Two-Dimensional Arrays

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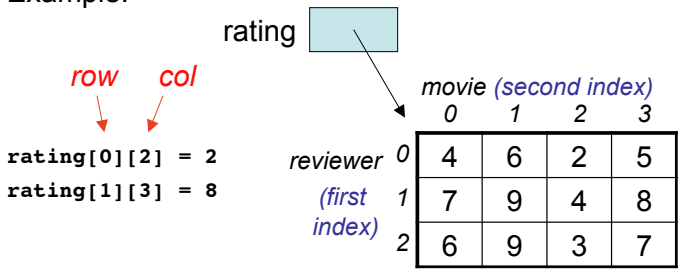
Two-Dimensional Arrays

- Arrays that we have consider up to now are one-dimensional arrays, a single line of elements.
- Often data come naturally in the form of a table, e.g., spreadsheet, which need a two-dimensional array.
- Examples:
  - Lab book of multiple readings over several days
  - Periodic table
  - Movie ratings by multiple reviewers.
    - Each row is a different reviewer
    - Each column is a different movie

Two-Dimensional Arrays

- Two-dimensional (2D) arrays are indexed by two subscripts, one for the row and one for the column.
- Example:



Similarity with 1D Arrays

- Each element in the 2D array must by the same type,
  - either a primitive type or object type.
- Subscripted variables can be use just like a variable:

```
rating[0][3] = 10;
```

- Array indices must be of type `int` and can be a literal, variable, or expression.

```
rating[3][j] = j;
```

- If an array element does not exists, the Java runtime system will give you an

```
ArrayIndexOutOfBoundsException
```

Declaring 2D Arrays

- Declare a local variable **`rating`** that references a 2D array of int:

```
int[][] rating;
```

- Declare a field `family` that reference a 2D array of `GiftCards`:

```
private GiftCard[][] family;
```

- Create a 2D array with 3 rows and 4 columns and assign the reference to the new array to `rating`:

```
rating = new int[3][4];
```

- Shortcut to declare and create a 2D array:

```
int[][] rating = new int[3][4];
```


Example 1

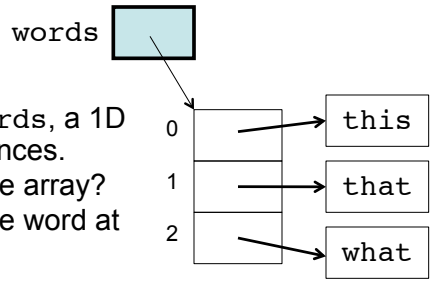
- Find the average rating by the reviewer in row 2.

```
int sum = 0;

for (int col = 0; col <= 3; col++) {
  sum += rating[2][col];
}
double average = (double) sum / 4;
```

reviewer \ movie	0	1	2	3
0	4	6	2	5
1	7	9	4	8
2	6	9	3	7

Size of 2D Arrays

- When you write a method that has a 2D array as a parameter, how do you determine the size of the array?



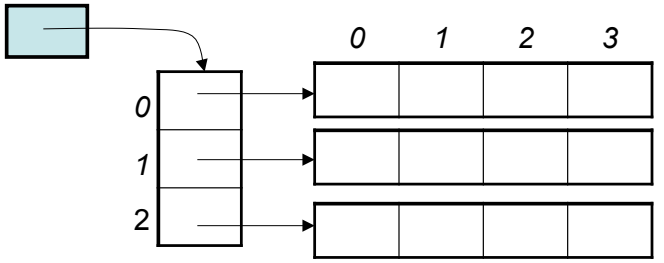
Hint:

- Consider a variable `words`, a 1D array of `String` references.
- What is the length of the array?
- What is the length of the word at index 2?

2D Array Implementation

- A 2D array is a 1D array of (references to) 1D arrays.

```
int[][] rating = new int[3][4];
```



Size of 2D Arrays

- Given

```
int[][] rating = new int[3][4];
```

- What is the value of **`rating.length`**?

  Answer: 3, the number of rows (first dimension)

- What is the value of **`rating[0].length`**?

  Answer: 4, the number of columns (second dimension)

Example 2

- Find the number of ratings above the value of the parameter.

```
public int countAbove(int[][] rating, int num) {

  int count = 0;

  for (int row = 0; row < rating.length; row++) {

    for (int col = 0; col < rating[0].length; col++) {
      if (rating[row][col] > num)
        count++;
    }
  }
  return count;
}
```

number of rows

number of columns

Example 3

- Print the average rating for the movie in column 3.

reviewer \ movie	0	1	2	3
0	4	6	2	5
1	7	9	4	8
2	6	9	3	7

```
int sum = 0;

for (int row = 0; row < rating.length ; row++) {

      sum += rating[ row ][ 3 ];
}

System.out.println((double) sum / rating.length );
```


Ragged Arrays

- Since a 2D array is a 1D array of references to 1D arrays, each of these latter 1D arrays (rows) can have a different length.

- How? Use an ***initializer list***.

row 1 row 2

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

3	5	7	9
4	2		
5	7	8	6
6			

Example 3 Revisited

- Print the average rating for the movie in column 3.

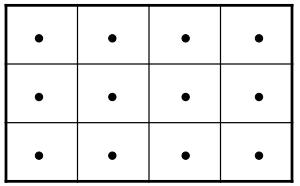
```
int count = 0;
double sum = 0;

for (int row = 0; row < rating.length; row++) {

    if (rating[row].length > 3) {

        sum += rating[ row ][ 3 ];
        count++;
    }
}

if (count > 0) {
   System.out.println((double) sum / count);
}
```

3	5	7	9
4	2		
5	7	8	6
6			

2D Array of Object References

- Recall that creating an array of object references fills the array with `null` values.
- Example:

```
GiftCard[][] family = new GiftCard[3][4]
```

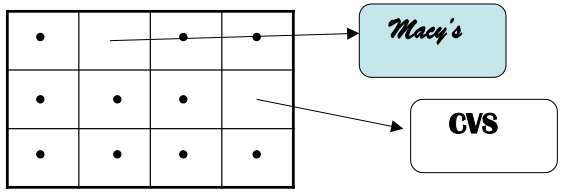


- *null*

2D Array of Object References

- Need to create the objects and assign the references to the array elements.
- Example:

```
family[0][1] = new GiftCard("Macy's", 50.0);
family[1][3] = new GiftCard("CVS", 15.0);
```



- *null*

Example 4

- Print the total value of the gift cards for each family member (rows): `printValueOfRows(family);`

```
public static void printValueOfRows(GiftCard[][] data) {

  for (int row = 0; row < data.length; row++) {

    double total = 0.0;  // find total for the row

    for (int col = 0; col < data[row].length; col++) {

      if (data[row][col] != null) {
        total += data[row][col].getBalance();
      }
    }
    System.out.println("Row " + row + ": $" + total);
  }
}
```