



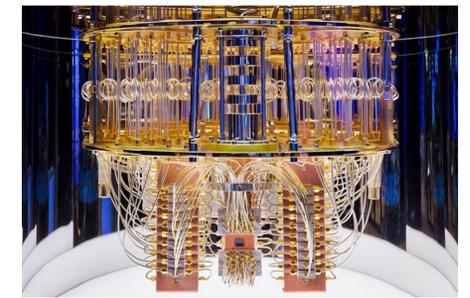
# Quantum Transformers for Image Generation

## 2025 Quantum Machine Learning REU Program

Atishay Narayanan<sup>1</sup>, Niraj Babar<sup>2</sup>, Sunil Vittal<sup>1</sup>, Glen Uehara<sup>1</sup>, Gennara De Luca<sup>1</sup>, Andreas Spanias<sup>1</sup>

<sup>1</sup>Department of Mathematics, Princeton University

<sup>2</sup>SenSIP Center, School of ECEE, Arizona State University

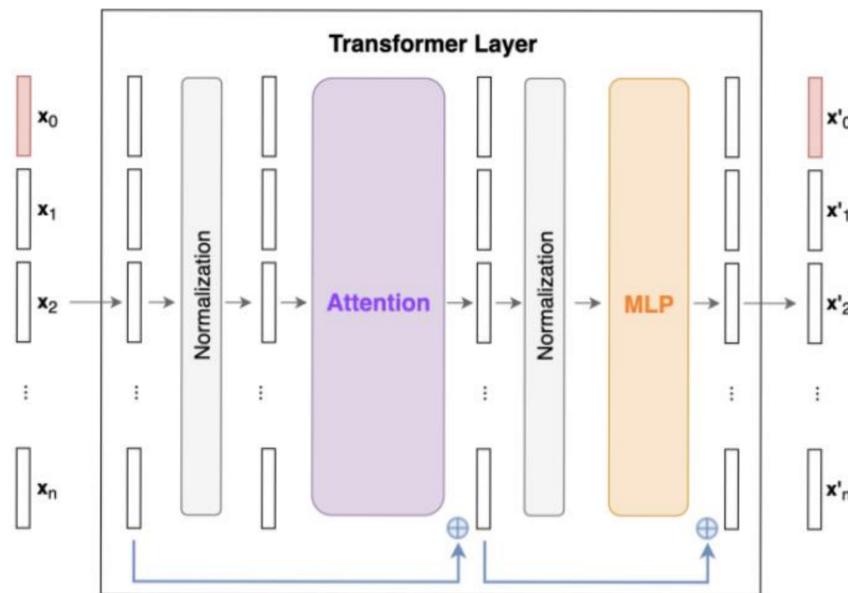


### RESEARCH BACKGROUND

- Quantum Computing has the potential to rapidly increase computation speed [1] by enabling parallelism via superposition and entanglement.
- Previous approaches at generating images with hybrid models have proven to be successful

### RESEARCH OBJECTIVES

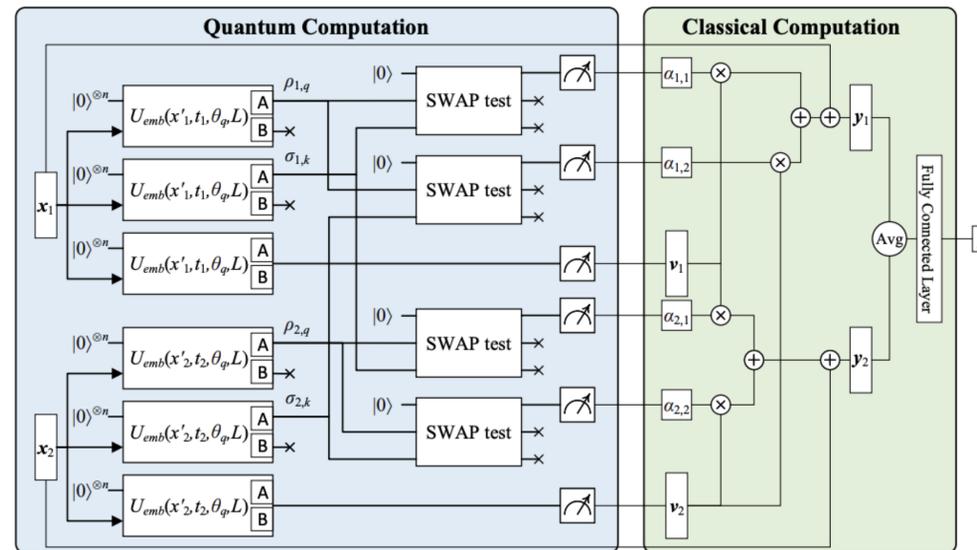
- Optimize training for decode-only Transformer
- Determine best circuit for computing self-attention in quantum
- Reconstruct half-images with quantum image transformer



Transformer layer [2]

### METHODS

- SOL supercomputer PyTorch, PennyLane, Braket
- MNIST Digit Data Set
  - Pre-processed by mapping pixels to 32 centroids obtained by k-means clustering dataset
- Transformer Architecture
- Quantum Self-Attention computation

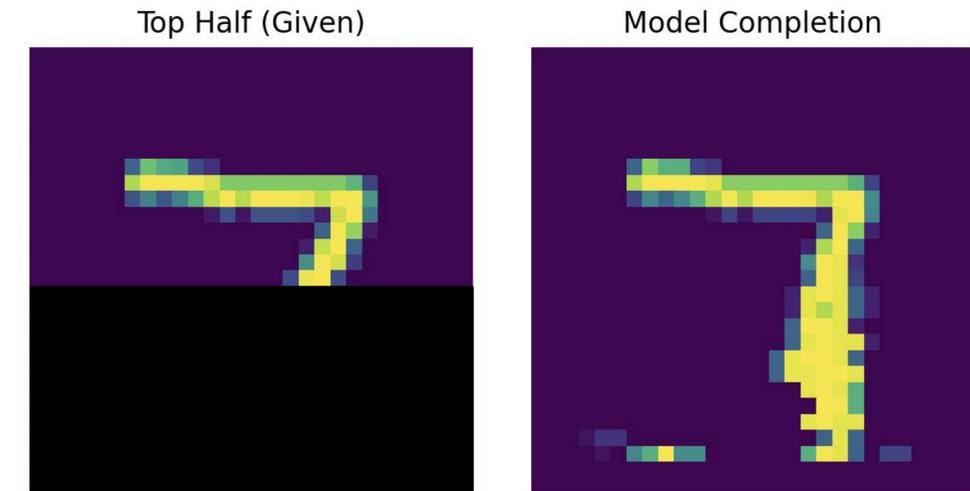


Quantum Mixed-State Self-Attention Network Framework [3]

### REFERENCES

- G. S. Uehara, A. Spanias, and W. Clark, "Quantum Information Processing algorithms with emphasis on machine learning," 2021 12th International Conference on Information, Intelligence, Systems & Applications (IISA), pp. 1–11, Jul. 2021
- Cherrat, et al., 2022. Quantum vision transformers. arXiv preprint arXiv:2209.08167.
- Chen, F., Zhao, Q., Feng, L., Chen, C., Lin, Y. and Lin, J., 2025. Quantum mixed-state self-attention network. Neural Networks, 185, p.107123.

### PRELIMINARY RESULTS



Model completion given half-digit context

### CONCLUSIONS

- Transformer model trains faster, but often lacks in performance compared to models optimized for image generation
- Increasing context size increases accuracy

### FURTHER WORK

- Attempt to train models on color image with a three-channel approach
- Mid-circuit measurement after attention block so qubits can be moved directly into Feed-Forward Multi-Layer Perceptron
- Fully quantum transformer, from encode to decode.