

2D Grid

Adjacency, Directional Array and DFS/BFS

#csspree Online

About CS Spree Project

CS Spree project is an initiative to engage students into Computer Science and Problem Solving.

Our discussions contain intuitive simulations and coding.

Connect with us: facebook.com/csspree

Author

Tanvir Ahmed Sojal



youtube.com/TanvirSojal



github.com/TanvirSojal



medium.com/@Sojal



linkedin.com/in/sojal



sojal.me

What is 2D grid?

2D grid is simply an array of array. Therefore, it is called 2-Dimensional array or 2D grid.

What is 2D grid?

2D grid is simply an array of array. Therefore, it is called 2-Dimensional array or 2D grid.

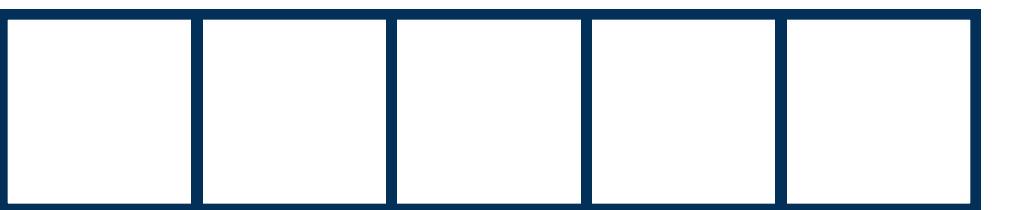
1-Dimensional Array



What is 2D grid?

2D grid is simply an array of array. Therefore, it is called 2-Dimensional array or 2D grid.

1-Dimensional Array

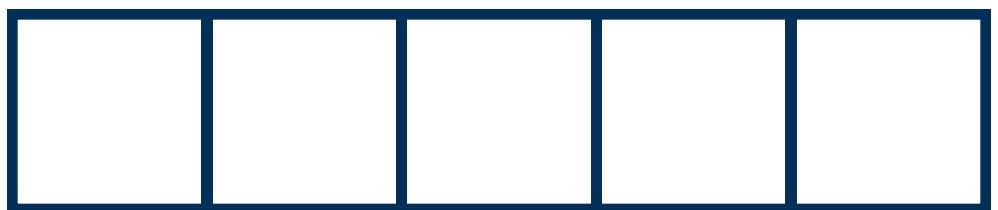


Declaration: `int A[5];`

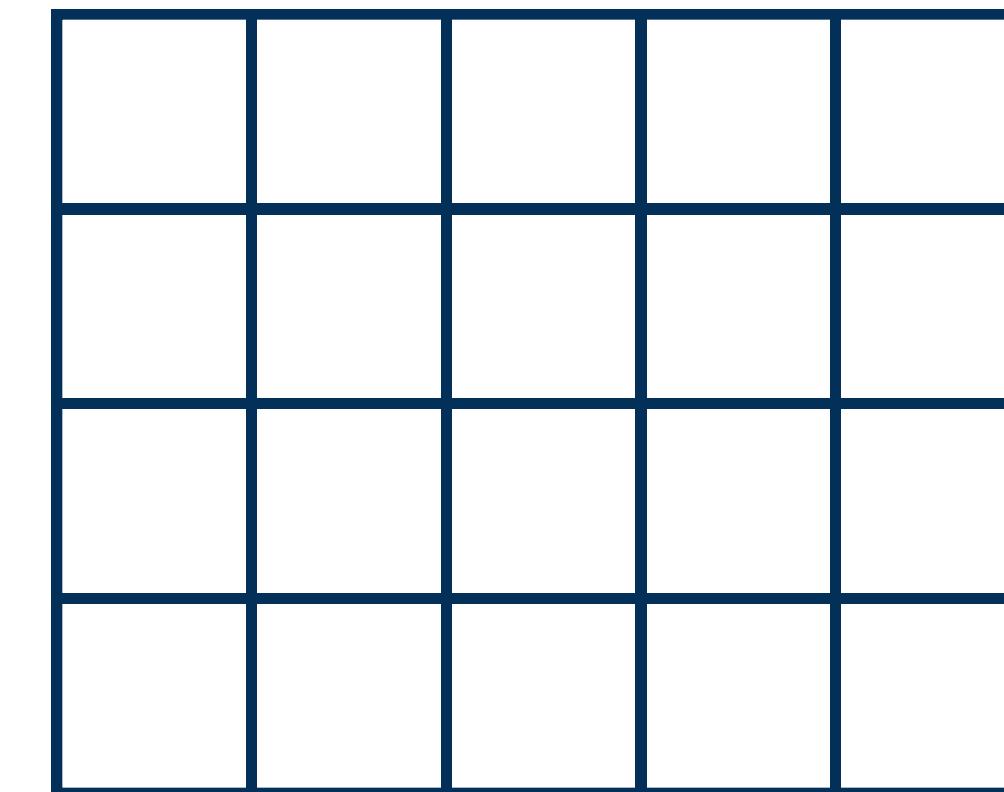
What is 2D grid?

2D grid is simply an array of array. Therefore, it is called 2-Dimensional array or 2D grid.

1-Dimensional Array



2-Dimensional Array

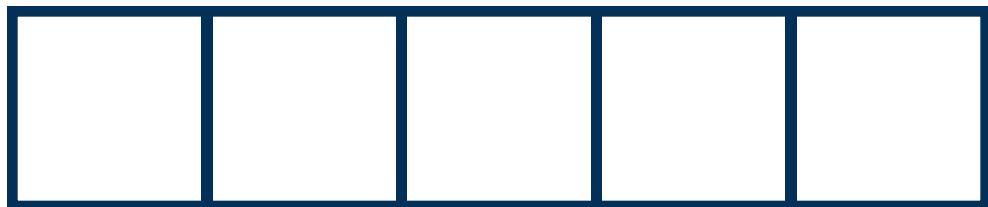


Declaration: `int A[5];`

What is 2D grid?

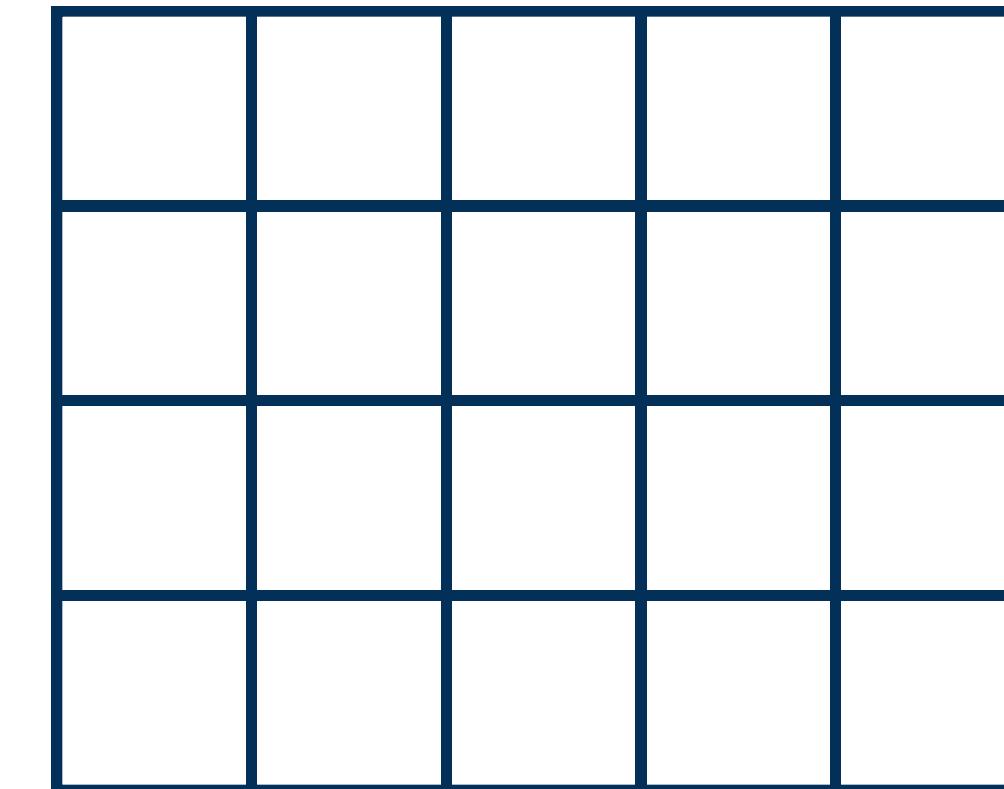
2D grid is simply an array of array. Therefore, it is called 2-Dimensional array or 2D grid.

1-Dimensional Array



Declaration: `int A[5];`

2-Dimensional Array

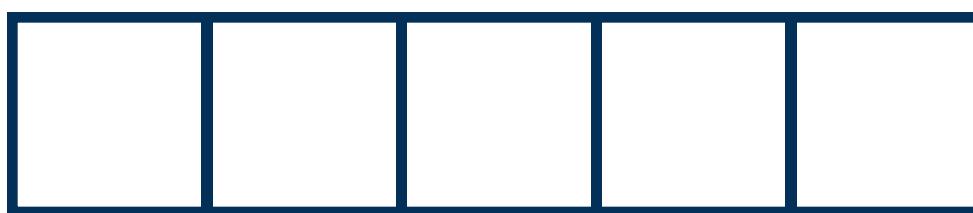


Declaration: `int A[4][5];`

What is 2D grid?

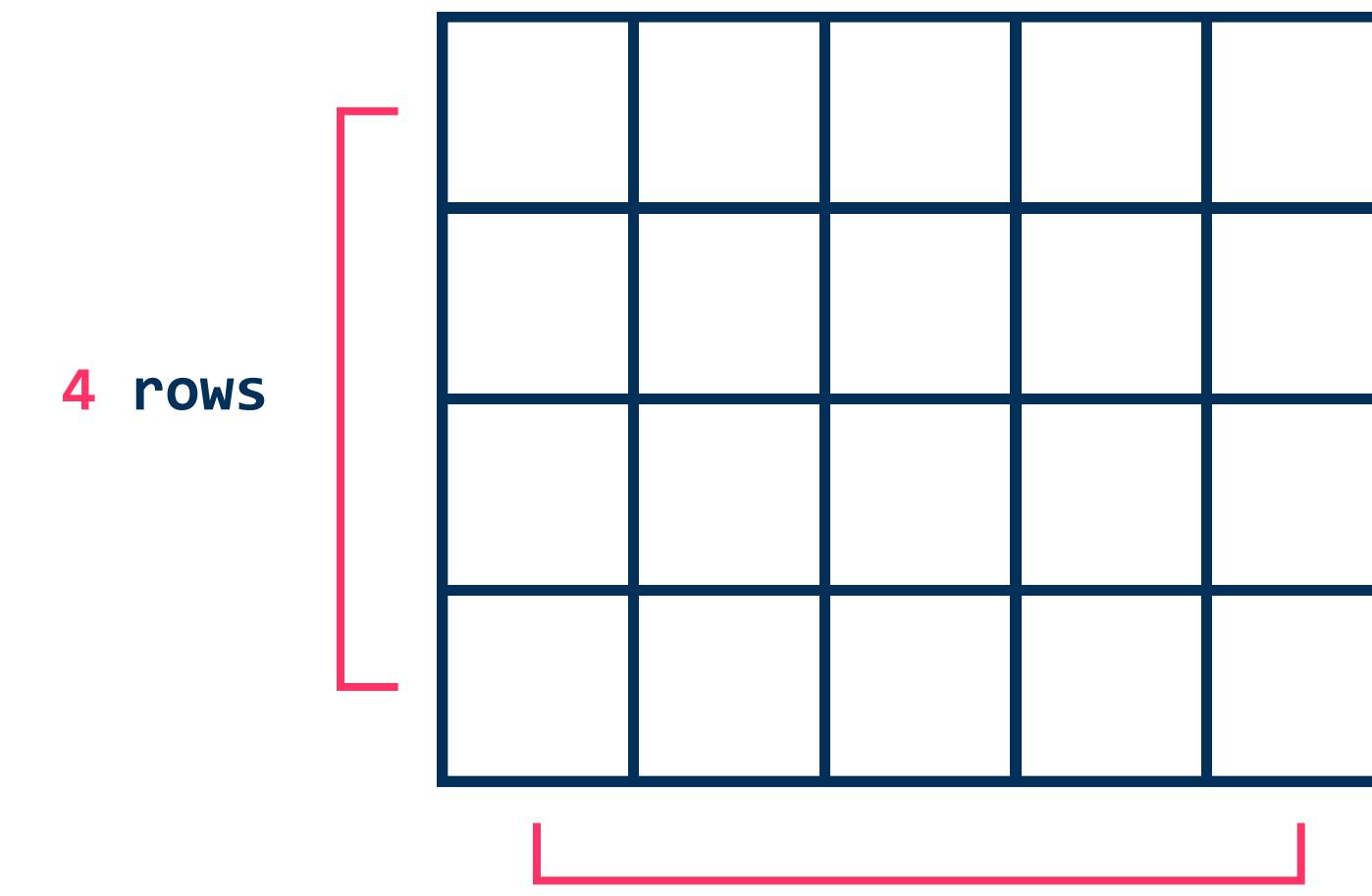
2D grid is simply an array of array. Therefore, it is called 2-Dimensional array or 2D grid.

1-Dimensional Array



Declaration: `int A[5];`

2-Dimensional Array

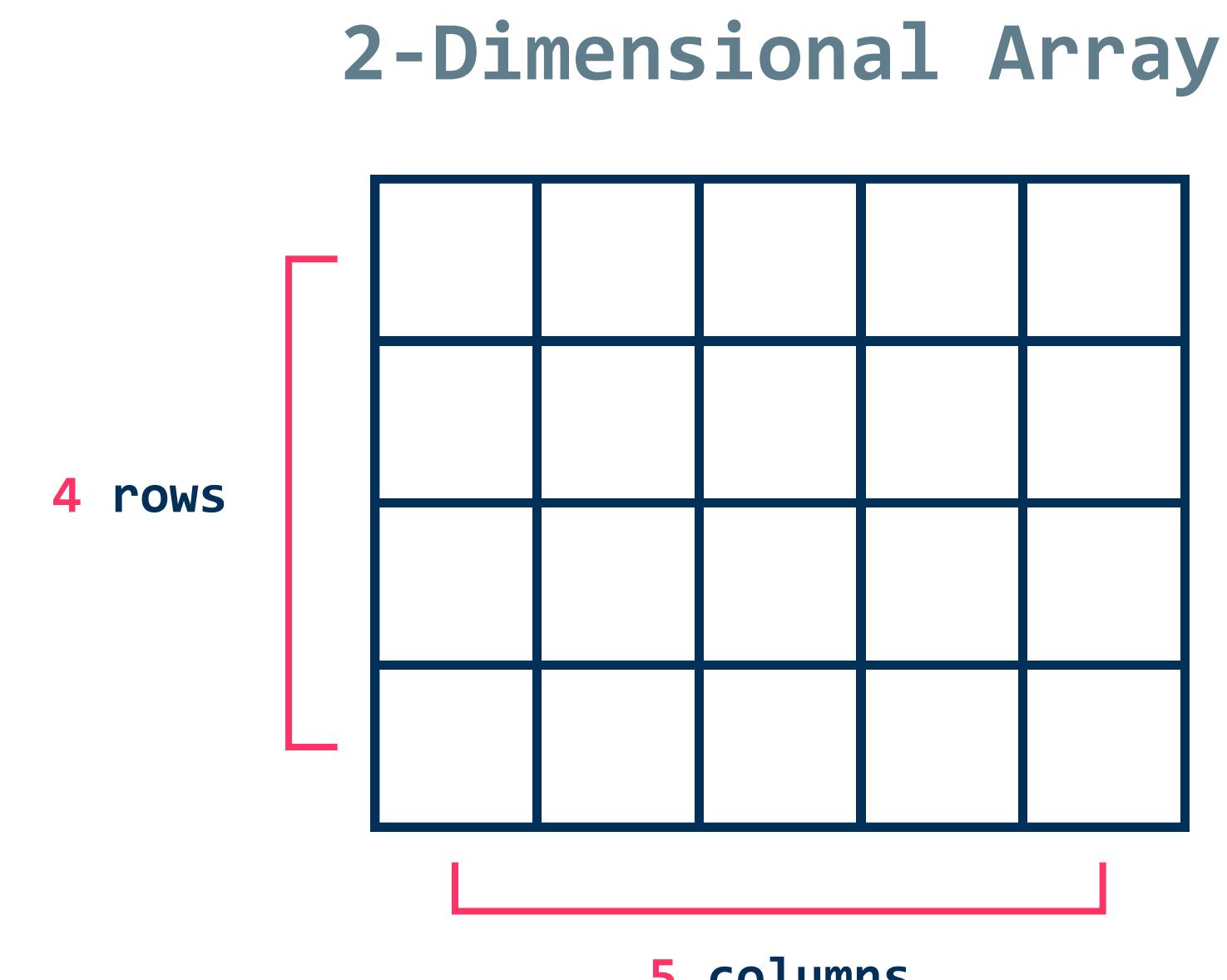


Declaration: `int A[4][5];`

What is 2D grid?

2D grid is simply an array of array. Therefore, it is called 2-Dimensional array or 2D grid.

```
/*
We created
an array of size 4
Where every index contains
an array of size 5
*/
```



Declaration: `int A[4][5];`

Working with 2D Grid

We use a linear loop to get input to or print output of an 1D Array.

```
for (int i = 0; i < n; i++){
    // input/output of A[i]
}
```

Working with 2D Grid

We use a linear loop to get input to or print output of an 1D Array.

```
for (int i = 0; i < n; i++){
    // input/output of A[i]
}
```

We use a nested loop to get input to or print output of a 2D Array.

```
for (int i = 0; i < row; i++){
    for (int j = 0; j < col; j++){
        // input/output of A[i][j]
    }
}
```

How to traverse 2D grid using Graph Traversal Algorithms?

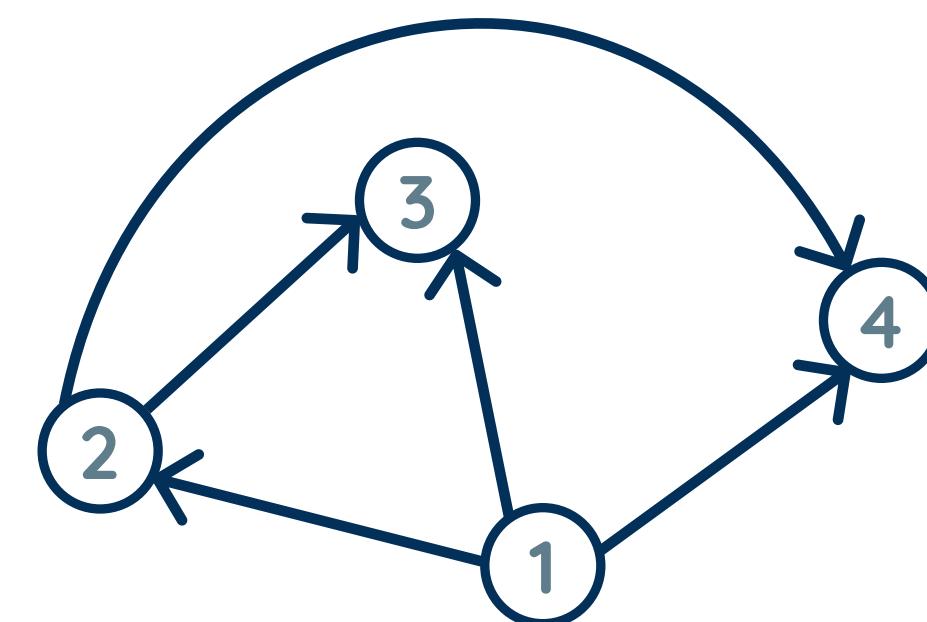
How to traverse 2D grid using Graph Traversal Algorithms?

- > We need list of adjacent nodes/grid cells for every cell

How to traverse 2D grid using Graph Traversal Algorithms?

- > We need list of adjacent nodes/grid cells for every cell

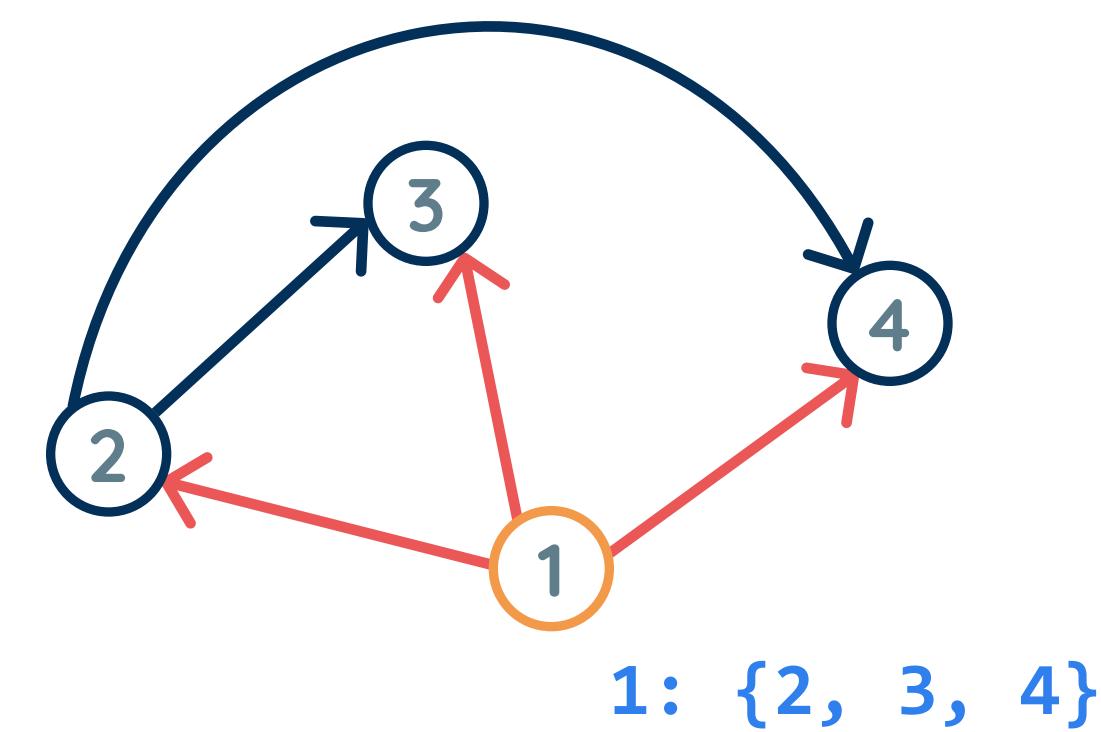
For explicit graphs, we are given edge information, and we store the adjacent nodes in adjacency list



How to traverse 2D grid using Graph Traversal Algorithms?

- > We need list of adjacent nodes/grid cells for every cell

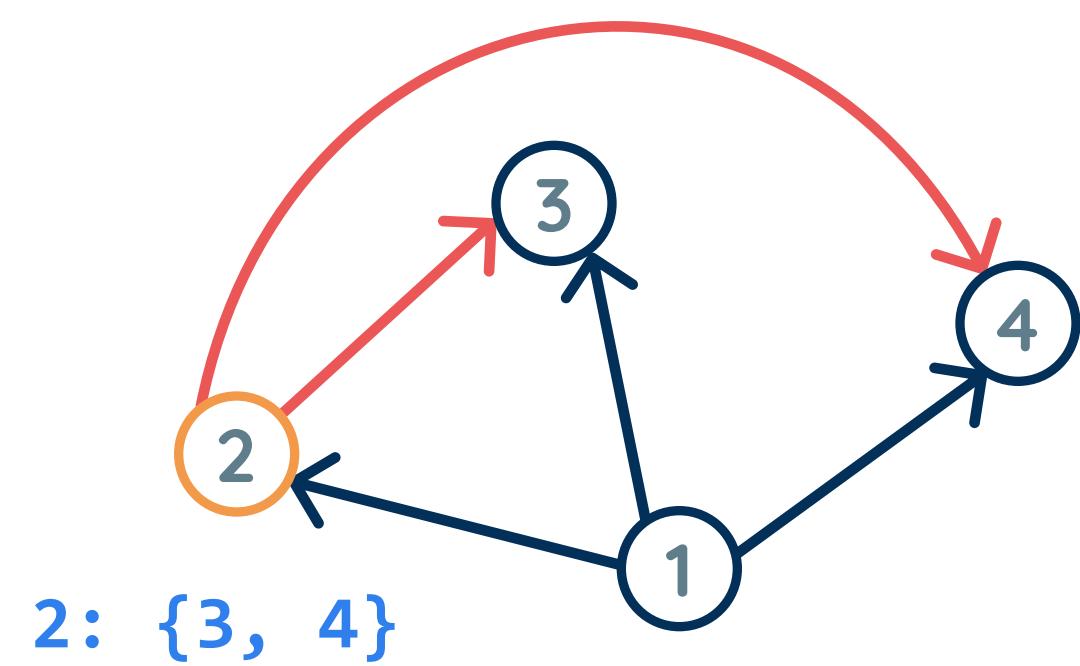
For explicit graphs, we are given edge information, and we store the adjacent nodes in adjacency list



How to traverse 2D grid using Graph Traversal Algorithms?

- > We need list of adjacent nodes/grid cells for every cell

For explicit graphs, we are given edge information, and we store the adjacent nodes in adjacency list

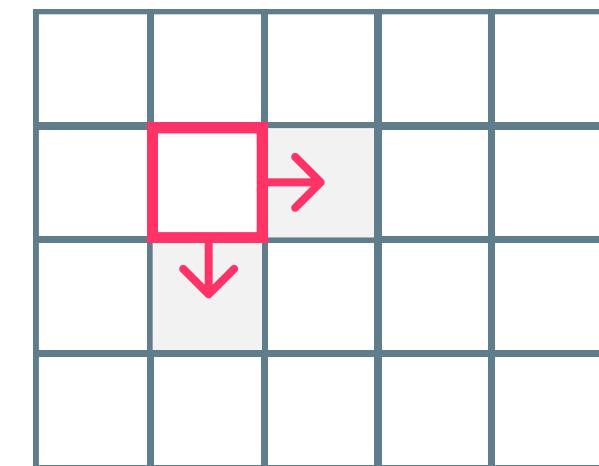


How to traverse 2D grid using Graph Traversal Algorithms?

- > We need list of adjacent nodes/grid cells for every cell

In grid, edges are not explicitly defined. Instead, a formula is given on who are the adjacent cell(s) of the current cell.

1. From any cell (x, y) , you can move to only right and bottom.

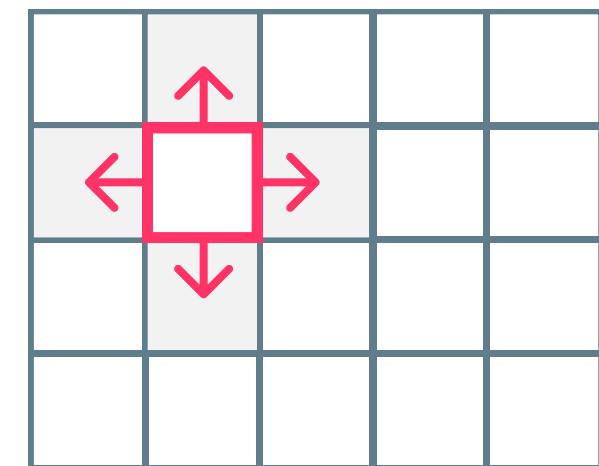


How to traverse 2D grid using Graph Traversal Algorithms?

- > We need list of adjacent nodes/grid cells for every cell

In grid, edges are not explicitly defined. Instead, a formula is given on who are the adjacent cell(s) of the current cell.

1. From any cell (x, y) , you can move to only right and bottom.
2. From any cell, you can move to any neighboring cell that shares a side.

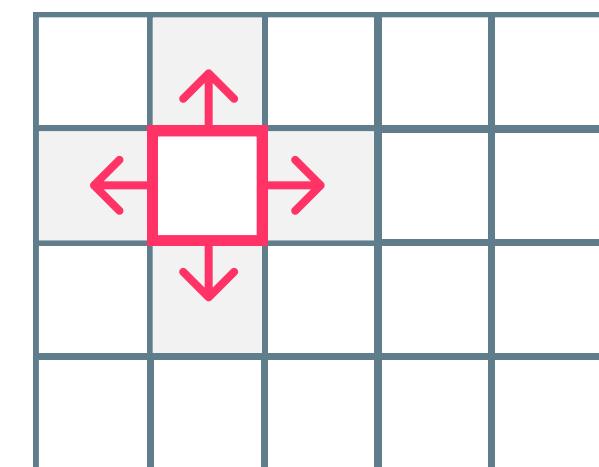


How to traverse 2D grid using Graph Traversal Algorithms?

- > We need list of adjacent nodes/grid cells for every cell

In grid, edges are not explicitly defined. Instead, a formula is given on who are the adjacent cell(s) of the current cell.

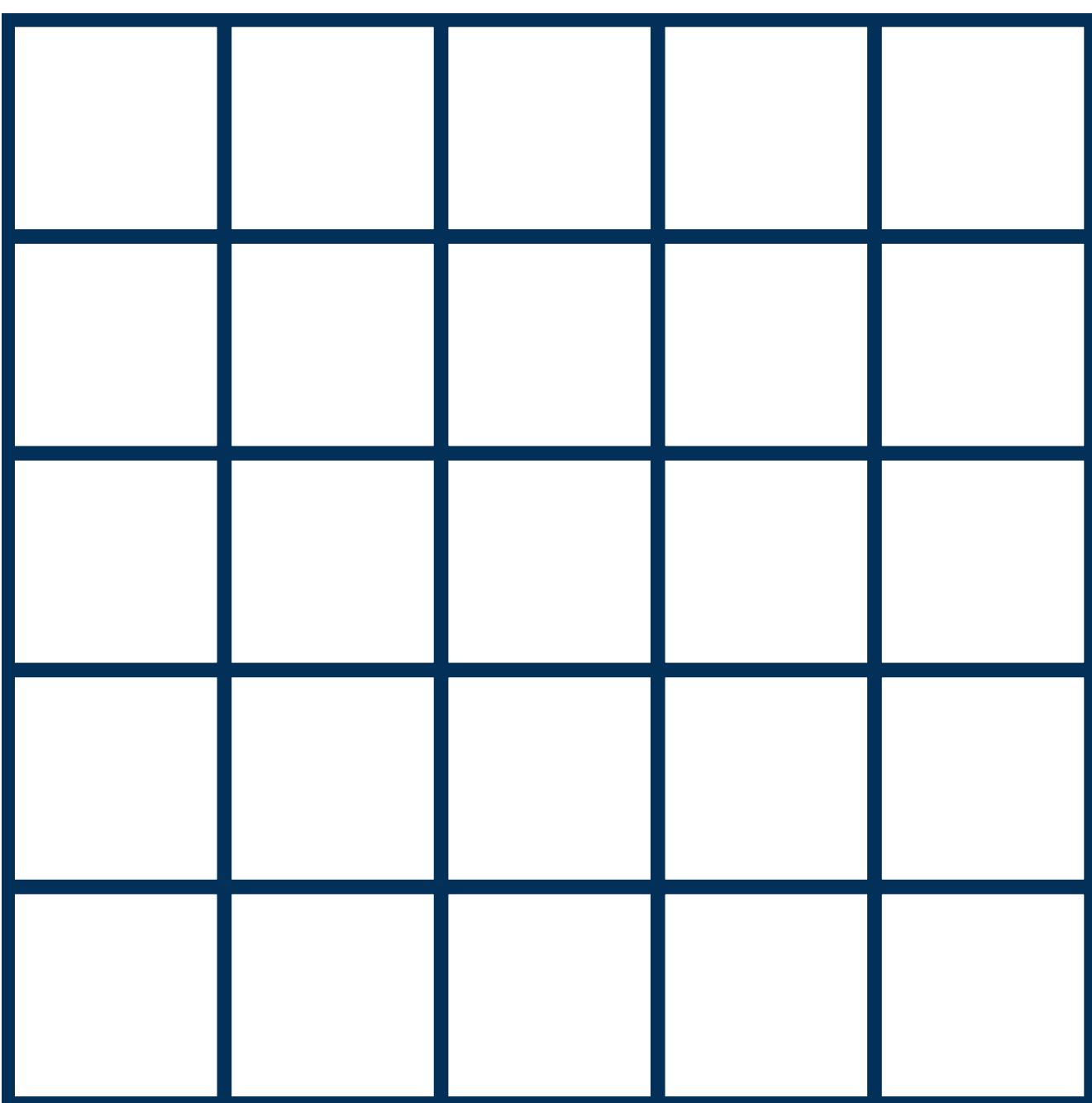
1. From any cell (x, y) , you can move to only right and bottom.
2. From any cell, you can move to any neighboring cell that shares a side.



- > So we need to calculate neighbors cell coordinates based on current cell

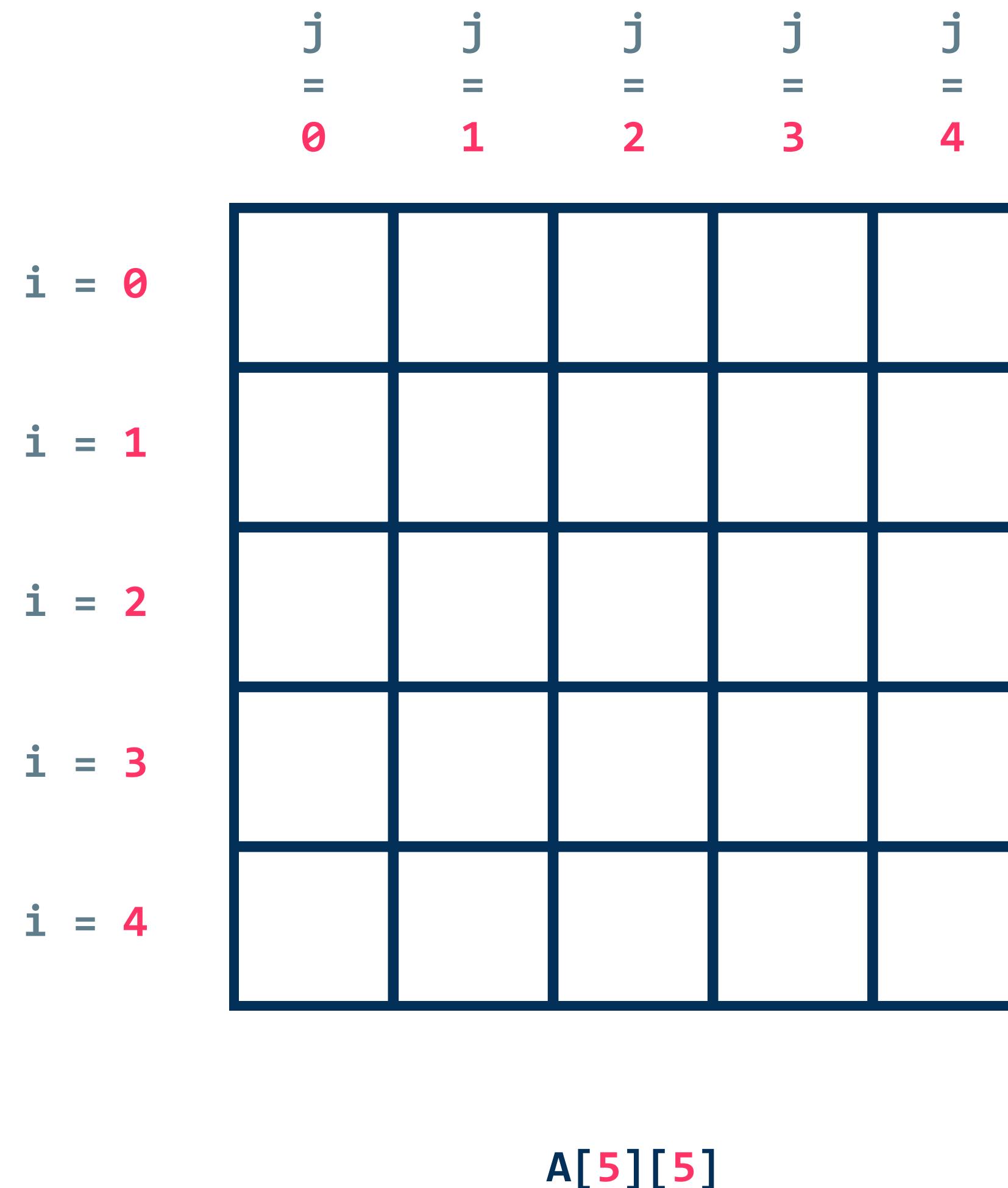
Calculating Neighbor Cells

Calculating Neighbor Cells



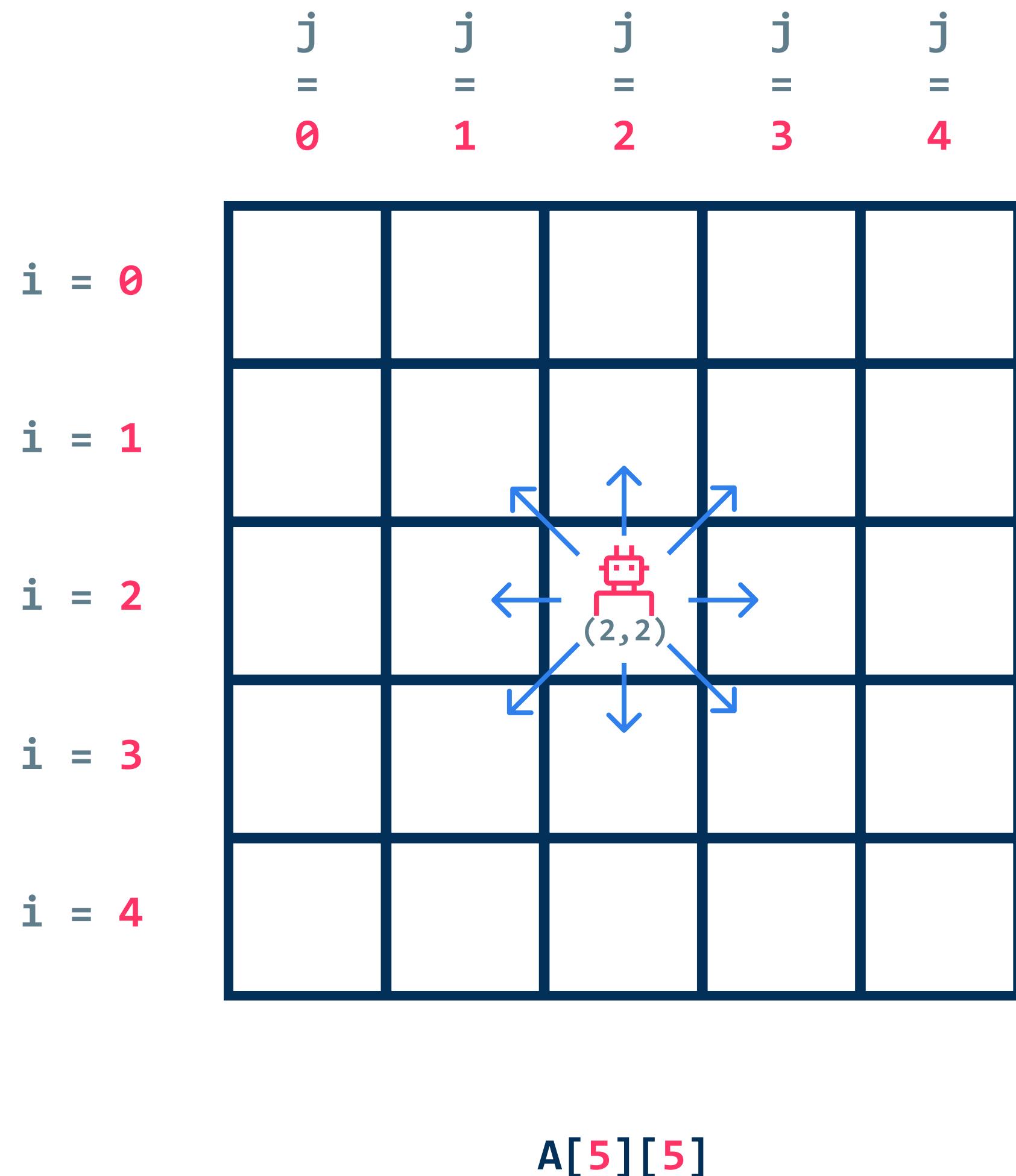
A[5][5]

Calculating Neighbor Cells



// identified rows as i
// and columns as j

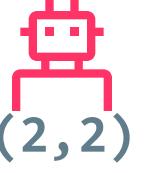
Calculating Neighbor Cells



// selected $A[2][2]$ is
// current cell

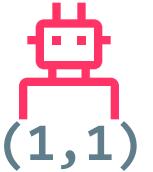
// assume in the problem,
// it is given that you can
// move to any cell within
// the board that is **one step**
// away from current cell
// horizontally, vertically
// or diagonally

Calculating Neighbor Cells

	j = 0	j = 1	j = 2	j = 3	j = 4	neighbors of (2, 2)
i = 0						$(2, 2) \rightarrow \{ (1, 1), (1, 2), (1, 3), (2, 1), (2, 3), (3, 1), (3, 2), (3, 3) \}$
i = 1		(1, 1)	(1, 2)	(1, 3)		
i = 2		(2, 1)	 (2, 2)	(2, 3)		
i = 3		(3, 1)	(3, 2)	(3, 3)		
i = 4						

A[5][5]

Calculating Neighbor Cells

	j = 0	j = 1	j = 2	j = 3	j = 4
i = 0	(0, 0)	(0, 1)	(0, 2)		
i = 1	(1, 0)	 (1, 1)	(1, 2)		
i = 2	(2, 0)	(2, 1)	(2, 2)		
i = 3					
i = 4					

A[5][5]

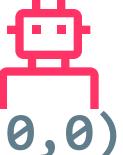
neighbors of (2, 2)

$(2, 2) \rightarrow \{ (1, 1), (1, 2), (1, 3), (2, 1), (2, 3), (3, 1), (3, 2), (3, 3) \}$

neighbors of (1, 1)

$(1, 1) \rightarrow \{ (0, 0), (0, 1), (0, 2), (1, 0), (1, 2), (2, 0), (2, 1), (2, 2) \}$

Calculating Neighbor Cells

	j = 0	j = 1	j = 2	j = 3	j = 4
i = 0	(0, 0) 	(0, 1)			
i = 1	(1, 0)	(1, 1)			
i = 2					
i = 3					
i = 4					

A[5][5]

neighbors of (2, 2)

$(2, 2) \rightarrow \{ (1, 1), (1, 2), (1, 3), (2, 1), (2, 3), (3, 1), (3, 2), (3, 3) \}$

neighbors of (1, 1)

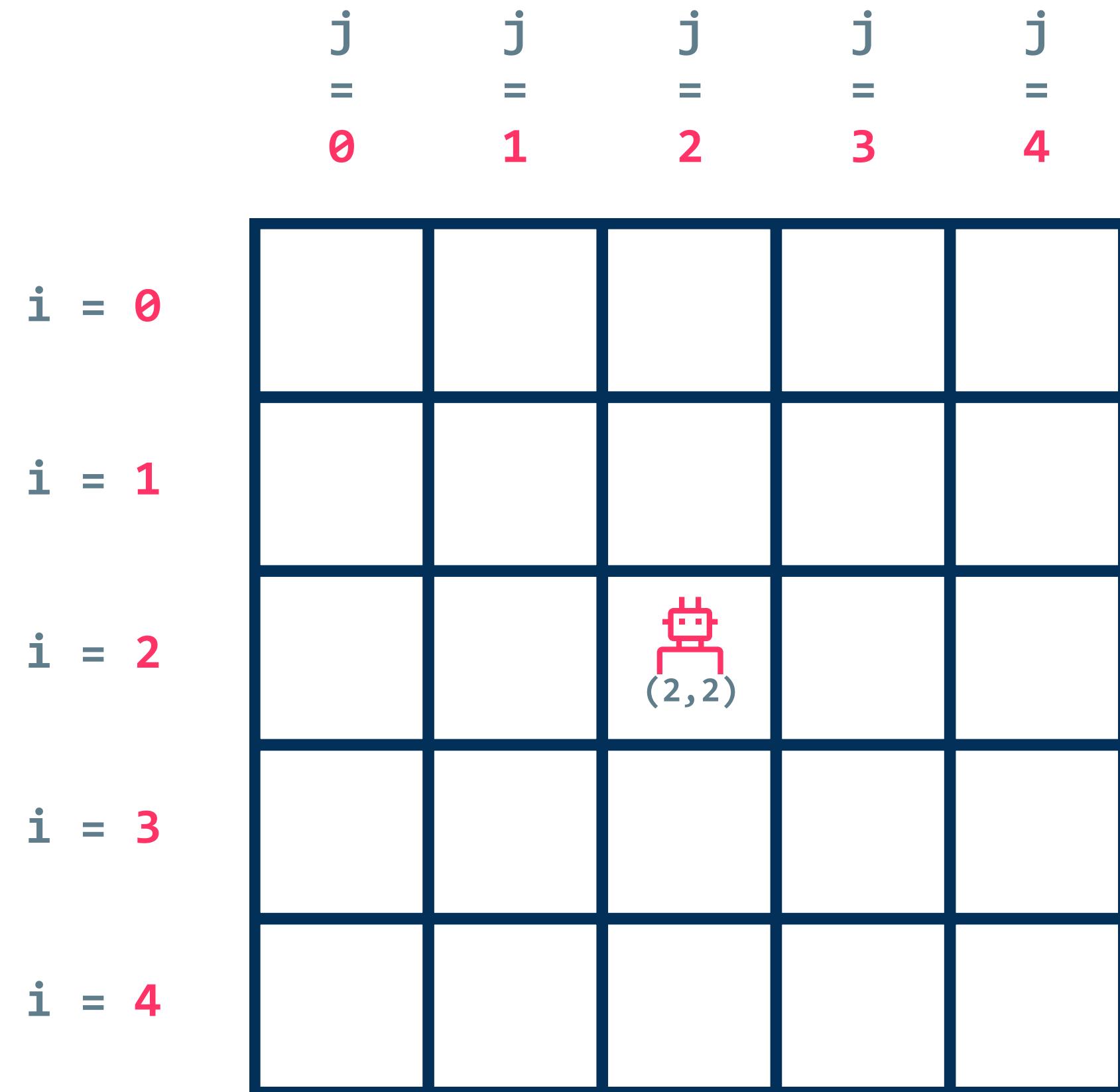
$(1, 1) \rightarrow \{ (0, 0), (0, 1), (0, 2), (1, 0), (1, 2), (2, 0), (2, 1), (2, 2) \}$

neighbors of (0, 0)

$(0, 0) \rightarrow \{ (0, 1), (1, 0), (1, 1) \}$

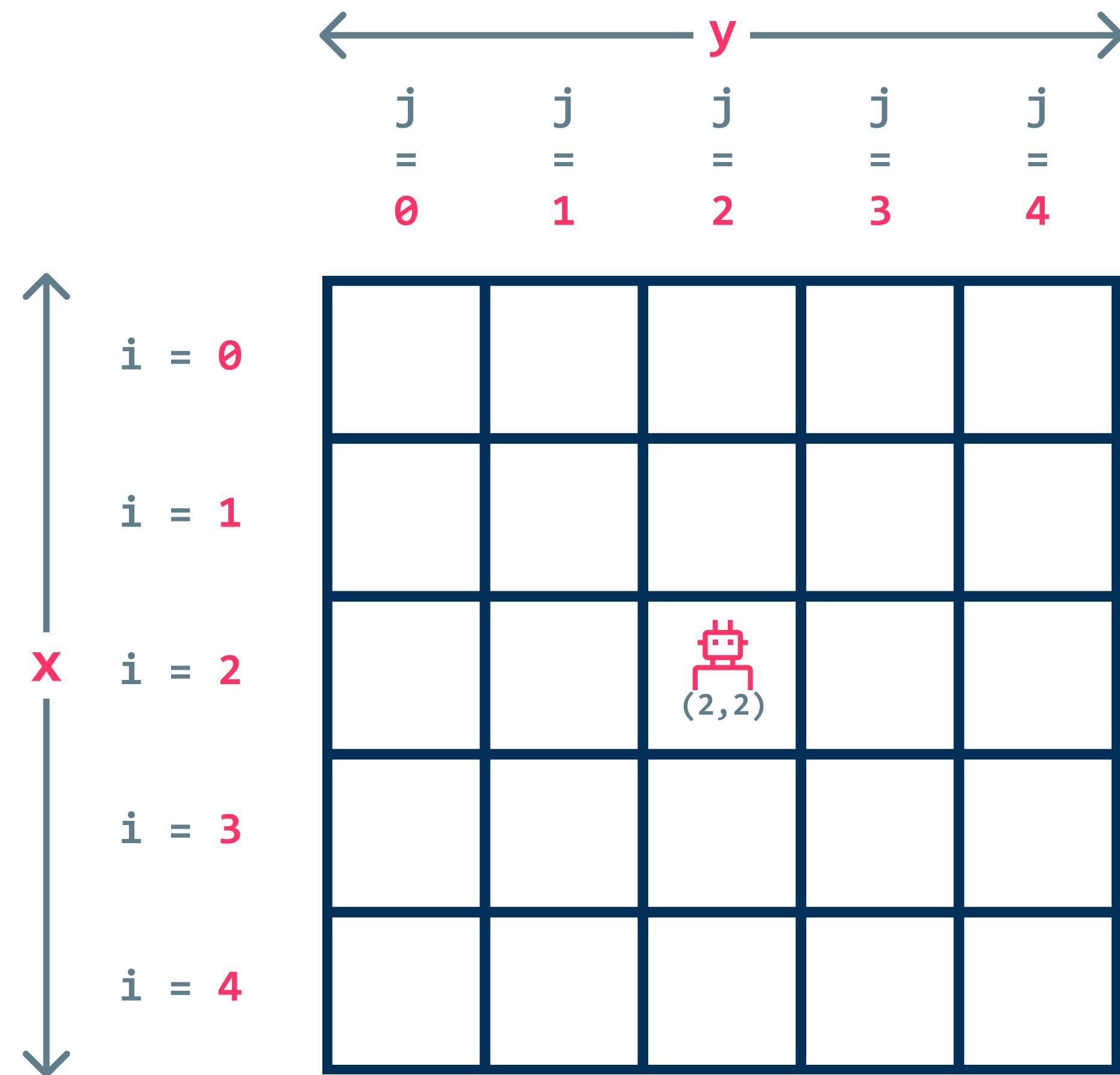
Calculating Neighbor Cells

Finding Co-ordinate Pattern



Calculating Neighbor Cells

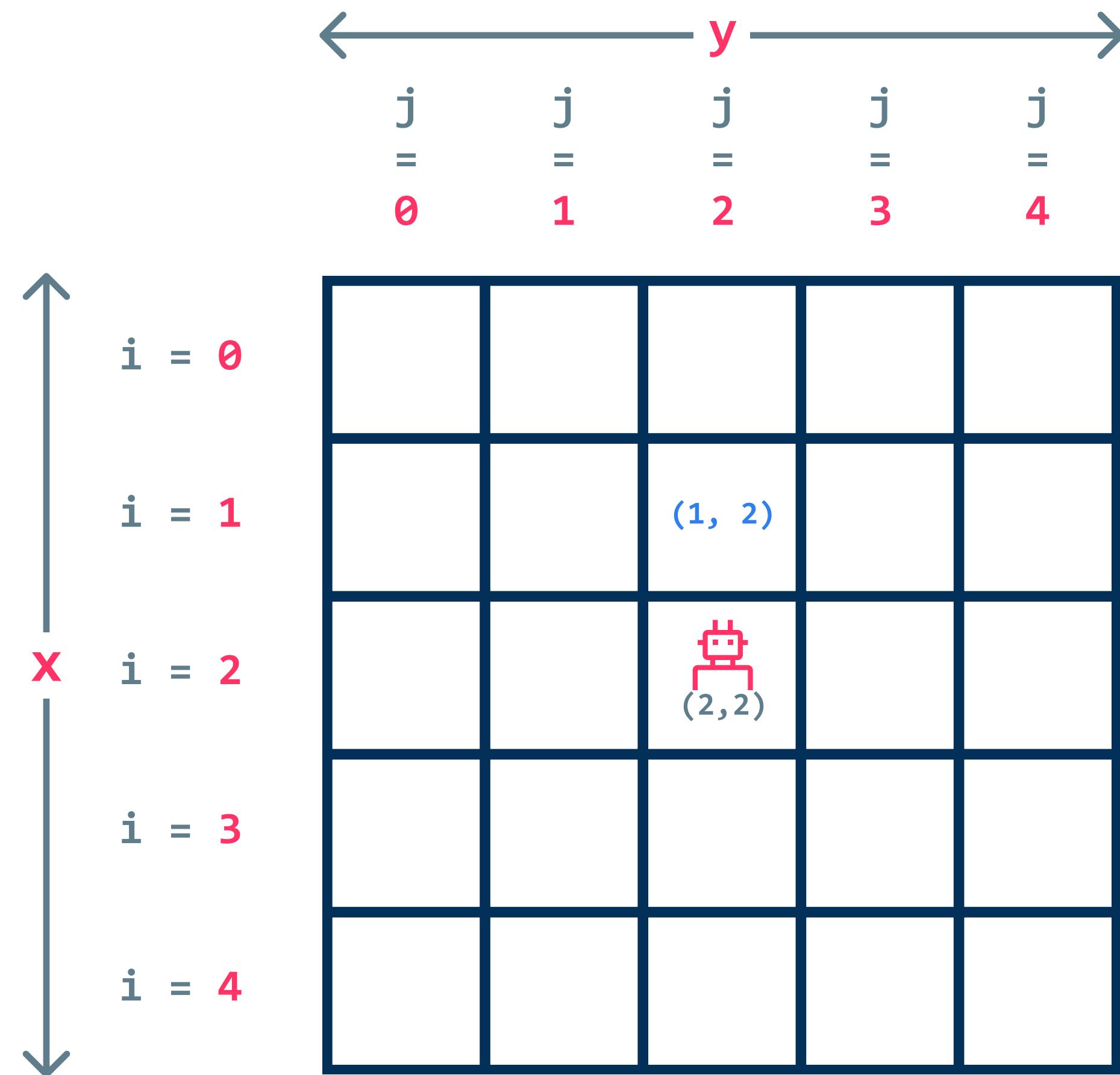
Finding Co-ordinate Pattern



adjacent cell co-ordinate	change in x (dx)	change in y (dy)
---------------------------	------------------	------------------

Calculating Neighbor Cells

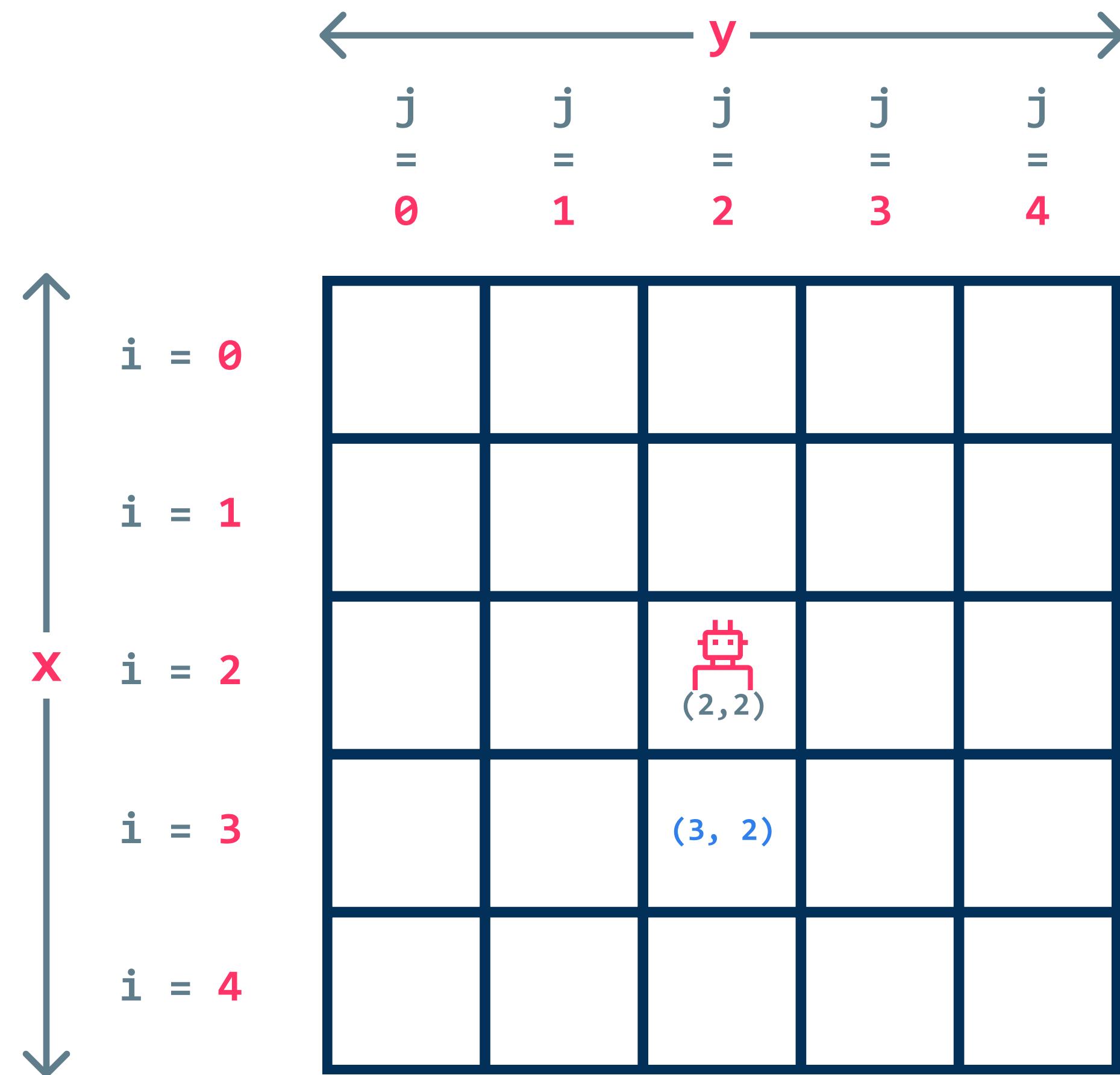
Finding Co-ordinate Pattern



adjacent cell co-ordinate	change in x (dx)	change in y (dy)
Top (1, 2)	-1	0

Calculating Neighbor Cells

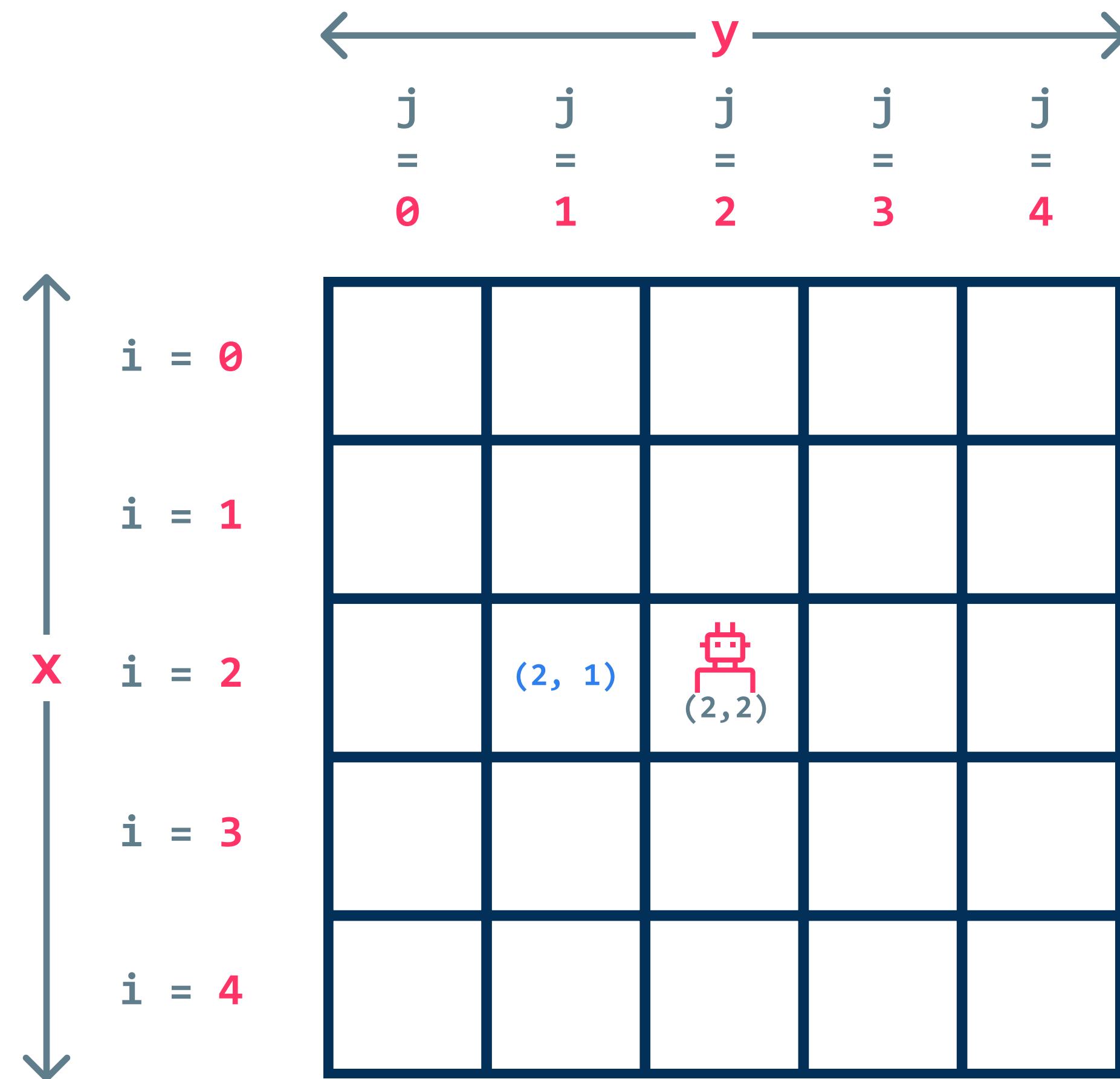
Finding Co-ordinate Pattern



adjacent cell co-ordinate	change in x (dx)	change in y (dy)
Top (1, 2)	-1	0
Bottom (3, 2)	+1	0

Calculating Neighbor Cells

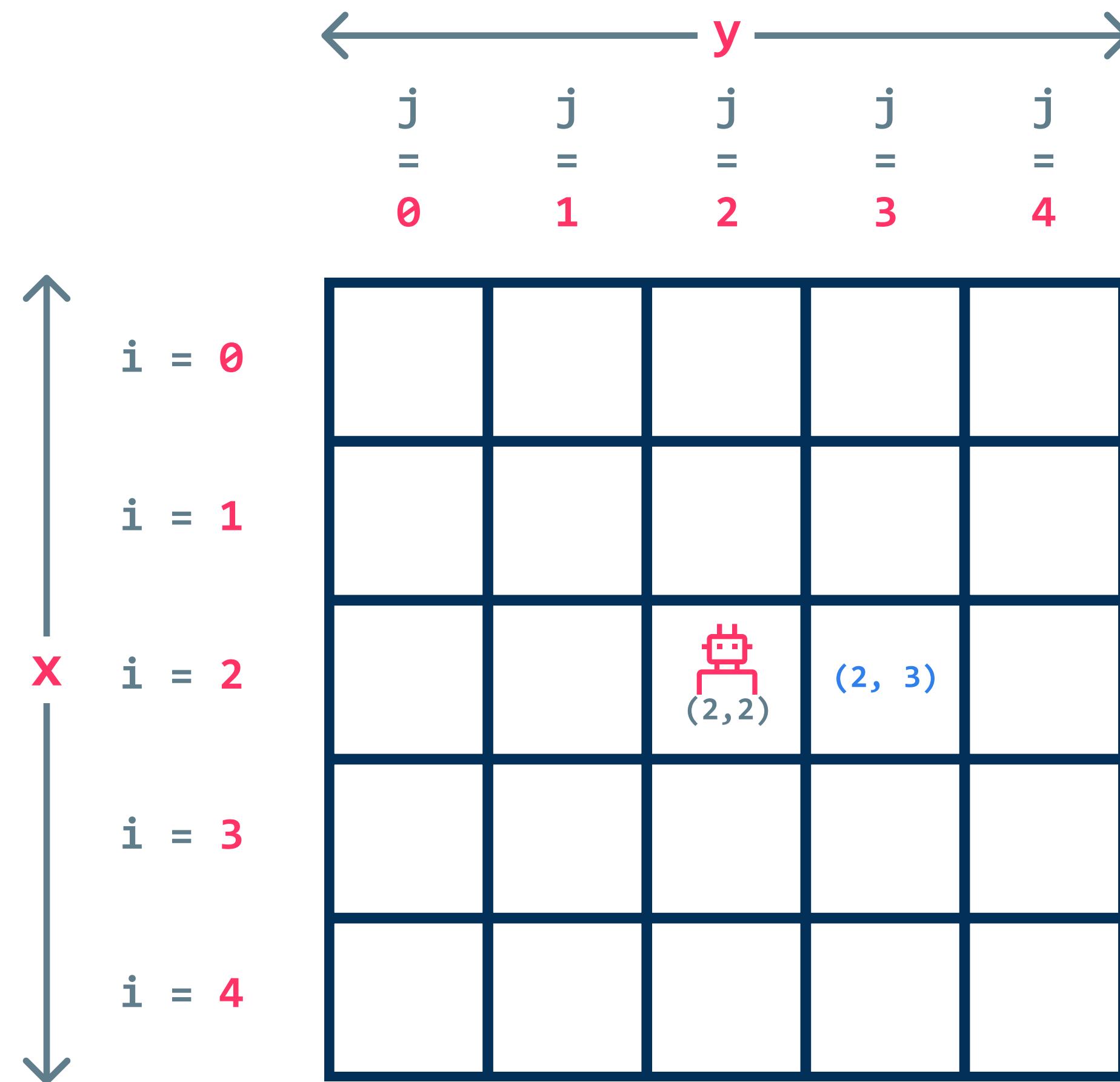
Finding Co-ordinate Pattern



adjacent cell co-ordinate	change in x (dx)	change in y (dy)
Top $(1, 2)$	-1	0
Bottom $(3, 2)$	+1	0
Left $(2, 1)$	0	-1

Calculating Neighbor Cells

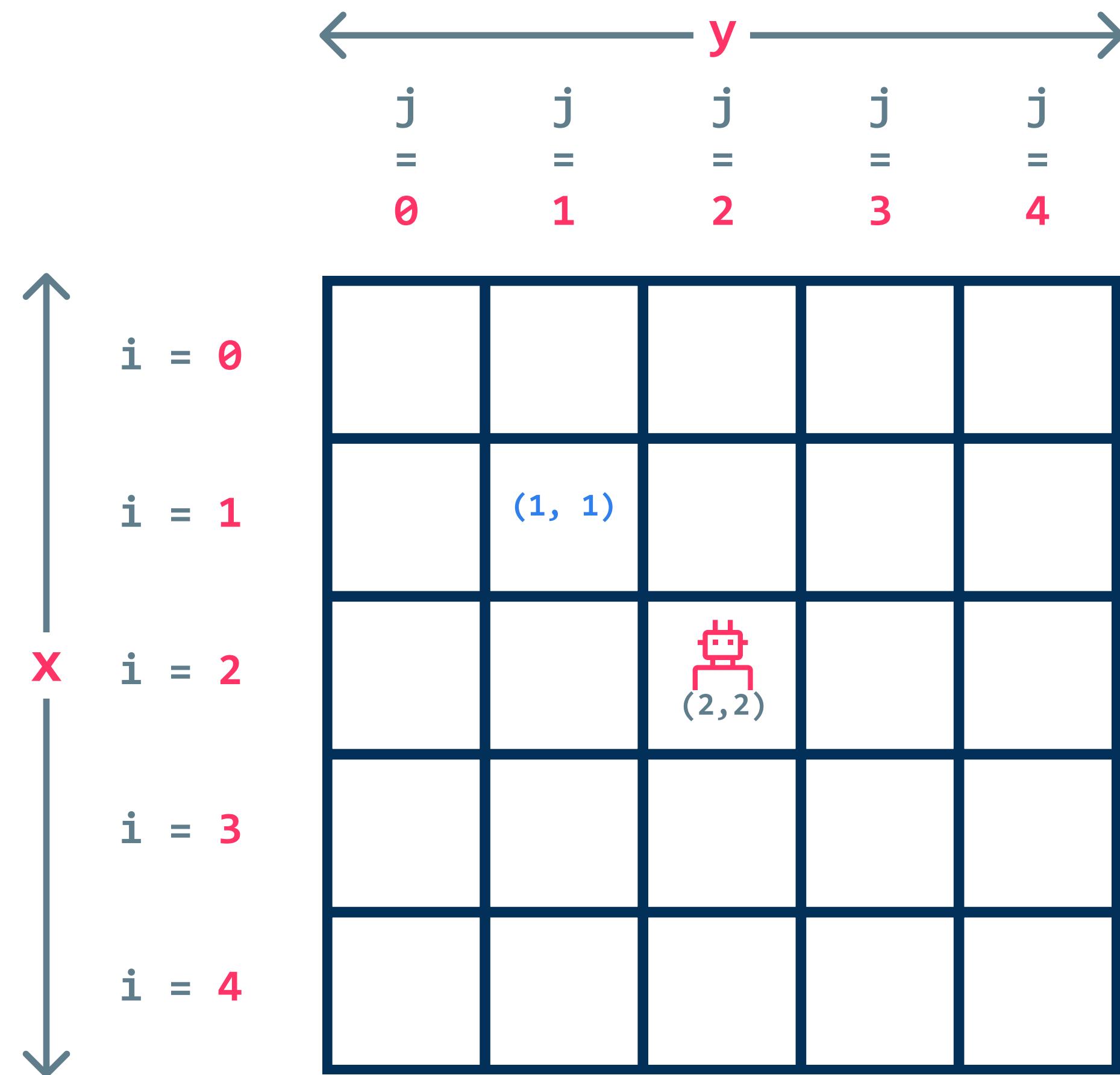
Finding Co-ordinate Pattern



adjacent cell co-ordinate	change in x (dx)	change in y (dy)
Top $(1, 2)$	-1	0
Bottom $(3, 2)$	+1	0
Left $(2, 1)$	0	-1
Right $(2, 3)$	0	+1

Calculating Neighbor Cells

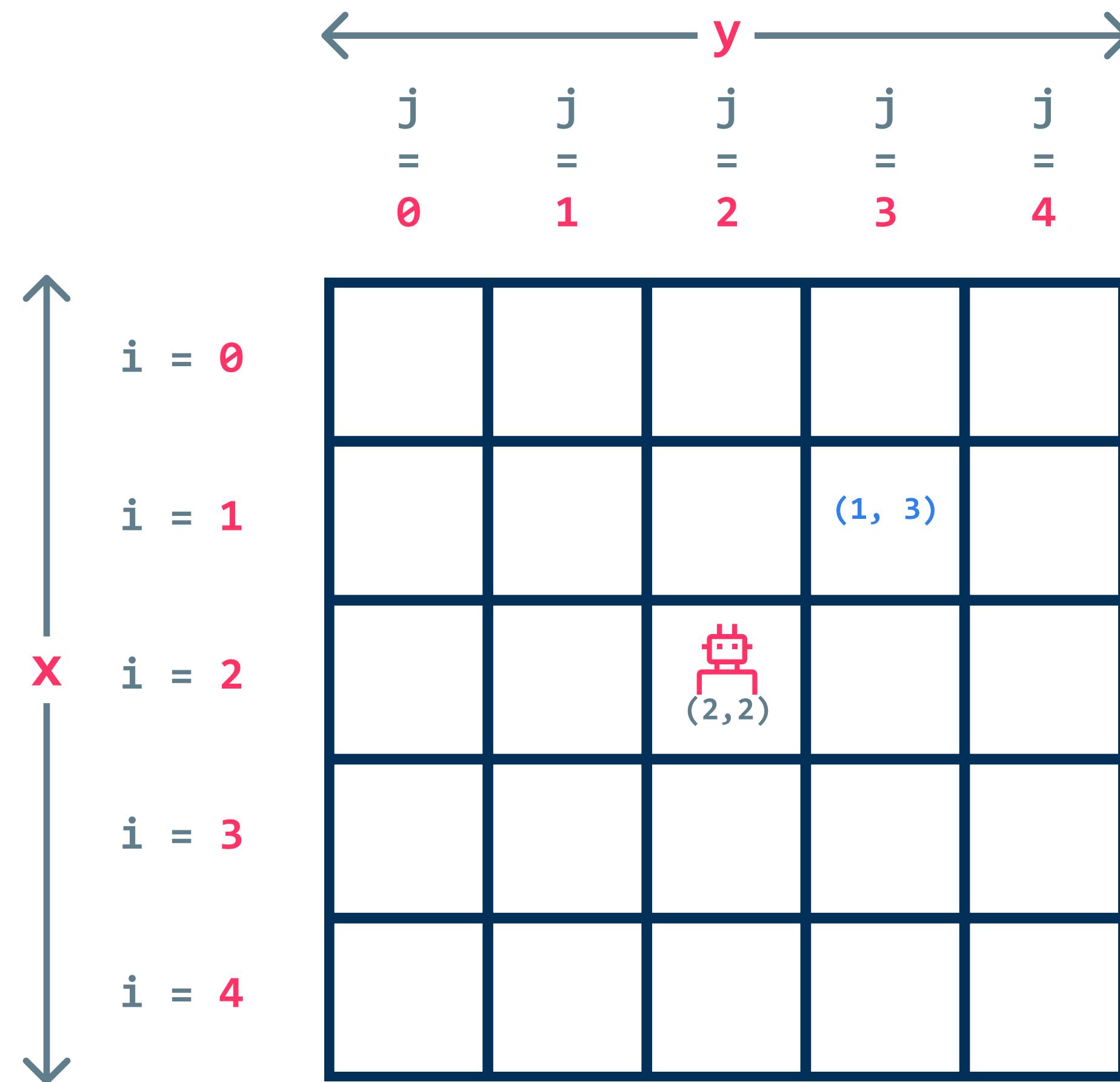
Finding Co-ordinate Pattern



adjacent cell co-ordinate	change in x (dx)	change in y (dy)
Top $(1, 2)$	-1	0
Bottom $(3, 2)$	+1	0
Left $(2, 1)$	0	-1
Right $(2, 3)$	0	+1
Top-Left $(1, 1)$	-1	-1

Calculating Neighbor Cells

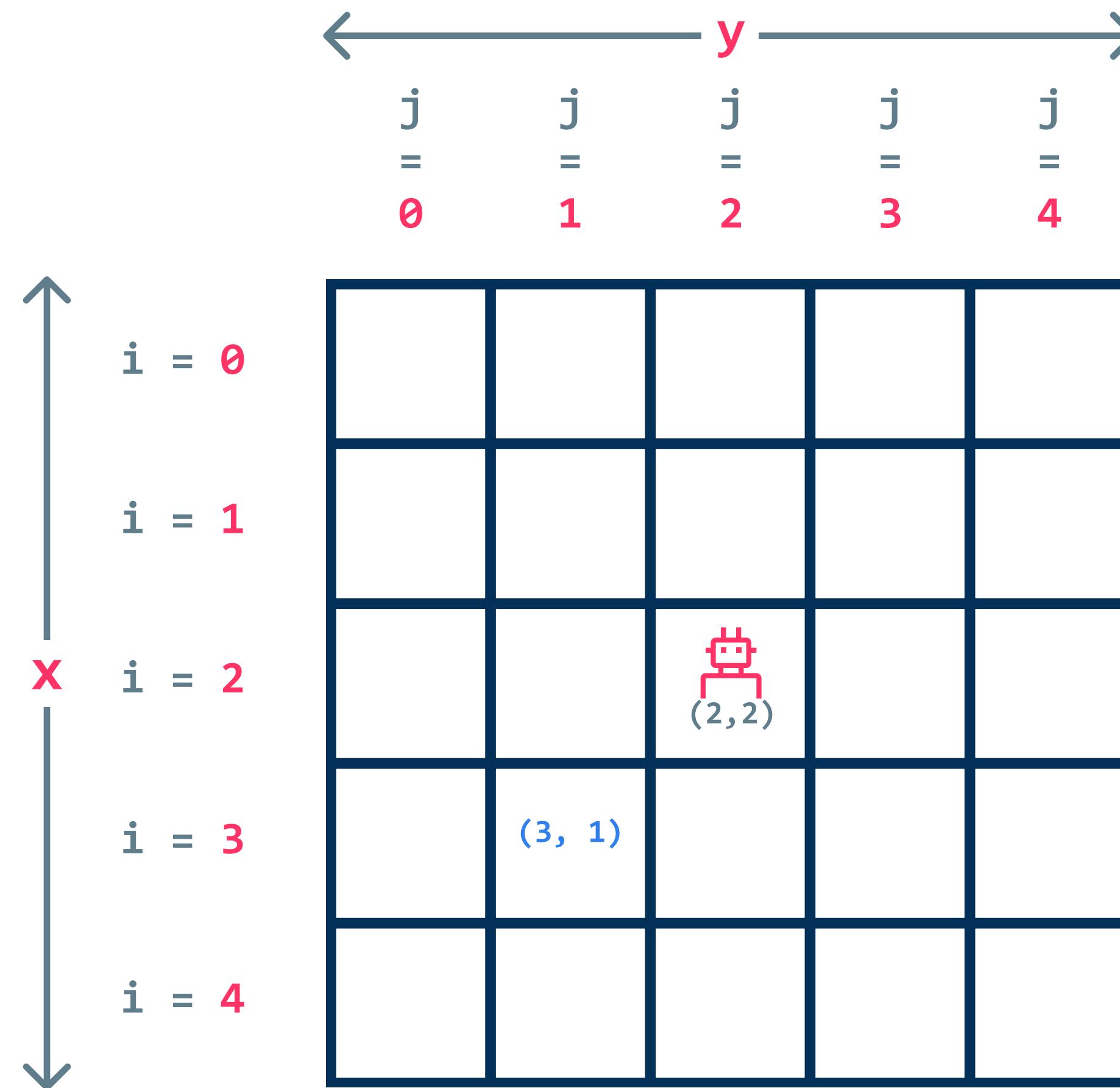
Finding Co-ordinate Pattern



adjacent cell co-ordinate	change in x (dx)	change in y (dy)
Top $(1, 2)$	-1	0
Bottom $(3, 2)$	+1	0
Left $(2, 1)$	0	-1
Right $(2, 3)$	0	+1
Top-Left $(1, 1)$	-1	-1
Top-Right $(1, 3)$	-1	+1

Calculating Neighbor Cells

Finding Co-ordinate Pattern



adjacent cell co-ordinate	change in x (dx)	change in y (dy)
Top $(1, 2)$	-1	0
Bottom $(3, 2)$	+1	0
Left $(2, 1)$	0	-1
Right $(2, 3)$	0	+1
Top-Left $(1, 1)$	-1	-1
Top-Right $(1, 3)$	-1	+1
Bottom-Left $(3, 1)$	+1	-1

Calculating Neighbor Cells

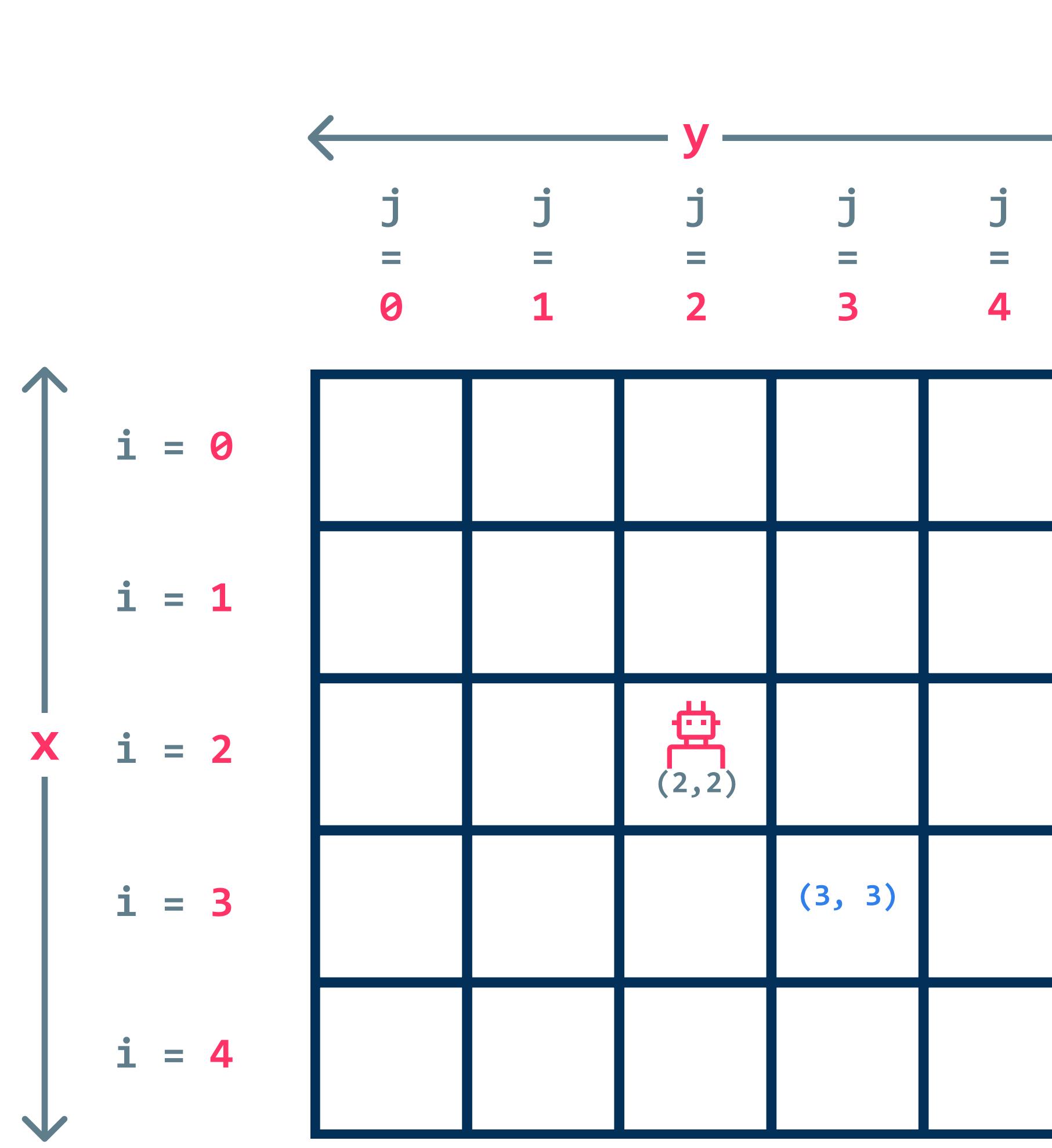


Diagram illustrating the calculation of neighbor cells for a 5x5 grid. The grid is indexed by i (row) and j (column).

Legend:

- $x = \text{row-axis}$
- $y = \text{col-axis}$

Grid indices:

- Row indices (i): $i = 0, 1, 2, 3, 4$
- Column indices (j): $j = 0, 1, 2, 3, 4$

Neighboring cells for cell $(2, 2)$:

adjacent cell co-ordinate	change in x (dx)	change in y (dy)
Top $(1, 2)$	-1	0
Bottom $(3, 2)$	+1	0
Left $(2, 1)$	0	-1
Right $(2, 3)$	0	+1
Top-Left $(1, 1)$	-1	-1
Top-Right $(1, 3)$	-1	+1
Bottom-Left $(3, 1)$	+1	-1
Bottom-Right $(3, 3)$	+1	+1

So, the neighbor calculations would be..

- x = row-axis
- y = col-axis

```
void dfs(int x, int y){  
    // make sure the cell falls within the grid  
  
    // visit the cell  
  
    dfs(x-1, y);  
    dfs(x+1, y);  
    dfs(x, y-1);  
    dfs(x, y+1);  
    dfs(x-1, y-1);  
    dfs(x-1, y+1);  
    dfs(x+1, y-1);  
    dfs(x+1, y+1);  
}
```

How can we simplify this?

Directional Array

Array to hold dx and dy so we can add the corresponding values to current cell value and get the neighbors.

- x = row-axis
- y = col-axis

Directional Array

Array to hold dx and dy so we can add the corresponding values to current cell value and get the neighbors.

• x = row-axis
• y = col-axis

adjacent cell co-ordinate	change in x (dx)	change in y (dy)
Top (1, 2)	-1	0
Bottom (3, 2)	+1	0
Left (2, 1)	0	-1
Right (2, 3)	0	+1
Top-Left (1, 1)	-1	-1
Top-Right (1, 3)	-1	+1
Bottom-Left (3, 1)	+1	-1
Bottom-Right (3, 3)	+1	+1

Directional Array

Array to hold dx and dy so we can add the corresponding values to current cell value and get the neighbors.

- x = row-axis
- y = col-axis

adjacent cell co-ordinate	change in x (dx)	change in y (dy)	
Top (1, 2)	-1	0	<code>dx[] = {}</code>
Bottom (3, 2)	+1	0	<code>dy[] = {}</code>
Left (2, 1)	0	-1	
Right (2, 3)	0	+1	• we take two arrays, where ith index of dx array will correspond to change in x and ith index of dy will correspond to change in y to get ith neighbor
Top-Left (1, 1)	-1	-1	
Top-Right (1, 3)	-1	+1	
Bottom-Left (3, 1)	+1	-1	
Bottom-Right (3, 3)	+1	+1	

Directional Array

Array to hold dx and dy so we can add the corresponding values to current cell value and get the neighbors.

- x = row-axis
- y = col-axis

adjacent cell co-ordinate	change in x (dx)	change in y (dy)
Top (1, 2)	-1	0
Bottom (3, 2)	+1	0
Left (2, 1)	0	-1
Right (2, 3)	0	+1
Top-Left (1, 1)	-1	-1
Top-Right (1, 3)	-1	+1
Bottom-Left (3, 1)	+1	-1
Bottom-Right (3, 3)	+1	+1

↓
dx[] = {-1}
dy[] = {0}

- we take two arrays, where ith index of dx array will correspond to change in x and ith index of dy will correspond to change in y to get ith neighbor

Directional Array

Array to hold dx and dy so we can add the corresponding values to current cell value and get the neighbors.

- x = row-axis
- y = col-axis

adjacent cell co-ordinate	change in x (dx)	change in y (dy)
Top (1, 2)	-1	0
Bottom (3, 2)	+1	0
Left (2, 1)	0	-1
Right (2, 3)	0	+1
Top-Left (1, 1)	-1	-1
Top-Right (1, 3)	-1	+1
Bottom-Left (3, 1)	+1	-1
Bottom-Right (3, 3)	+1	+1

$$\begin{aligned} \text{dx[]} &= \{-1, 1\} \\ \text{dy[]} &= \{0, 0\} \end{aligned}$$



- we take two arrays, where ith index of dx array will correspond to change in x and ith index of dy will correspond to change in y to get ith neighbor

Directional Array

Array to hold dx and dy so we can add the corresponding values to current cell value and get the neighbors.

• x = row-axis
• y = col-axis

adjacent cell co-ordinate	change in x (dx)	change in y (dy)
Top (1, 2)	-1	0
Bottom (3, 2)	+1	0
Left (2, 1)	0	-1
Right (2, 3)	0	+1
Top-Left (1, 1)	-1	-1
Top-Right (1, 3)	-1	+1
Bottom-Left (3, 1)	+1	-1
Bottom-Right (3, 3)	+1	+1

$dx[] = \{-1, 1, 0\}$

$dy[] = \{0, 0, -1\}$



- we take two arrays, where ith index of dx array will correspond to change in x and ith index of dy will correspond to change in y to get ith neighbor

Directional Array

Array to hold dx and dy so we can add the corresponding values to current cell value and get the neighbors.

• x = row-axis
• y = col-axis

adjacent cell co-ordinate	change in x (dx)	change in y (dy)
Top (1, 2)	-1	0
Bottom (3, 2)	+1	0
Left (2, 1)	0	-1
Right (2, 3)	0	+1
Top-Left (1, 1)	-1	-1
Top-Right (1, 3)	-1	+1
Bottom-Left (3, 1)	+1	-1
Bottom-Right (3, 3)	+1	+1

↓
 $dx[] = \{-1, 1, 0, 0\}$
 $dy[] = \{0, 0, -1, 1\}$

- we take two arrays, where ith index of dx array will correspond to change in x and ith index of dy will correspond to change in y to get ith neighbor

Directional Array

Array to hold dx and dy so we can add the corresponding values to current cell value and get the neighbors.

• x = row-axis
• y = col-axis

adjacent cell co-ordinate	change in x (dx)	change in y (dy)	
Top (1, 2)	-1	0	\downarrow
Bottom (3, 2)	+1	0	$dx[] = \{-1, 1, 0, 0, -1\}$
Left (2, 1)	0	-1	$dy[] = \{0, 0, -1, 1, -1\}$
Right (2, 3)	0	+1	
Top-Left (1, 1)	-1	-1	
Top-Right (1, 3)	-1	+1	
Bottom-Left (3, 1)	+1	-1	
Bottom-Right (3, 3)	+1	+1	

- we take two arrays, where ith index of dx array will correspond to change in x and ith index of dy will correspond to change in y to get ith neighbor

Directional Array

Array to hold dx and dy so we can add the corresponding values to current cell value and get the neighbors.

• x = row-axis
• y = col-axis

adjacent cell co-ordinate	change in x (dx)	change in y (dy)	
Top (1, 2)	-1	0	\downarrow
Bottom (3, 2)	+1	0	
Left (2, 1)	0	-1	
Right (2, 3)	0	+1	
Top-Left (1, 1)	-1	-1	
Top-Right (1, 3)	-1	+1	
Bottom-Left (3, 1)	+1	-1	
Bottom-Right (3, 3)	+1	+1	

$dx[] = \{-1, 1, 0, 0, -1, -1\}$

$dy[] = \{0, 0, -1, 1, -1, 1\}$

- we take two arrays, where ith index of dx array will correspond to change in x and ith index of dy will correspond to change in y to get ith neighbor

Directional Array

Array to hold dx and dy so we can add the corresponding values to current cell value and get the neighbors.

• x = row-axis
• y = col-axis

adjacent cell co-ordinate	change in x (dx)	change in y (dy)
Top (1, 2)	-1	0
Bottom (3, 2)	+1	0
Left (2, 1)	0	-1
Right (2, 3)	0	+1
Top-Left (1, 1)	-1	-1
Top-Right (1, 3)	-1	+1
Bottom-Left (3, 1)	+1	-1
Bottom-Right (3, 3)	+1	+1

dx[] = {-1, 1, 0, 0, -1, -1, 1}
dy[] = {0, 0, -1, 1, -1, 1, -1}

- we take two arrays, where ith index of dx array will correspond to change in x and ith index of dy will correspond to change in y to get ith neighbor



Directional Array

Array to hold dx and dy so we can add the corresponding values to current cell value and get the neighbors.

- x = row-axis
- y = col-axis

adjacent cell co-ordinate	change in x (dx)	change in y (dy)
Top (1, 2)	-1	0
Bottom (3, 2)	+1	0
Left (2, 1)	0	-1
Right (2, 3)	0	+1
Top-Left (1, 1)	-1	-1
Top-Right (1, 3)	-1	+1
Bottom-Left (3, 1)	+1	-1
Bottom-Right (3, 3)	+1	+1

`dx[] = {-1, 1, 0, 0, -1, -1, 1, 1}`

`dy[] = {0, 0, -1, 1, -1, 1, -1, 1}`



- we take two arrays, where ith index of dx array will correspond to change in x and ith index of dy will correspond to change in y to get ith neighbor

Directional Array

```
• x = row-axis  
• y = col-axis  
dx[] = {-1, 1, 0, 0, -1, -1, 1, 1}  
dy[] = {0, 0, -1, 1, -1, 1, -1, 1}  
  
dfs(x, y){  
    // visit x,y  
  
    // calculate neighbors  
    for (i = 0; i < 8; i++){  
        next_x = x + dx[i];  
        next_y = y + dy[i];  
  
        dfs(next_x, next_y);  
    }  
}
```

Directional Array

- x = row-axis
- y = col-axis

dx[] = {-1, 1, 0, 0,
dy[] = {0, 0, -1, 1,

-1, -1, 1, 1
-1, 1, -1, 1}

**side
moves**

**diagonal
moves**

- in some problems, only 4 side moves are allowed, so if we keep them in the first four indices, we can use the same directional array and iterate over first 4 indices instead of all 8

Directional Array for Knight Moves

- x = row-axis
- y = col-axis

kx[] = {1, 1, 2, 2, -1, -1, -2, -2}

ky[] = {2, -2, 1, -1, 2, -2, 1, -1}

think how it is constructed!

