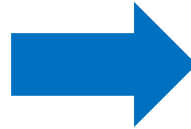


What is Sudoku?

		8	2	3		6	5	7
5	7	6			1		2	3
9	3		7	6	5	4		
7	2		6	9			3	
3	6	5			8	7	4	9
		4	5	7	3	1	6	
	5			8	7		1	6
2	1	9			6	3	7	8
6	8		3	1	2		9	



1	4	8	2	3	9	6	5	7
5	7	6	8	4	1	9	2	3
9	3	2	7	6	5	4	8	1
7	2	1	6	9	4	8	3	5
3	6	5	1	2	8	7	4	9
8	9	4	5	7	3	1	6	2
4	5	3	9	8	7	2	1	6
2	1	9	4	5	6	3	7	8
6	8	7	3	1	2	5	9	4

Fill 9x9 matrix with numbers

What is Sudoku?

1	4	8	2	3	9	6	5	7
5	7	6	8	4	1	9	2	3
9	3	2	7	6	5	4	8	1
7	2	1	6	9	4	8	3	5
3	6	5	1	2	8	7	4	9
8	9	4	5	7	3	1	6	2
4	5	3	9	8	7	2	1	6
2	1	9	4	5	6	3	7	8
6	8	7	3	1	2	5	9	4

Rules:

- Use numbers from 1-9
- Do not repeat any numbers in each horizontal line
- Do not repeat any numbers in each vertical line
- Do not repeat any numbers in each 3x3 block

Objective

		8	2	3		6	5	7
5	7	6			1		2	3
9	3		7	6	5	4		
7	2		6	9			3	
3	6	5			8	7	4	9
		4	5	7	3	1	6	
	5			8	7		1	6
2	1	9			6	3	7	8
6	8		3	1	2		9	

Image



Input



Program



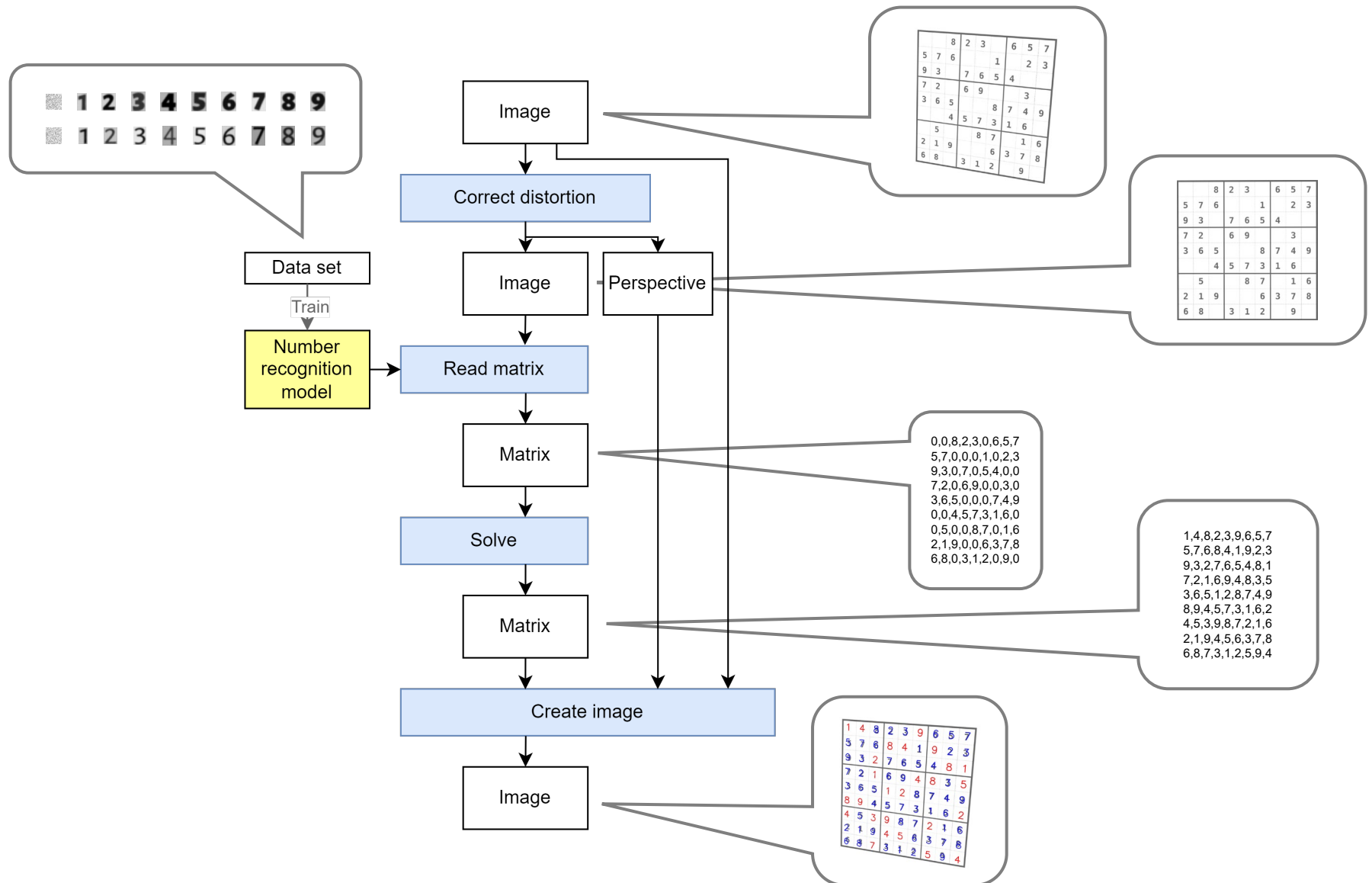
Output

1	4	8	2	3	9	6	5	7
5	7	6	8	4	1	9	2	3
9	3	2	7	6	5	4	8	1
7	2	1	6	9	4	8	3	5
3	6	5	1	2	8	7	4	9
8	9	4	5	7	3	1	6	2
4	5	3	9	8	7	2	1	6
2	1	9	4	5	6	3	7	8
6	8	7	3	1	2	5	9	4

Image

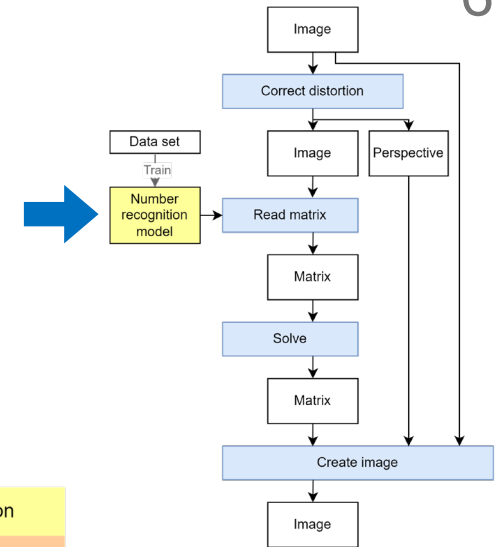
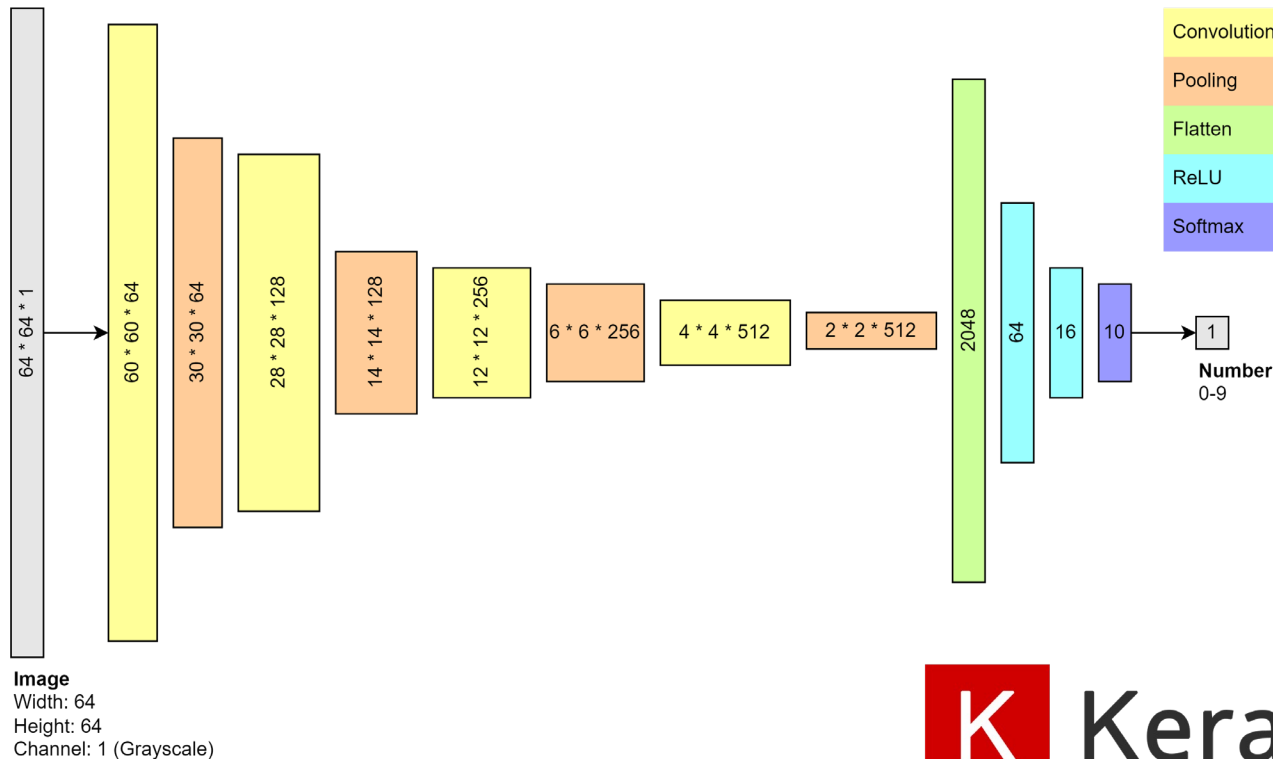
Return image of filled matrix

Architecture



Create model

- Convolutional Neural Network
Keras



Train model

- Dataset

[Kaggle: Standard Fonts Digit Dataset \(0-9\)](#)

- Data augmentation

Rotation

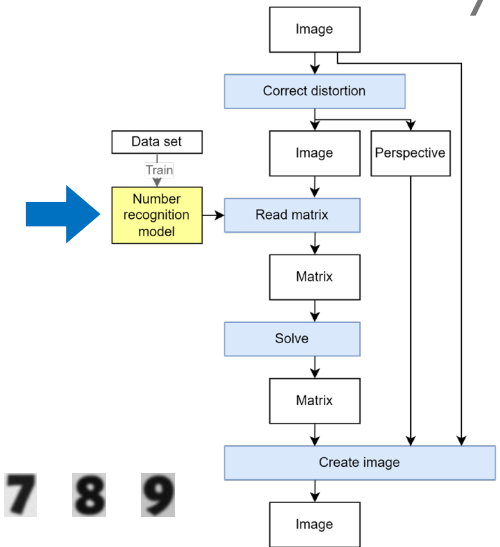
Zoom

Shift

- Preprocess image

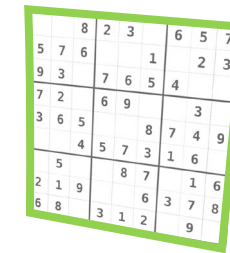
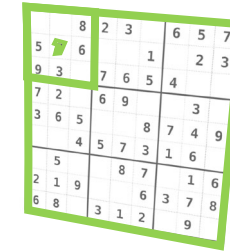
Blur

Binarization

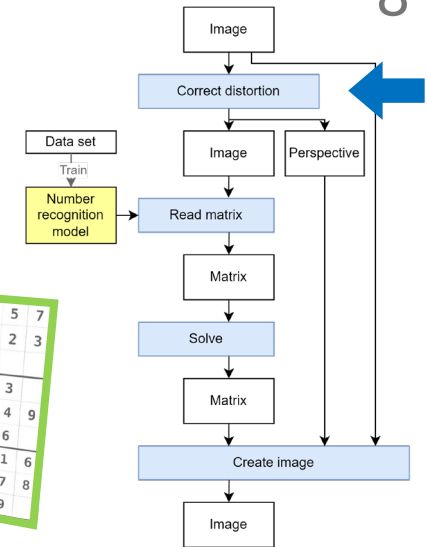


Correct distortion

- Find contours (Edge of shape)
- Find largest quadrangle
- Transform from quadrangle to square



	8	2	3	6	5	7
5	7	6		1	2	3
9	3	7	6	5	4	
7	2	6	9		3	
3	6	5		8	7	4
	4	5	7	3	1	6
	5		8	7		1
2	1	9		6	3	7
6	8	3	1	2		9



Read matrix

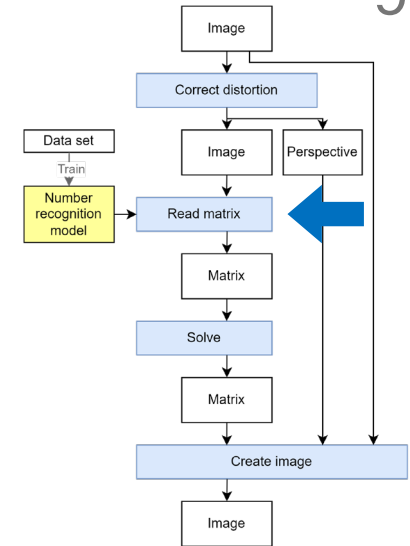
- Divide and process image

Blur

Binarization

Erode

		8	2	3		6	5	7
5	7	6			1		2	3
9	3		7	6	5	4		
7	2		6	9			3	
3	6	5			8	7	4	9
		4	5	7	3	1	6	
	5			8	7		1	6
2	1	9			6	3	7	8
6	8		3	1	2		9	

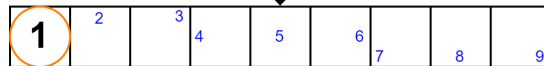
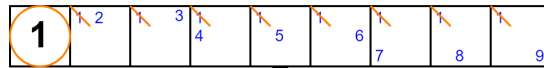


- Predict number

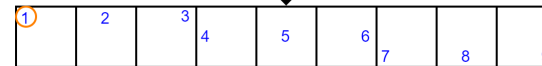
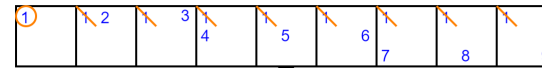
0,0,8,2,3,0,6,5,7
 5,7,0,0,0,1,0,2,3
 9,3,0,7,0,5,4,0,0
 7,2,0,6,9,0,0,3,0
 3,6,5,0,0,0,7,4,9
 0,0,4,5,7,3,1,6,0
 0,5,0,0,8,7,0,1,6
 2,1,9,0,0,6,3,7,8
 6,8,0,3,1,2,0,9,0

Solve

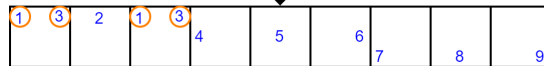
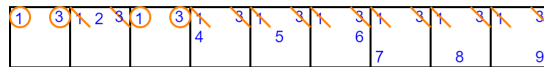
- Rule-based method



Candidates
Solved



Candidates
Solved

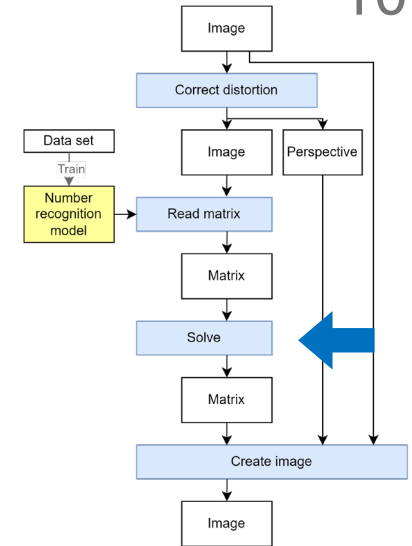


Candidates
Solved

- Contrarian law

Enter a number temporally and if the contradiction occurs, try another number

1,4,8,2,3,9,6,5,7
 5,7,6,8,4,1,9,2,3
 9,3,2,7,6,5,4,8,1
 7,2,1,6,9,4,8,3,5
 3,6,5,1,2,8,7,4,9
 8,9,4,5,7,3,1,6,2
 4,5,3,9,8,7,2,1,6
 2,1,9,4,5,6,3,7,8
 6,8,7,3,1,2,5,9,4

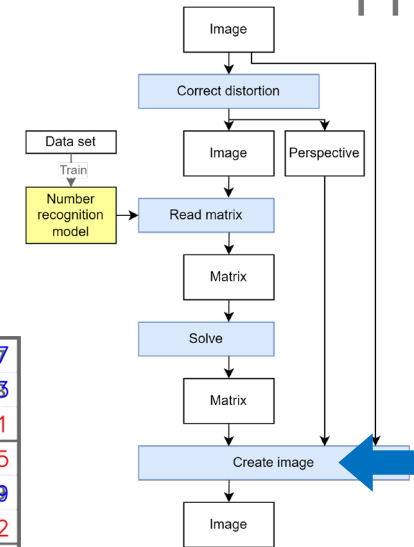


Create Image

- Draw numbers on image
- Transform from square to quadrangle

1	4	8	2	3	9	6	5	7
5	7	6	8	4	1	9	2	3
9	3	2	7	6	5	4	8	1
7	2	1	6	9	4	8	3	5
3	6	5	1	2	8	7	4	9
8	9	4	5	7	3	1	6	2
4	5	3	9	8	7	2	1	6
2	1	9	4	5	6	3	7	8
6	8	7	3	1	2	5	9	4

1	4	8	2	3	9	6	5	7
5	7	6	8	4	1	9	2	3
9	3	2	7	6	5	4	8	1
7	2	1	6	9	4	8	3	5
3	6	5	1	2	8	7	4	9
8	9	4	5	7	3	1	6	2
4	5	3	9	8	7	2	1	6
2	1	9	4	5	6	3	7	8
6	8	7	3	1	2	5	9	4



Result

		8	2	3		6	5	7
5	7	6			1		2	3
9	3		7	6	5	4		
7	2		6	9			3	
3	6	5			8	7	4	9
		4	5	7	3	1	6	
	5			8	7		1	6
2	1	9			6	3	7	8
6	8		3	1	2		9	

Input

1	4	8	2	3	9	6	5	7
5	7	6	8	4	1	9	2	3
9	3	2	7	6	5	4	8	1
7	2	1	6	9	4	8	3	5
3	6	5	1	2	8	7	4	9
8	9	4	5	7	3	1	6	2
4	5	3	9	8	7	2	1	6
2	1	9	4	5	6	3	7	8
6	8	7	3	1	2	5	9	4

Output

Succeeded!