



# **Developing Proof Readiness with New Logic Puzzles**

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on High School Mathematics

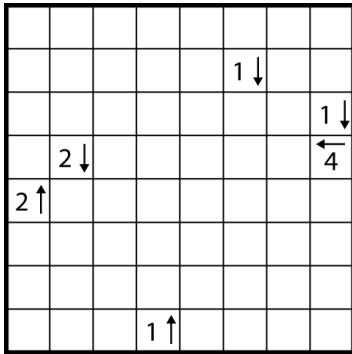
July 30, 2011  
Orlando, Florida



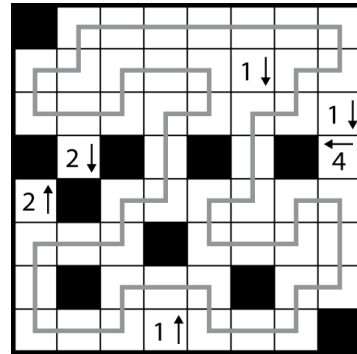
# YAJILIN

Yajilin puzzles were created by the Japanese puzzle magazine Nikoli and first appeared in 1999. The name is a contraction of *yajirushi* (directing arrow) and *rinku* (link). They have been published in English under the name Arrow Ring.

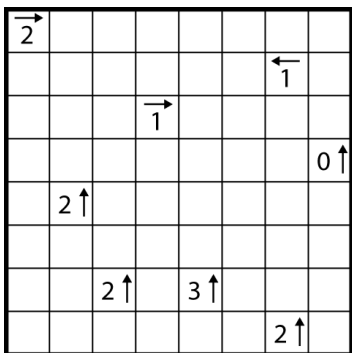
Two examples of Yajilin puzzles and their solutions are shown below. Look at the two examples and their unique solutions to determine both the goal of Yajilin and the rules that govern these puzzles.



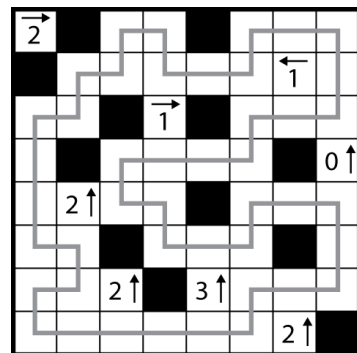
**Yajilin Example A**



**Yajilin Example A Solution**



**Yajilin Example B**



**Yajilin Example B Solution**

As you have probably already determined, the goal of a Yajilin puzzle is to create a path that is a closed loop. The rules for determining the path are:

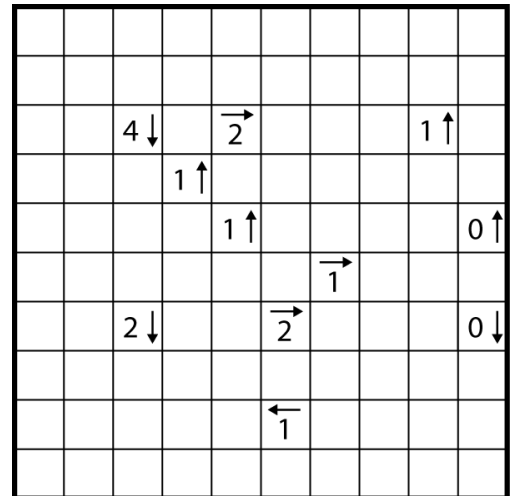
- The arrows point in the direction of the indicated number of black squares.
- A black square cannot be horizontally or vertically adjacent to another black square.
- Every square in the grid must contain either a number and arrow, a black square, or a part of the closed loop.

Using deductive and spatial reasoning you should be able to determine each puzzle's unique solution.

### Starting points

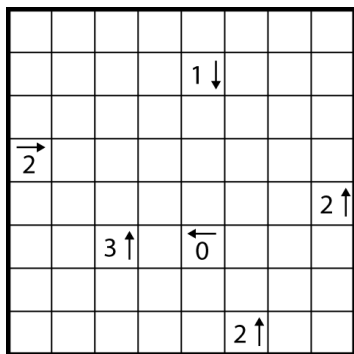
Look at the example 10x10 puzzle below. There are several starting strategies in finding the solution to this puzzle:

- *Black square placements*
  - Are there numbers that lead to only one possible placement of black squares in the direction of the indicated arrow? Keep in mind that black squares cannot be horizontally or vertically adjacent to other black squares.
  - Are there empty grid squares that cannot be part of the loop? If so, then they must be shaded black.
- *Placing the loop*
  - Are there empty grid squares that cannot contain black squares? If so, then they must be part of the loop.
  - Are there squares that must be shaded black? What do you know about the squares adjacent to the black squares in the grid?

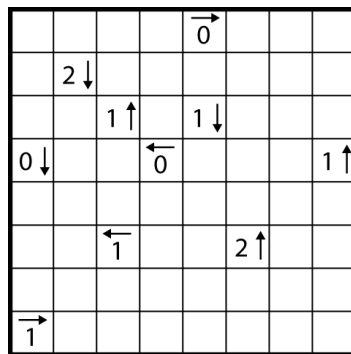


**Yajilin Example C**

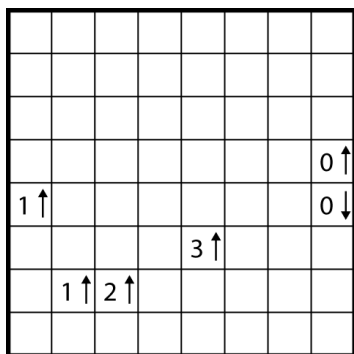
Remember that each puzzle has a unique solution and that the path must be a closed loop. These facts can often be very useful in completing a puzzle.



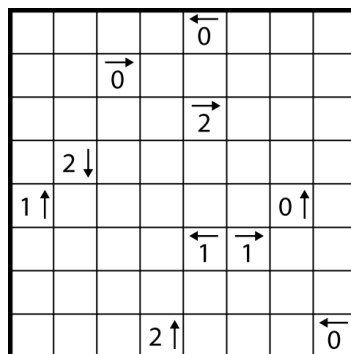
**Yajilin Puzzle 1**



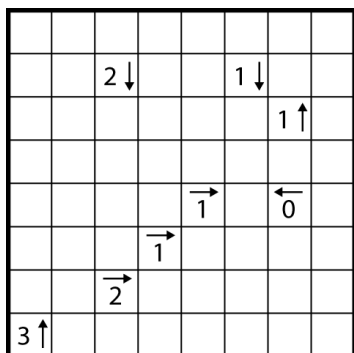
**Yajilin Puzzle 2**



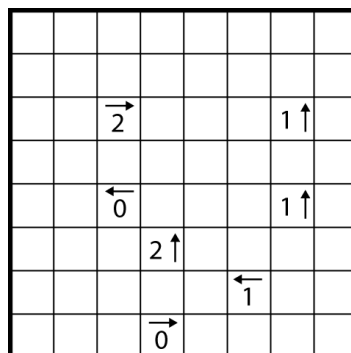
**Yajilin Puzzle 3**



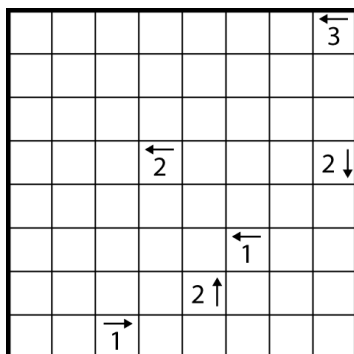
**Yajilin Puzzle 4**



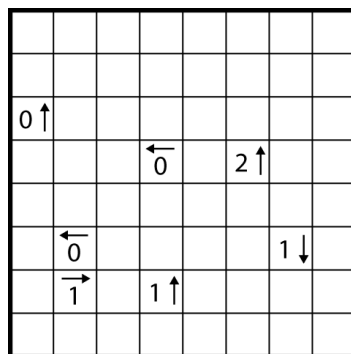
**Yajilin Puzzle 5**



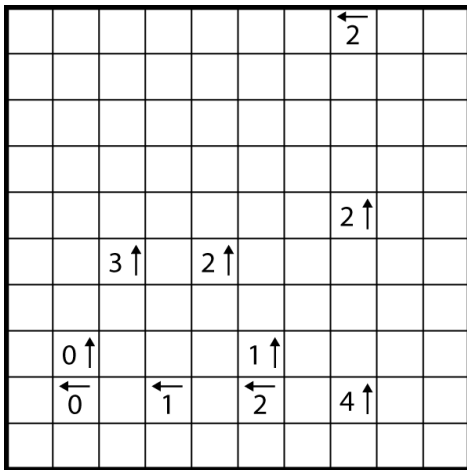
**Yajilin Puzzle 6**



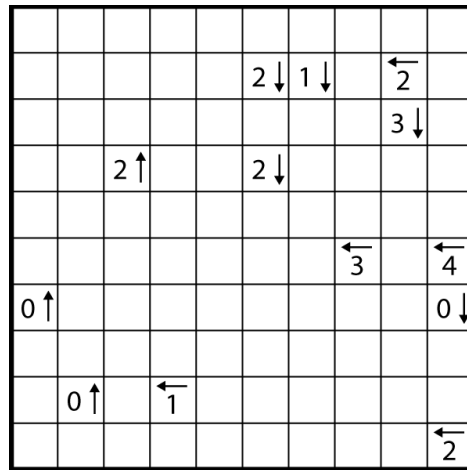
**Yajilin Puzzle 7**



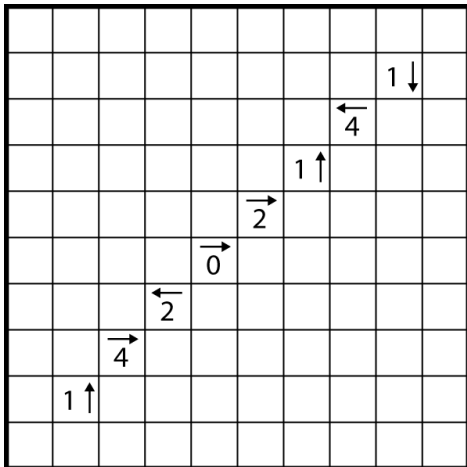
**Yajilin Puzzle 8**



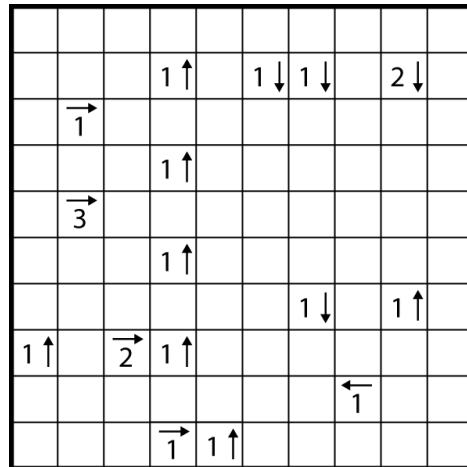
**Yajilin Puzzle 9**



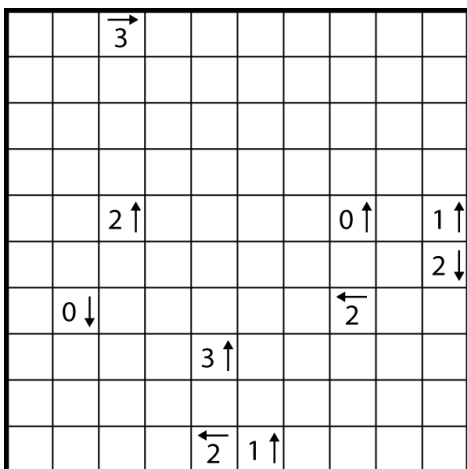
**Yajilin Puzzle 10**



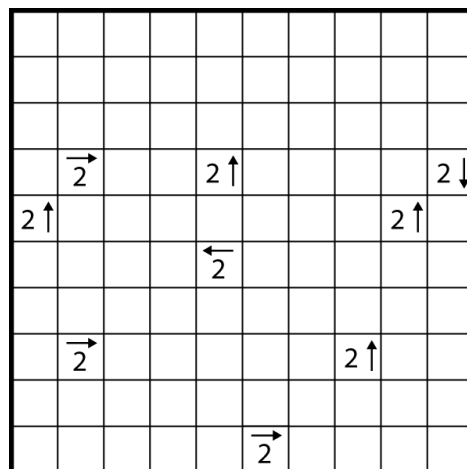
**Yajilin Puzzle 11**



**Yajilin Puzzle 12**



**Yajilin Puzzle 13**



**Yajilin Puzzle 14**

# RIPPLE EFFECT

Unlike many other logic puzzles that originated in Japan, Ripple Effect puzzles are more commonly known by an English name. They were created by the Japanese puzzle magazine *Nikoli* and first appeared in 1998.

Two examples of Ripple Effect puzzles and their solutions are shown below. Look at the two examples and their unique solutions to determine both the goal of Ripple Effect and the rules that govern these puzzles.

		3			
	2			2	
		4			
			1		
	2			2	
			4		

**Ripple Effect Example A**

2	1	3	4	1	2
1	2	1	3	2	1
3	1	4	2	1	3
1	4	2	1	3	1
4	2	3	5	2	4
1	3	1	4	1	2

**Ripple Effect Example A Solution**

			3		
			1		
					3
2					
		2			
		1			

**Ripple Effect Example B**

1	2	1	3	1	2
3	1	2	1	3	1
4	3	1	2	1	3
2	1	3	1	2	1
1	4	2	3	1	2
3	2	1	4	3	1

**Ripple Effect Example B Solution**

As you have probably already determined, the goal of a Ripple Effect puzzle is to fill each region in the grid with positive integers 1 through  $n$  (where  $n$  is the number of squares in a given region). The rules for placing the numbers are:

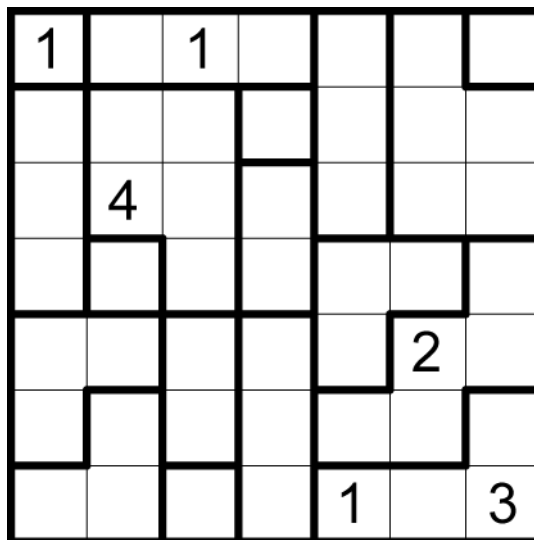
- Each number 1 through  $n$  appears exactly once in each region made up of  $n$  squares.
- If two identical numbers appear in the same row or column, at least that many cells with other numbers must separate them.

Using deductive and spatial reasoning you should be able to determine each puzzle's unique solution.

### Starting points

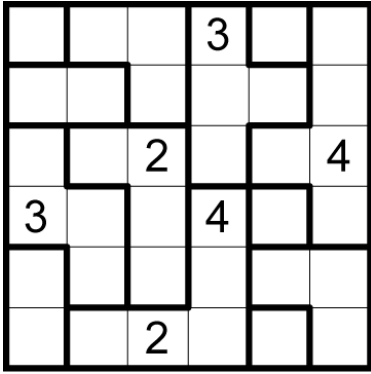
Look at the example puzzle below. There are several starting strategies in finding the solution to this puzzle:

- Single squares – What number has to go in a region with a single square?
- Eliminate location options – Find a region where a specific number could only be placed in one spot. For example, in the L-shaped region to the left and above the number 2 that is placed in this grid, what number can only be placed in one of the three squares?
- Eliminate number options – Find a square in a region where only one number could be placed. For example, in the region at the bottom right of the grid, which open square only has one number option remaining and why?

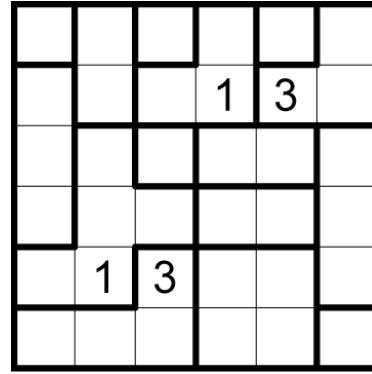


**Ripple Effect Example C**

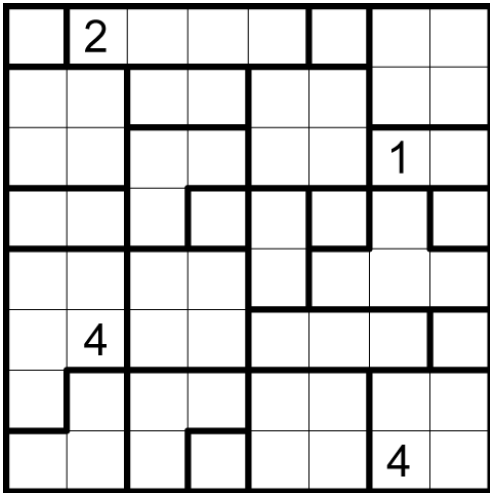
Remember that each puzzle has a unique solution. This fact can often be very useful in completing a puzzle.



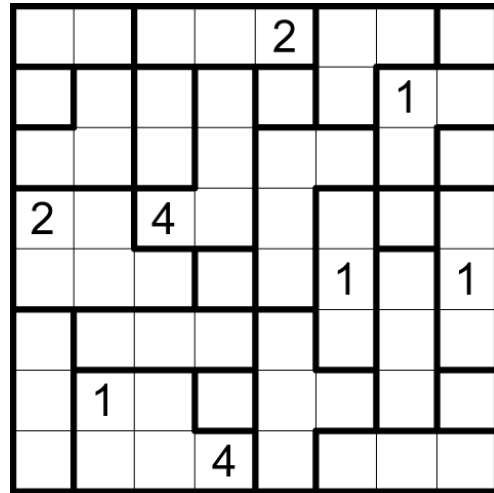
**Ripple Effect Puzzle 1**



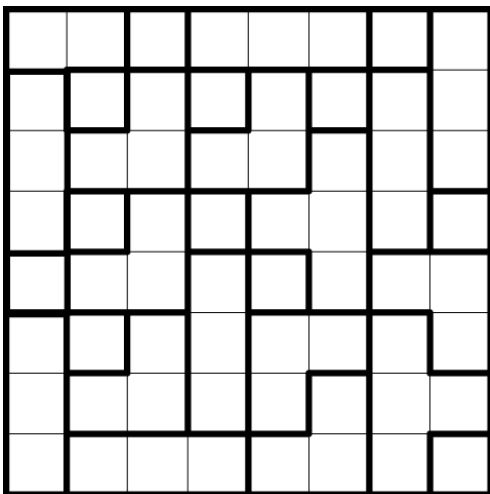
**Ripple Effect Puzzle 2**



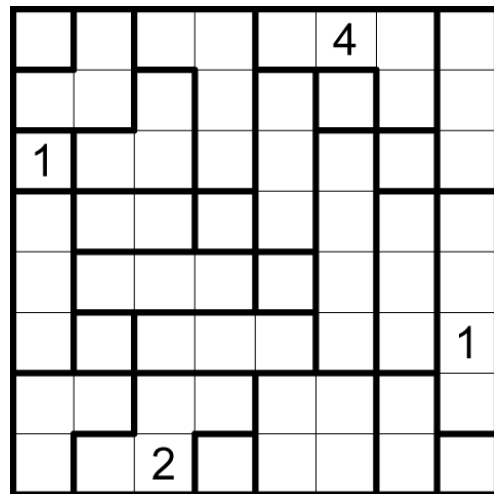
**Ripple Effect Puzzle 3**



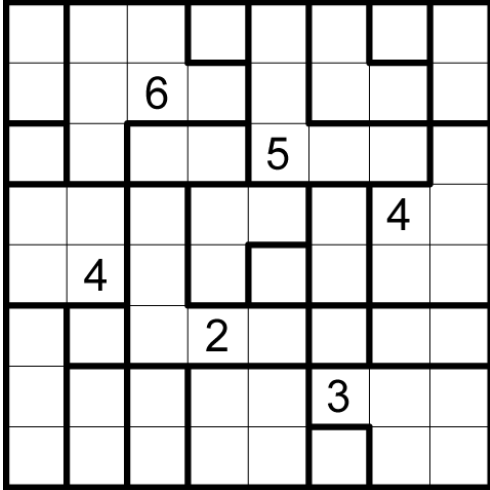
**Ripple Effect Puzzle 4**



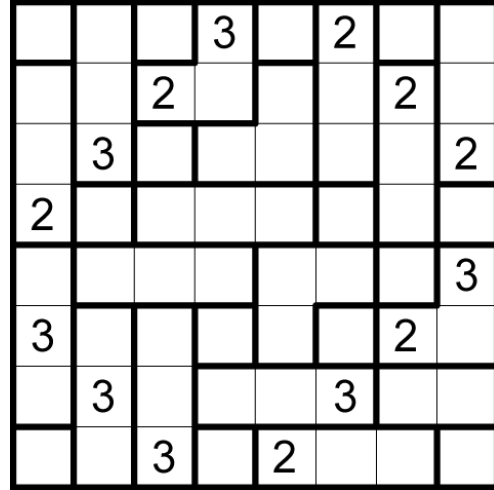
**Ripple Effect Puzzle 5**



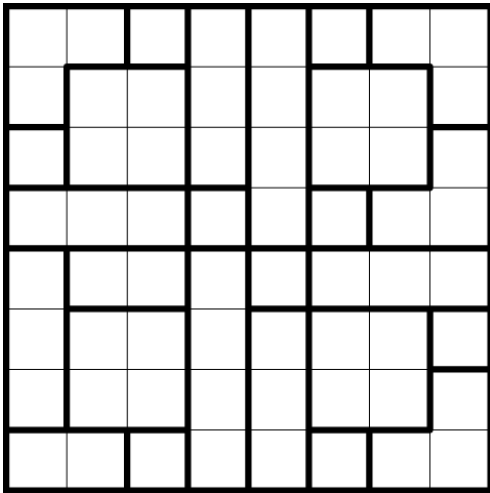
**Ripple Effect Puzzle 6**



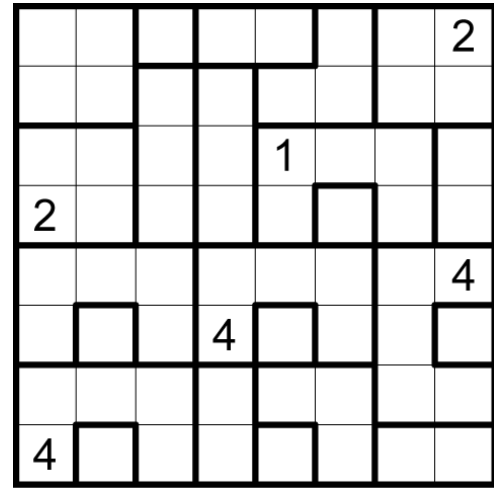
**Ripple Effect Puzzle 7**



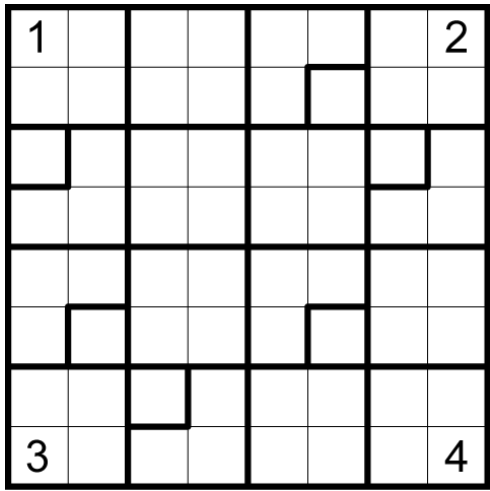
**Ripple Effect Puzzle 8**



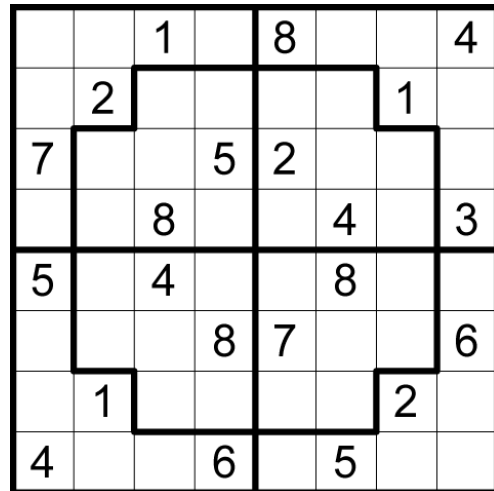
**Ripple Effect Puzzle 9**



**Ripple Effect Puzzle 10**



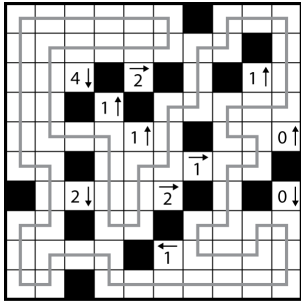
**Ripple Effect Puzzle 11**



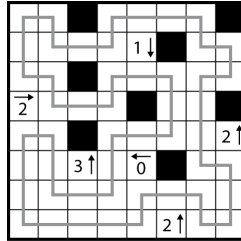
**Ripple Effect Puzzle 12**

# SOLUTIONS

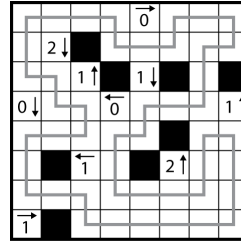
## Yajilin



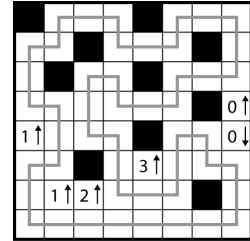
**Example C**



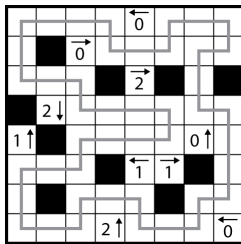
**Puzzle 1**



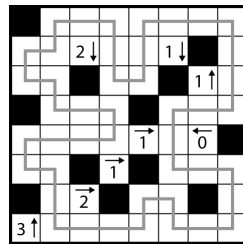
**Puzzle 2**



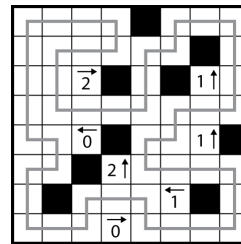
**Puzzle 3**



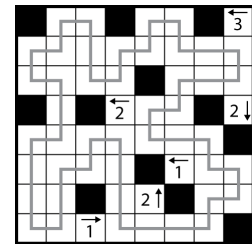
**Puzzle 4**



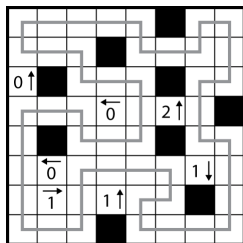
**Puzzle 5**



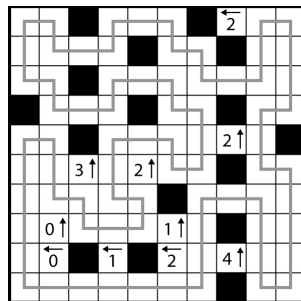
**Puzzle 6**



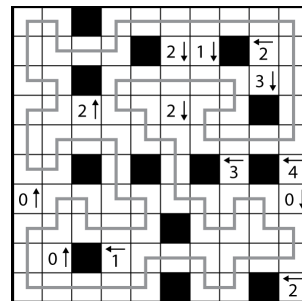
**Puzzle 7**



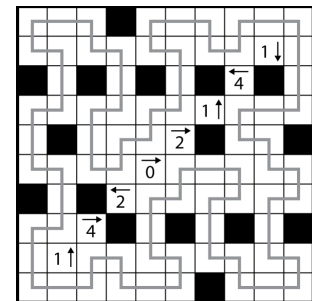
**Puzzle 8**



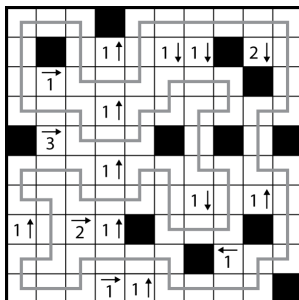
**Puzzle 9**



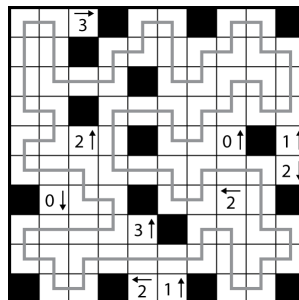
**Puzzle 10**



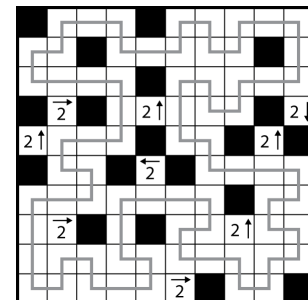
**Puzzle 11**



**Puzzle 12**



**Puzzle 13**



**Puzzle 14**

# SOLUTIONS

## Ripple Effect

1	2	1	3	2	4	1
3	1	2	1	3	1	2
1	4	3	2	1	5	3
2	1	5	1	2	3	4
1	2	1	3	1	2	5
3	1	2	1	3	1	2
2	3	1	2	1	4	3

**Example C**

1	2	1	3	1	2
2	1	3	2	4	1
4	3	2	1	5	4
3	2	1	4	1	3
2	1	4	1	3	1
1	5	2	3	1	2

**Puzzle 1**

1	2	1	3	1	2
3	1	2	1	3	1
2	3	1	2	1	3
1	2	4	1	2	1
5	1	3	4	1	2
2	4	1	2	3	1

**Puzzle 2**

1	2	1	3	4	1	2	3
4	1	2	1	3	2	4	1
2	3	1	2	1	4	1	2
1	2	3	1	2	1	3	1
5	1	4	3	1	2	1	4
3	4	2	1	3	1	2	1
2	3	1	2	4	3	1	2
1	2	3	1	2	1	4	3

**Puzzle 3**

2	1	3	1	2	1	3	1
1	2	1	3	1	2	1	3
3	1	2	1	3	4	2	1
2	5	4	2	1	3	1	2
4	1	3	1	2	1	3	1
1	2	1	3	4	2	1	3
3	1	2	1	3	1	2	1
2	3	5	4	2	3	1	2

**Puzzle 4**

1	2	1	3	1	2	1	3
3	1	2	1	3	1	2	1
1	3	1	2	1	3	1	2
2	1	3	1	2	1	3	1
1	2	1	3	1	4	2	3
3	1	2	1	3	2	4	1
2	3	1	2	1	3	1	2
1	2	3	1	2	1	3	1

**Puzzle 5**

1	3	1	2	1	4	2	1
2	1	3	4	2	1	3	2
1	2	1	3	1	2	1	3
3	1	2	1	3	1	2	4
1	3	1	2	1	3	1	2
2	1	3	1	2	4	3	1
1	2	1	3	4	2	1	3
3	4	2	1	3	1	2	1

**Puzzle 6**

1	2	4	1	2	3	1	2
2	1	6	5	3	1	2	1
1	3	1	2	5	4	1	3
3	2	5	1	2	1	4	2
1	4	1	3	1	2	1	5
2	1	3	2	4	1	2	1
1	2	1	4	2	3	1	2
3	1	2	1	3	1	5	4

**Puzzle 7**

1	2	1	3	1	2	1	3
3	1	2	1	3	1	2	1
1	3	1	2	1	3	1	2
2	1	3	1	2	1	3	1
1	2	1	3	1	2	1	3
3	1	2	1	3	1	2	1
2	3	1	2	1	3	1	2
1	2	3	1	2	1	3	1

**Puzzle 8**

1	2	1	3	4	1	2	3
3	4	2	1	3	2	4	1
1	3	1	2	1	3	1	2
2	1	3	1	2	1	3	1
1	2	1	3	1	2	1	3
3	1	2	1	3	4	2	1
2	3	4	2	1	3	1	2
1	2	1	4	2	1	3	1

**Puzzle 9**

3	4	1	2	1	3	1	2
1	2	3	1	2	1	4	3
4	1	2	3	1	4	2	1
2	3	1	2	5	1	3	2
1	5	4	1	3	2	1	4
3	1	2	4	1	5	2	1
1	2	3	1	2	1	5	3
4	1	5	2	1	3	1	2

**Puzzle 10**

1	3	2	4	1	3	1	2
2	4	3	1	2	1	3	4
1	2	4	3	1	2	1	3
3	1	2	1	3	4	2	1
1	3	1	2	1	3	4	2
2	1	3	4	2	1	3	1
1	2	1	3	4	2	1	3
3	4	2	1	3	1	2	4

**Puzzle 11**

4	5	1	3	8	6	7	4
8	2	3	4	6	7	1	5
7	6	1	5	2	3	8	2
6	7	8	2	1	4	5	3
5	2	4	1	3	8	6	7
2	3	5	8	7	2	4	6
3	1	6	7	5	1	2	8
4	8	7	6	1	5	3	4

**Puzzle 12**