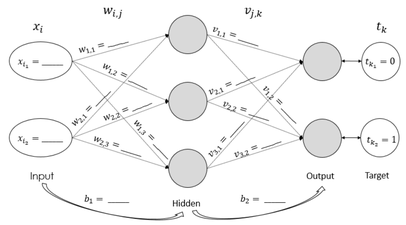
Lesson Plan

Lesson 1: Partial Derivatives

KHANACADEMY

Students will watch videos, make notes, practice, and compare answers

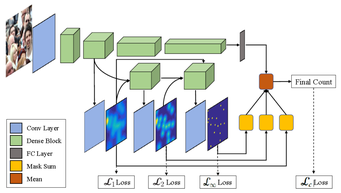
Lesson 2: Neural Networks



Students will use:

- a tutorial and a handout to perform the forward pass and the backpropagation of a neural network
  - In the Forward Pass, students will
    - choose inputs, weights and biases
    - compute hidden and output neurons
    - apply the activation function (sigmoid function)
    - calculate the loss function (mean square error)
  - In the Backpropagation, students will
    - find the derivative of the sigmoid function
    - find partial derivatives of the error due to weights
    - compute new weights (gradient descent algorithm)
- a Python code to check answers

Lesson 3: CRCV and Crowd Counting



Students will learn about CRCV, discuss the relevance of their projects, and use the DEMO for crowd counting
http://crcv.ucf.edu/news&info/crowdcountingdemo.php

Lesson 4: Artificial Intelligence

Students will watch different videos, make notes, share their comments, and discuss the role of neural networks in Artificial Intelligence and Computer Vision and the impact of these new technologies

"Artificial Intelligence, deep learning, machine learning
– whatever you're doing if you don't understand it –
learn it. Because otherwise you're going to be a dinosaur within 3 years."

Mark Cuban, Upfront Summit 2017

UCF CENTER FOR RESEARCH IN COMPUTER VISION

Ana Gonzalez
AP Calculus
The Osceola County School for the Arts
UCF RET 2018

Calculus, Neural Networks, and Artificial Intelligence

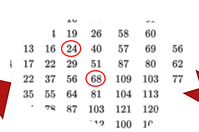
How partial derivatives and chain rule are used in neural networks and how neural networks are designed and used in computer vision and artificial intelligence

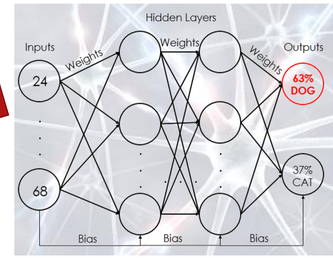
Neural Networks

How do neural networks work?

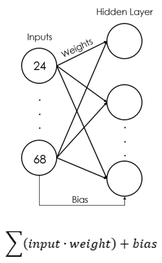
A neural network is a series of algorithms that attempts to identify underlying relationships in a set of data by using a process that mimics the way the human brain operates. (Investopedia)





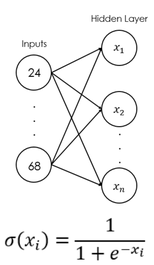


Forward Pass



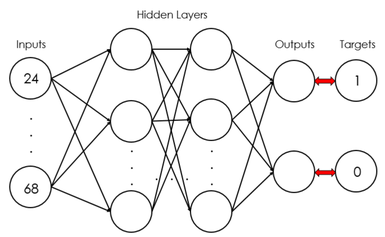
$$\sum(input \cdot weight) + bias$$

Activation Function



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

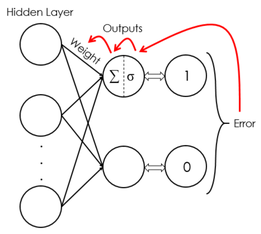
Loss Function



The objective while running a neural network is to increase the prediction accuracy and to reduce the error, hence minimizing the loss function.

$$\frac{1}{2}\sum(target - output)^2$$

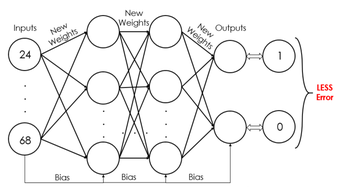
Backpropagation



Backpropagation involves computing the derivatives due to each weight to determine how much a change in the weights affects the total error.

Gradient Descent

Gradient Descent is used while training a neural network to find the values of the weights that minimize the loss function as far as possible.



$$new\ weight = weight - learning\ rate \cdot \frac{\partial Error}{\partial weight}$$

AP Calculus Enduring Understandings

EU 2.2: A function's derivative, which is itself a function, can be used to understand the behavior of the function.

EU 2.3: The derivative has multiple interpretations and applications including those that involve instantaneous rate of change.

Calculus Topics

Sigmoid Function

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

Derivative of the Sigmoid Function

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

Chain Rule

$$f(g(x))' = f'(g(x))g'(x)$$

Partial Derivatives

A derivative of a function of two or more variables with respect to one variable, the other(s) being treated as constant.

Computer Science Topics

Computer Vision



An interdisciplinary field that deals with how computers can be made for gaining high-level understanding from digital images or videos. (Wikipedia)

Artificial Intelligence



Applied when a machine mimics "cognitive" functions that humans associate with other human minds, such as "learning" and "problem solving". (Wikipedia)

Acknowledgements

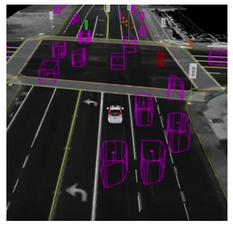
Special thanks to:
Rodney LaLonde, Kishan Athrey, Dr. Niels Lobo and Dr. Mubarak Shah

What are some examples of applications of neural networks in Computer Vision and Artificial Intelligence?

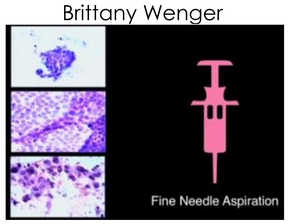
Object Detection – Fei Fei Li



Driverless Cars – Chris Urmson



Breast Cancer Detection – Brittany Wenger



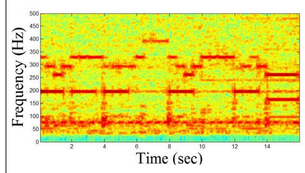
AlphaGo – Demis Hassabis



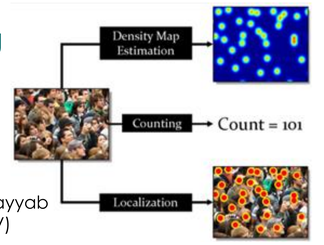
Art – Blaise Aguera y Arcas



Sound Recovery – Abe Davis



Crowd Counting



Kishan Athrey, Muhammad Tayyab and Dr. Mubarak Shah (CRCV)