Deep Learning Made Easy

The Basics

Schedule

week	Date	Topic
1	02.11	Introduction
2	02.18	The basics: python, math, and AI development
3	02.25	AI history & Perceptron
4	03.06	Training: forward propagation & backpropagation
5	03.13	CNN
6	03.20	Metrics
7	03.27	Word embedding
8	04.03	RNN
9	04.10	Autoencoder & GAN
10	04.17	Project presentation

Today's Class

- Recap
- What is CNN?
  - What is convolution?
  - Stride
  - Padding
  - Max pooling
  - Dropout
- Lab time

Recap – neural network

- Neural network as a function
  - y = f(x)
- Perceptron
  - Y = WX + b
  - Two inputs: x1, x2
  - One output: y
  - Linear regression
- XOR problem
  - Linear regression can’t solve the XOR problem
  - Require multivariate regression

Recap - Training

- What it take to train a neural network:
  - Hypothesis: H = WX + b
  - Activation function: Sigmoid, tanh, ReLU, LeakyReLU, Softmax, etc.
  - Cost function: MSE, cross entropy, etc.
  - Gradient descent: backpropagation
- Training a neural network is basically the problem of minimizing the cost function: minimize cost(W, b)
- Gradient descent is the most popular optimizer.
- Training a neural network is NOT easy!
  - Finding hyperparameters, random initial weights, local minima, vanishing/exploding gradients, overfitting/underfitting, etc.

Activation functions

- Introduces non-linearity
- Normalizes the output: activation functions are also called Normalization functions
- Different kinds
  - Step function: $$f(\mathbf{x}) = \begin{cases} 1 & \text{if } \mathbf{w} \cdot \mathbf{x} + b > 0, \\ 0 & \text{otherwise} \end{cases}$$
  - Sigmoid:

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

$S(x)$ = sigmoid function

e = Euler's number

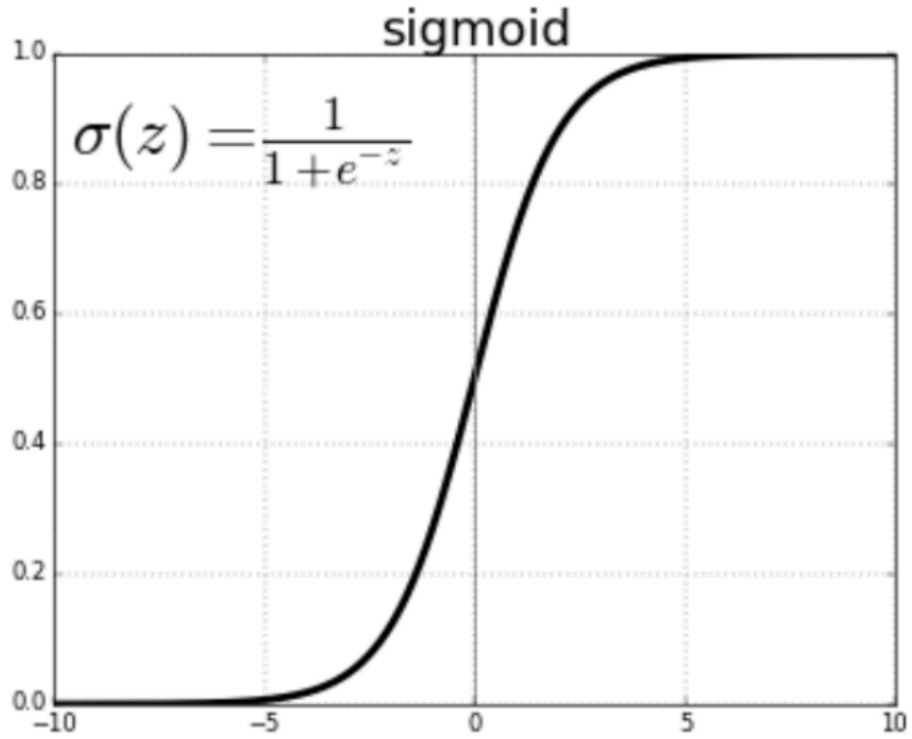
Activation function: Sigmoid

- Sigmoid:

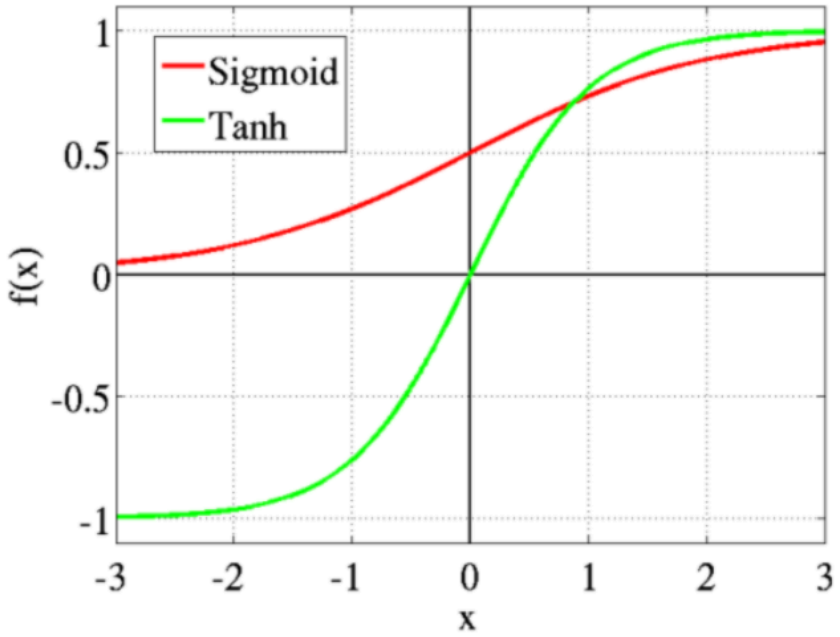
$$S(x) = \frac{1}{1 + e^{-x}}$$

$S(x)$ = sigmoid function

e = Euler's number



Activation functions: Sigmoid and Tanh



https://www.neuronactivator.com/blog/what-even-is-activation-function

Activation Functions: ReLU and Leaky ReLU

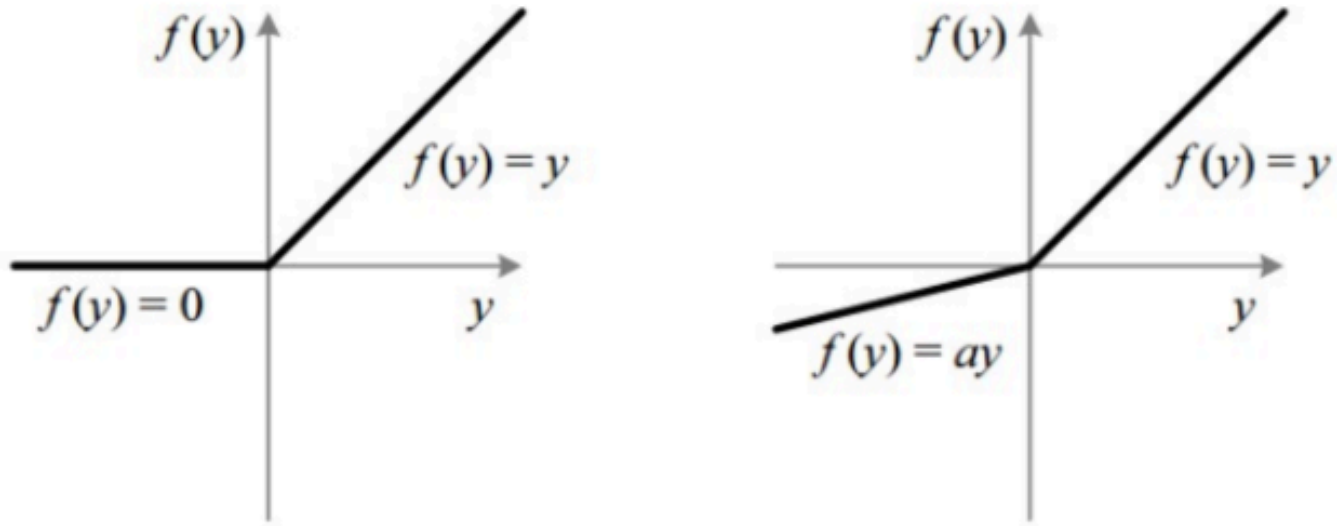


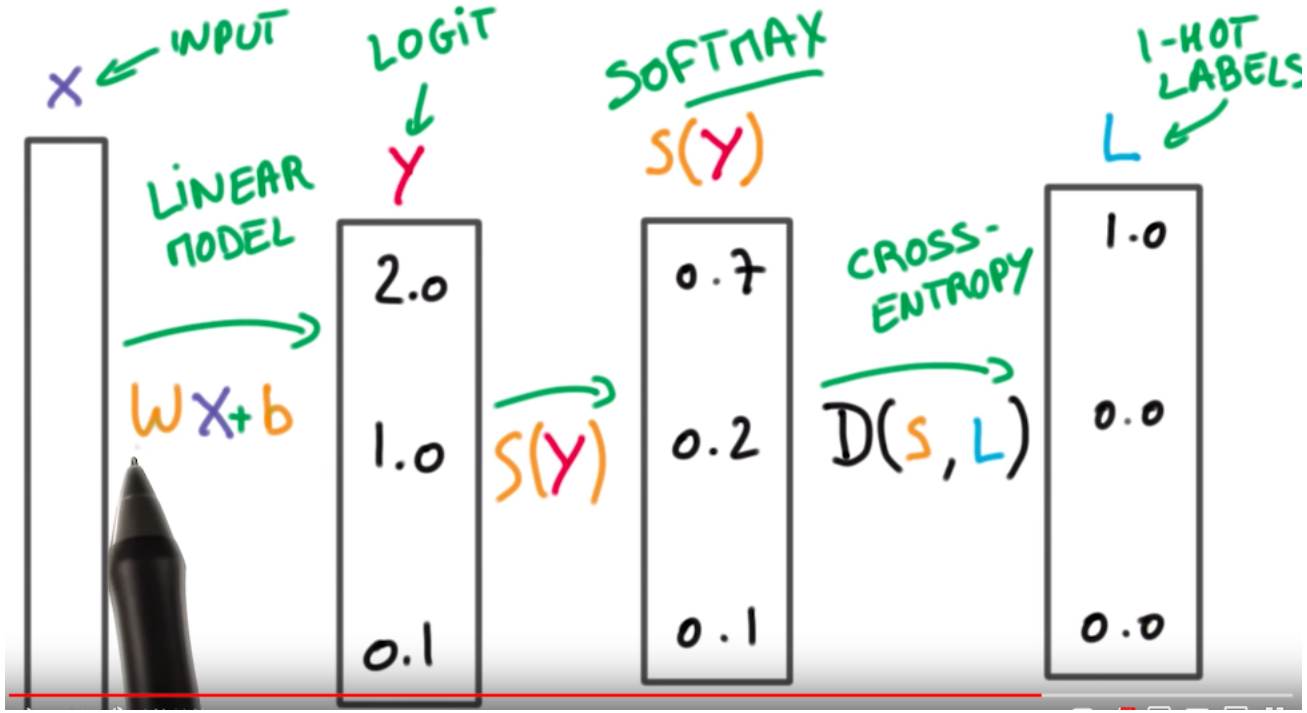
Fig : ReLU v/s Leaky ReLU

https://www.neuronactivator.com/blog/what-even-is-activation-function

Activation Function: Softmax

- The softmax function is often used in the final layer of a neural network-based classifier.
- All probabilities sum to one
- Often used with a log loss (or cross-entropy) cost function
- To solve a non-linear variant of multinomial logistic regression.

Loss Function: Cross Entropy

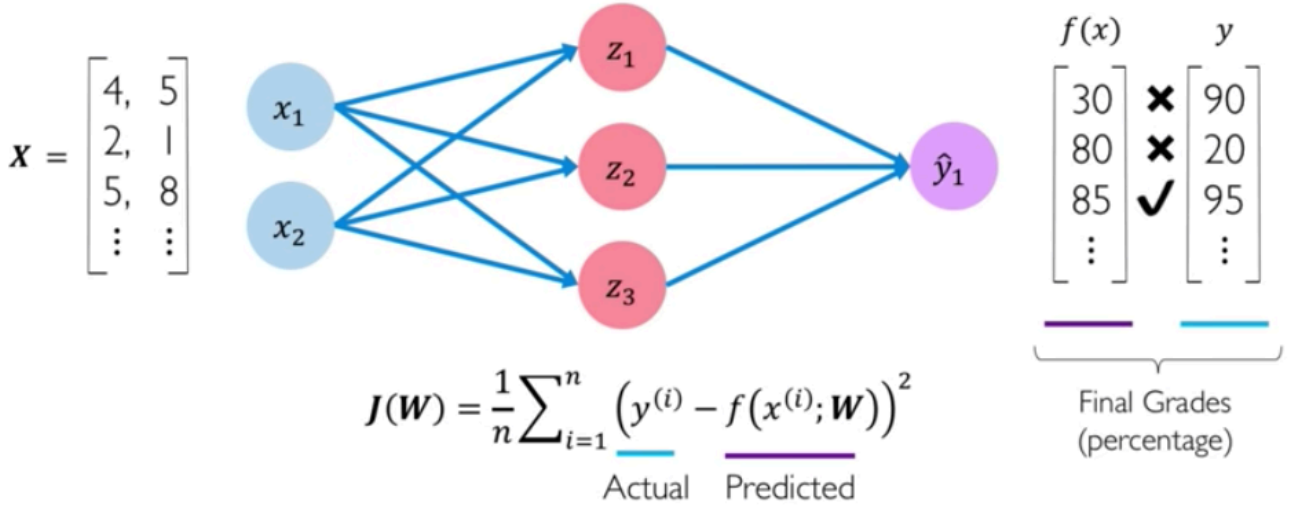


https://medium.com/data-science-bootcamp/understand-cross-entropy-loss-in-minutes-9fb263caee9a

Loss Function: Mean Squared Error

Mean Squared Error Loss

Mean squared error loss *can be used with regression models that output continuous real numbers*

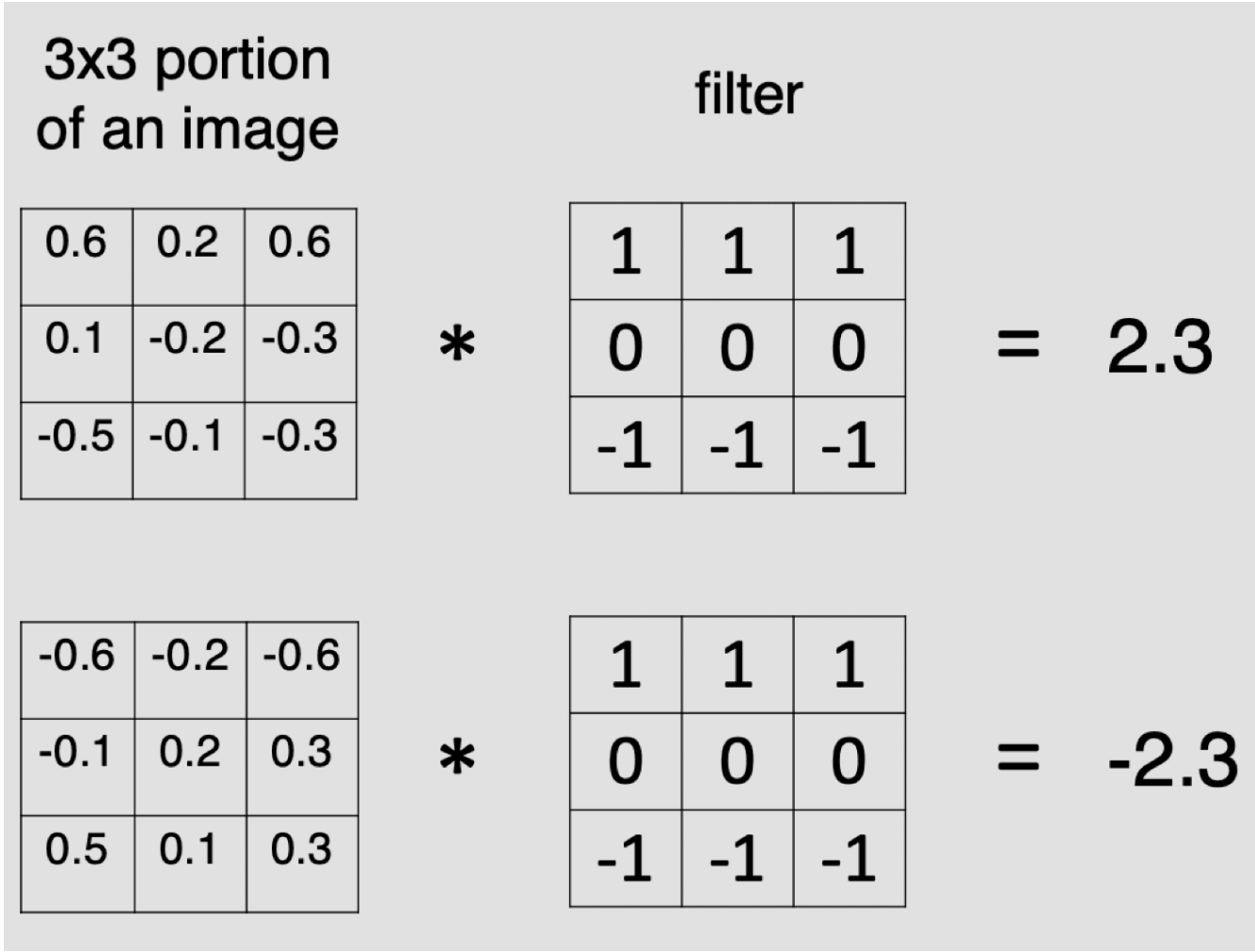



```
loss = tf.reduce_mean( tf.square(tf.subtract(y, predicted)) )
```

http://introtodeeplearning.com/

What is convolution?

- A kernel (filter is applied to an image)
- Element-wise multiplication (dot product) is performed to calculate the output
- The effect of convolution can be seen in [here]



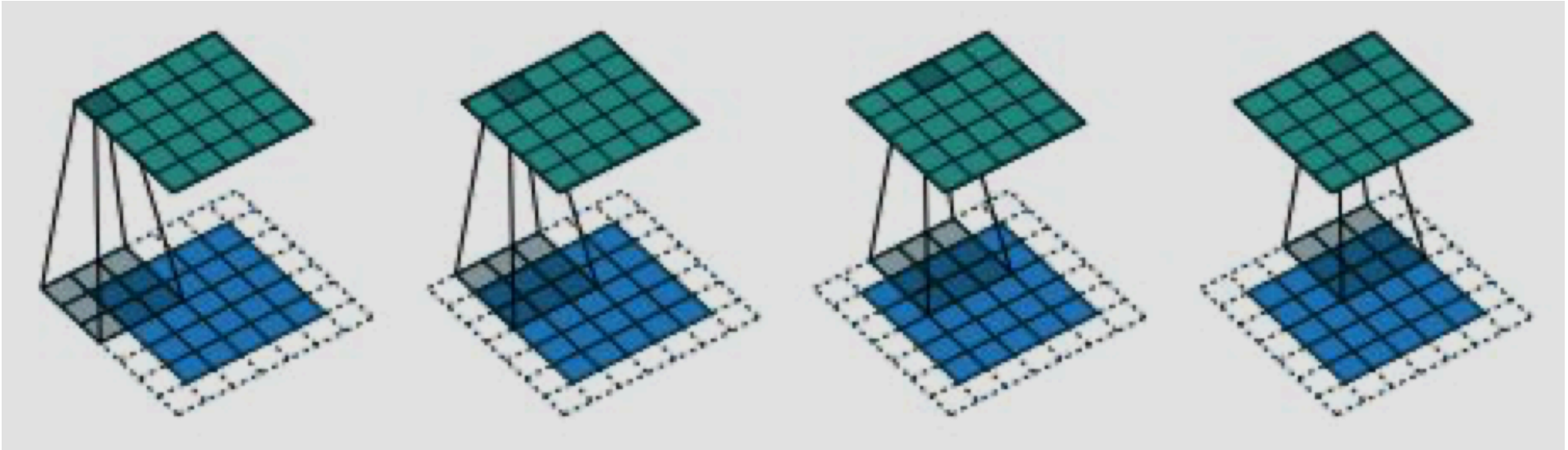
* Generative Deep Learning (David Foster)

What is involved in convolution

- Stride: step size
- Padding: putting zeroes around the outer edge of the input data. “same” means the output size will be the same as the input size when stride = 1.
- Kernel: the filter that extracts features
- Max pooling: means pooling the maximum value from the filtered feature map. The result is a down-sampling image (reduced dimensionality)
- Batch normalization: normalizing
- Dropout: regularization technique to prevent overfitting

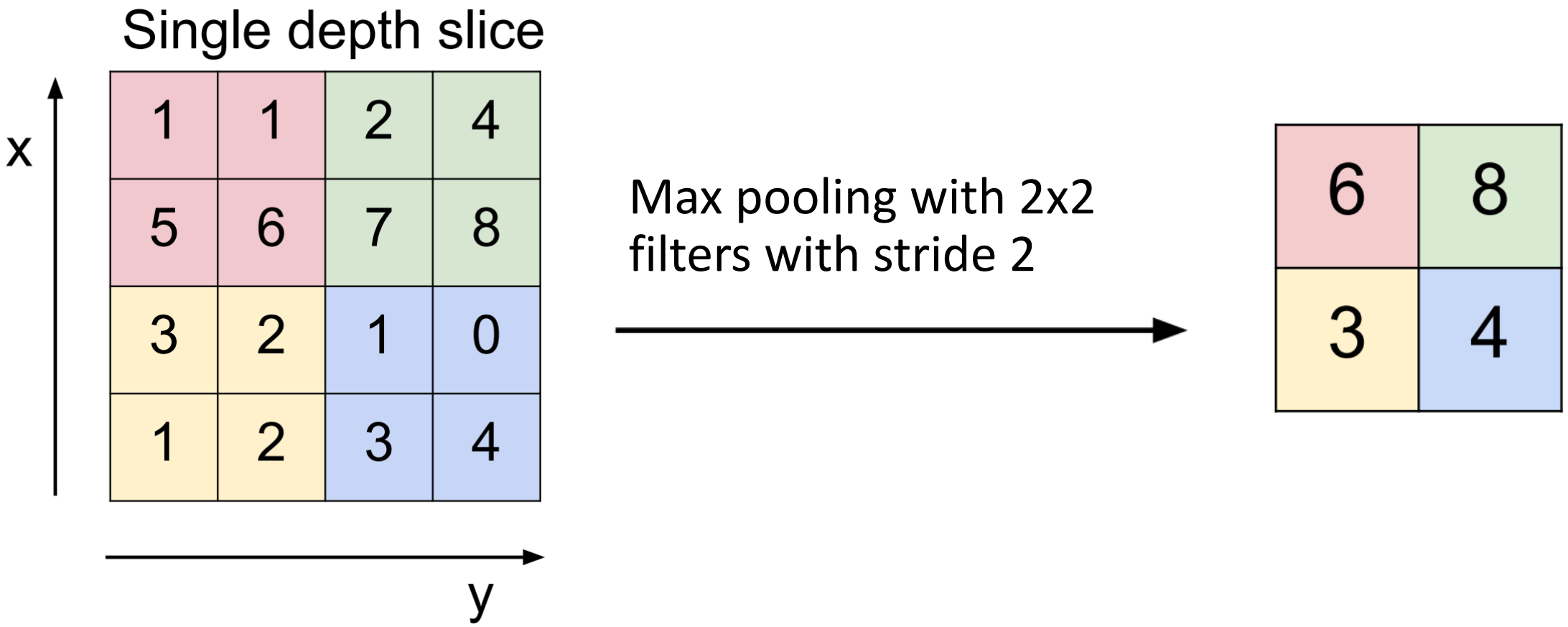
Convolution in action

- stride = 1, padding = “same”



- What will happen if there is no padding?

Max pooling


Single depth slice
x
y
1 1 2 4
5 6 7 8
3 2 1 0
1 2 3 4
Max pooling with 2x2 filters with stride 2
6 8
3 4

Visualization Tools

- Convolution Visualizer
- CNN Explainer

Neural Style Transfer

- The example is copied from the TensorFlow tutorial:
  - https://github.com/changsin/DeepLearningMadeEasy/blob/main/04-cnn-style-transfer.ipynb
- Try a different content and style of your own choosing.

Assignment

- Try other types of training for Teachable Machine: i.e., audio and pose.
- Try a different content and styles in the neural style transfer notebook.

Lab time

- To clone: from your terminal
  - >git clone https://github.com/changsin/DeepLearningMadeEasy.git
- Or use google colab to open the git hub repository
- Git is an open source version control system
  - Github is a host service using git.