Machine Learning and Financial Applications

Lecture 8
Deep Neural Networks

Video tutorial:
https://youtu.be/zKN9HOnAByQ

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A Review of Terminology

Neuron

Weight

Bias

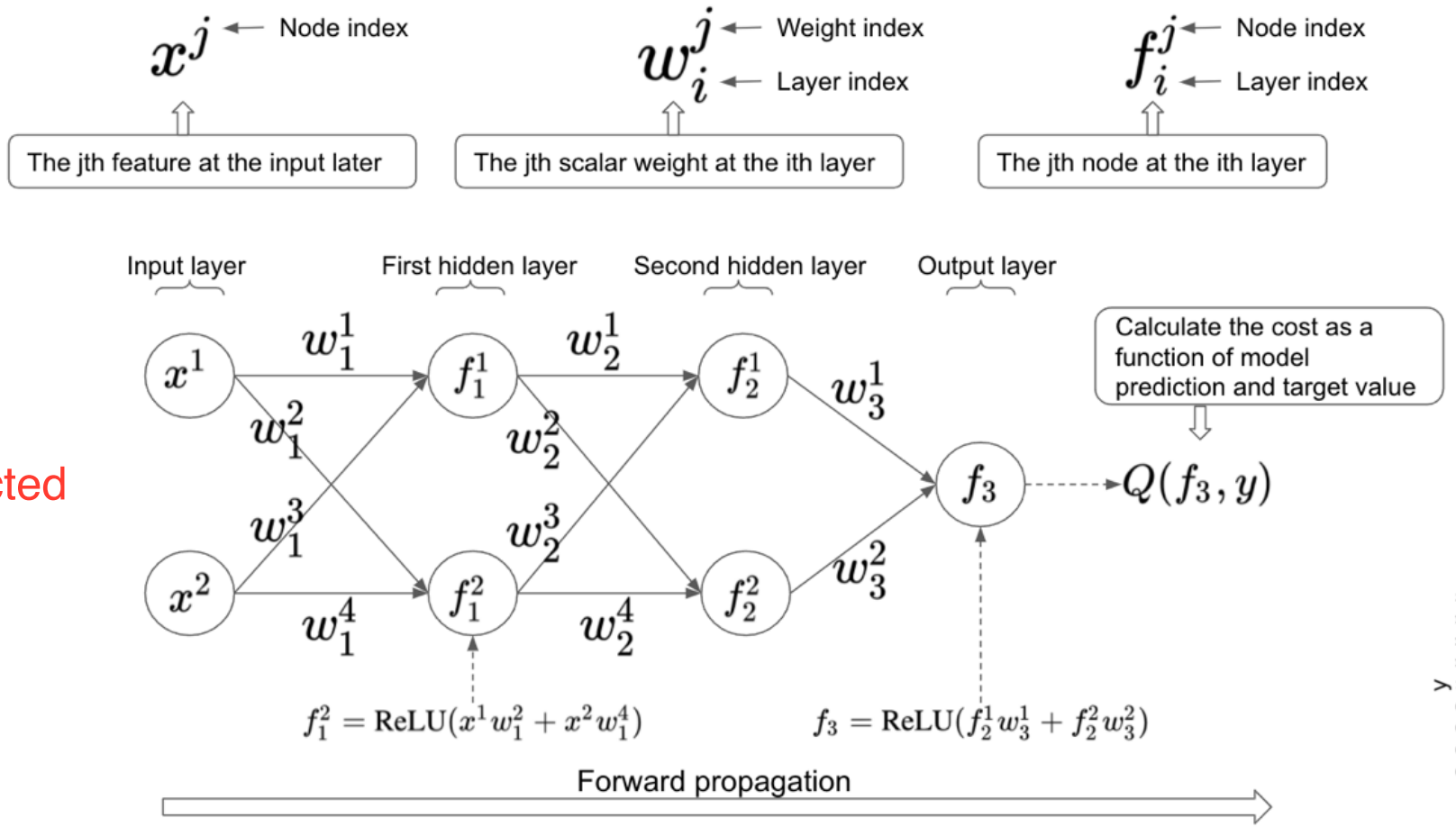
Activation function

Layer

- Feedforward neural network
- Backpropagation
- Loss function
- Optimizer
- Epoch

- Batch size
- Regularization
- Dropout
- Learning rate
- CNN/RNN

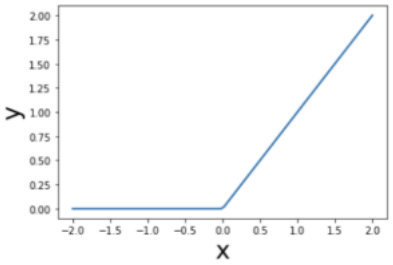
Forward Propagation



fully connected

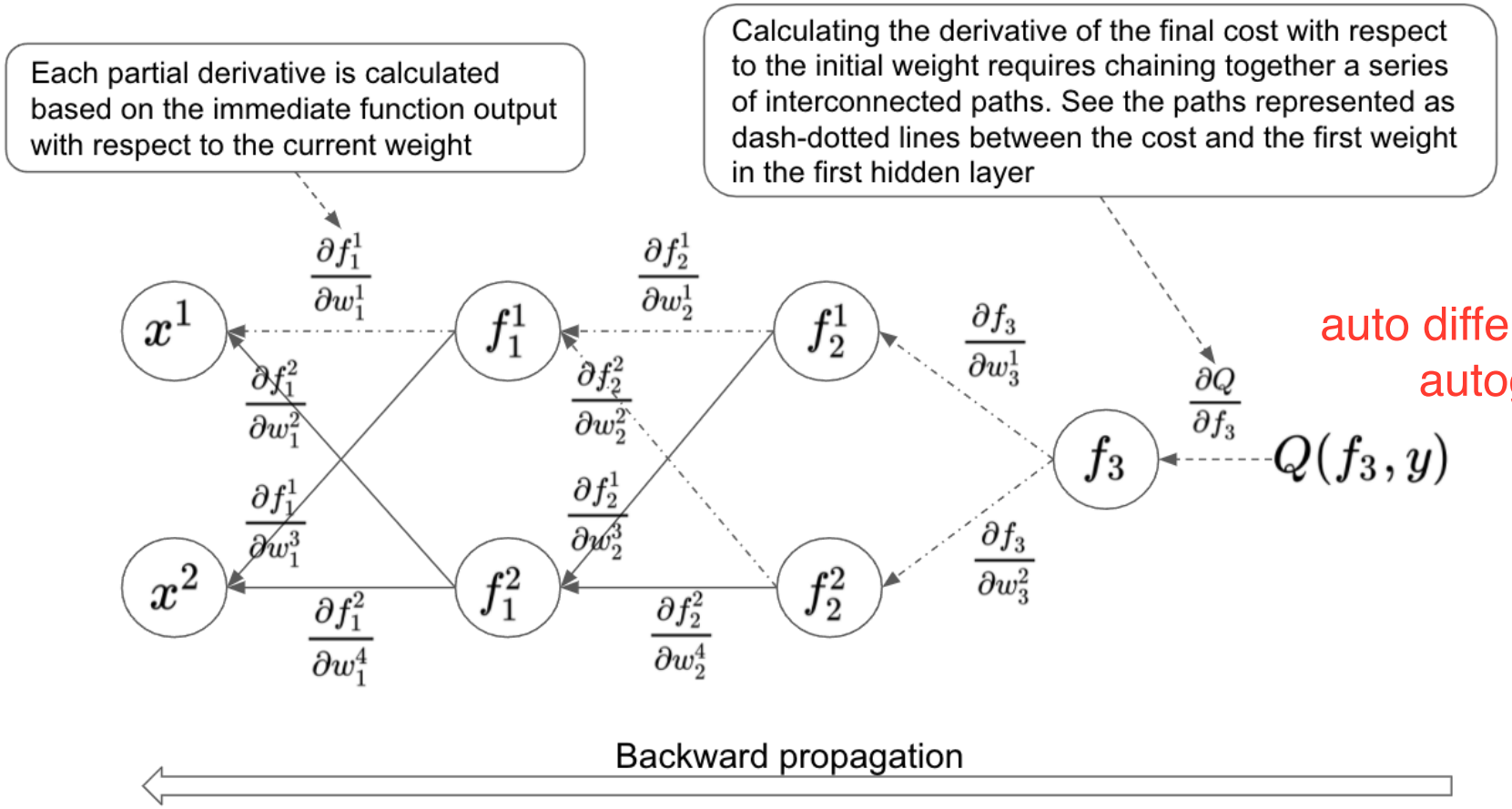
ReLU

$$\phi(x) = \begin{cases} 0 & \text{if } x \leq 0 \\ x & \text{if } x > 0 \end{cases}$$



Backward Propagation

he initialization
xavier initialization



auto differentiation
autograd

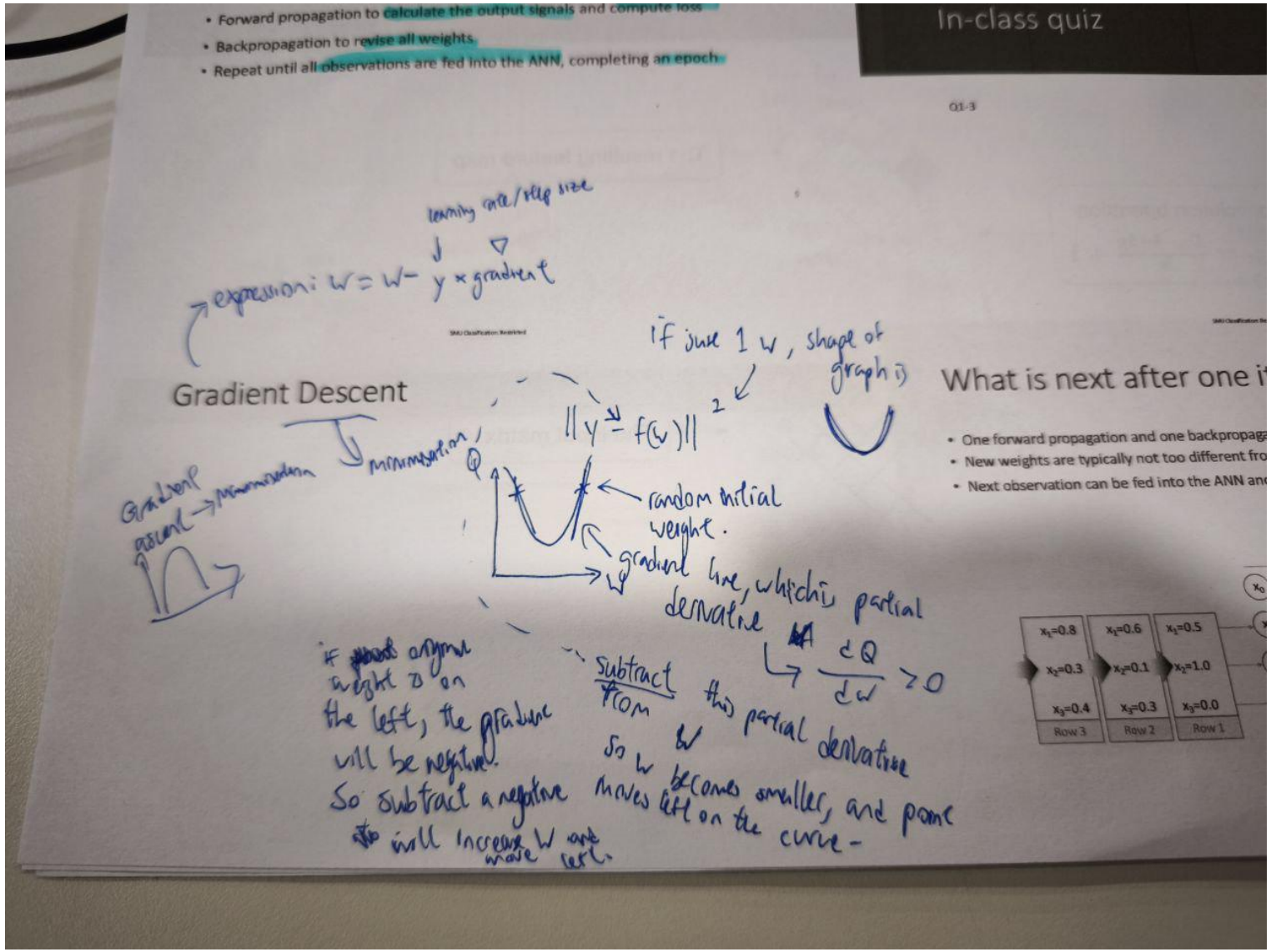
The Overall Training Process

- Randomly initialize all weights
- Select observation(s)
- Forward propagation to calculate the output signals and compute loss
- Backpropagation to revise all weights
- Repeat until all observations are fed into the ANN, completing an epoch

In-class quiz

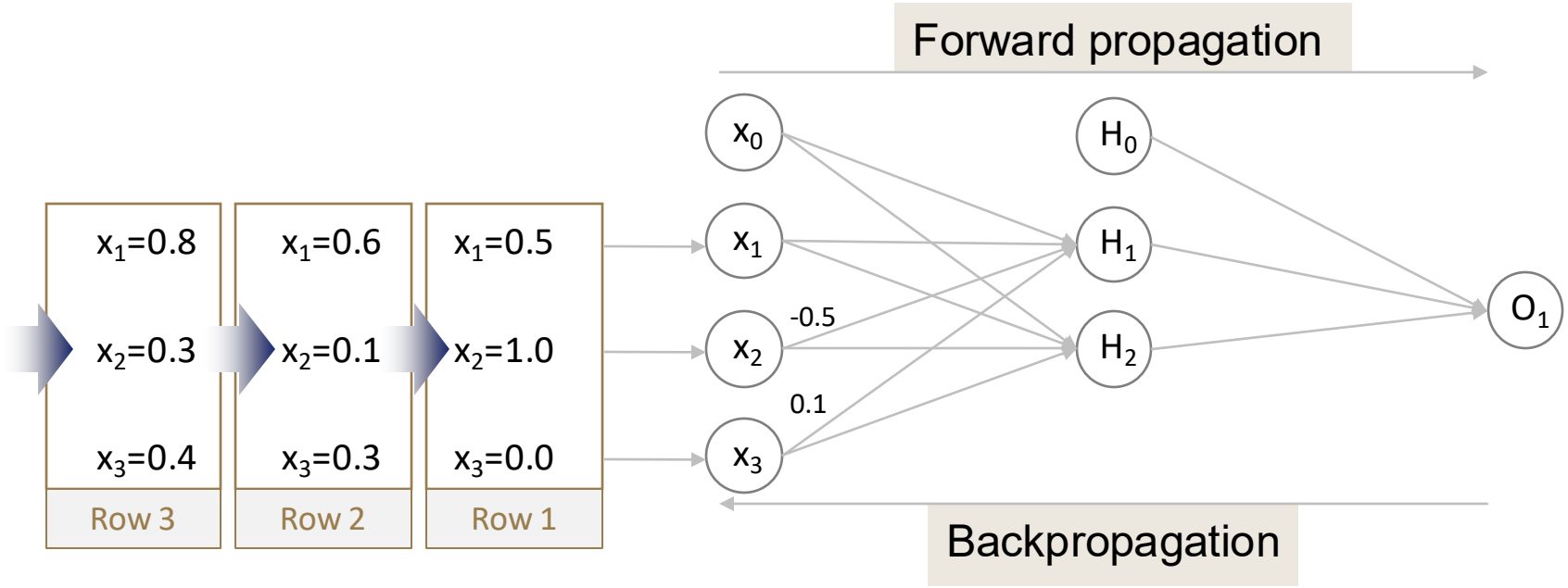
Q1-3

Gradient Descent



What is next after one iteration?

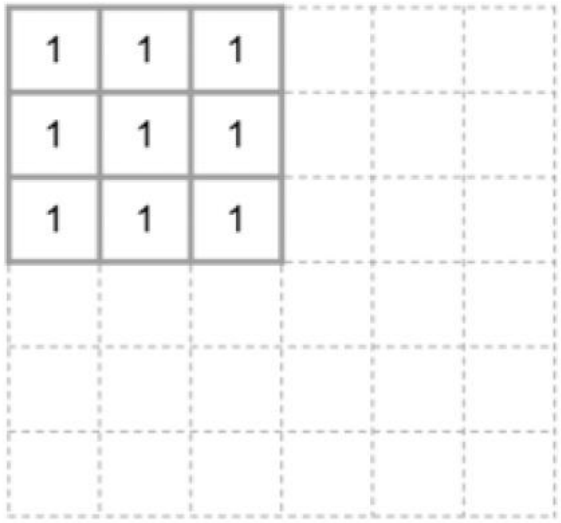
- One forward propagation and one backpropagation conducted with one observation
- New weights are typically not too different from original weights
- Next observation can be fed into the ANN and update all weights again slowly



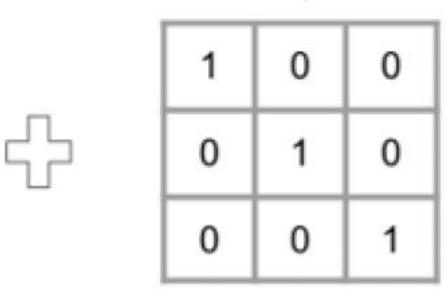
Convolutional Neural Network (CNN)

Convolution operation

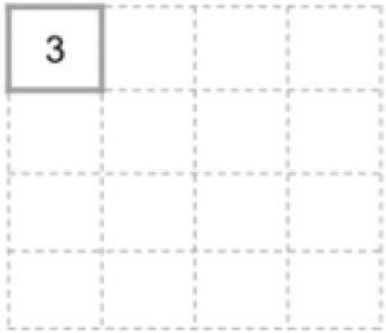
A specific local region (patch) of the grayscale input image data shown in solid line, with the rest of the image shown in dashed line. Each cell holds a pixel value between 0 and 255.



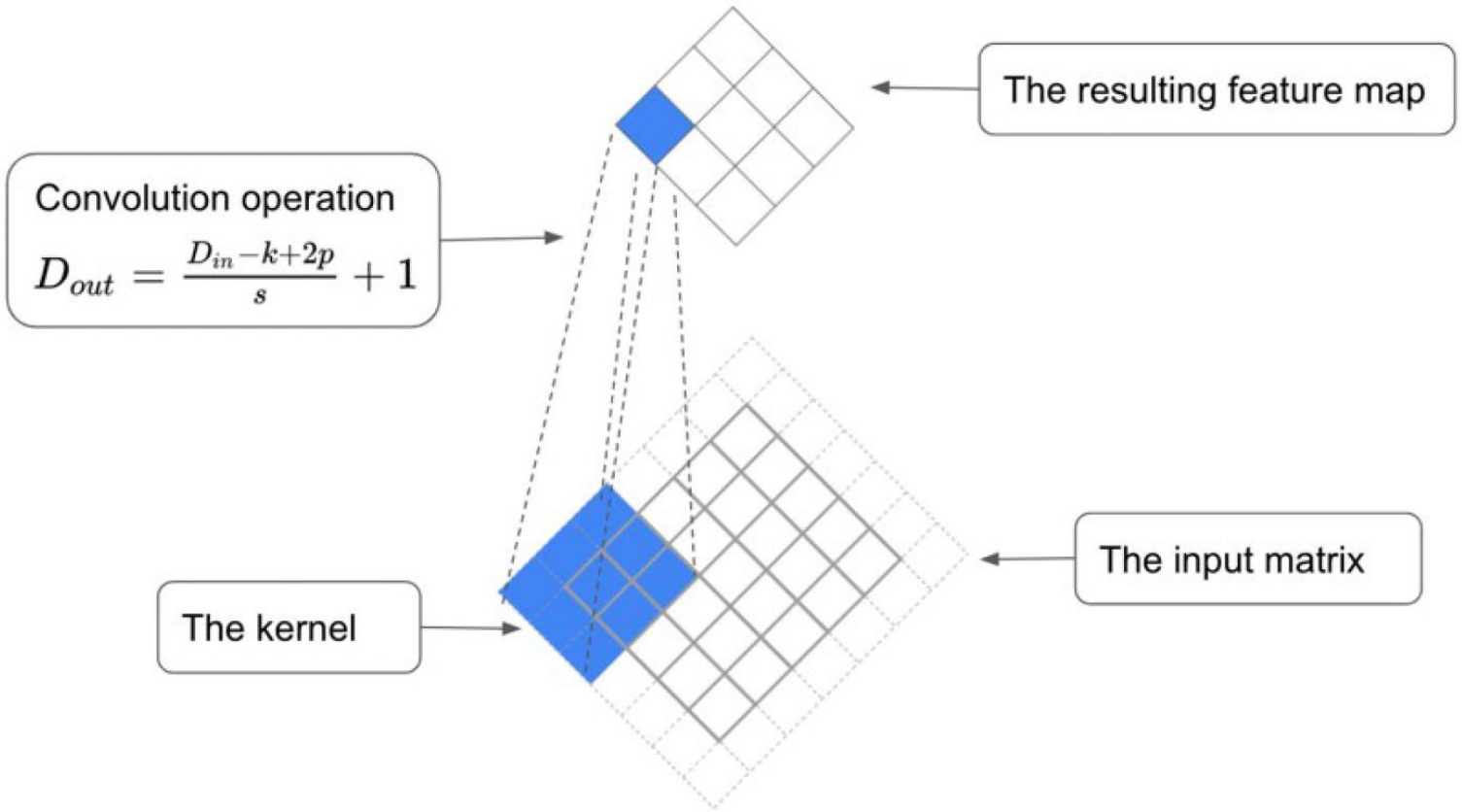
A 3x3 kernel defined by a convolution layer. Each cell in the kernel holds a weight parameter. The kernel will convolve with the input patch via a weighted sum operation, i.e., element-wise multiplication and summation.



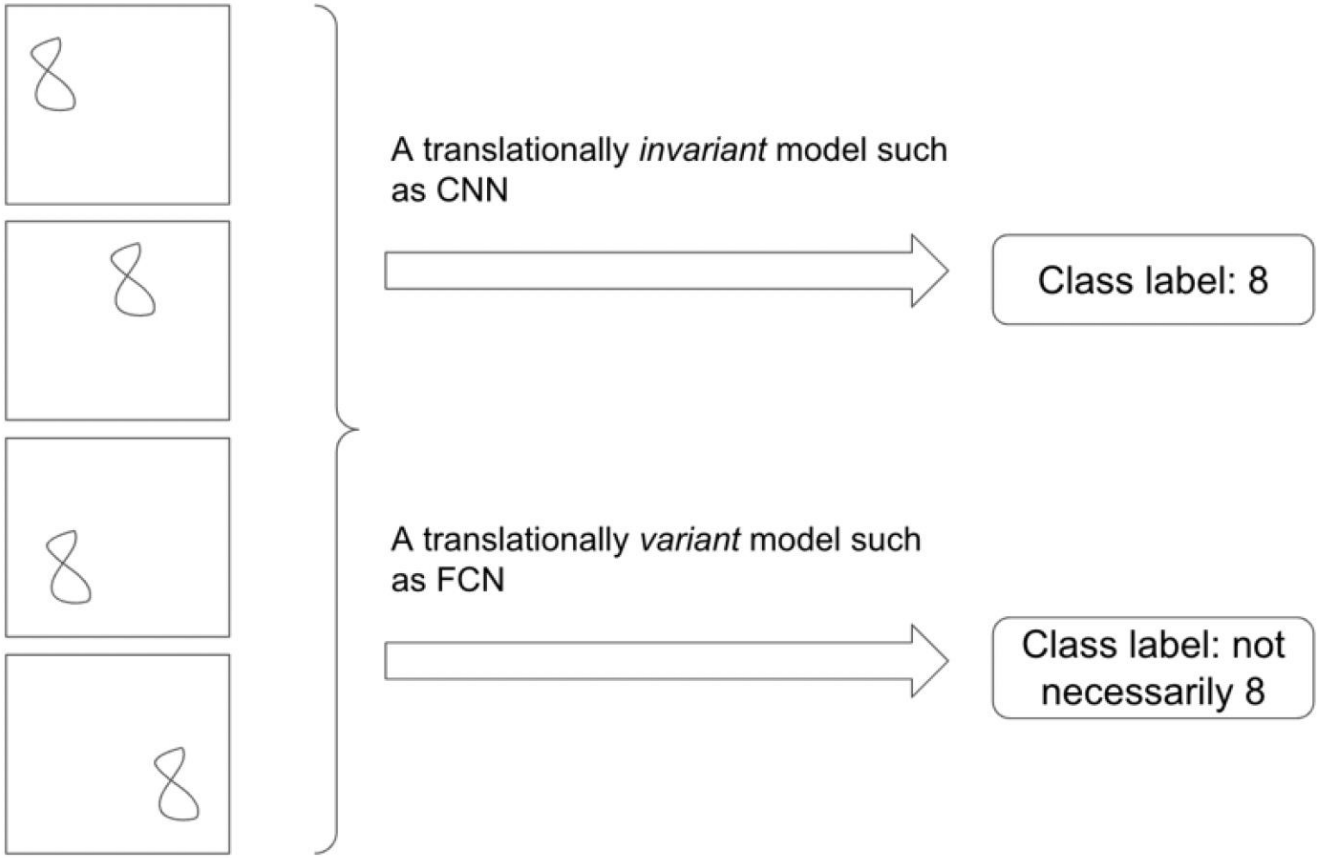
The resulting feature map, with the example convoluted feature in solid bold and others in dashed line.



Sliding the kernel to produce feature maps



Translational invariance



In-class quiz

Q4-7


Coding session