2D Arrays in C#

Working Example: Vision

Suppose, that you want to save the number of cars in stock. The company sells five types of cars in five different colours.

	Red	Black	Brown	Blue	Gray
Suzuki	10	7	12	10	4
Toyota	18	11	15	17	2
Nissan	23	19	12	16	14
BMW	7	12	16	0	2
Audi	3	5	6	2	1

Solution

In C++, we initialized the 2D array as follows.

```
int cars[5][5] = {{10, 7, 12, 10, 4},
                  {18, 11, 15, 17, 2},
                  {23, 19, 12, 16, 14},
                  {7, 12, 16, 0, 2},
                  {3, 5, 6, 2, 1}
                 };
```

Solution

In C#, we initialize the 2D array as follows.

```
int cars[5][5] = {{10, 7, 12, 10, 4},
                  {18, 11, 15, 17, 2},
                  {23, 19, 12, 16, 14},
                  {7, 12, 16, 0, 2},
                  {3, 5, 6, 2, 1}
                 };
```

```
int [,] cars   = {{10, 7, 12, 10, 4},
                  {18, 11, 15, 17, 2},
                  {23, 19, 12, 16, 14},
                  {7, 12, 16, 0, 2},
                  {3, 5, 6, 2, 1}
                 };
```

Solution

In C#, if we just want to declare the 2D array then it is as follows.

```
int [,] cars    = new int[5,5];
```

Accessing the Elements

In C++, we accessed the elements of the 2D array as follows.

	Red	Black	Brown	Blue	Gray
Suzuki	10	7	12	10	4
Toyota	18	11	15	17	2
Nissan	23	19	12	16	14
BMW	7	12	16	0	2
Audi	3	5	6	2	1

Accessing the Elements

In C++, we accessed the elements of the 2D array as follows.

```
cars[0][2];
```

	Red	Black	Brown	Blue	Gray
Suzuki	10	7	12	10	4
Toyota	18	11	15	17	2
Nissan	23	19	12	16	14
BMW	7	12	16	0	2
Audi	3	5	6	2	1

Accessing the Elements

In C#, we access the elements of the 2D array as follows.

✗ `cars[0][2];`

✓ `cars[0,2];`

	Red	Black	Brown	Blue	Gray
Suzuki	10	7	12	10	4
Toyota	18	11	15	17	2
Nissan	23	19	12	16	14
BMW	7	12	16	0	2
Audi	3	5	6	2	1

Working Example: Vision

Write a Function that returns the sum of all the colors of all the cars.

	Red	Black	Brown	Blue	Gray
Suzuki	10	7	12	10	4
Toyota	18	11	15	17	2
Nissan	23	19	12	16	14
BMW	7	12	16	0	2
Audi	3	5	6	2	1

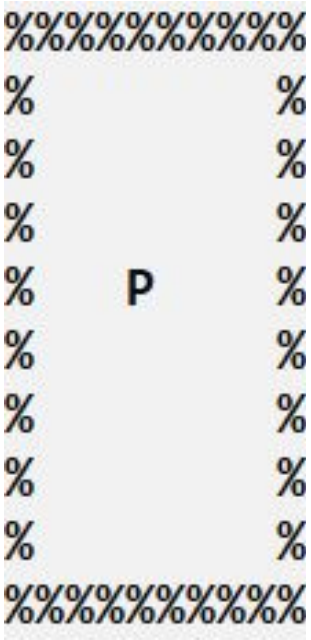
Solution

```
static int printSum(int [,] cars)
{
    int sum = 0;
    for (int x = 0; x < 5; x++)
       {
           for (int y = 0; y < 5; y++)
           {
               sum = sum + cars[x, y];
           }
       }
    return sum;
}
```

```
static void Main(string[] args)
    {
        int [,] cars = {
                        { 10, 7, 12, 10, 4},
                        { 18, 11, 15, 17, 2},
                        { 23, 19, 12, 16, 14},
                        { 7, 12, 16, 0, 2},
                        { 3, 5, 6, 2, 1}
                        };
        int sum;
        sum = printSum(cars);
        Console.WriteLine("Sum is: {0}", sum);
        Console.Read();
    }
```

Game Development in C#

PacMan Game



PacMan Game: Maze

```
char[,] maze = new char[10,10] {
                    { '%', '%', '%', '%', '%', '%', '%', '%', '%', '%'},
                    { '%', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', '%'},
                    { '%', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', '%'},
                    { '%', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', '%'},
                    { '%', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', '%'},
                    { '%', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', '%'},
                    { '%', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', '%'},
                    { '%', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', '%'},
                    { '%', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', '%'},
                    { '%', '%', '%', '%', '%', '%', '%', '%', '%', '%'}
                };
```

Solution C++

In C++, we used gotoxy(x,y)
To display something on the specific location on the console.

```
void movePacmanRight()
{
    if (maze[pacmanX][pacmanY + 1] == ' ' || maze[pacmanX][pacmanY + 1] == '.')
    {
        maze[pacmanX][pacmanY] = ' ';
        gotoxy(pacmanY, pacmanX);
        cout << " ";
        pacmanY = pacmanY + 1;
        gotoxy(pacmanY, pacmanX);
        cout << "P";
    }
}
```

Solution C#: MovePacManUp

In C#, we will use Console.SetCursorPosition(x,y)
To display something on the specific location on the console.

```
static void movePacManUp(char[,] maze, ref int pacmanX, ref int pacmanY)
        {
            if (maze[pacmanX - 1,pacmanY] == ' ' || maze[pacmanX - 1,pacmanY] == '.')
            {
                maze[pacmanX,pacmanY] = ' ';
                Console.SetCursorPosition(pacmanY, pacmanX);
                Console.Write(" ");
                pacmanX = pacmanX - 1;
                Console.SetCursorPosition(pacmanY, pacmanX);
                Console.Write("P");
            }
        }
```

Solution C#: MovePacManDown

In C#, we will use Console.SetCursorPosition(x,y)
To display something on the specific location on the console.

```
static void movePacManDown(char[,] maze, ref int pacmanX, ref int pacmanY)
        {
            if (maze[pacmanX + 1,pacmanY] == ' ' || maze[pacmanX + 1,pacmanY] == '.')
            {
                maze[pacmanX,pacmanY] = ' ';
                Console.SetCursorPosition(pacmanY, pacmanX);
                Console.Write(" ");
                pacmanX = pacmanX + 1;
                Console.SetCursorPosition(pacmanY, pacmanX);
                Console.Write("P");
            }
        }
```

Solution C#: MovePacManLeft

In C#, we will use Console.SetCursorPosition(x,y)
To display something on the specific location on the console.

```
static void movePacManLeft(char[,] maze, ref int pacmanX, ref int pacmanY)
        {
            if (maze[pacmanX,pacmanY - 1] == ' ' || maze[pacmanX,pacmanY - 1] == '.')
            {
                maze[pacmanX,pacmanY] = ' ';
                Console.SetCursorPosition(pacmanY, pacmanX);
                Console.Write(" ");
                pacmanY = pacmanY - 1;
                Console.SetCursorPosition(pacmanY, pacmanX);
                Console.Write("P");
            }
        }
```

Solution C#: MovePacManRight

In C#, we will use Console.SetCursorPosition(x,y)
To display something on the specific location on the console.

```
static void movePacManRight(char[,] maze, ref int pacmanX, ref int pacmanY)
        {
            if (maze[pacmanX,pacmanY + 1] == ' ' || maze[pacmanX,pacmanY + 1] == '.')
            {
                maze[pacmanX,pacmanY] = ' ';
                Console.SetCursorPosition(pacmanY, pacmanX);
                Console.Write(" ");
                pacmanY = pacmanY + 1;
                Console.SetCursorPosition(pacmanY, pacmanX);
                Console.Write("P");
            }
        }
```

Solution C#: MovePacManRight

In C#, we will use Console.SetCursorPosition(x,y)
To display something on the specific location on the console.

```
static void movePacManRight(char[,] maze, ref int pacmanX, ref int pacmanY)
        {
            if (maze[pacmanX,pacmanY + 1] == ' ' || maze[pacmanX,pacmanY + 1] == '.')
            {
                maze[pacmanX,pacmanY] = ' ';
                Console.SetCursorPosition(pacmanY, pacmanX);
                Console.Write(" ");
                pacmanY = pacmanY + 1;
                Console.SetCursorPosition(pacmanY, pacmanX);
                Console.Write("P");
            }
        }
```

Important thing to note here is that we are passing the X and Y coordinates of Pacman by reference to this function, so the changes are done in the single variable.

Solution C++

```
main(){
    bool gameRunning = true;
    while (gameRunning){
        Sleep(100);
        system("CLS");
        printMaze();
        printScore();
        if (GetAsyncKeyState(VK_LEFT)){
            movePacmanLeft();
        }
        if (GetAsyncKeyState(VK_RIGHT)){
            movePacmanRight();
        }
        if (GetAsyncKeyState(VK_UP)){
            movePacmanUP();
        }
        if (GetAsyncKeyState(VK_DOWN)){
            movePacmanDown();
        }
        if (GetAsyncKeyState(VK_ESCAPE)){
            gameRunning = false; } }
}
```

Solution C++

In C++, we used GetAsyncKeyState(KeyCode) To detect if the key was pressed or not.

```
main(){
    bool gameRunning = true;
    while (gameRunning){
        Sleep(100);
        system("CLS");
        printMaze();
        printScore();
        if (GetAsyncKeyState(VK_LEFT)){
            movePacmanLeft();
        }
        if (GetAsyncKeyState(VK_RIGHT)){
            movePacmanRight();
        }
        if (GetAsyncKeyState(VK_UP)){
            movePacmanUP();
        }
        if (GetAsyncKeyState(VK_DOWN)){
            movePacmanDown();
        }
        if (GetAsyncKeyState(VK_ESCAPE)){
            gameRunning = false; } }
}
```

Solution C#

In C#, we will use
Keyboard.IsKeyPressed(Key.UpArrow)
To detect if the key is pressed or not.

```
static void Main(string[] args)
        {
            int pacmanX = 4; int pacmanY = 4;
            char[,] maze = new char[10,10] {
                { '%', '%', '%', '%', '%', '%', '%', '%', '%', '%'},
                { '%', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', '%'},
                { '%', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', '%'},
                { '%', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', '%'},
                { '%', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', '%'},
                { '%', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', '%'},
                { '%', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', '%'},
                { '%', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', '%'},
                { '%', ' ', ' ', ' ', ' ', ' ', ' ', ' ', ' ', '%'},
                { '%', '%', '%', '%', '%', '%', '%', '%', '%', '%'}};
            printMaze(maze);
            Console.SetCursorPosition(pacmanY, pacmanX);
            Console.Write("P");
            while (true){
                Thread.Sleep(150);
                if (Keyboard.IsKeyPressed(Key.UpArrow)){
                    movePacManUp(maze, ref pacmanX, ref pacmanY);
                }
                if (Keyboard.IsKeyPressed(Key.DownArrow)){
                    movePacManDown(maze, ref pacmanX, ref pacmanY);
                }
                if (Keyboard.IsKeyPressed(Key.LeftArrow)){
                    movePacManLeft(maze, ref pacmanX, ref pacmanY);
                }
                if (Keyboard.IsKeyPressed(Key.RightArrow)){
                    movePacManRight(maze, ref pacmanX, ref pacmanY);
                }
            }
        }
```

EZInput Package

In order to use the function
Keyboard.IsKeyPressed(Key.UpArrow)
We have to install and include the EZInput package first.

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Threading.Tasks;
using EZInput;
```

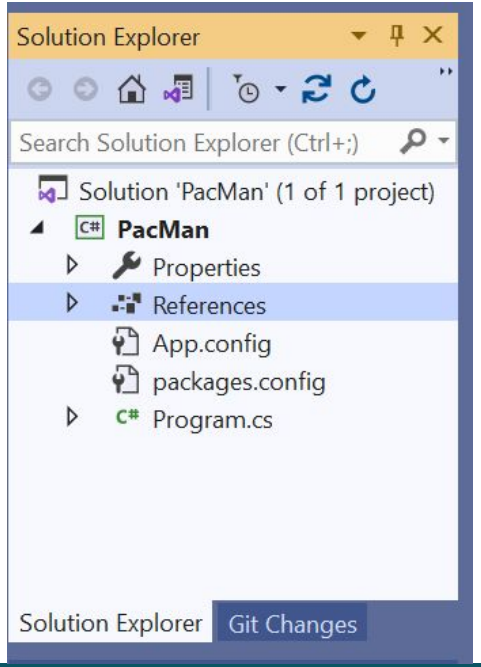
EZInput Package

In order to use the function
Keyboard.IsKeyPressed(Key.UpArrow)
We have to install and include the EZInput package first.

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Threading.Tasks;
using EZInput;
```

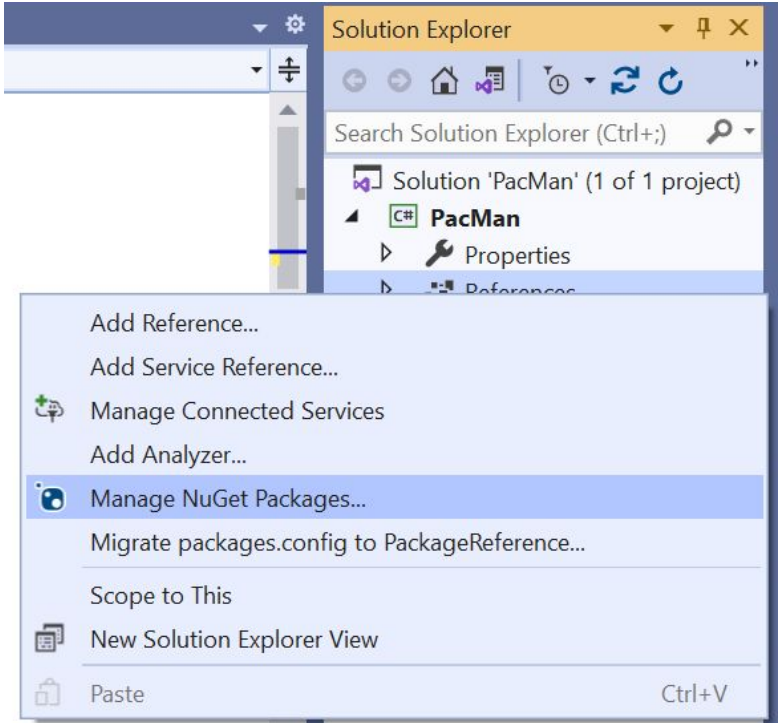
EZInput Package

In order to install the Package, right click on the references in Solution Explorer Window



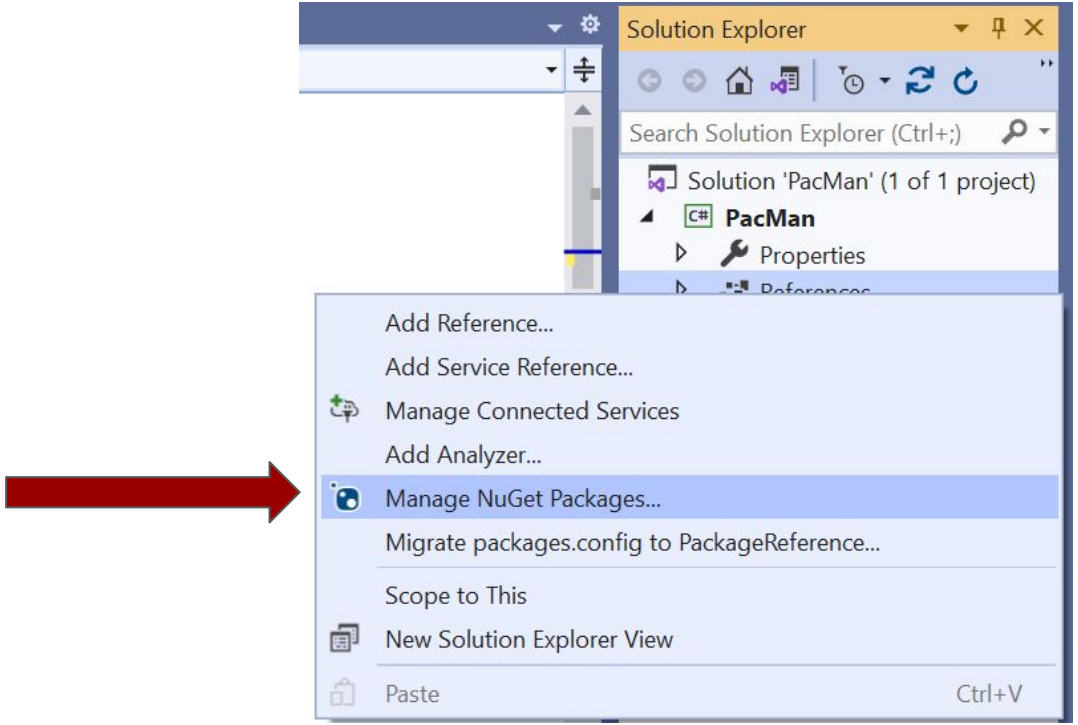
EZInput Package

Then Click on the Manage NuGet Packages.



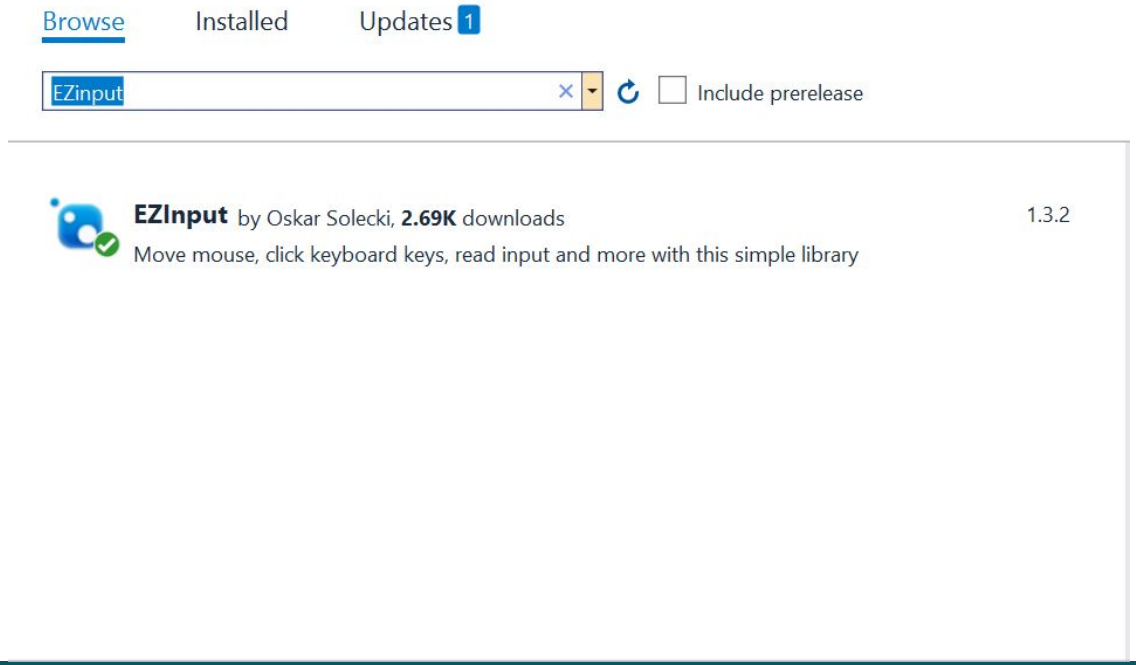
EZInput Package

Then Click on the Manage NuGet Packages.



EZInput Package

Search EZInput in the browser and install the package.



EZInput Package

And then include the EZInput package using the following instruction.

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Threading.Tasks;
using EZInput;
```

Learning Objective

Write C# programs to solve complex 2D problems and convert previous 2D game into C#.

Self Assessment

1. In probability theory, a probability matrix is a matrix such that:
The matrix is a square matrix (same number of rows as columns). All entries are probabilities, i.e. numbers between 0 and 1. All rows add up to 1.

The following is an example of a probability matrix:

```
[
  [0.5, 0.5, 0.0],
  [0.2, 0.5, 0.3],
  [0.1, 0.2, 0.7]
]
```

Self Assessment

Note that though all rows add up to 1, there is no restriction on the columns, which may or may not add up to 1.

Write a function that determines if a matrix is a probability matrix or not.

Fun fact:

for most probability matrices M (for example, if M has no zero entries), the matrix powers M^n converge (as n increases) to a matrix where all rows are identical.

Self Assessment

Test Cases:

Input	Output	Explanation

[
  [0.5, 0.5, 0.0],
  [0.2, 0.5, 0.3],
  [0.1, 0.2, 0.7]
]
isProbMatrix()
	true	

[
  [0.5, 0.5, 0.0],
  [0.2, 0.5, 0.3]
]
isProbMatrix()
	false	// Not a square matrix.

Self Assessment

Test Cases:

Input	Output	Explanation

[
  [0.5, 0.4],
  [0.5, 0.6]
]
isProbMatrix()
	false	// Rows do not add to 1.

[
  [2, -1],
  [-1, 2]
]
isProbMatrix()
	false	// Entries not between 0 and 1.