2021 Virtual Research Colloquium: Neural Networks on the Edge

Presented By:

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NASA in Kansas

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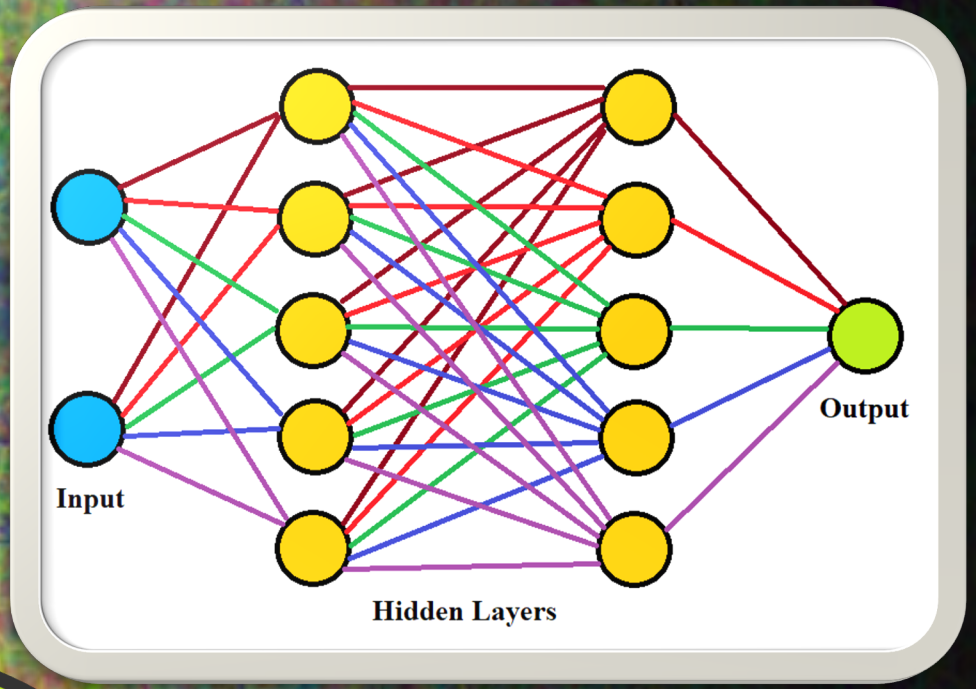
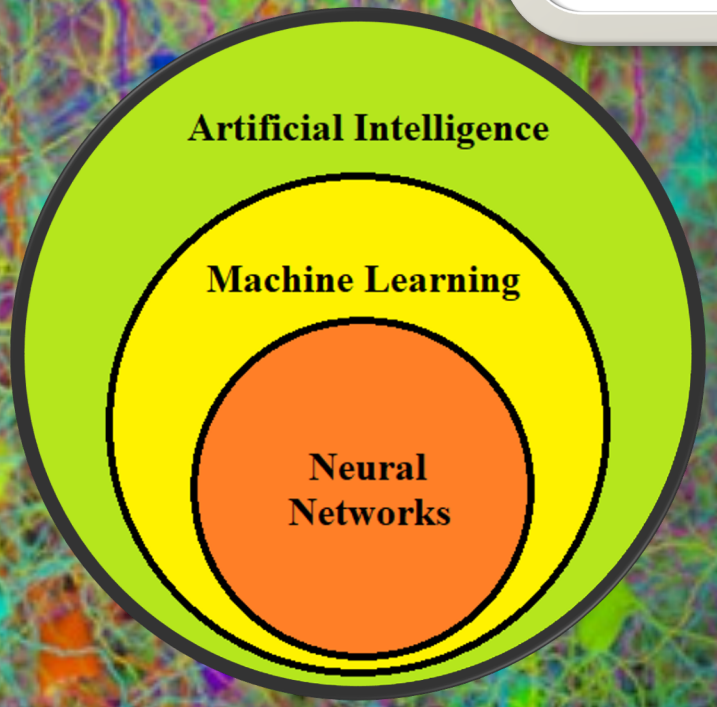
https://nasainkansas.org/



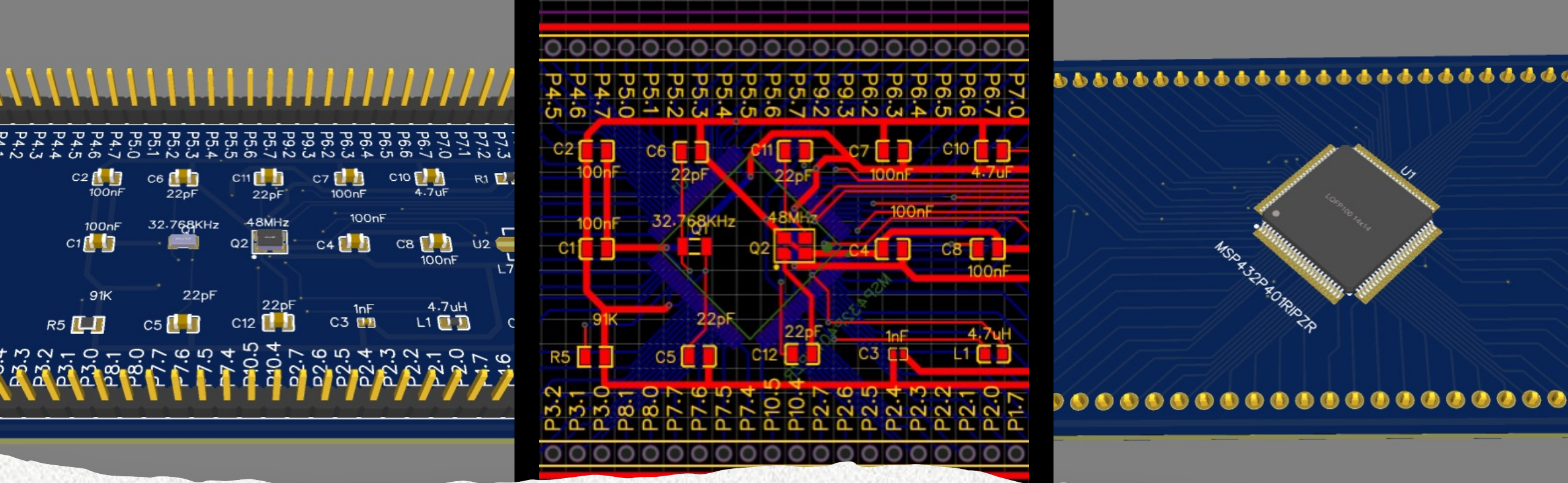


Neural Networks

Inspired by biological neurons.

State of the art for pattern recognition.

https://en.wikipedia.org/wiki/Neural_network#/media/File:Forest_of_synthetic_pyramidal_dendrites_grown_using_Cajal's_laws_of_neuronal_branching.png



What is On the Edge?

Advantages:

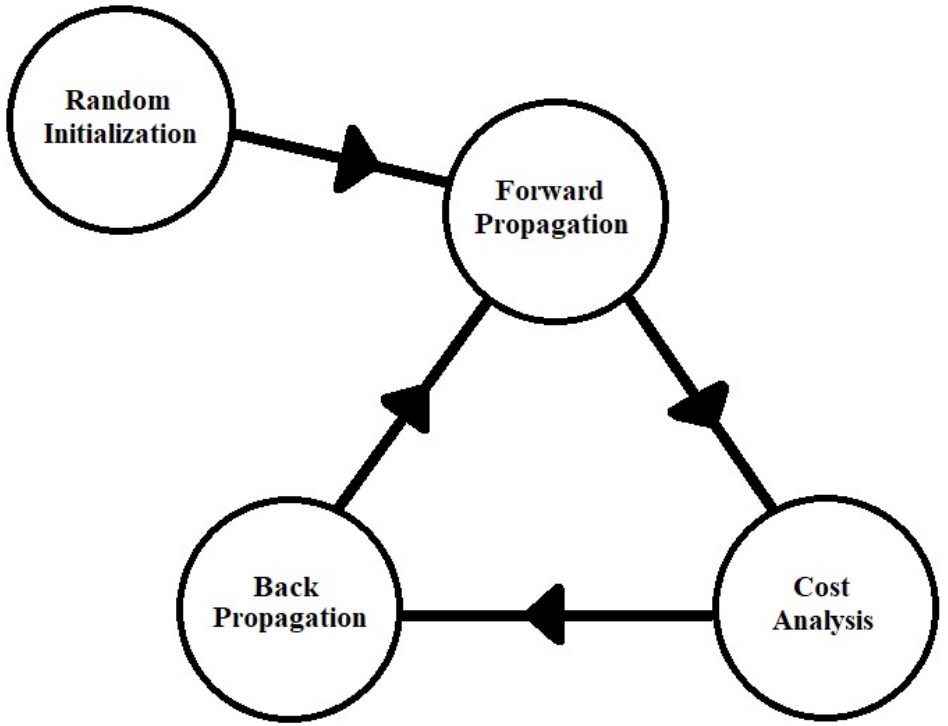
- Edge computing is not limited by network speeds.
- Use pretrained neural networks to perform complex tasks such as pattern recognition.

Disadvantages:

- Cannot take advantage of powerful computing power.
- Typically, static operations, and difficult to implement training.

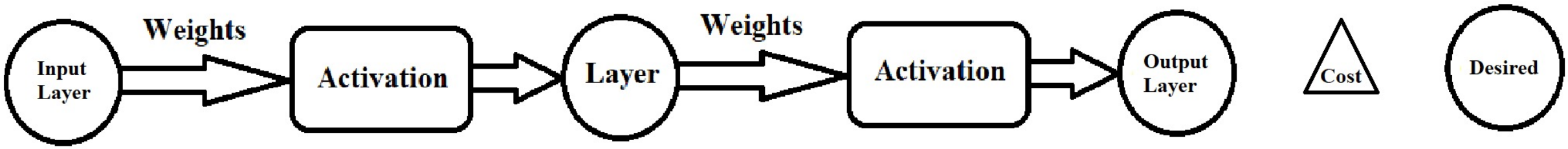
Training:

- Training The Network
  - Forward Propagation
  - Cost Analysis
  - Back Propagation
- Repeat



$$Activation_N = \frac{1}{1 + e^{-L_N * W_N}}$$

$$Activation_{N+1} = \frac{1}{1 + e^{-L_{N+1} * W_{N+1}}}$$



$$Layer_N = \sum (W_N * L_N)$$

$$Layer_{N+1} = \sum (W_{N+1} * L_{N+1})$$

$$Cost = (Output - Desired)^2$$

Understanding Forward Propagation

- Weights: Connections between neurons
- Layers: Neurons in network
- Activations: Sigmoid, RELU, Tanh, Linear, Step, etc.
- Cost: Error of a specific iteration

Understanding Back Propagation

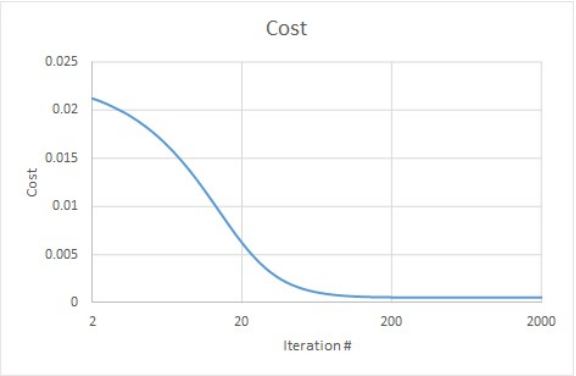
- Beginning with 4 neuron neural network
- Worked through relevant calculus
- Implemented back propagation on simple network
- Verified that the cost function was reducing

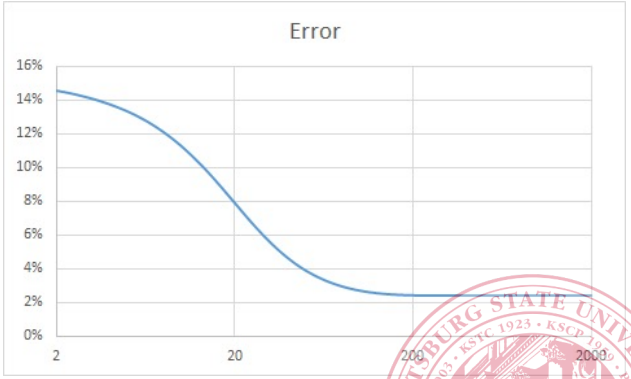
$$\frac{\partial Cost}{\partial Weight^{Layer}} = \frac{\partial (Weights * Layer)^{Layer}}{\partial Weight^{Layer}} * \frac{\partial Activation^{Layer}}{\partial (Weights * Layer)^{Layer}} * \frac{\partial Cost}{\partial Activation^{Layer}}$$

$$\frac{\partial Cost}{\partial Activation^{Layer}} = 2(Output - Desired)$$

$$\frac{\partial Activation^{Layer}}{\partial (Weight * Bias)^{Layer}} = \partial Activation(Weights * Layer)$$

$$\frac{\partial (Weights * Layer)^{Layer}}{\partial Weight^{Layer}} = Activation^{Layer}$$

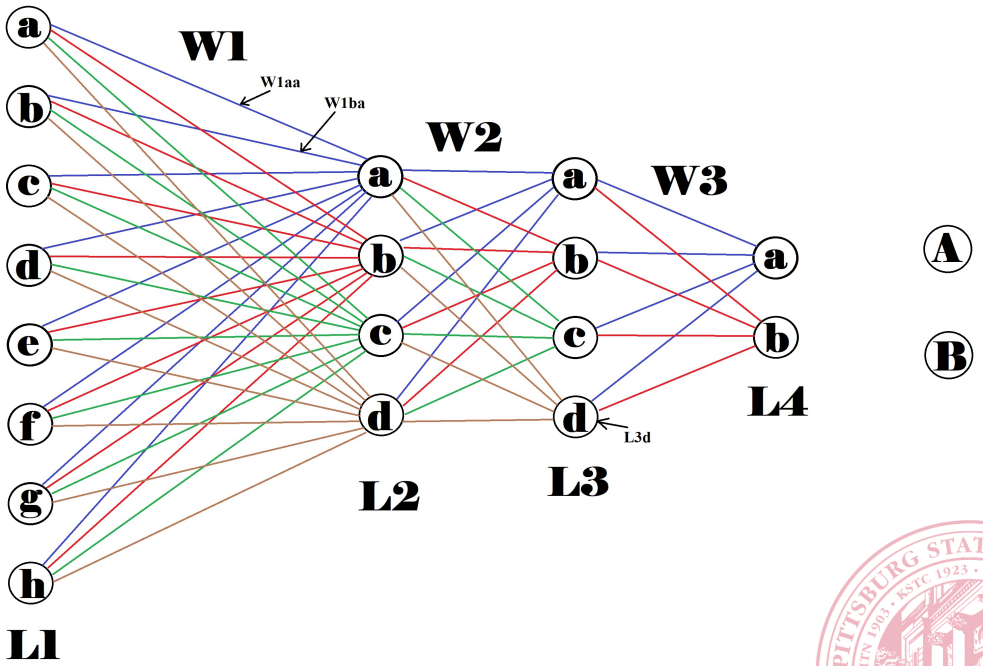




Successfully training a network:

```
L1 Inputs
 [0.4, 0.1, 0.9, 0.7, 0.1, 0.1, 0.9, 0.1]


Initial Desired
 [0.1, 0.9]


Initial Output
 [0.8713614934972438, 0.7033872162790458]


Final Output
 [0.1000000000000015, 0.9000000000000001]


Initial Cost
 [24.75342733  1.60821065]


Final Cost
 [9.34560510e-29 5.12790403e-31]
```

Colabratory Neural Network.txt



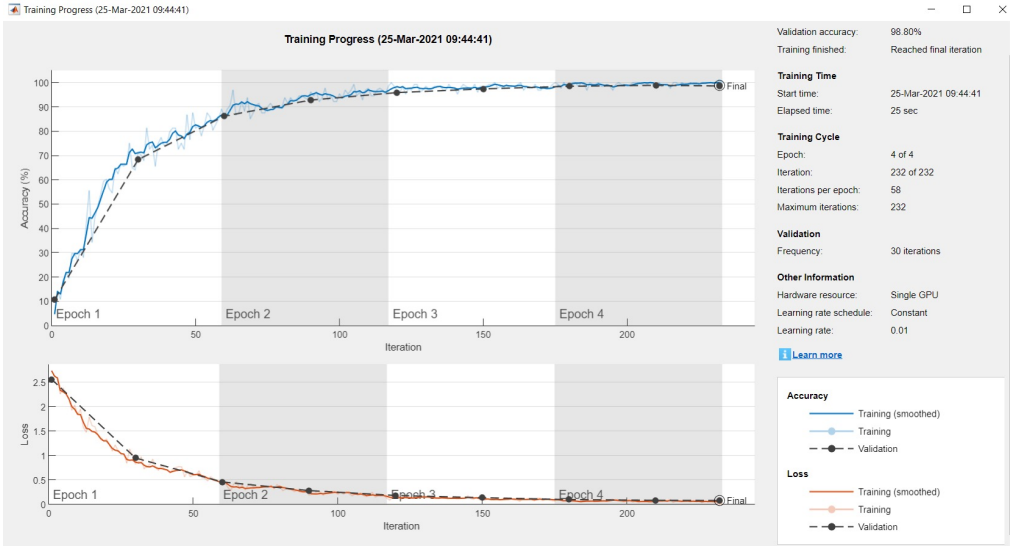
Training with MatLab, using GoogLe Net

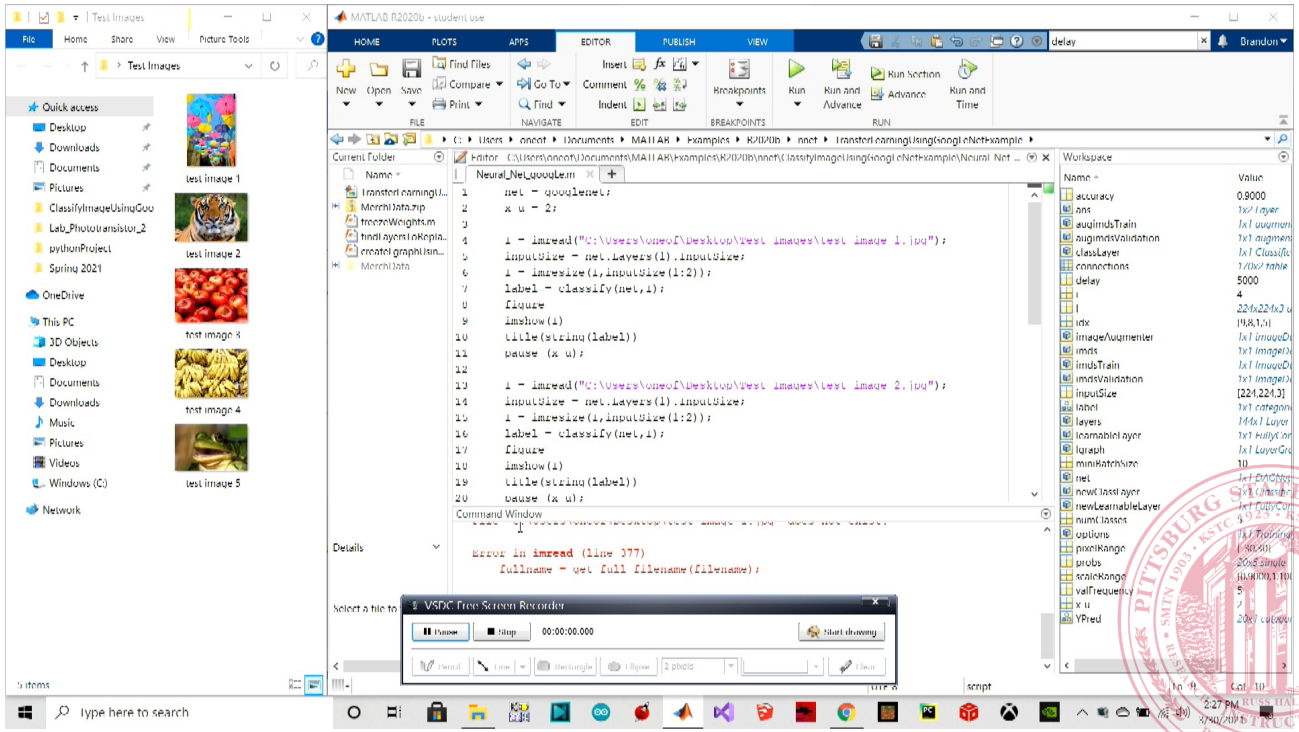
Training GoogLe net on a personal computer

Implement that network for image recognition

Results were good.

Apple was identified as a pomegranate.





banana

bullfrog

pomegranate

tiger

umbrella

Future Goals:

- Develop my own image recognition library.
- Learn how to use video recognition software on the edge.
- Implement a trained neural network on a microcontroller.

Thank you for watching!

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