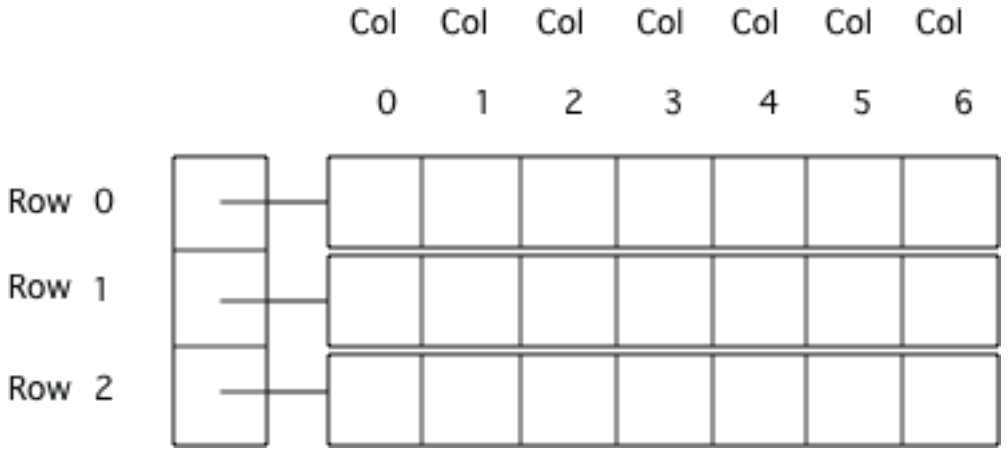
- declare a 2D array
- initialize a 2D array with the `new` keyword or with an initializer list
- identify the dimensions of a 2D array
- access 2D array values
- modify 2D array values
- traverse a 2D array using the `for-loop`
- solve problems using 2D arrays

Two-Dimensional Arrays

- A one-dimensional array stores an ordered sequence of elements.
- A two-dimensional array can be thought of as a table of elements, with rows and columns.



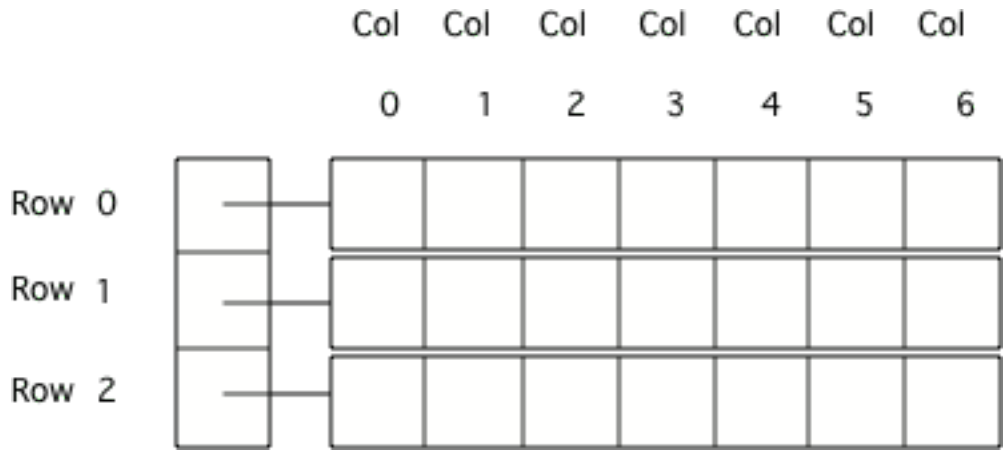
One-dimensional array



Two-dimensional array

Arrays of Arrays

- Ultimately, a 2D array is an array of arrays.



- 2D arrays are declared and initialized by specifying the size of each dimension separately: `int[][] matrix = new int[3][7];`

Declaration and Initialization

- Here's the general way to initialize a *rectangular* 2D array:
  - `arrayType[][] arrayName = new arrayType[rows][cols];`
- To reference a single element at row *r* and column *c*:
  - int value = arrayName[r][c];

Expression	Type	Description
arrayName	int[][]	2D array of integers, or an array of integer arrays
arrayName[3]	int[]	Array of integers
arrayName[3][4]	int	integer

Iterating over a Rectangular 2D Array

```
int nRows = 10;
int nCols = 5;
double[][] a = new double[nRows][nCols];
for (int i = 0; i < nRows; i++) {
    for (int j = 0; j < nCols; j++) {
        a[i][j] = 1.0;
    }
}
```

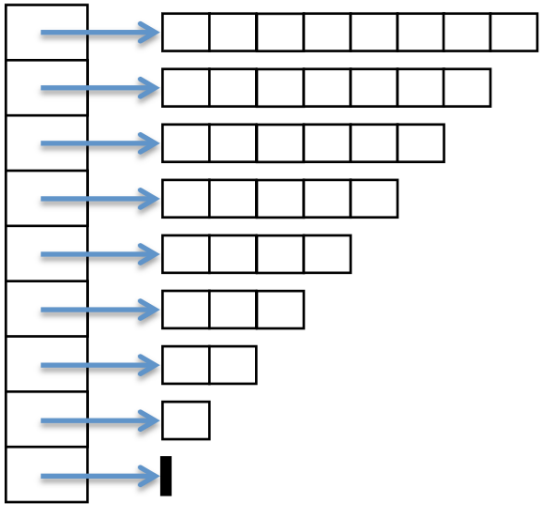
Initialize a 2D array with 10 rows and 5 columns. Then, set each value to 1.0

2D Arrays Can Be Jagged/Ragged

- A jagged (or ragged) 2D array has different numbers of columns in each row.
    - Alternatively, each array stored in the array of arrays has a different length.

```
int numRows = 9;
double[][] a = new double[numRows][];
for (int i = 0; i < a.length; i++) {
        a[i] = new double[numRows - i - 1];
}
```

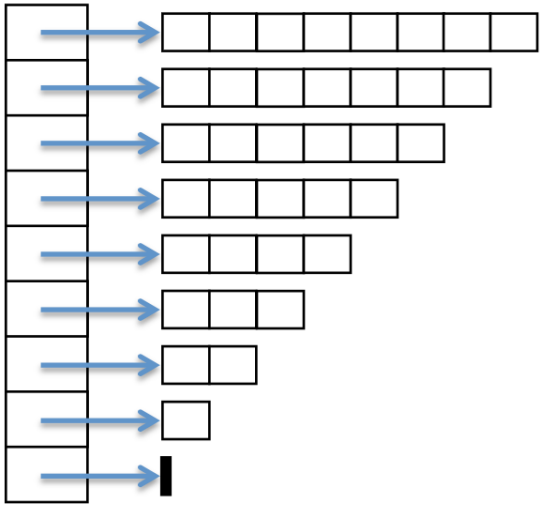
Initializing an array of null arrays, then initializing each inner array with a different length.



Iterating over a Jagged 2D Array unsafely

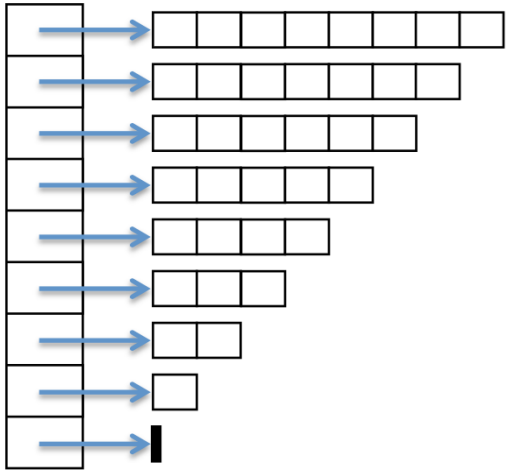
```
int numRows = 9;
double[][] a = new double[numRows][];
for (int i = 0; i < numRows; i++) {
      a[i] = new double[numRows – i - 1];
}

for (int i = 0; i < numRows; i++) {
      for (int j = 0; j < nCols; j++) {
                  a[i][j] = 1.0;
   }
}
```



What happens if we run this code?

Iterating over a Jagged 2D Array Safely



```
int numRows = 9;
double[][] a = new double[numRows][];
for (int i = 0; i < n; i++) {
      a[i] = new double[numRows – i - 1];
}

for (int i = 0; i < a.length; i++) {
      for (int j = 0; j < a[i].length; j++) {
                  a[i][j] = 1.0;
   }
}
```

Explicit 2D Array Initialization

- ```
  int scores[][] = {{44, 55, 66, 77},
                    {36},
                    {87, 97},
                    {68, 78, 88}};
  ```

- (Write out the array of arrays.)
  ```