FISQ: A Few-Shot, Interpretable, and Self-Supervised Quantum Machine Learning Approach to Automated Real-Time Prediction Across Multiple Domains

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To ascertain complex relationships between inputs and outputs and achieve high accuracies on specialized tasks, Machine Learning algorithms require vast amounts of high-quality data, compute power, and billions of parameters. In many instances, the quantity of data or compute power needed is unobtainable and even if present, the resulting model is unable to effectively capture granularities between multimodal data, adapt its learnings to other problem domains, or explain its predictions. Therefore, a novel end-to-end self-supervised quantum machine learning approach to provide interpretable predictions on fewer data is proposed. In a procedural flow, data can be sourced from virtually any data modality including images, text, audio, video, and signals. A synthetic data pipeline that includes a diffusion model automatically accounts for imbalances in the dataset. Images are encoded using a Quantum Convolutional Neural Network, text-based (including audio-derived text) data is encoded using a Bidirectional Encoder Representation model; videos and signals are encoded manually. Each of the encoded representations are passed into a contrastive self-supervised embedder, which learns relationships between the data simultaneously and encapsulates its learnings in a feature vector output. This vector is mapped to a Quantum Neural Network that outputs a final prediction for a specified task. The proposed approach was tested on benchmark datasets and the downstream task of identifying diagnoses, prognoses, and treatments for 1200 diseases on patient profiles sourced from the TCGA, JPND, and DDXPlus datasets; in both instances, the model outperformed all other state-of-the-art approaches with far fewer data and proved to output explainable predictions.

Awards Won:

University of Texas at Dallas: Scholarship of $5,000 per year, renewable for up to four years