IMAGE PROCESSING

NUMBER RECOGNIZER

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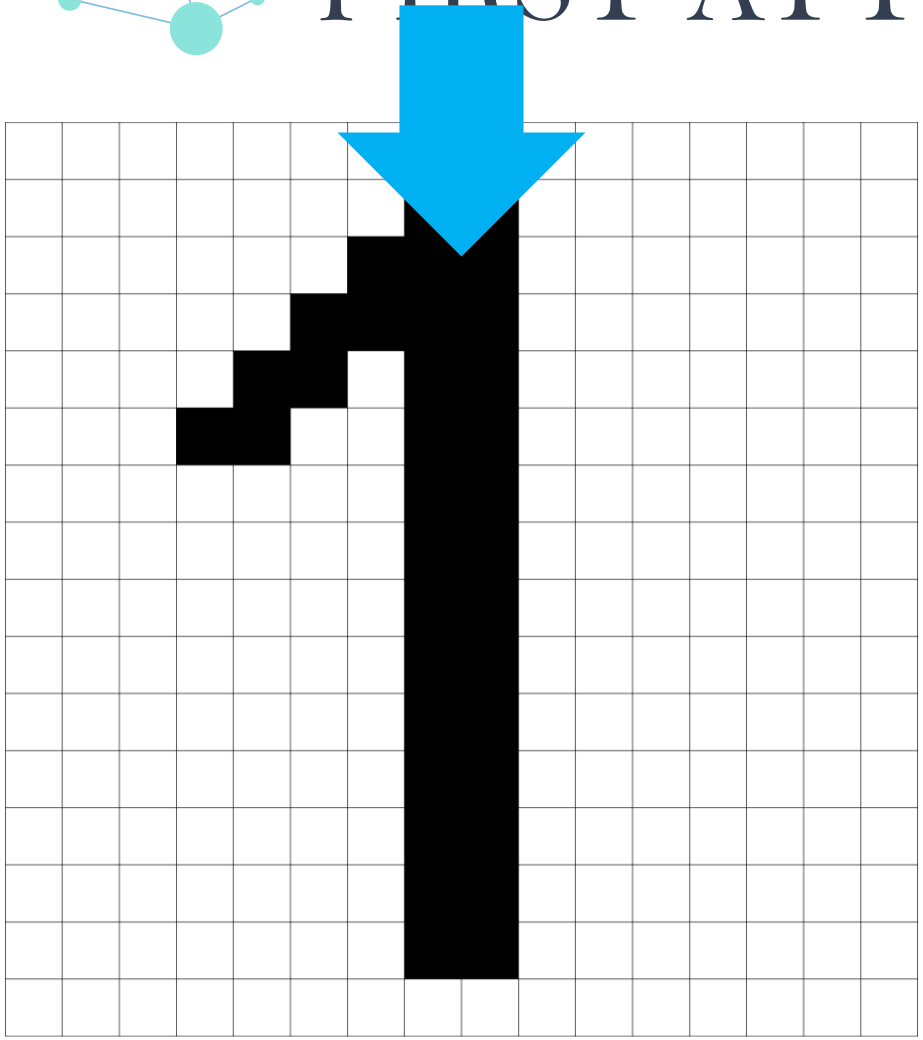
FIRST ATTEMPT



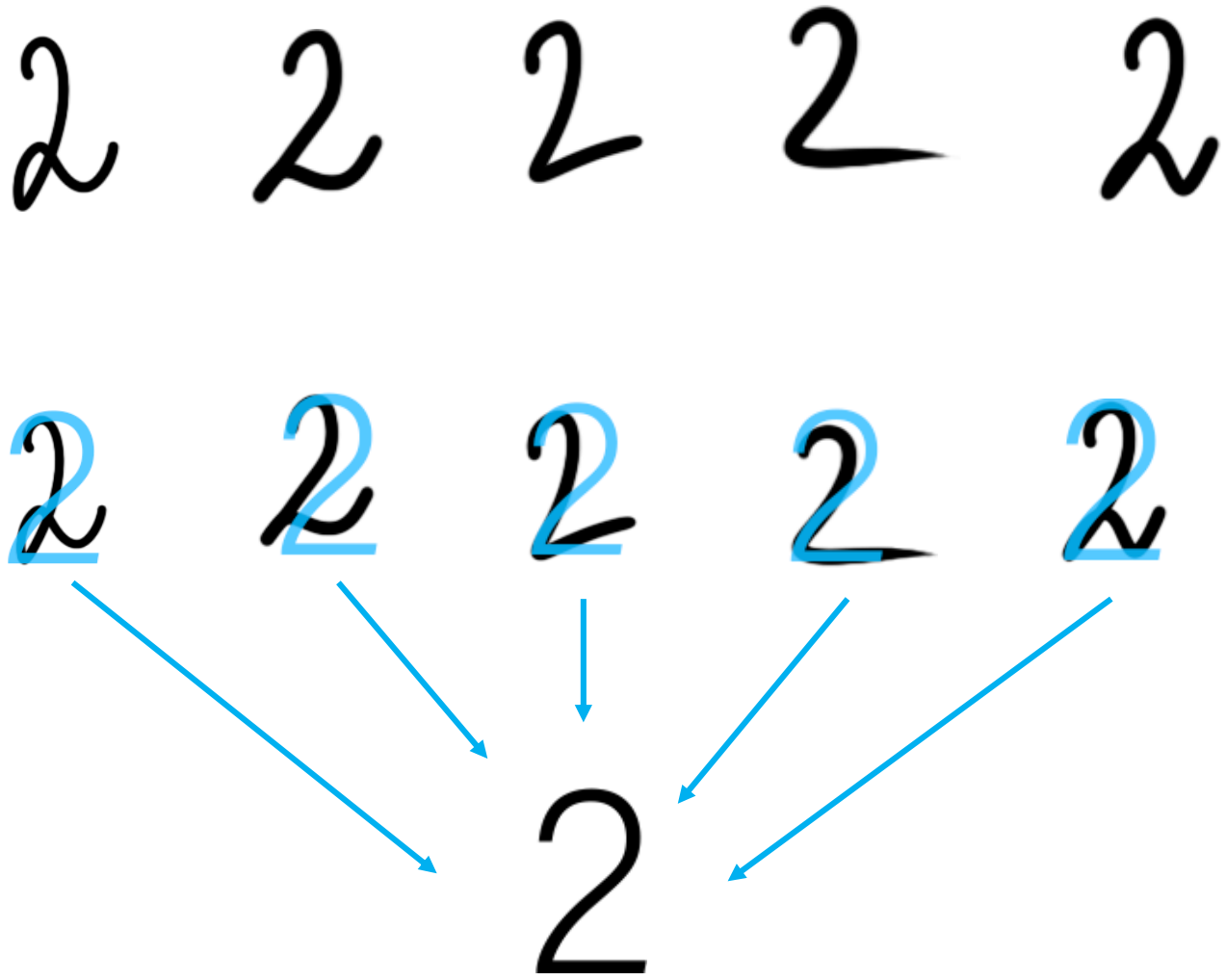
0
2
3
4
4
4
2
2
2
2
2
2
2
2
2
0

0	0	0	1	2	2	2	14	14	0	0	0	0	0	0	0

- I learned how BMP images store information
- Converted images into matrix (representing black and white by 1 and 0)
- Got information where exactly was the number (Searching area of the image)
- Pretty logical but old school idea

PATTERN

PATTERN

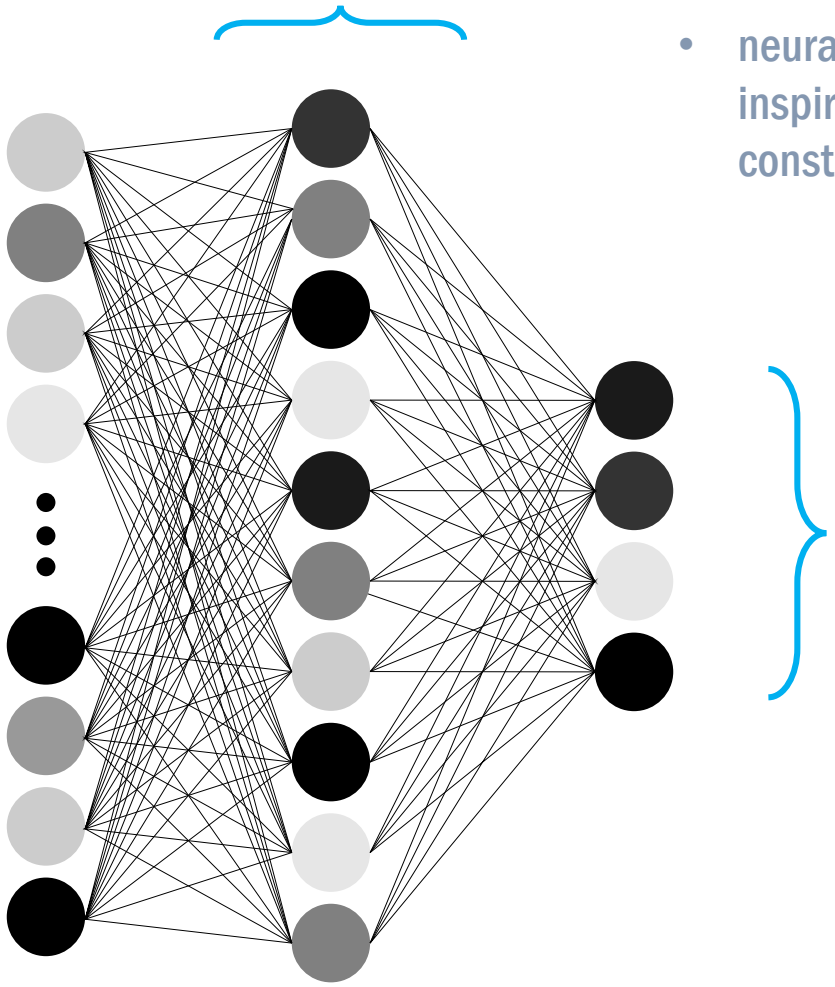


- 2 can be written several different ways
- These images' are not same pixel by pixel
- Our brain still identifies them as number "2"
- Why is that happening?

NEURAL NETWORK

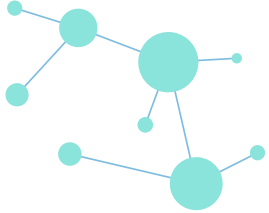
HIDDEN LAYERS

INPUT

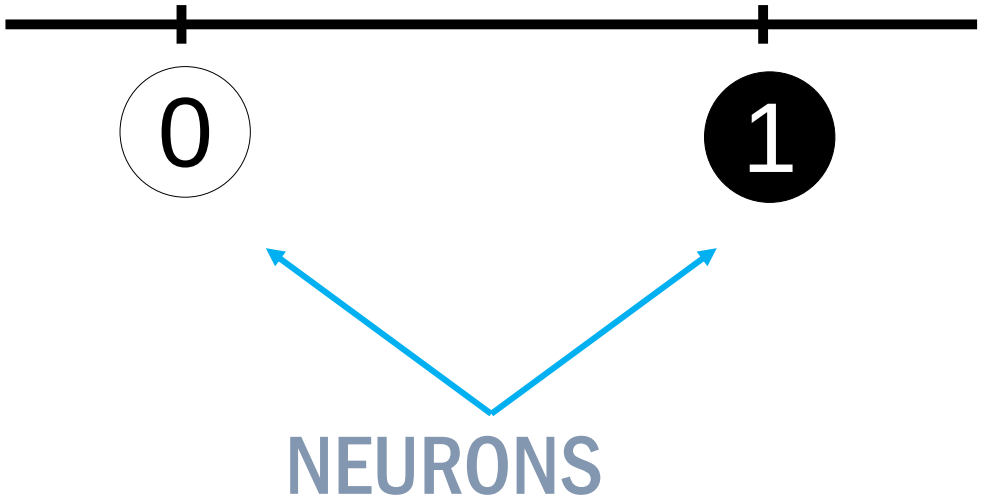


OUTPUT

- neural networks (NNs), are computing systems inspired by the biological neural networks that constitute animal brains.



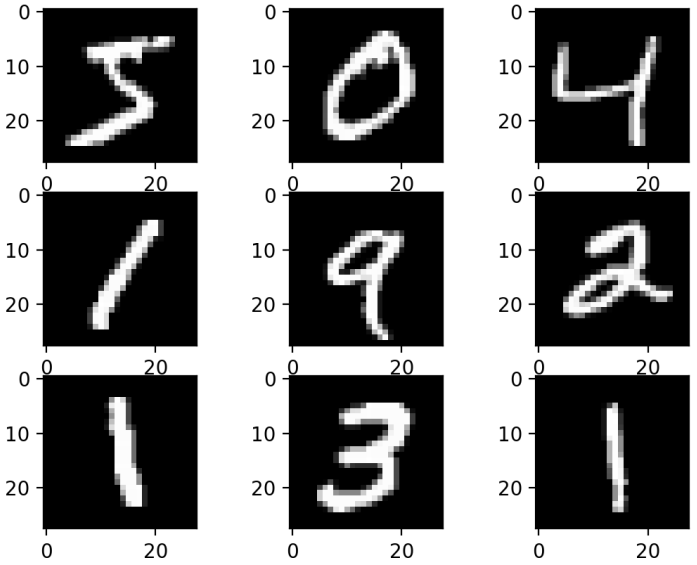
NEURAL NETWORK



- Each neuron represents number from 0 to 1
- This neurons are connected to each other
- Each neuron is connected to every neuron of previous layer
- Connections has weights

NEURAL NETWORK

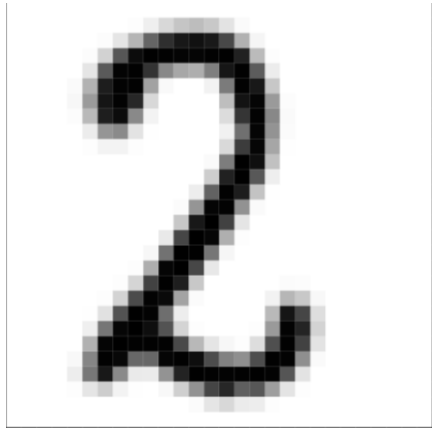
python™



- I write code in python as it is great language for machine learning
- I used MNIST database of handwritten digits
- Also I used Keras - an open-source library that provides a Python interface for artificial neural networks

Keras

WE HAVE IMAGE OF NUMBER - 2



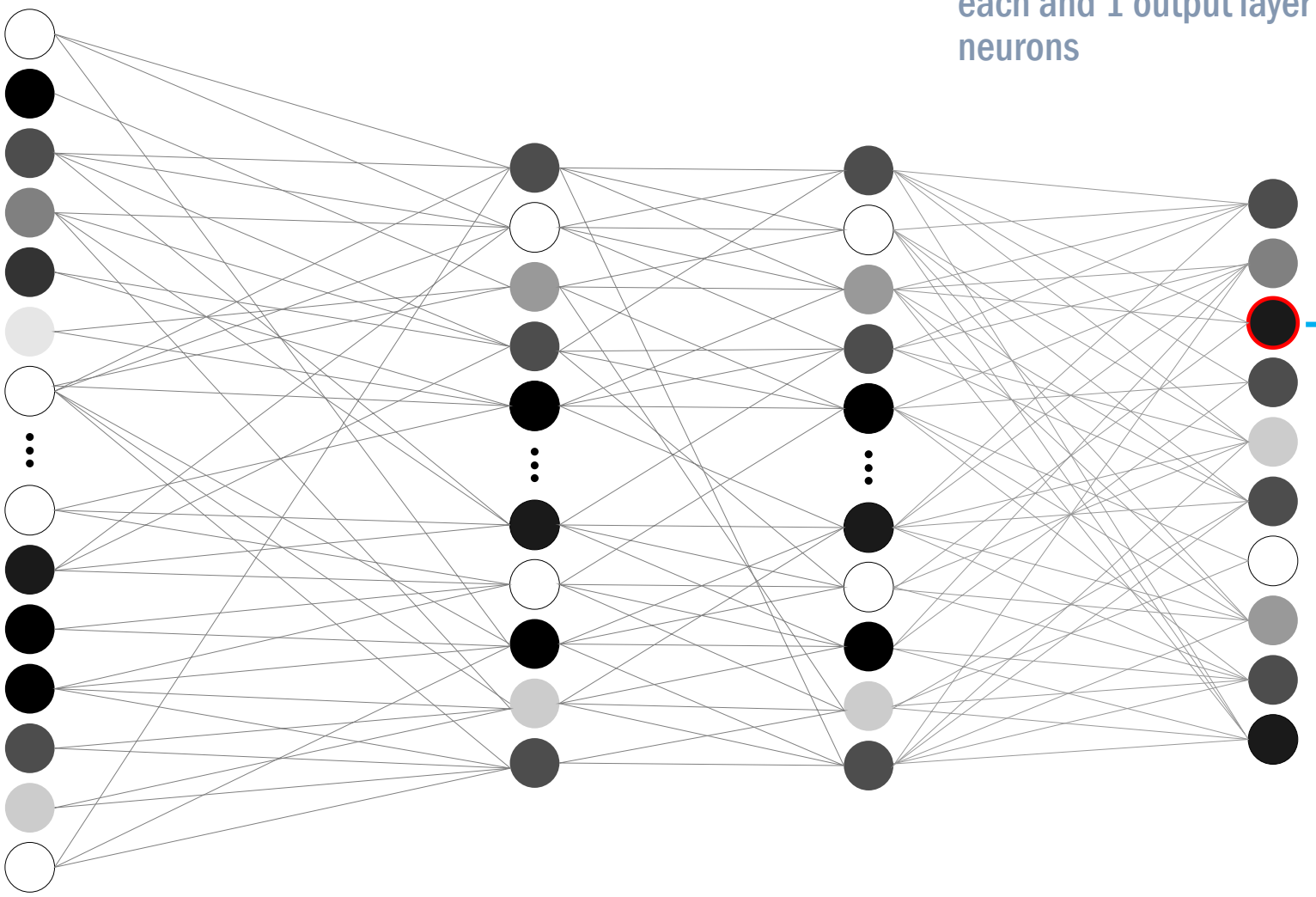
28x28

- Create matrix based on image
- each pixel will be neuron from 0 to 1 indicating on how black the pixel is.
- After we need to flatten the image so we can make one vector from it
- This vector will be input layer

NETWORK

I have created 2 layers with 64 neurons each and 1 output layer with 10 neurons

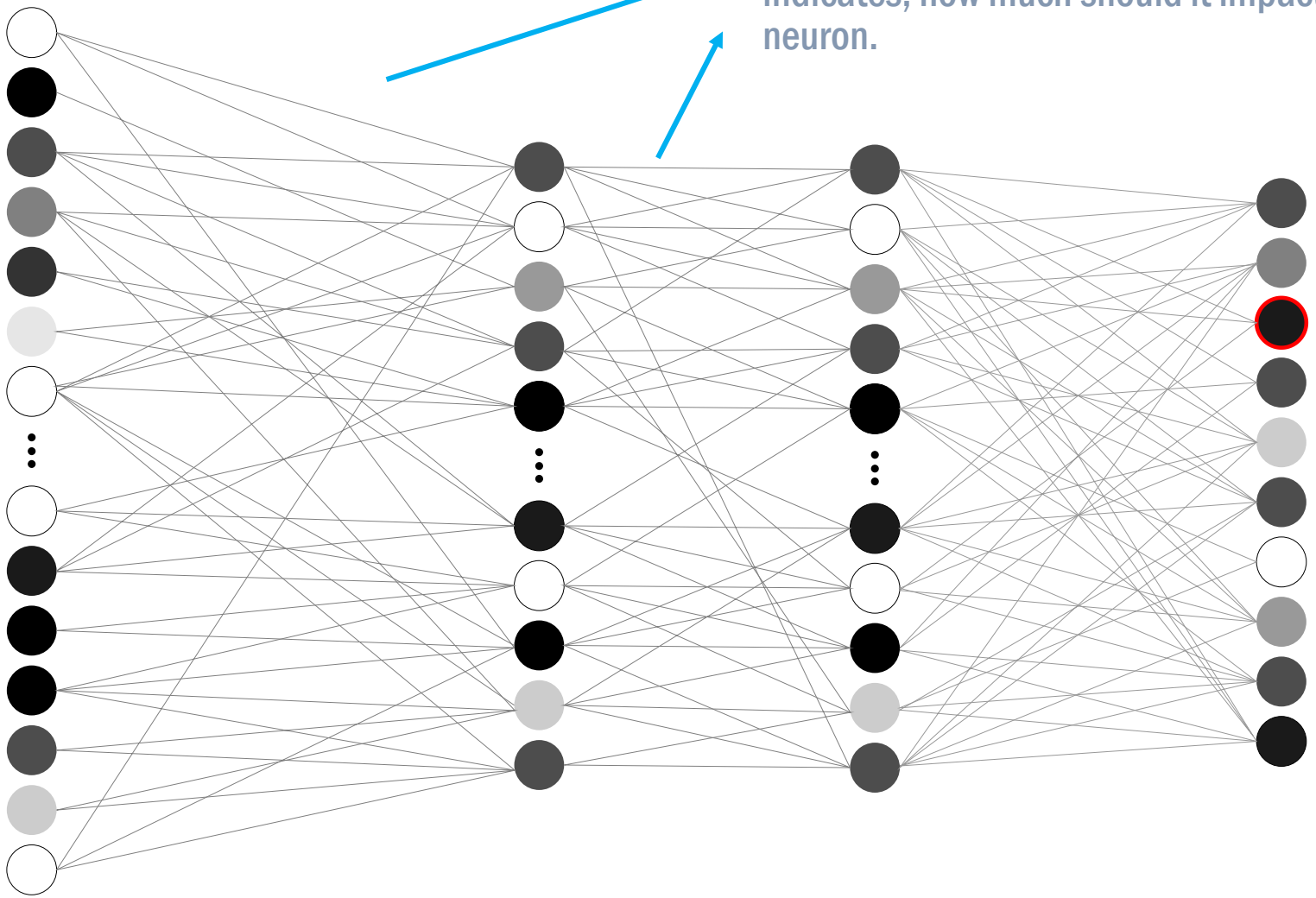
IMAGE DATA

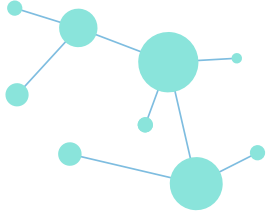


DESIRED ANSWER

TRAINING

Channels that connect neurons have weight, that indicates, how much should it impact the next neuron.





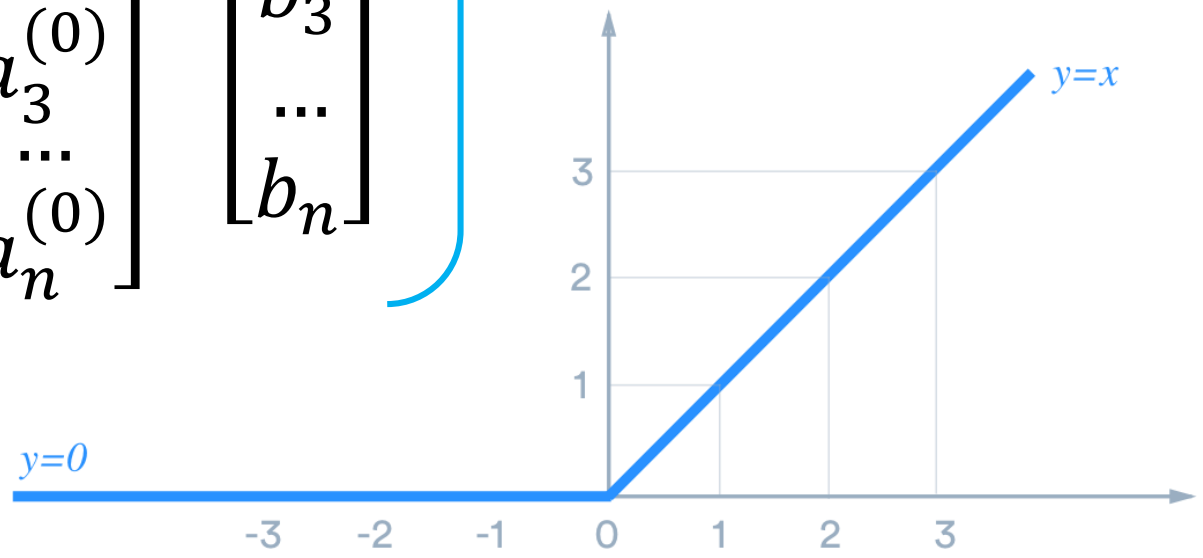
WEIGHT & BIAS

$$\sigma(x) = \frac{1}{1 + e^{-x}}$$

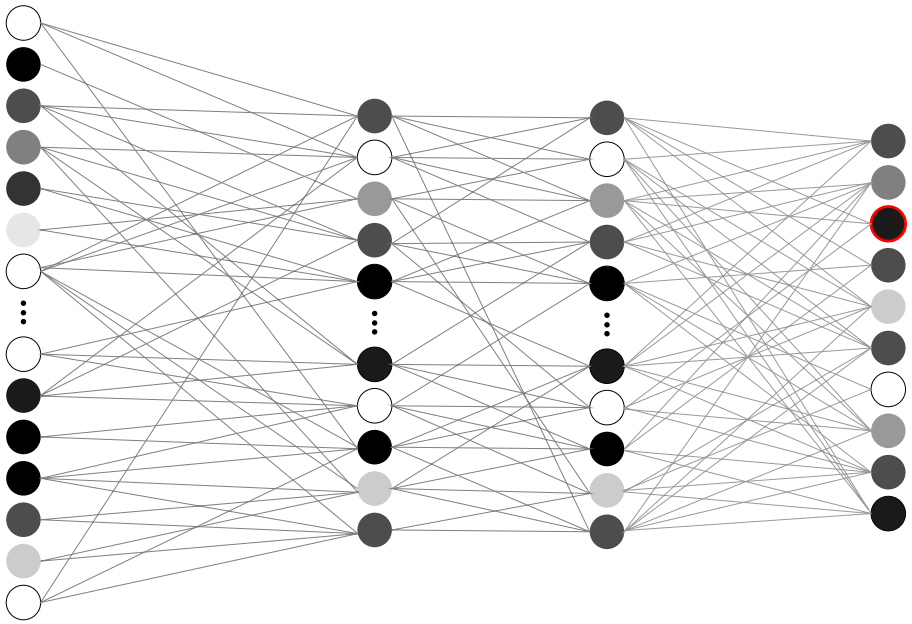
$$\sigma\left(\begin{bmatrix} w_{0,0} & w_{0,1} & \dots & w_{0,n} \\ w_{1,0} & w_{1,1} & \dots & w_{1,n} \\ w_{2,0} & w_{2,1} & \dots & w_{2,n} \\ w_{3,0} & w_{3,1} & \dots & w_{3,n} \\ & & \dots & \\ w_{k,0} & w_{k,1} & \dots & w_{k,n} \end{bmatrix} \begin{bmatrix} a_0^{(0)} \\ a_1^{(0)} \\ a_2^{(0)} \\ a_3^{(0)} \\ \dots \\ a_n^{(0)} \end{bmatrix} + \begin{bmatrix} b_0 \\ b_1 \\ b_2 \\ b_3 \\ \dots \\ b_n \end{bmatrix}\right)$$

WEIGHT & BIAS

$$ReLU\left(\begin{bmatrix} w_{0,0} & w_{0,1} & \dots & w_{0,n} \\ w_{1,0} & w_{1,1} & \dots & w_{1,n} \\ w_{2,0} & w_{2,1} & \dots & w_{2,n} \\ w_{3,0} & w_{3,1} & \dots & w_{3,n} \\ & & \dots & \\ w_{k,0} & w_{k,1} & \dots & w_{k,n} \end{bmatrix} \begin{bmatrix} a_0^{(0)} \\ a_1^{(0)} \\ a_2^{(0)} \\ a_3^{(0)} \\ \dots \\ a_n^{(0)} \end{bmatrix} + \begin{bmatrix} b_0 \\ b_1 \\ b_2 \\ b_3 \\ \dots \\ b_n \end{bmatrix}\right)$$

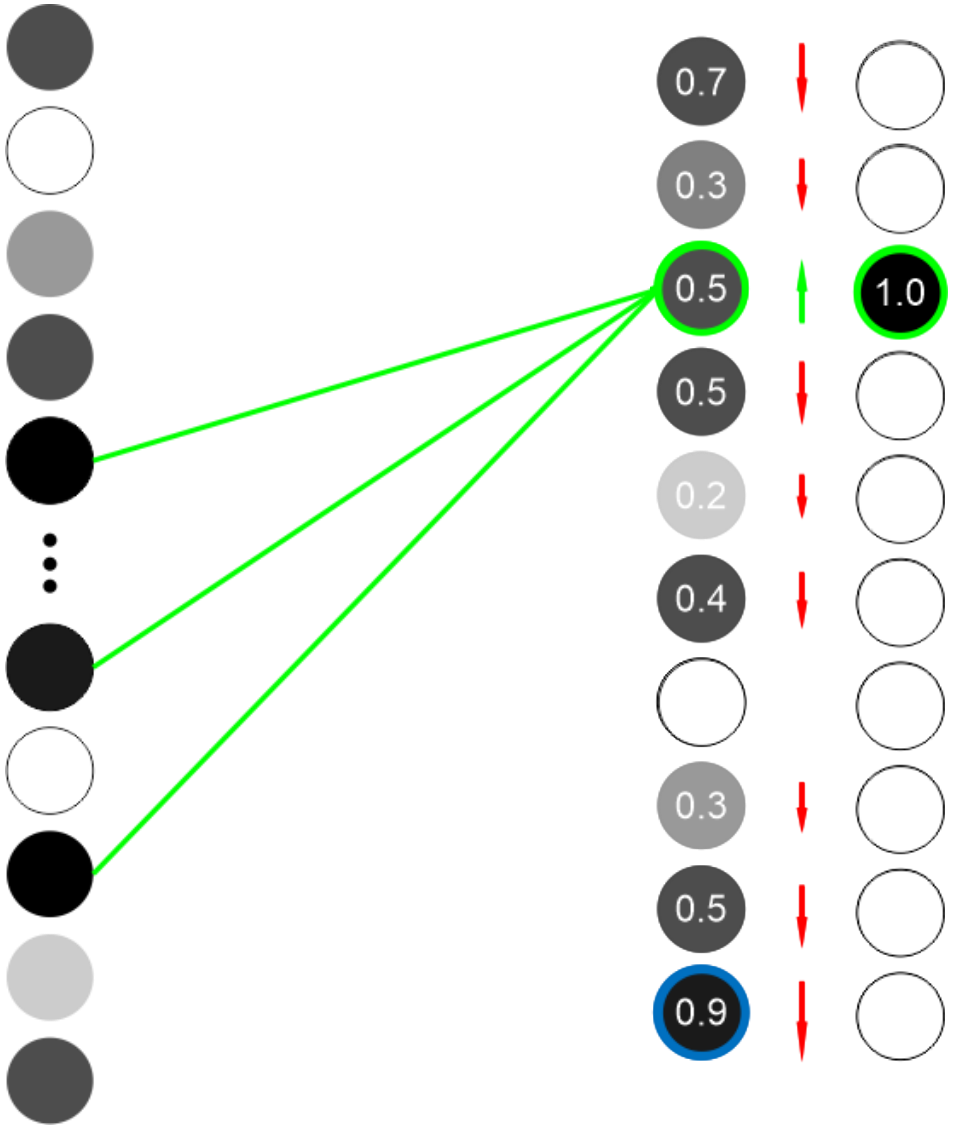


IF PROGRAM PREDICTS WRONG



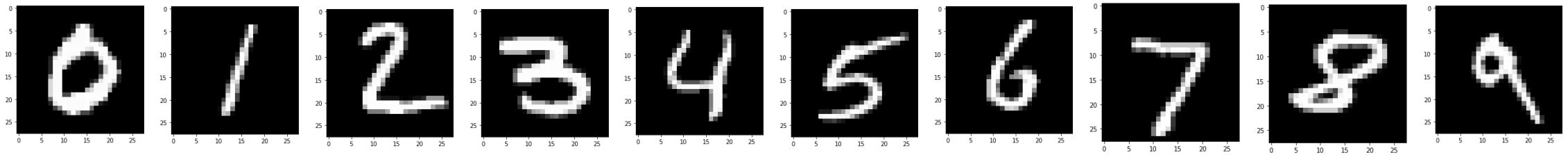
- At the training program has not only test images also **right answers**
- When prediction is wrong, it knows what output should be in that situation
- The process of neural network learning is called back propagation
- Computer sees which neuron needs to be higher which should be lower and adjusts that
- Change impact other neurons so and all these changes are averaged

TRAINING PROCESS



RESULTS

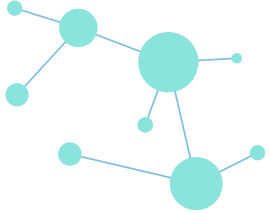
IMAGES



RESULTS / LABELS

[0 1 2 3 4 5 6 7 8 9]

[0 1 2 3 4 5 6 7 8 9]



FUTURE GOALS

- Learn more about Deep learning
- Improve my machine learning skills
- Experiments with different types of images
- Find numbers in more complex images and Identify them
- I strongly believe that machine learning will be the most powerful weapon to solve everyday human problems

THANKS FOR YOUR ATTENTION

2020

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