

Lecture 6

Multidimensional Arrays

- Thus far, you have used one-dimensional arrays to model linear collections of elements.
- You can use a two-dimensional array to represent a matrix or a table.

- Example, table that describes the distances between the cities

Distance Table (in miles)

	Chicago	Boston	New York	Atlanta	Miami	Dallas	Houston
Chicago	0	983	787	714	1375	967	1087
Boston	983	0	214	1102	1763	1723	1842
New York	787	214	0	888	1549	1548	1627
Atlanta	714	1102	888	0	661	781	810
Miami	1375	1763	1549	661	0	1426	1187
Dallas	967	1723	1548	781	1426	0	239
Houston	1087	1842	1627	810	1187	239	0

```
double[][] distances = {  
    {0, 983, 787, 714, 1375, 967, 1087},  
    {983, 0, 214, 1102, 1763, 1723, 1842},  
    {787, 214, 0, 888, 1549, 1548, 1627},  
    {1375, 1763, 1549, 661, 0, 1426, 1187},  
    {967, 1723, 1548, 781, 1426, 0, 239},  
    {1087, 1842, 1627, 810, 1187, 239, 0}  
};
```

- **Declare array ref var**
 - `dataType[][] refVar;`
- **Create array and assign its reference to variable**
 - `refVar = new dataType[10][10];`
- **Combine declaration and creation in one statement**
 - `dataType[][] refVar = new dataType[10][10];`
- **Alternative syntax**
 - `dataType refVar[][] = new dataType[10][10];`

```
int[][] matrix = new int[10][10];
```

or

```
int matrix[][] = new int[10][10];
```

```
matrix[0][0] = 3;
```

```
for (int i = 0; i < matrix.length; i++)  
    for (int j = 0; j < matrix[i].length; j++)  
        matrix[i][j] = (int) (Math.random() * 1000);
```

```
double[][] x;
```



	[0]	[1]	[2]	[3]	[4]
[0]	0	0	0	0	0
[1]	0	0	0	0	0
[2]	0	0	0	0	0
[3]	0	0	0	0	0
[4]	0	0	0	0	0

```
matrix = new int[5][5];
```

```
matrix.length? 5
```

```
matrix[0].length? 5
```

	[0]	[1]	[2]	[3]	[4]
[0]	0	0	0	0	0
[1]	0	0	0	0	0
[2]	0	7	0	0	0
[3]	0	0	0	0	0
[4]	0	0	0	0	0

```
matrix[2][1] = 7;
```

	[0]	[1]	[2]
[0]	1	2	3
[1]	4	5	6
[2]	7	8	9
[3]	10	11	12

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

```
array.length? 4
```

```
array[0].length? 3
```

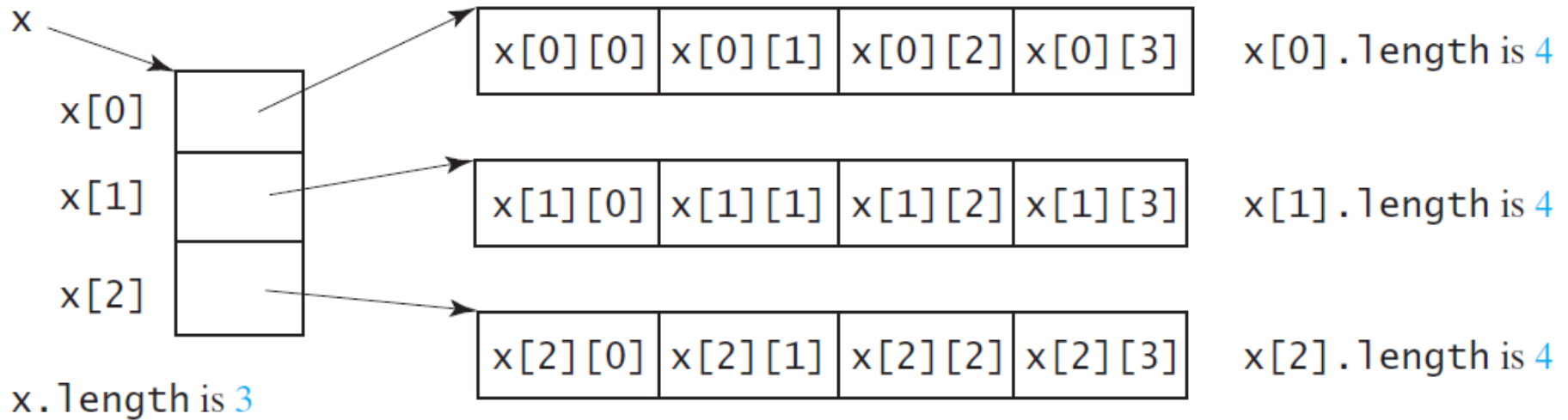
- You can also use an array initializer to declare, create and initialize a two-dimensional array.

- Example:

```
int[][] array = {  
    {1, 2, 3},  
    {4, 5, 6},  
    {7, 8, 9},  
    {10, 11, 12}  
};  
  
int[][] array = new int[4][3];  
array[0][0] = 1; array[0][1] = 2; array[0][2] = 3;  
array[1][0] = 4; array[1][1] = 5; array[1][2] = 6;  
array[2][0] = 7; array[2][1] = 8; array[2][2] = 9;  
array[3][0] = 10; array[3][1] = 11; array[3][2] = 12;
```




- `int[][] x = new int[3][4];`





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

```
array.length
```

```
array[0].length
```

```
array[1].length
```

```
array[2].length
```

```
array[3].length
```

```
array[4].length  ArrayIndexOutOfBoundsException
```

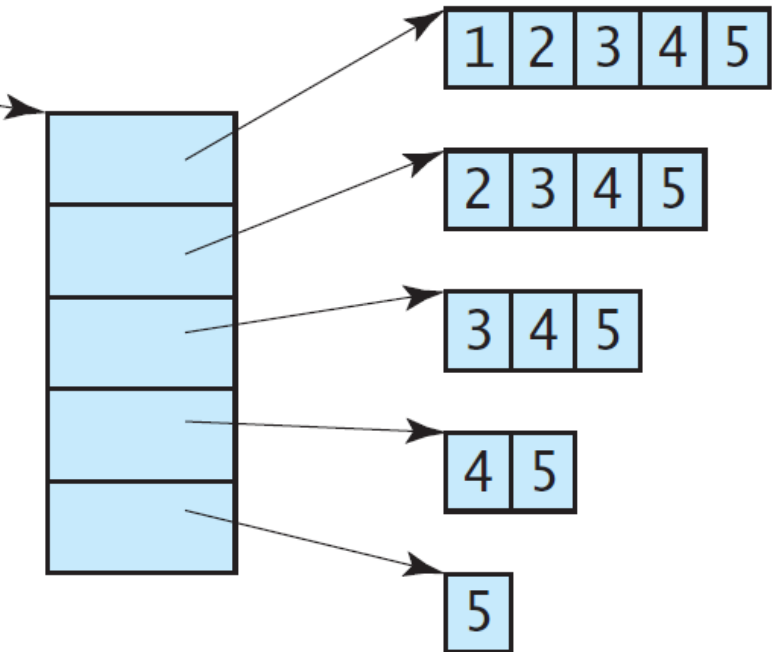
- Each row in a two-dimensional array is itself an array.
- The rows can have different lengths. Such an array is known as a **ragged array**.
- Example:

```
int[][] matrix = {  
    {1, 2, 3, 4, 5},  
    {2, 3, 4, 5},  
    {3, 4, 5},  
    {4, 5},  
    {5}  
};
```

```
matrix.length is 5  
matrix[0].length is 5  
matrix[1].length is 4  
matrix[2].length is 3  
matrix[3].length is 2  
matrix[4].length is 1
```



```
int[][] triangleArray = {  
    {1, 2, 3, 4, 5},  
    {2, 3, 4, 5},  
    {3, 4, 5},  
    {4, 5},  
    {5}  
};
```





- Initializing arrays with input values
- Printing arrays
- Summing all elements
- Summing all elements by column
- Which row has the largest sum
- Finding the smallest index of the largest element
- Random shuffling



```
java.util.Scanner input = new Scanner(System.in);
System.out.println("Enter " + matrix.length + " rows and
" +
    matrix[0].length + " columns: ");
for (int row = 0; row < matrix.length; row++) {
    for (int column = 0; column < matrix[row].length;
column++) {
        matrix[row][column] = input.nextInt();
    }
}
```



```
for (int row = 0; row < matrix.length; row++) {  
    for (int column = 0; column < matrix[row].length;  
column++) {  
        matrix[row][column] = (int) (Math.random() * 100);  
    }  
}
```

```
for (int row = 0; row < matrix.length; row++) {  
    for (int column = 0; column < matrix[row].length;  
column++) {  
        System.out.print(matrix[row][column] + " ");  
    }  
  
    System.out.println();  
}
```



```
int total = 0;
for (int row = 0; row < matrix.length; row++) {
    for (int column = 0; column < matrix[row].length;
column++) {
        total += matrix[row][column];
    }
}
```



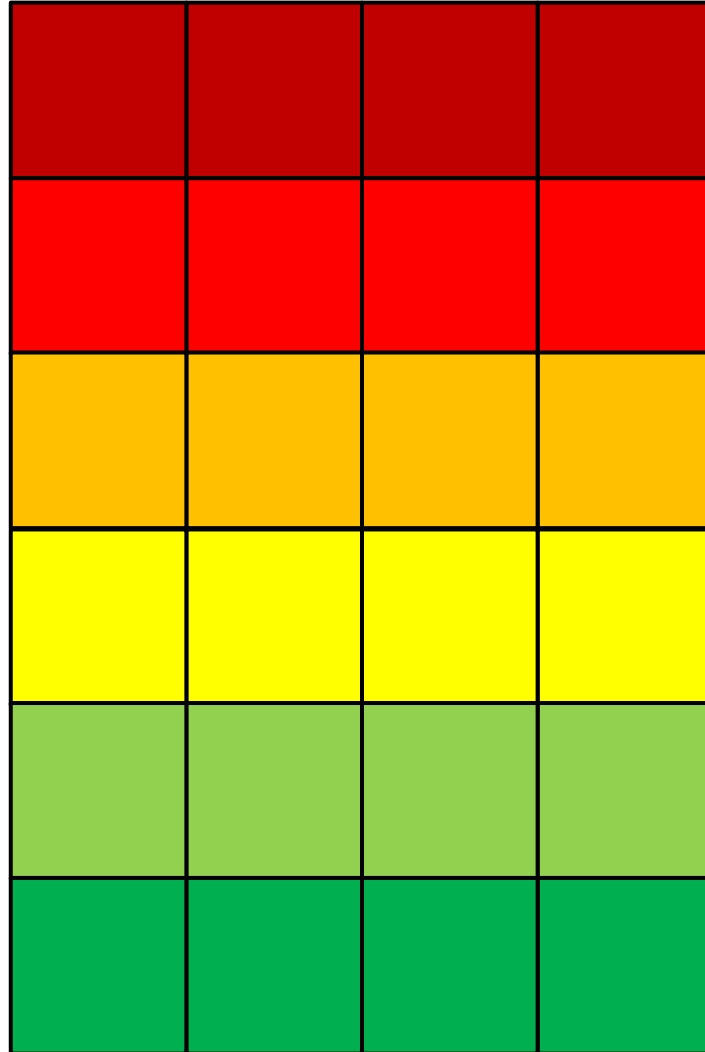
```
for (int column = 0; column < matrix[0].length; column++)  
{  
    int total = 0;  
    for (int row = 0; row < matrix.length; row++)  
        total += matrix[row][column];  
    System.out.println("Sum for column " + column + " is "  
        + total);  
}
```



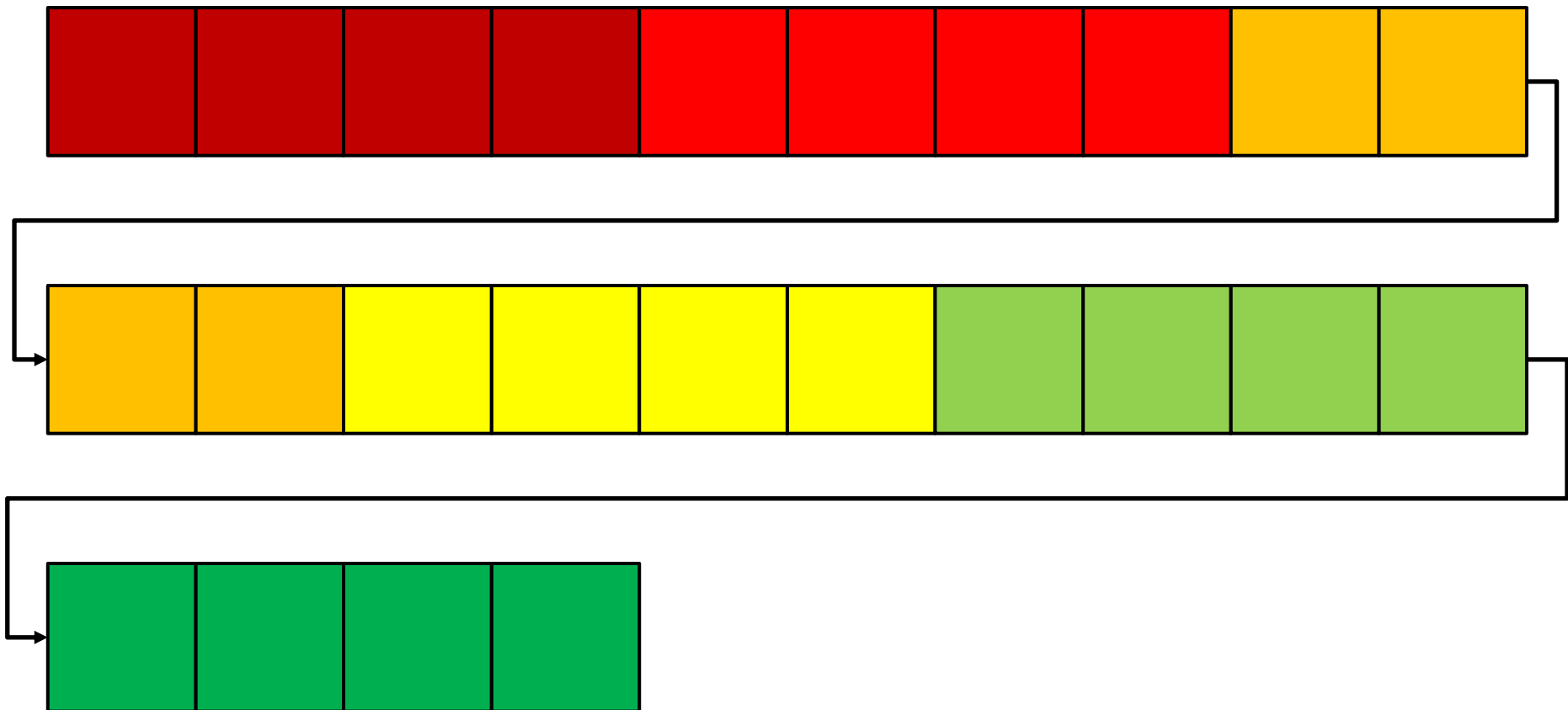
```
for (int i = 0; i < matrix.length; i++) {  
    for (int j = 0; j < matrix[i].length; j++) {  
        int i1 = (int)(Math.random() * matrix.length);  
        int j1 = (int)(Math.random() * matrix[i].length);  
        // Swap matrix[i][j] with matrix[i1][j1]  
        int temp = matrix[i][j];  
        matrix[i][j] = matrix[i1][j1];  
        matrix[i1][j1] = temp;  
    }  
}
```

```
double[][] image = new double[6][4];
```


```
double[][] image = new double[6][4];
```

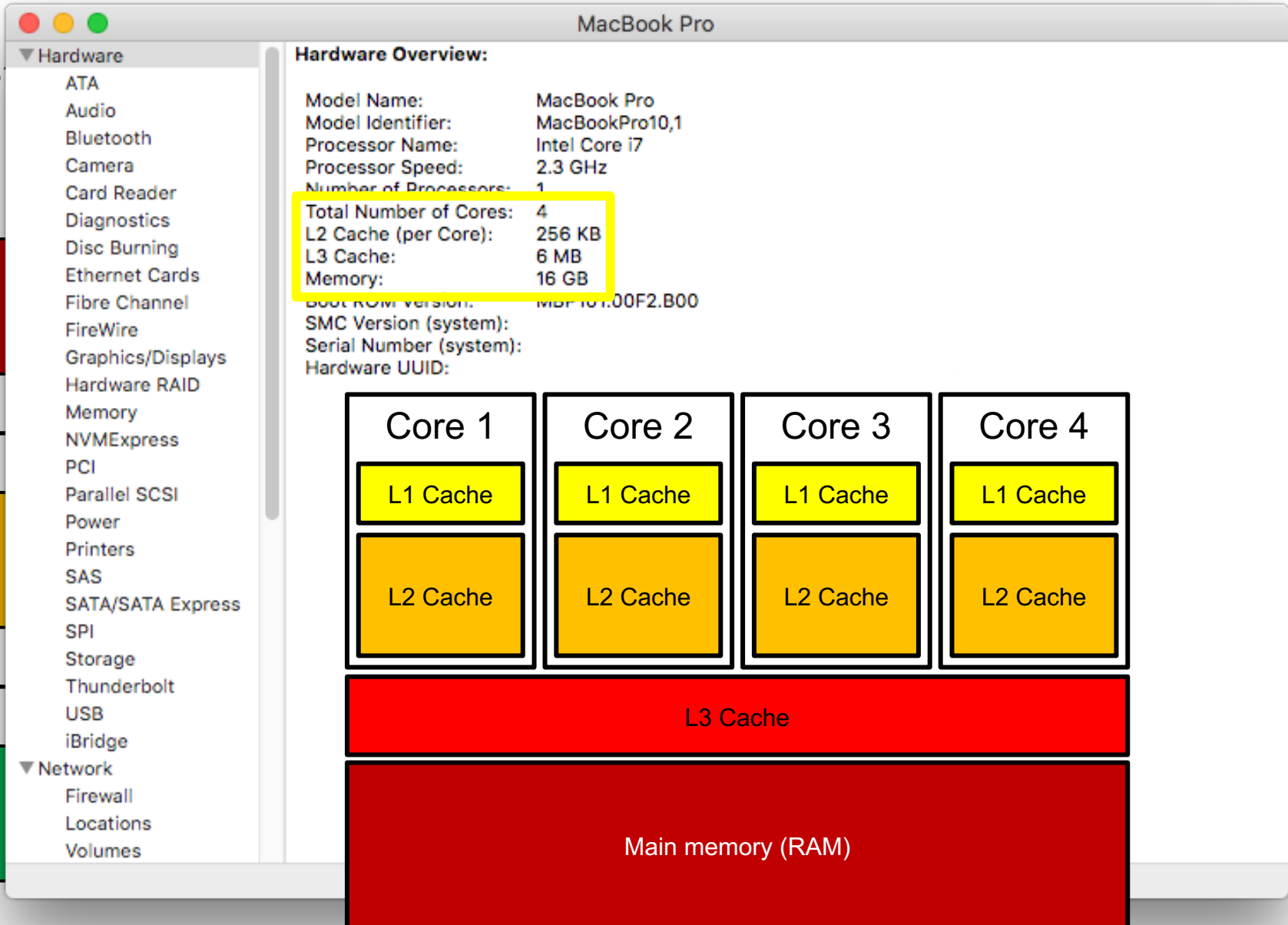


```
double[][] image = new double[6][4];
```

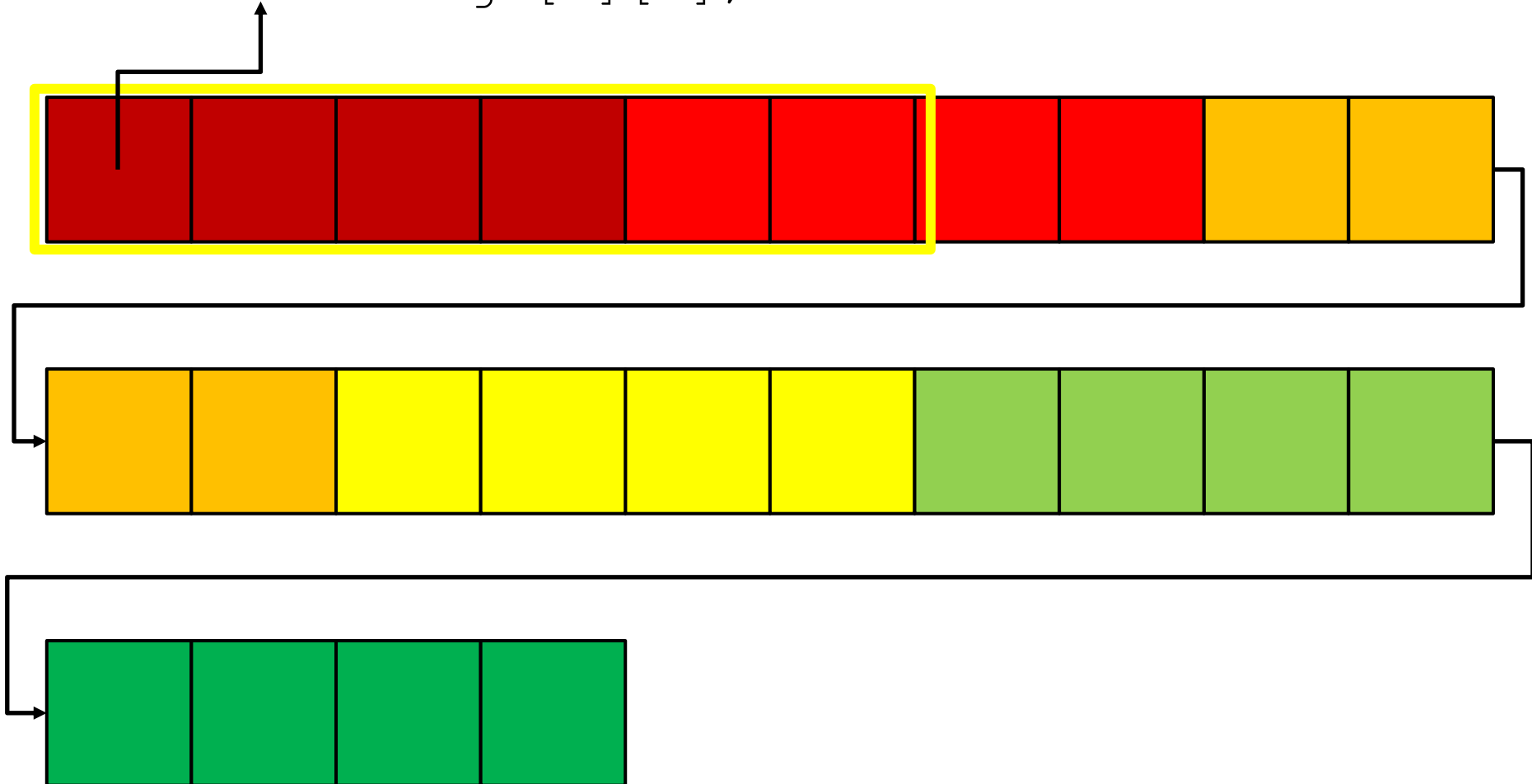




do



```
double[][] image = new double[4][6];
double c = image[0][0];
```



- Occasionally, you will need to represent n-dimensional data structures.
- In Java, you can create n-dimensional arrays for any integer n.
- The way to declare two-dimensional array variables and create two-dimensional arrays can be generalized to declare n-dimensional array variables and create n-dimensional arrays for $n \geq 3$.



```
double[][][] scores = {  
    {{7.5, 20.5}, {9.0, 22.5}, {15, 33.5}, {13, 21.5}, {15, 2.5}},  
    {{4.5, 21.5}, {9.0, 22.5}, {15, 34.5}, {12, 20.5}, {14, 9.5}},  
    {{6.5, 30.5}, {9.4, 10.5}, {11, 33.5}, {11, 23.5}, {10, 2.5}},  
    {{6.5, 23.5}, {9.4, 32.5}, {13, 34.5}, {11, 20.5}, {16, 7.5}},  
    {{8.5, 26.5}, {9.4, 52.5}, {13, 36.5}, {13, 24.5}, {16, 2.5}},  
    {{9.5, 20.5}, {9.4, 42.5}, {13, 31.5}, {12, 20.5}, {16, 6.5}}  
};
```

Which student

Which exam

Multiple-choice or essay

