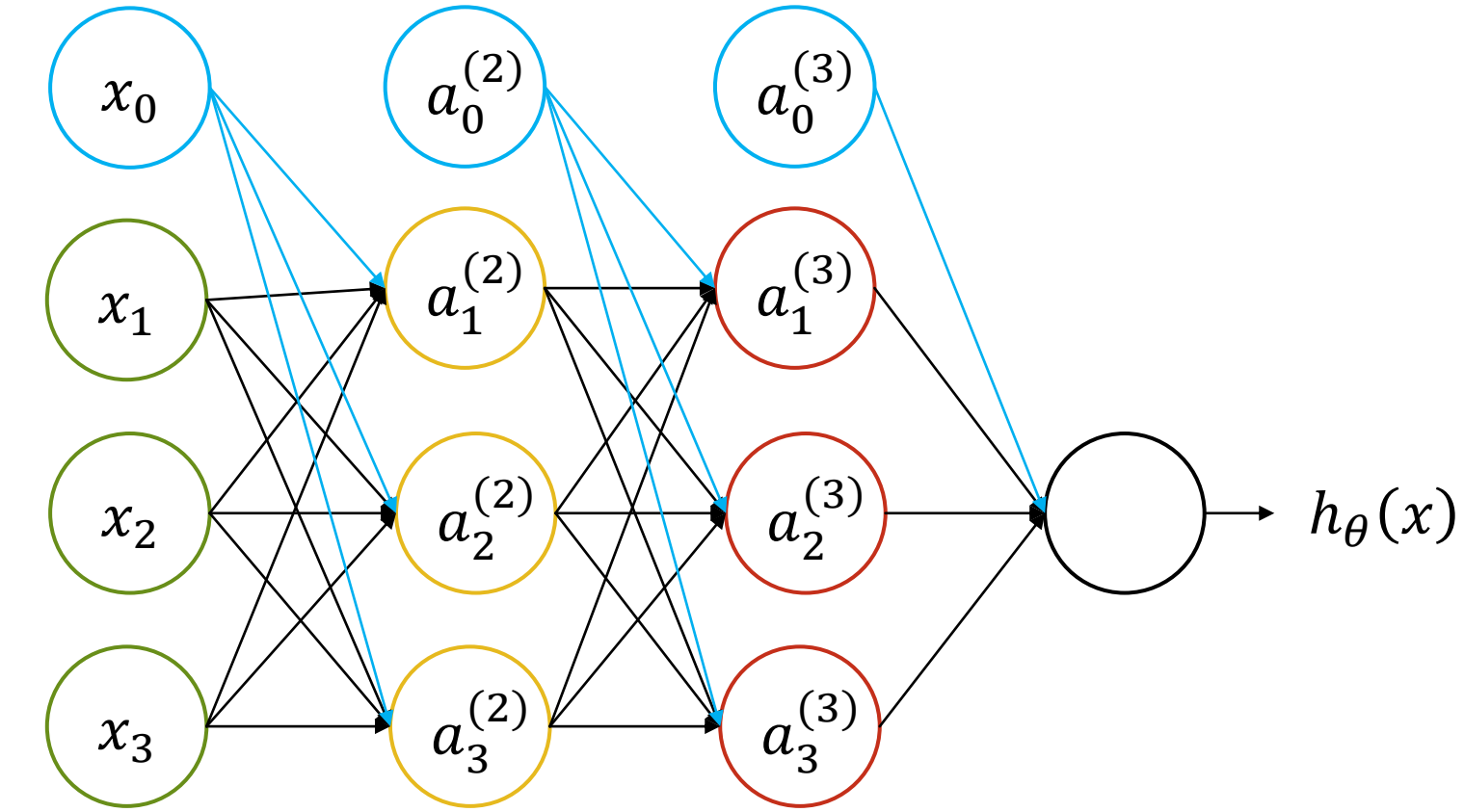
AI in Healthcare

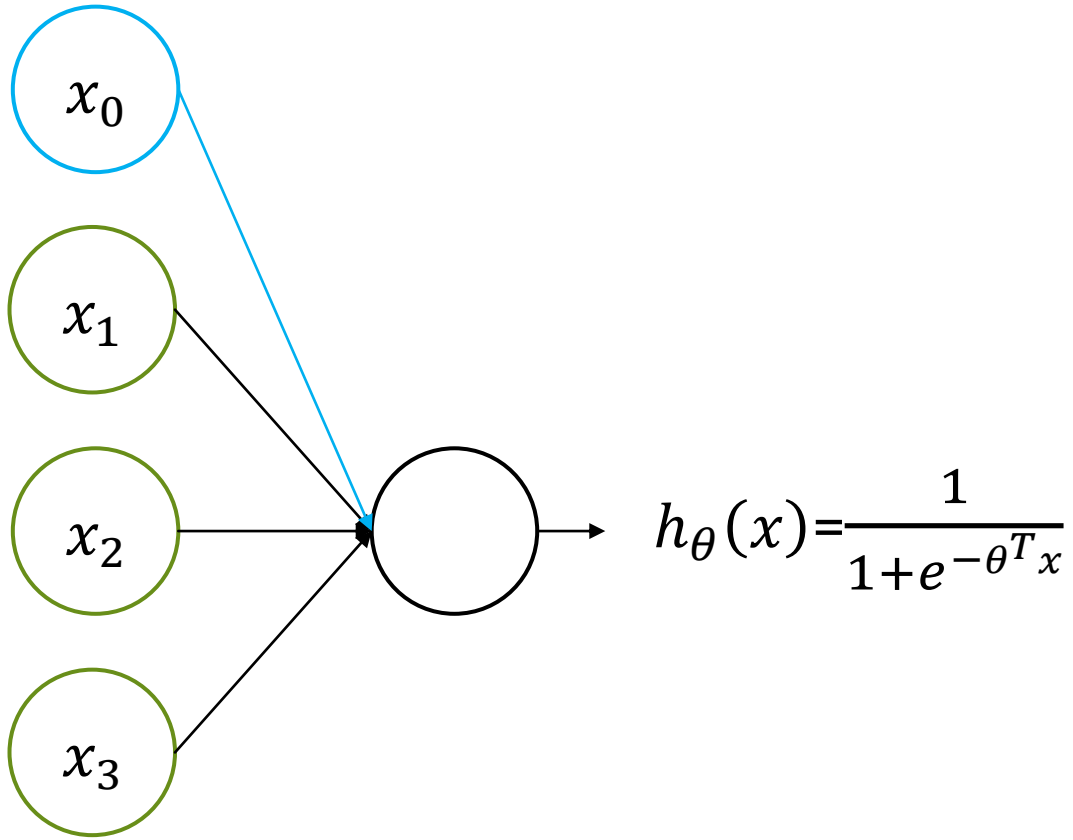
Artificial neural network

ANN Model

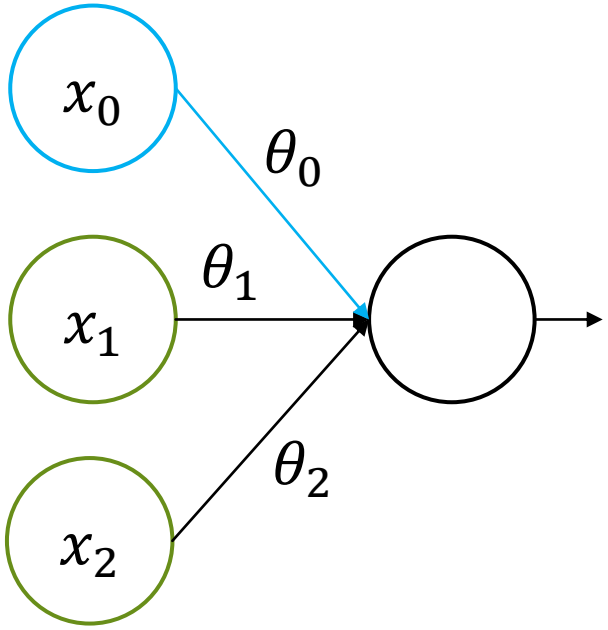

x_0
x_1
x_2
x_3
$a_0^{(2)}$
$a_1^{(2)}$
$a_2^{(2)}$
$a_3^{(2)}$
$a_0^{(3)}$
$a_1^{(3)}$
$a_2^{(3)}$
$a_3^{(3)}$
$h_\theta(x)$
Layer 1
Input layer
Layer 2
Hidden layer
Layer 3
Hidden layer
Layer 4
Output layer

ANN Model of Single Neuron

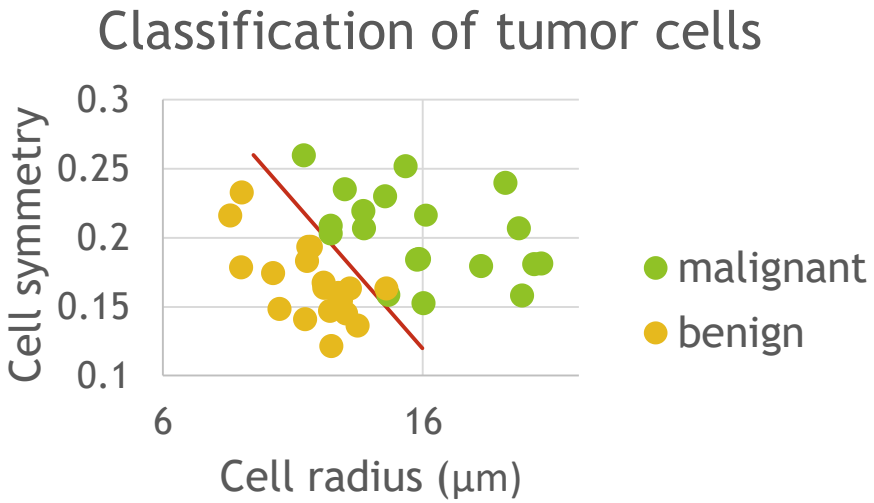
- Inputs $x = \begin{bmatrix} x_0 \\ x_1 \\ \dots \\ x_n \end{bmatrix}$
- Weights or parameters $\theta = \begin{bmatrix} \theta_0 \\ \theta_1 \\ \dots \\ \theta_n \end{bmatrix}$
- Sigmoid (logistic) activation function $g(z) = \frac{1}{1+e^{-z}}$
- The model of a single neuron is essentially logistic regression



ANN Model of Single Neuron



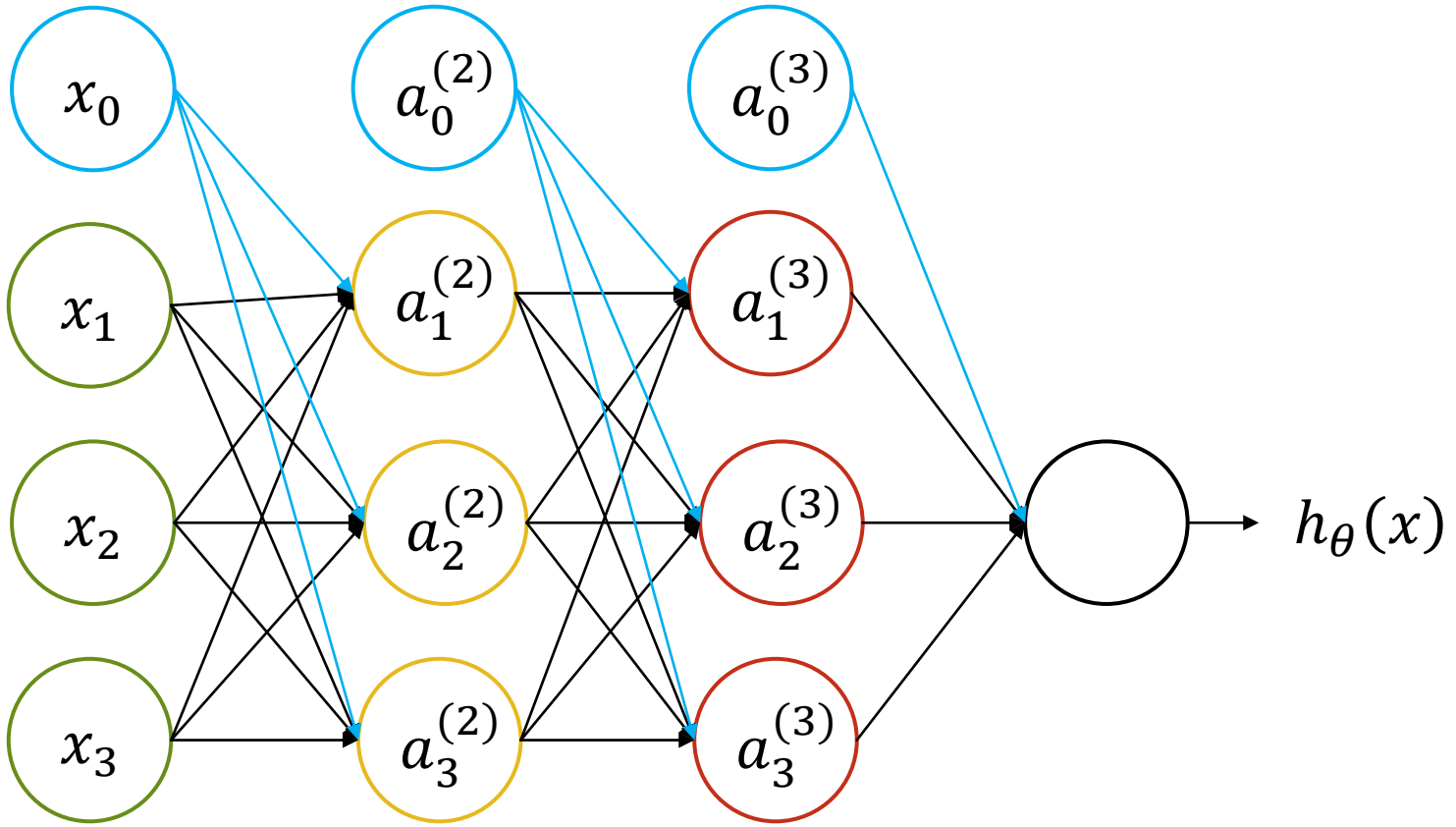
$$h_\theta(x) = \frac{1}{1 + e^{-(\theta_0 + \theta_1 x_1 + \theta_2 x_2)}}$$



ANN Model

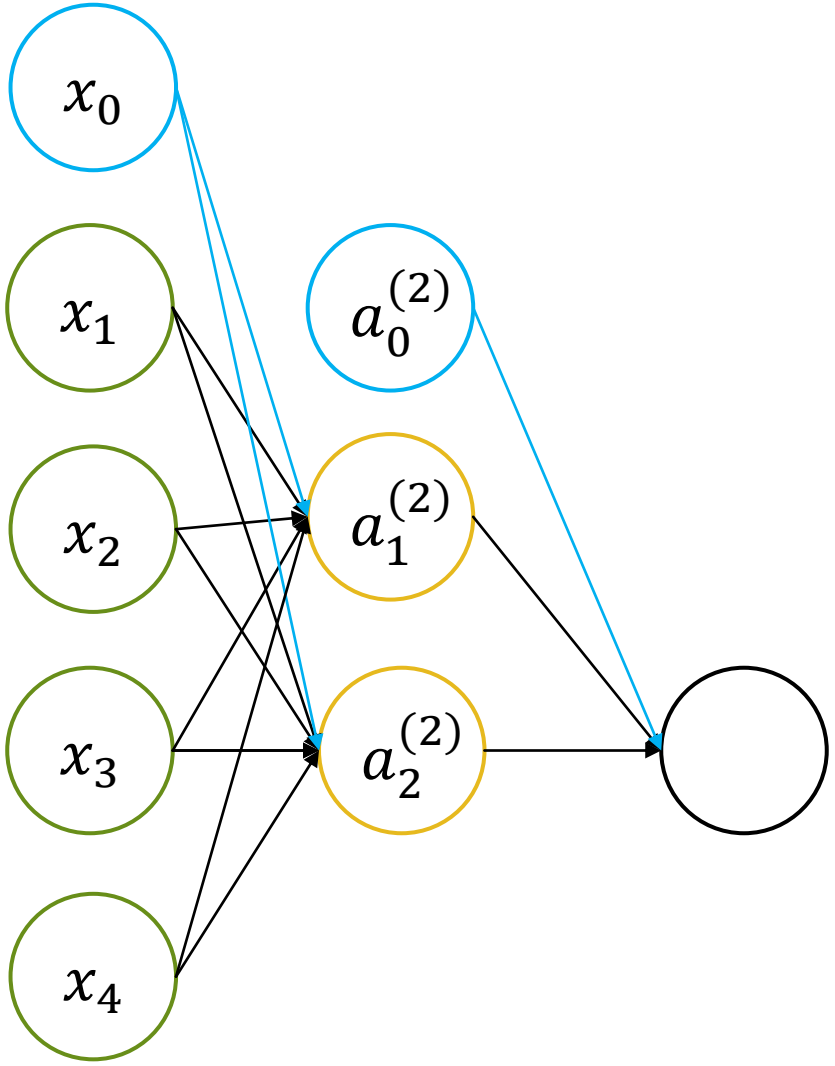
- $a_i^{(j)}$ - „activation“ of unit i in layer j
- $\Theta^{(j)}$ - matrix of weights controlling function mapping from layer j to layer j+1.
- If network has s_j units in layer j and s_{j+1} units in layer j+1, then $\Theta^{(j)}$ will have a dimension of s_{j+1}x s_j+1
- $\Theta^{(1)}$ is a 3x4 matrix. An example:

$$\Theta^{(1)} = \begin{bmatrix} 5 & 7 & 2 & 2 \\ 1 & 9 & 4 & 7 \\ 7 & 0 & 3 & 8 \end{bmatrix}$$



- $a_1^{(2)} = g\left(\Theta_{10}^{(1)} x_0 + \Theta_{11}^{(1)} x_1 + \Theta_{12}^{(1)} x_2 + \Theta_{13}^{(1)} x_3\right)$
- $a_2^{(2)} = g\left(\Theta_{20}^{(1)} x_0 + \Theta_{21}^{(1)} x_1 + \Theta_{22}^{(1)} x_2 + \Theta_{23}^{(1)} x_3\right)$
- $a_1^{(4)} = h_\theta(x) = g\left(\Theta_{10}^{(3)} a_0^{(3)} + \Theta_{11}^{(3)} a_1^{(3)} + \Theta_{12}^{(3)} a_2^{(3)} + \Theta_{13}^{(3)} a_3^{(3)}\right)$

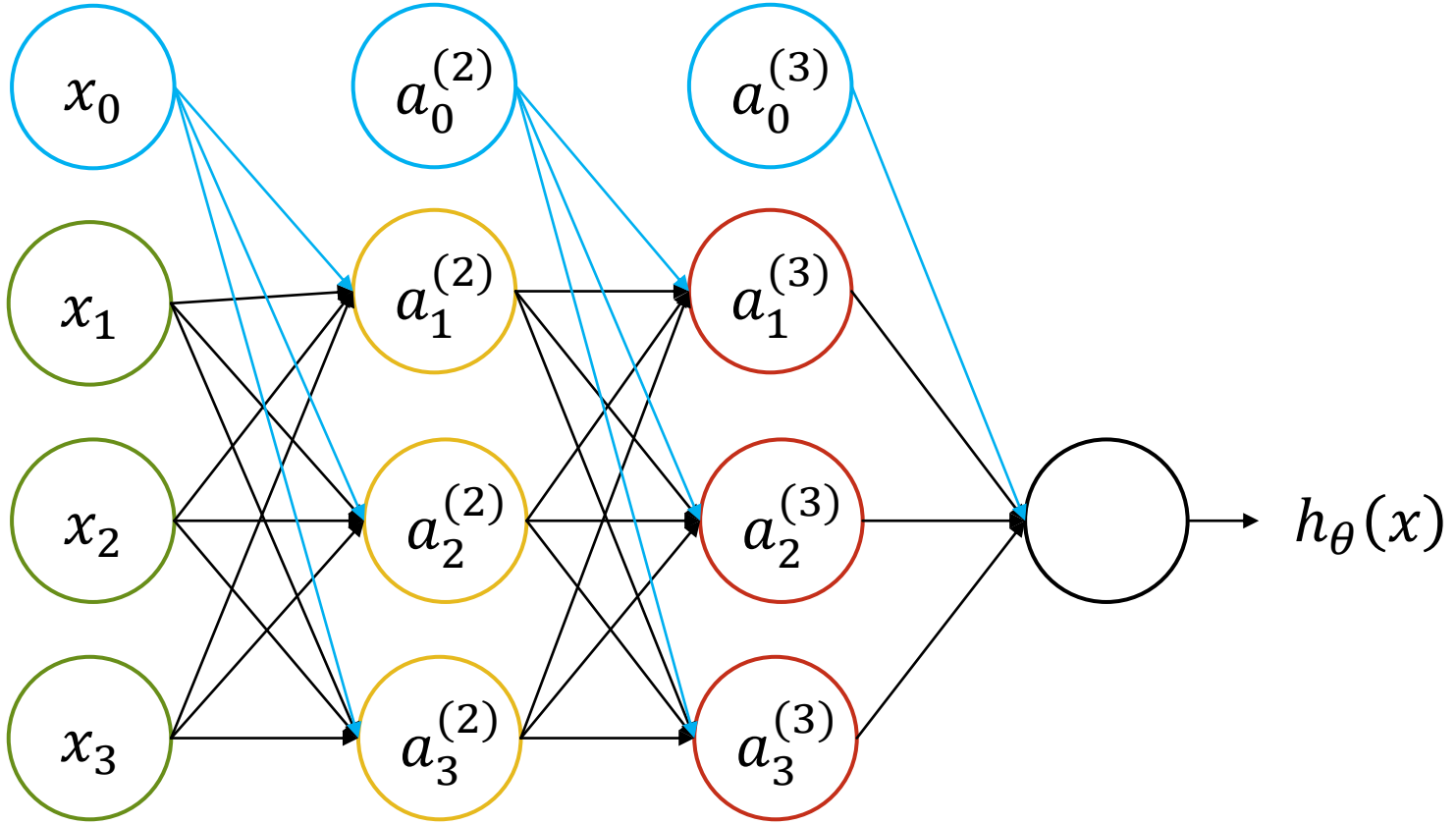
Exercise



- What is the dimension of $\Theta^{(1)}$?
  - 5x2
  - 5x3
  - 3x5
  - 2x5
- What is the dimension of $\Theta^{(2)}$?
  - 1x3
  - 1x2
  - 2x4
  - 1x4

Exercise

- How to compute $a^{(2)}$ using vectors $\Theta^{(1)}$ and $a^{(1)} = x$?
- What is the dimension of $a^{(2)}$



- $a_1^{(2)} = g\left(\Theta_{10}^{(1)} x_0 + \Theta_{11}^{(1)} x_1 + \Theta_{12}^{(1)} x_2 + \Theta_{13}^{(1)} x_3\right)$
- $a_2^{(2)} = g\left(\Theta_{20}^{(1)} x_0 + \Theta_{21}^{(1)} x_1 + \Theta_{22}^{(1)} x_2 + \Theta_{23}^{(1)} x_3\right)$
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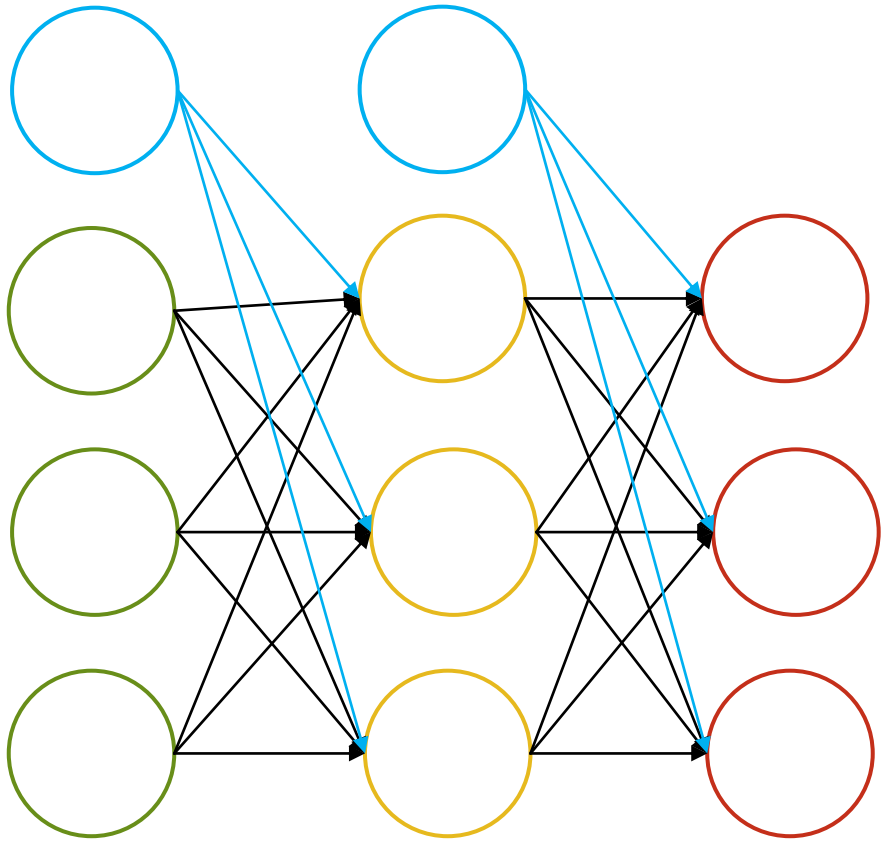
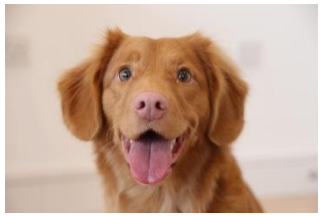
Multiple outputs (one-vs-all)

- When the output is $h_\theta(x) \approx \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$, we predict cat
- When the output is $h_\theta(x) \approx \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$, we predict dog
- When the output is $h_\theta(x) \approx \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$, we predict monkey



Cat?

Dog?



Monkey?

Exercise

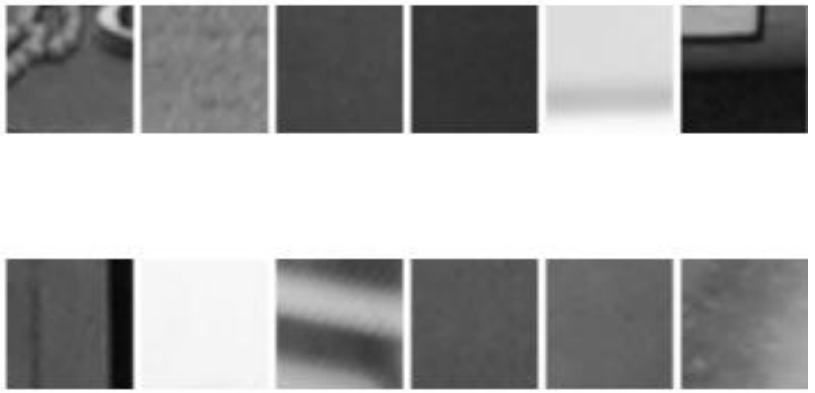
- If a neural network has overfit the data, what can we do?

Detecting objects from images

An example from Andrew Ng Coursera course „Machine Learning“

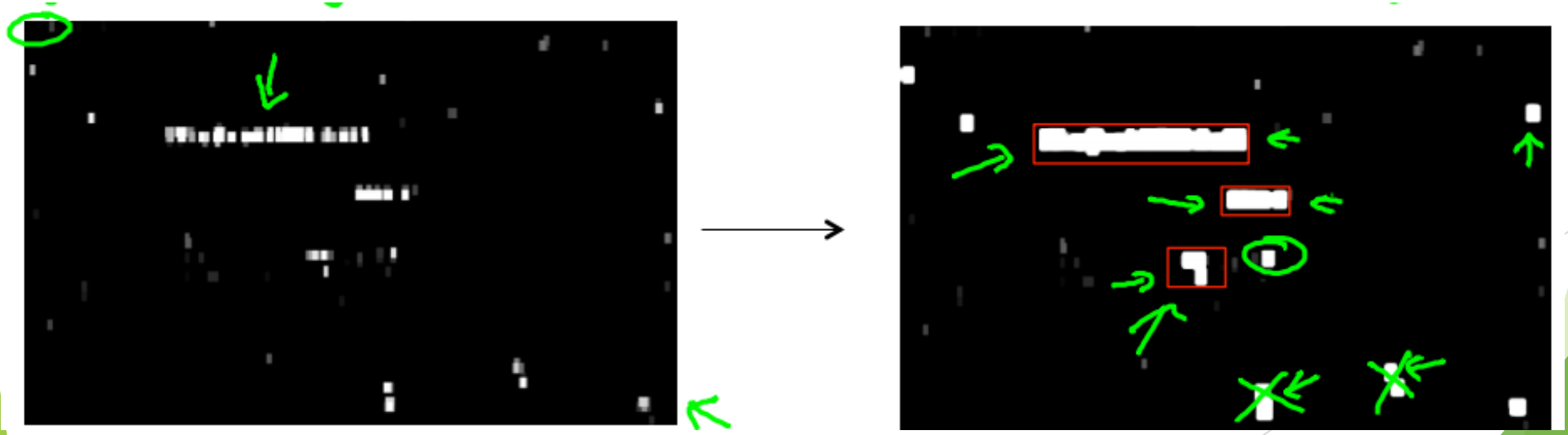
Text detection

Positive examples $(y = 1)$

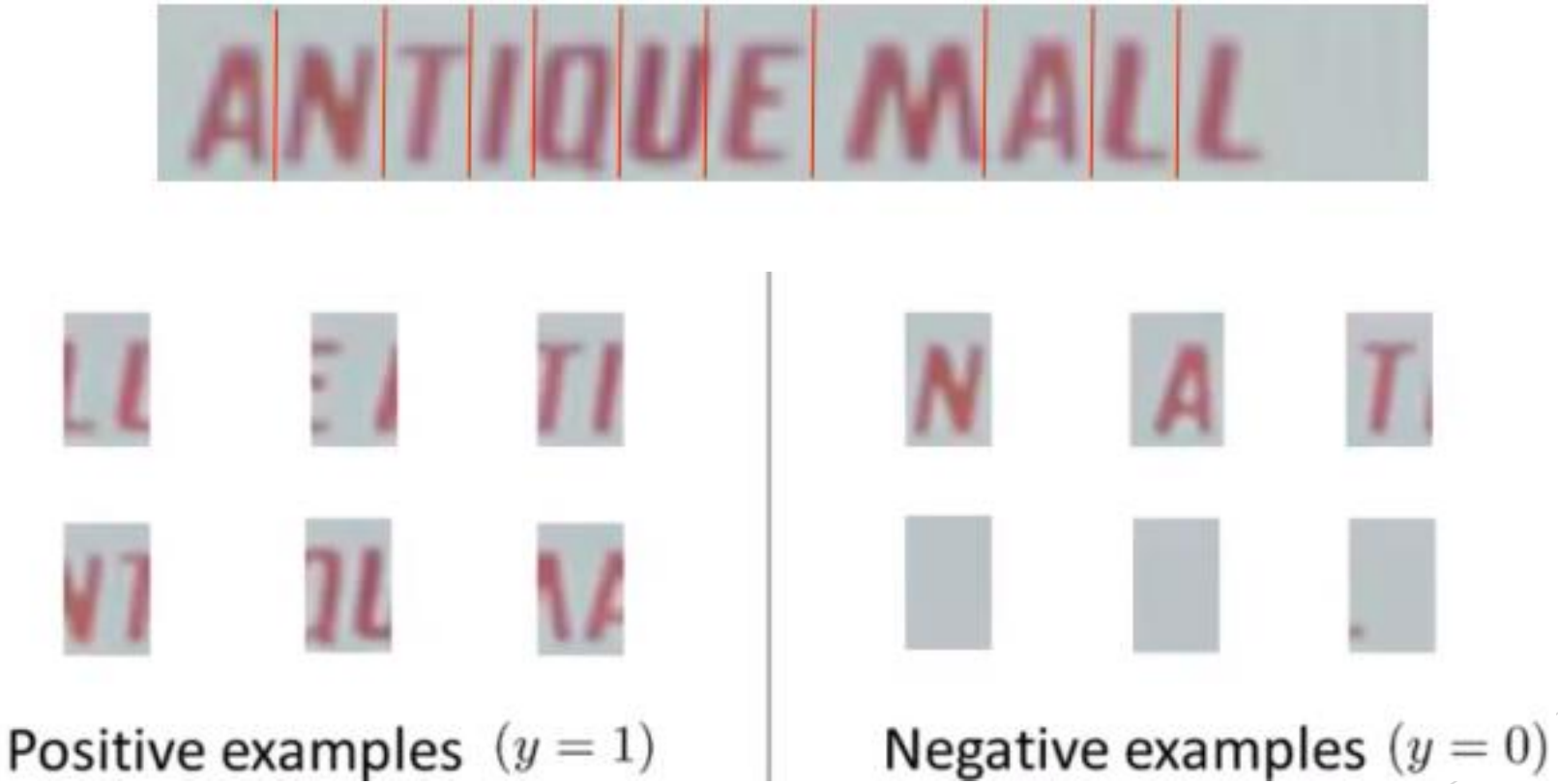


Negative examples $(y = 0)$

Text detection



Character segmentation



Character classification

Additional information

Andrew Ng Coursera course „Machine Learning“

MATLAB Assignment

- Dataset ex3_data.mat contains 5000 images with 20x20 pixels. Images are of numbers from 0 to 9. Y shows, which number is shown on each image. If y is 1 then number 1 is shown. If y is 10 then number 0 is shown.
- Divide data into training set and test set
- Create artificial neural network model on training set using function *ann.m*
- Predict the outputs for test set using function *predict.m*
- Calculate classification accuracy