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# Two-Dimensional Arrays (Solutions)

## Multiple Choices

1. What is the correct way of creating a 2-dimensional rectangular array of int with 5 rows and 2 columns named myMatrix?
	* int[][] myMatrix = new int[5][2];
	* int[][] myMatrix = new int[2][5];
	* int[,] myMatrix = new int[2, 5];
	* int[,] myMatrix = new int[5, 2];
2. Consider the following code:
* int[,] grades = {{10, 20}, {30, 40}};
Console.WriteLine(grades[1,0]);
* What will it display?
	+ Nothing
	+ 10
	+ 20
	+ grades
	+ 30
	+ grades[1,0]
	+ 40

## Exercises

1. Write a statement that creates a 2-dimensional rectangular array of int with 5 rows and 3 columns.
* Solution
* int[,] matrix = new int[5, 3];
1. Write a statement that creates a 2-dimensional jagged array of int with 2 rows. The first row should contain an array containing 1, the second row should contain an array containing 2, 3.
* Solution
* int[][] jaggedArray = new int[2][];
 jaggedArray[0] = new int[1] { 1 };
 jaggedArray[1] = new int [2]{ 2, 3};
1. Write a declaration for a 2-dimensional rectangular array of int containing the following data:

|   |   |   |
| --- | --- | --- |
| 10 | 20 | 30 |
| 40 | 50 | 60 |
| 70 | 80 | 90 |

* Solution
* int[,] matrix =
 {
 {10, 20, 30},
 {40, 50, 60},
 {70, 80, 90}
 };
1. Write a declaration for a 2-dimensional ragged array of int containing the following data:

|   |   |   |
| --- | --- | --- |
| 10 | 20 |  |
| 40 |  |  |
| 70 | 80 | 90 |

* Solution
* int[][] data = new int[3][];
 data[0] = new int[3] { 10, 20, 30 };
 data[1] = new int[1] { 40 };
 data[2] = new int[3] { 70, 80, 90 };
1. Suppose we have a 2-dimensional rectangular array named temp that has been declared and initialized. How can we know the number of rows in this array?
* Solution
* By using the GetLength method: temp.GetLength(0) is the number of rows in the temp array.
1. Suppose we have a 2-dimensional rectangular array named temp that has been declared and initialized. How can we know the number of elements in this array?
* Solution
* By using the Length field: temp.Length is the number of elements in the temp array. We can also compute the product of temp.GetLength(0) and temp.GetLength(1).
1. Write a Display static method that takes as an argument a 2-dimensional array and displays it at the screen.
* Solution
* static void Display(int[,] matP)
 {
 for (int row = 0; row < matP.GetLength(0); row++)
 {
 for (int col = 0; col < matP.GetLength(1); col++)
 {
 Console.Write(
 String.Format("|{0,4} ", matP[row, col])
 );
 }
 Console.WriteLine(" |");
 }
 }
1. Write a program that display “Every row contains its own index” if the 2-dimensional rectangular array of int matrix is such that its first row contains the value 0, its second row contains the value 1, etc.
* Solution
* bool foundIndex = true;
 for (int row = 0; row < matrix.GetLength(0); row++)
 {
 if(row == 0 || foundIndex)
 {
 foundIndex = false;
 for (int col = 0; col < matrix.GetLength(1); col++)
 {
 if (matrix[row, col] == row) {
 foundIndex = true;
 }
 }
 }
 }

 if(foundIndex){
 Console.WriteLine("Every row contains its own index");
 }
1. Write a program that display the average of each row of a 2-dimensional jagged array of int jArray.
* Solution
* double sum;
 for(int i = 0; i < jArray.Length; i++)
 {
 sum = 0;
 for (int j = 0; j < jArray[i].Length; j++)
 {
 sum += jArray[i][j];
 }
 Console.WriteLine("Average for row #" + i
 + " is " + sum / jArray[i].Length);
 }
1. Write a program that display the sum of the values on the diagonal of a 2-dimensional rectangular array of int jArray.
* Solution
* int sum = 0;
 for (int i = 0; i < matrix.GetLength(0); i++)
 {
 sum += matrix[i, i];
 }
 Console.WriteLine(sum);
1. Write a program that “rotate” a 2-dimensional array 90° clockwise. For example, the array
* int[,] matrix =
 {
 { 1, 2, 3 },
 { 4, 5, 6 },
 { 7, 8, 9 },
 { 10, 11, 12 },
 };
* would become
* | 10 | 7 | 4 | 1 |
| 11 | 8 | 5 | 2 |
| 12 | 9 | 6 | 3 |
* Solution
* static void Rotate(ref int[,] matP)
 {
 int[,] tmp = new int[
 matP.GetLength(1),
 matP.GetLength(0)
 ];
 for (int row = 0; row < tmp.GetLength(0); row++)
 {
 for (int col = 0; col < tmp.GetLength(1); col++)
 {
 tmp[row, col] = matP[
 tmp.GetLength(1) - col - 1,
 row
 ];
 }
 }
 matP = tmp;
 }

## Wrapping-up Problem

1. Answer the following questions using a 2-dimensional jagged array **and** a 2-dimensional rectangular array.
	1. Write statements that declare a 2-dimensional array with at least 2 rows containing values 1 through 6.
	2. Write statements that display the values stored in a 2-dimensional array called arTest.
	3. Write statements displaying “Ranked” if the sum of the values stored in each row is greater than the sum of the values in the preceding row in the arTest array. For example, the following rectangular and jagged arrays are both ranked, as 4 < 5 < 6.
	* 2 1 1
	3 1 1
	5 1 0
	* 4 0
	3 1 1
	2 2 1 1
* Solution
* using System;

class Program
{
 static void Main(string[] args)
 {
 // Rectangular Arrays
 int[,] testR1 =
 {
 { 1, 2, 3 },
 { 4, 5, 6 },
 };
 int[,] testR2 =
 {
 { 1, 2, 3 },
 { 4, 5, 6 },
 { 0, 2, 10 },
 };

 // Code for DisplayR and RankedR is below, in their own methods.
 DisplayR(testR1);
 DisplayR(testR2);
 Console.WriteLine("Ranked:" + RankedR(testR2));

 // Jagged Arrays
 int[][] testJ1 = new int[2][];
 testJ1[0] = new int[4] { 1, 2, 3, 4 };
 testJ1[1] = new int[2] { 5, 6 };

 int[][] testJ2 = new int[3][];
 testJ2[0] = new int[4] { 1, 2, 3, 4 };
 testJ2[1] = new int[2] { 5, 6 };
 testJ2[2] = new int[3] { 0, 2, 10 };

 // Code for DisplayJ and RankedJ is below, in their own methods.
 DisplayJ(testJ1);
 DisplayJ(testJ2);

 Console.WriteLine("Ranked:" + RankedJ(testJ2));
 }

 /\* Rectangular arrays \*/
 static void DisplayR(int[,] a)
 {
 for (int row = 0; row < a.GetLength(0); row++)
 {
 for (int col = 0; col < a.GetLength(1); col++)
 {
 Console.Write(a[row, col] + " ");
 }
 Console.WriteLine();
 }
 }

 static bool RankedR(int[,] a)
 {
 bool rsf = true;
 int countp = 0;
 int count = 0;
 for (int row = 0; row < a.GetLength(0); row++)
 {
 for (int col = 0; col < a.GetLength(1); col++)
 {
 count += a[row, col];
 }
 // Helper line:
 Console.WriteLine(
 $"Previous: {countp} Current: {count}"
 );
 if (row == 0)
 {
 countp = count;
 }
 else if (countp >= count)
 rsf = false;
 countp = count;
 count = 0;
 }
 return rsf;
 }

 /\* Jagged Arrays \*/
 static void DisplayJ(int[][] a)
 {
 for (int row = 0; row < a.Length; row++)
 {
 for (int col = 0; col < a[row].Length; col++)
 {
 Console.Write(a[row][col] + " ");
 }
 Console.WriteLine();
 }
 }

 static bool RankedJ(int[][] a)
 {
 bool rsf = true;
 int countp = 0;
 int count = 0;
 for (int row = 0; row < a.Length; row++)
 {
 for (int col = 0; col < a[row].Length; col++)
 {
 count += a[row][col];
 }
 // Helper line:
 Console.WriteLine(
 $"Previous: {countp} Current: {count}"
 );
 if (row == 0)
 {
 countp = count;
 }
 else if (countp >= count)
 rsf = false;
 countp = count;
 count = 0;
 }
 return rsf;
 }
}
* [*(Download this code)*](https:///princomp.github.io/code/projects/RankedArrays.zip)

## Problem: Toward a Crossword Puzzle Solver

The goal of this problem is to work toward the creation of a program that solve crossword puzzles. We will reason in the simple case where the “word” is actually simply a pair of number (so, “1, 2” or “8, 101”).

In the following, assume given two int variables first and second, as well as a 2-dimensional rectangular array values.

1. Write a program that display “pair found” if first and second occur next to each other in the same row.
2. Edit your program so that “pair found” is displayed also if second occurs before first in the same row.
3. Edit your program so that “pair found” is displayed also if first occurs “above” second (that is, if they are next to each other in the same column),
4. Edit your program so that “pair found” is displayed also if second occurs “above” first,
5. Edit your program so that “pair found” is displayed also if first and second occur diagonally,
6. Edit your program so that “pair found” is displayed also if first and first occur anti-diagonally.

Test your program thoroughly, possibly bundling it in a static class to ease testing and debugging.

Solution

A possible implementation, as a static class, is as follows:

﻿using System; // required to use String.Format

public static class Crossword
{
 public static string Display(int[,] arrP)
 {
 string ret = "";
 for (int row = 0; row < arrP.GetLength(0); row++)
 {
 ret += "|";
 for (int col = 0; col < arrP.GetLength(1); col++)
 {
 ret += String.Format("{0,4}|", arrP[row, col]);
 }
 ret += "\n";
 }
 return ret;
 }

 public static bool Pair(
 int[,] arrP,
 int first,
 int second
 )
 {
 return PairRow(arrP, first, second)
 || PairRowInverse(arrP, first, second)
 || PairCol(arrP, first, second)
 || PairColInverse(arrP, first, second)
 || PairDiag(arrP, first, second)
 || PairDiagInverse(arrP, first, second);
 }

 public static bool PairRow(
 int[,] arrP,
 int first,
 int second
 )
 {
 bool foundPair = false;
 for (int row = 0; row < arrP.GetLength(0); row++)
 {
 for (int col = 0; col + 1 < arrP.GetLength(1); col++)
 {
 if (
 arrP[row, col] == first
 && arrP[row, col + 1] == second
 )
 {
 foundPair = true;
 }
 }
 }
 return foundPair;
 }

 public static bool PairRowInverse(
 int[,] arrP,
 int first,
 int second
 )
 {
 return PairRow(arrP, second, first);
 }

 public static bool PairCol(
 int[,] arrP,
 int first,
 int second
 )
 {
 bool foundPair = false;
 for (int row = 0; row + 1 < arrP.GetLength(0); row++)
 {
 for (int col = 0; col < arrP.GetLength(1); col++)
 {
 if (
 arrP[row, col] == first
 && arrP[row + 1, col] == second
 )
 {
 foundPair = true;
 }
 }
 }
 return foundPair;
 }

 public static bool PairColInverse(
 int[,] arrP,
 int first,
 int second
 )
 {
 return PairCol(arrP, second, first);
 }

 public static bool PairDiag(
 int[,] arrP,
 int first,
 int second
 )
 {
 bool foundPair = false;
 for (int row = 0; row + 1 < arrP.GetLength(0); row++)
 {
 for (int col = 0; col + 1 < arrP.GetLength(1); col++)
 {
 if (
 arrP[row, col] == first
 && arrP[row + 1, col + 1] == second
 )
 {
 foundPair = true;
 }
 }
 }
 return foundPair;
 }

 public static bool PairDiagInverse(
 int[,] arrP,
 int first,
 int second
 )
 {
 return PairDiag(arrP, second, first);
 }
}

[*(Download this code)*](https:///princomp.github.io/code/projects/CrossWord.zip)