Quantum Machine Learning with PennyLane

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WOMANIUM | QUANTUM

1. Problem

For this project, our goal was to work through several PennyLane exercises and tutorials to better understand quantum machine learning. While there is much research into algorithms and optimizations for classical machine learning, there is also research into the same for quantum. Since there are some problems better solved using a quantum computer and others that are solved more efficiently using a specific algorithm on a classical computer, our goal was to get a better understanding of how to use quantum computing or a hybrid approach and determine the accuracy of our solution to the problem.

2. Solution

- Since we're both quantum computing hobbyists, our goal was to work through the first 3 tasks to get more familiar with quantum computing but with quantum machine learning more specifically
  - Task 1 was to work through Pennylane Codebook exercises found at https://pennylane.ai/codebook/
  - Task 2 focused on working through a Variational Classifier tutorial to become more familiar with how variational circuits can be used in hybrid machine learning models
  - Task 3's assignment was a tutorial on Quantum Neural Networks to get us more familiar with how a quantum circuit can be used as one of the convolutional layers in a "Quanvolutional Neural Network"

3. Success Metrics

- Our success metric was 100% completion of the 3 tasks outlined in the previous slide
  - Task 1's success metric was illustrated by a green checkmark on each of the assignments in the following courses and a Jupyter Notebook full of code and basic explanations
    - Introduction to Quantum Computing
    - Single-Qubit Gates
    - Circuits with Many Qubits
  - Task 2 and 3's success metric was a completed notebook with output that looked like that of the tutorial
    - For these 2 tasks, we focused on accurate predictions while minimizing the cost function

4. Future Scope

There are several steps for the future scope

- Working through additional PennyLane Codebook exercises and machine learning tutorials
- Expanding our project to include Task 4 and experimenting with quantum or hybrid models for learning the sine curve
- Expanding our project to include Task 5 for conspicuity detection in production, comparing QNNs and other models to several well-performing classical models

  Potential limitations: time and processing power when working with large [image] datasets