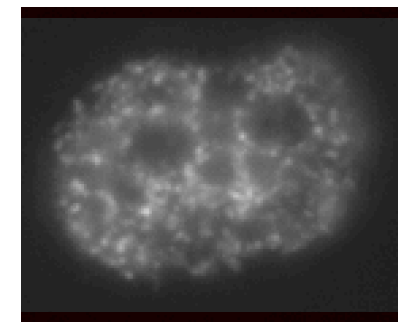
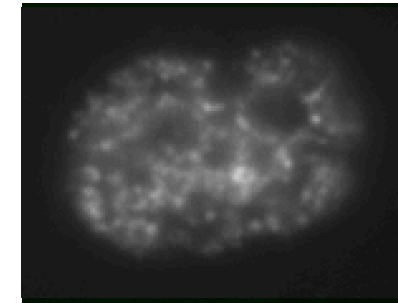
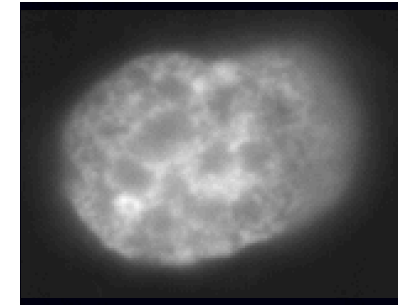
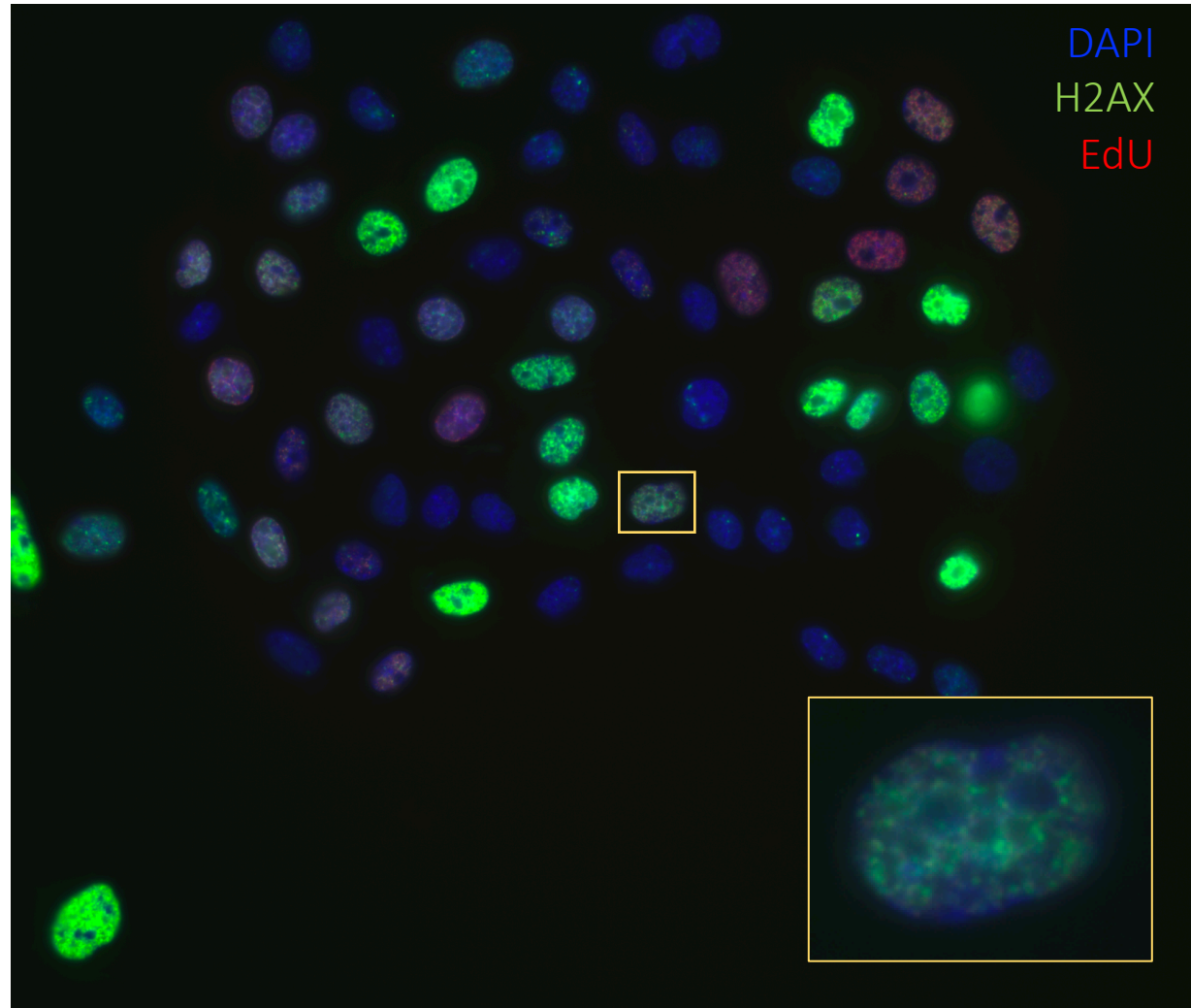


20.109

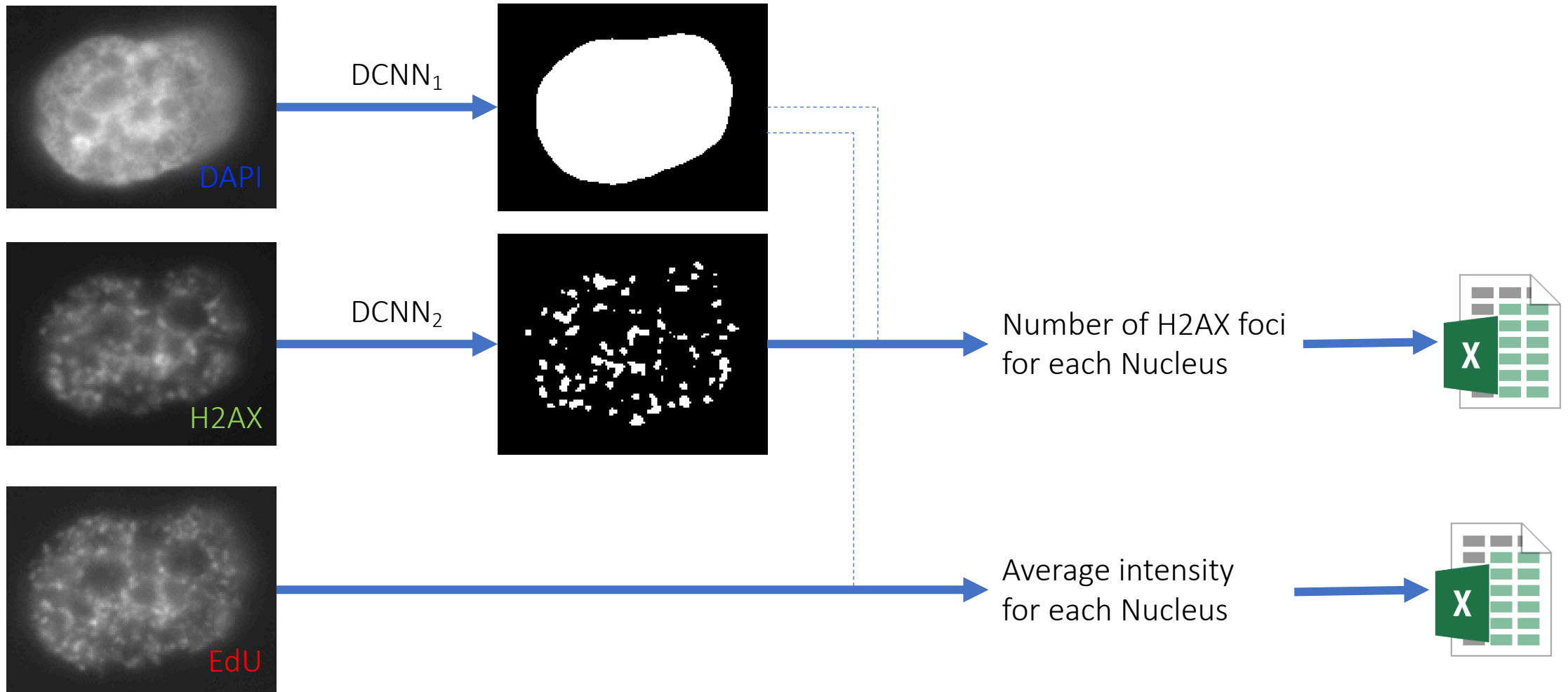
# Foci Analysis using Deep Convolutional Neural Networks

Dushan N. Wadduwage, 20190926

# Data

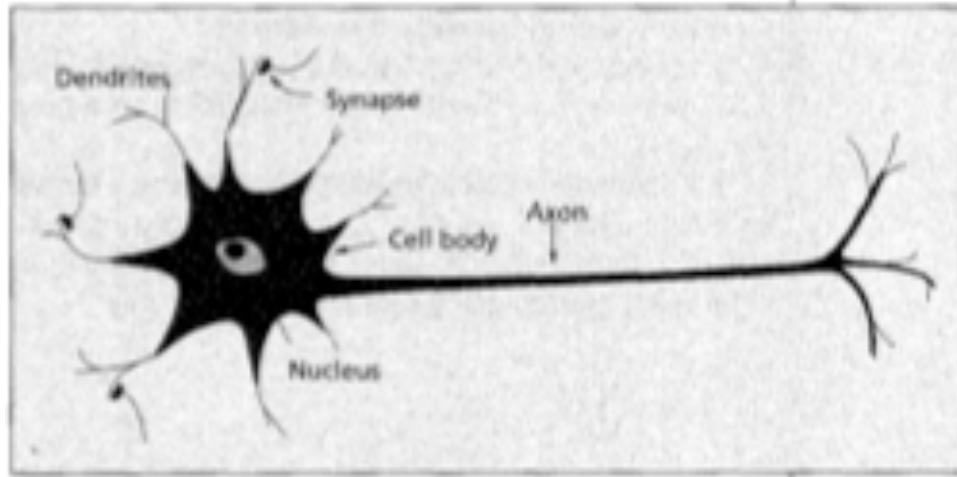


# Analysis Pipeline

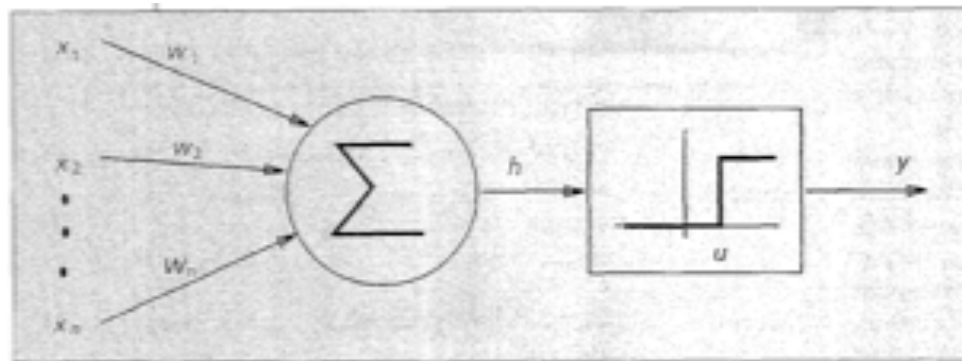
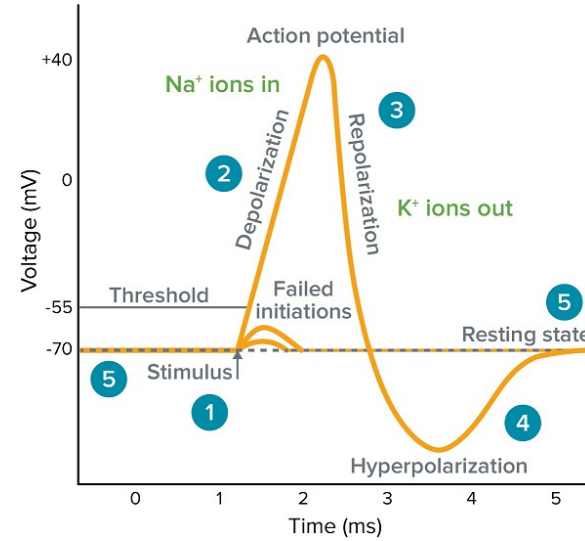


# Deep Convolutional Neural Networks

# Perceptron



Jain et. al. 1996

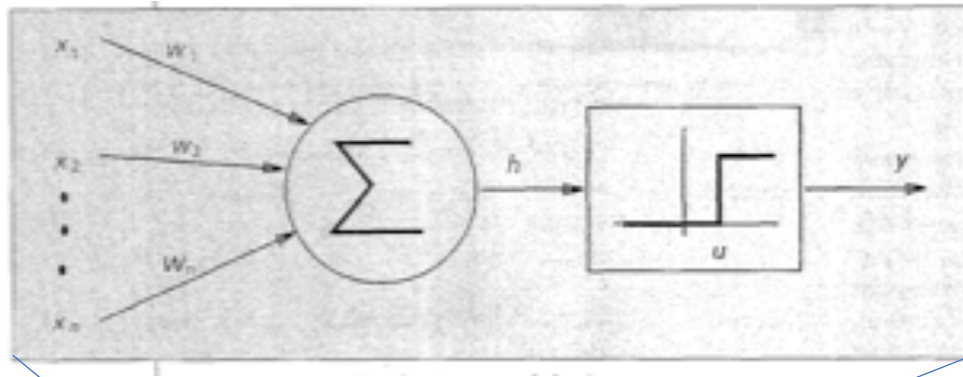


McCulloch & Pitts 1943

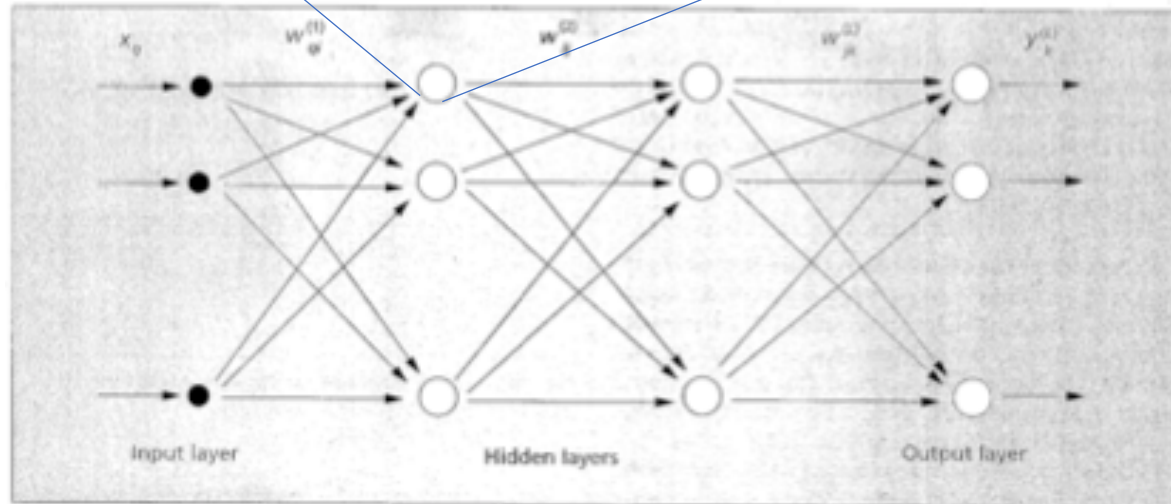
Rosenblatt 1958

$$y = \begin{cases} 0, & \text{if } \sum w_i x_i \leq u \\ 1, & \text{if } \sum w_i x_i > u \end{cases}$$

# Artificial Neural Networks (ANNs)



$$y = \begin{cases} 0, & \text{if } \sum w_i x_i \leq u \leq 0 \\ 1, & \text{if } \sum w_i x_i \geq u > 0 \end{cases}$$



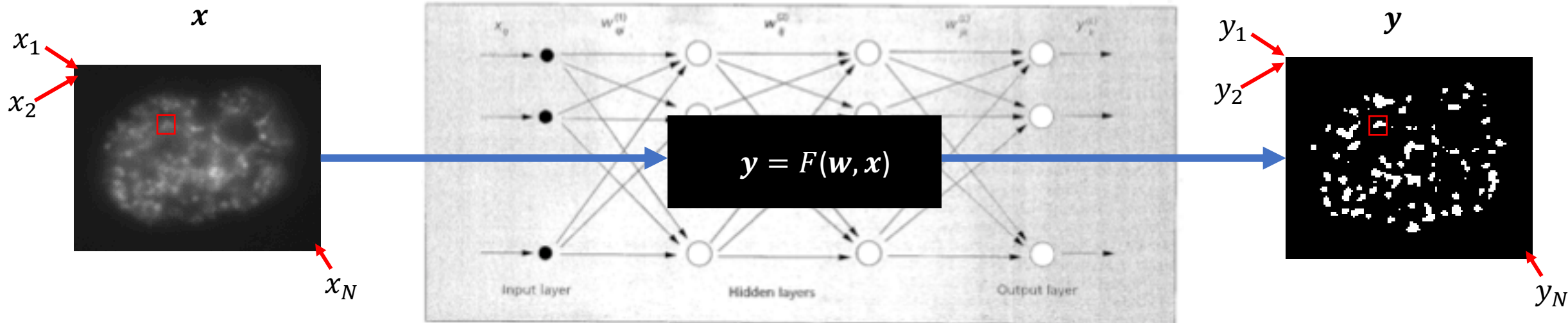
$$y_1 = F_1(\{w_{ij}\}, \{x_i\})$$

$$y_2 = F_2(\{w_{ij}\}, \{x_i\})$$

$$(\mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_N) = F(\{w_{ij}\}, (x_1, x_2, \dots))$$

$$y_N = F_N(\{w_{ij}\}, \{x_i\})$$

# Image processing with ANNs



$$\mathbf{y} = F(\mathbf{w}, \mathbf{x})$$

## What about $w$ ?

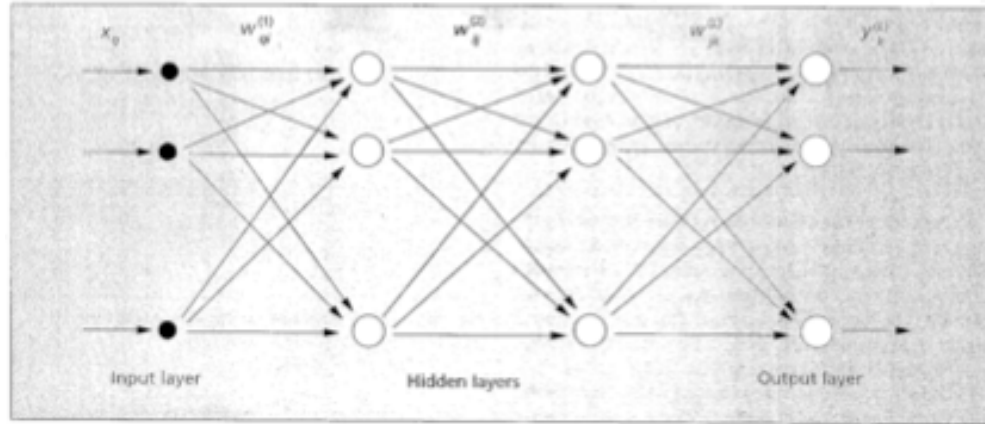
is found by "training" through backpropagation

24	24	25	26	28	29	30	28	27	27	27
26	25	27	28	32	35	36	33	30	29	29
27	28	29	32	37	40	40	38	36	34	32
29	30	31	34	40	43	42	40	40	38	35
30	32	35	39	44	43	41	41	38	36	36
30	32	36	41	44	41	38	38	38	38	36
32	33	36	38	40	37	36	35	35	35	34
33	33	35	35	35	35	35	34	34	34	34
34	33	33	33	33	32	33	32	33	33	31
33	33	31	31	32	31	31	29	31	31	30
32	31	31	30	30	30	28	30	29	29	29

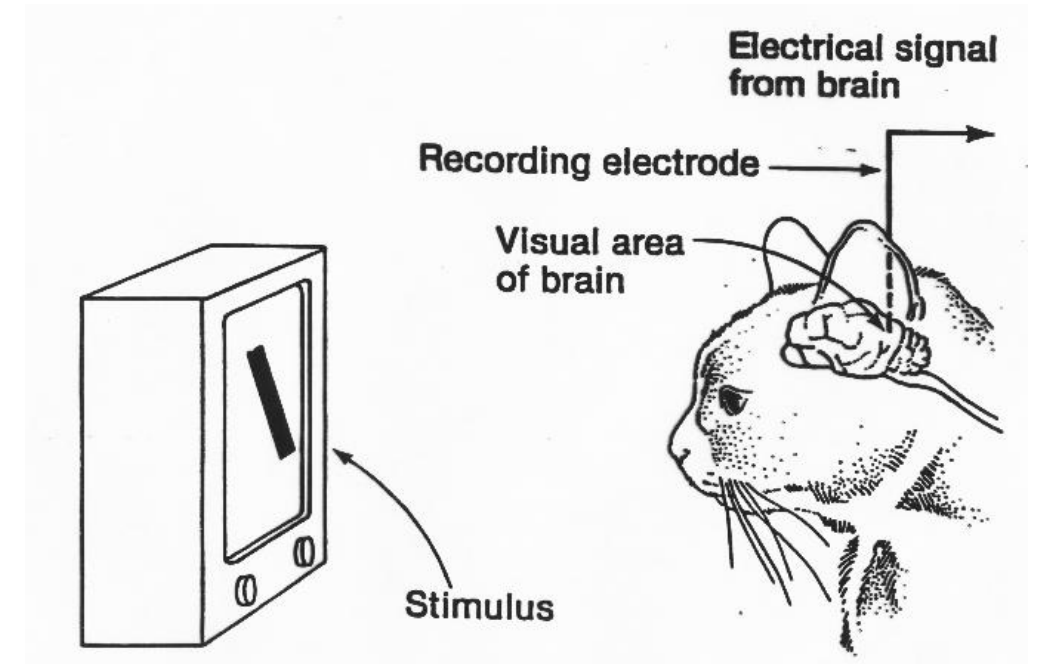
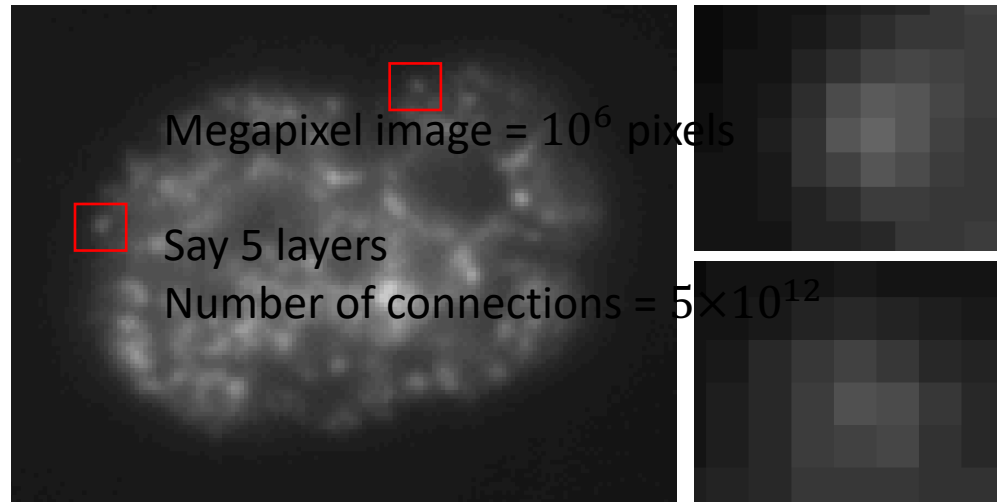
[illegible]



# Architecture of the network



Fully connected neural network





# Convolutional Neural Networks

24	24	25	26	28	29	30	28	27	27	27
26	25	27	28	32	35	36	33	30	29	29
27	28	29	32	37	40	40	38	36	34	32
29	30	31	34	40	43	42	40	40	38	35
30	32	35	39	44	43	41	41	41	38	36
30	32	36	41	44	41	38	38	38	38	36
32	33	36	38	40	37	36	35	35	35	34
33	33	35	35	35	35	35	34	34	34	34
34	33	33	33	33	32	33	32	33	33	31
33	33	31	31	32	31	31	29	31	31	30
32	31	31	30	30	30	28	30	29	29	29

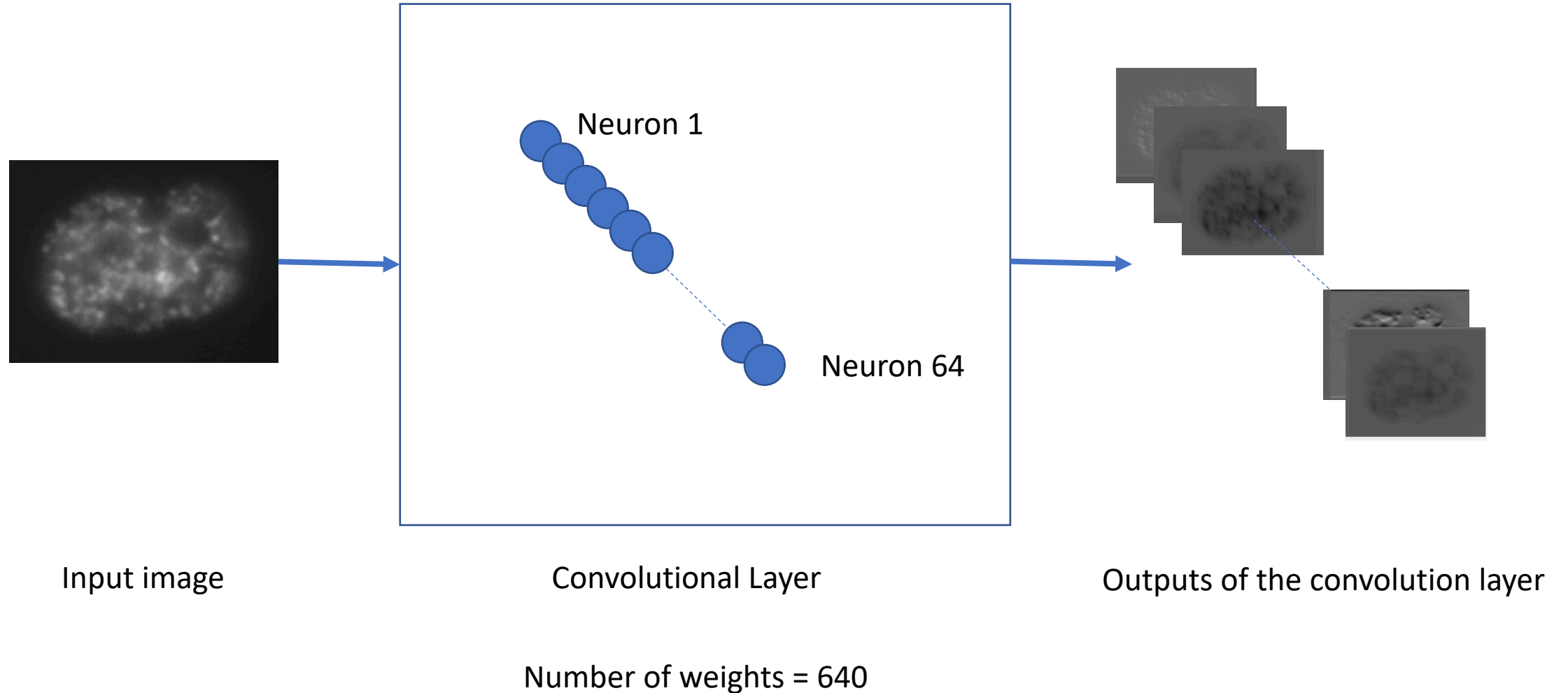


Neuron 1

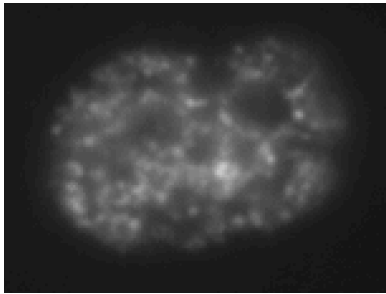
Weights =  $\{w_0, w_1, w_2, \dots, w_9\}$

$$y = \sum w_i x_i$$

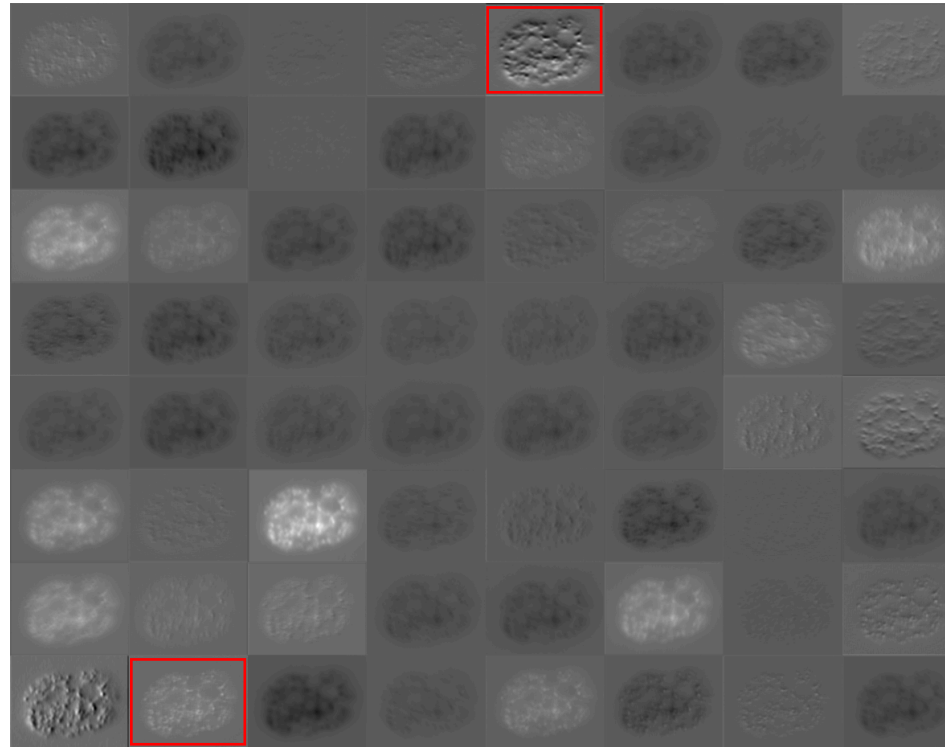
# Convolutional Neural Networks



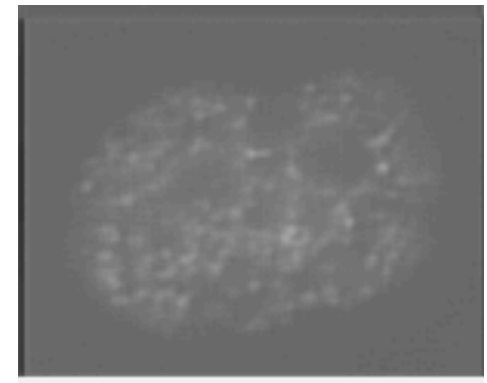
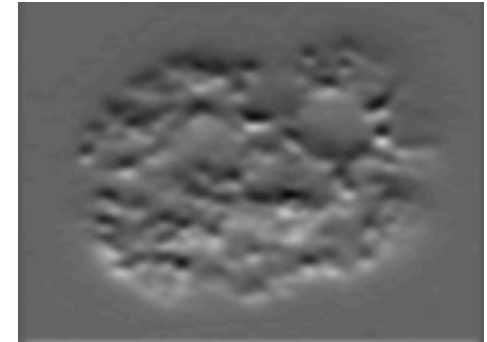
# Convolutional Neural Networks



Input image



Outputs of the convolution layer



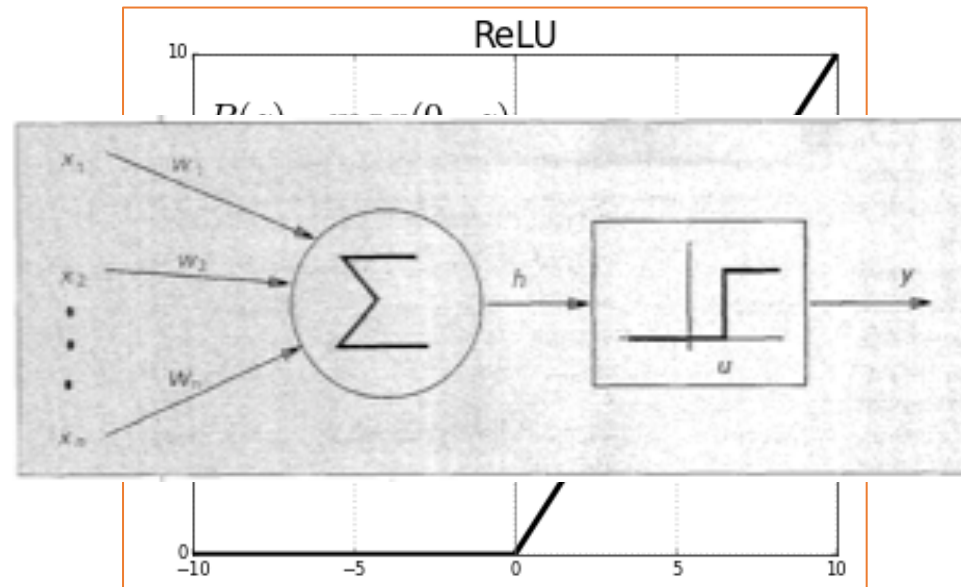
# Convolutional Neural Networks

Activation function

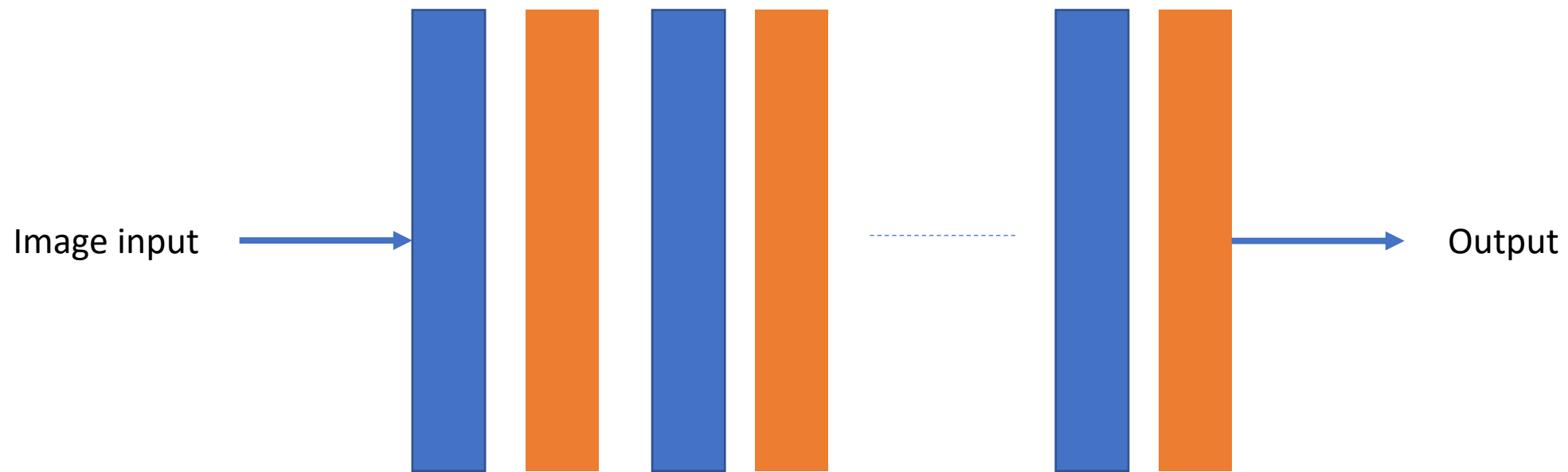
Image input

Convolution layer

$$y = \sum w_i x_i$$



# Convolutional Neural Networks



# Convolutional Neural Networks



Number of convolutional layers = 20  
Maximum number of weights in layer = 36928  
Number of weights ~ 750,000

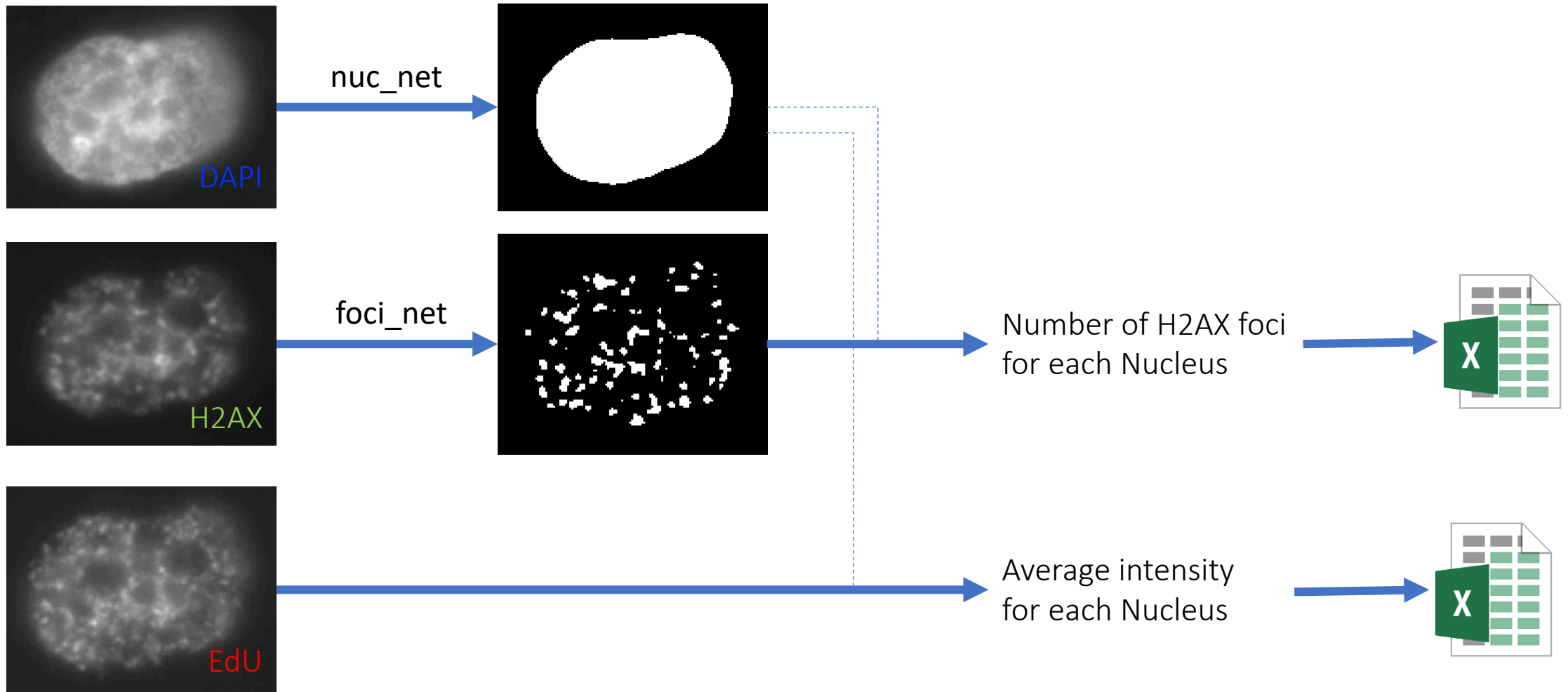
# Summary

1. Perceptron
2. Artificial Neural Networks, ANNs (multi layer Perceptrons)
3. Image processing with ANNs
4. Convolutional Neural Networks

<http://introtodeeplearning.com>



# Analysis Pipeline



Demo