Quantum Computing and Love: Two of the World's Greatest Mysteries

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Introduction

- Quantum computing is gaining momentum, even though the hardware still needs improvement.
- This project evaluates how well a quantum algorithm predicts romantic relationship satisfaction compared to a classical machine learning model.
- After preparing survey data for machine learning, I train both an SVM and a VQC and compare their accuracy and training time.
- I expect the quantum model to underperform in accuracy but potentially show a speed advantage.

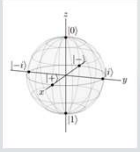
Dataset

- **Dataset:** Romantic Love Survey 2022, collected from 1556 people in English-speaking countries who are in romantic relationships.
- **Features:** Personality, relationship characteristics, romantic love measures, partner perceptions, and well-being.
- **Previous Studies:** Often cluster respondents into relationship "types."
- **Purpose:** Predicting an individual's satisfaction in the relationship from these factors.

Quantum Information

- Quantum systems can encode more information than classical systems.
- Current hardware is highly sensitive to errors, limiting circuit size and complexity.
- Goal: fault-tolerant quantum computer.
- "[Quantum Machine Learning] explores learning algorithms that can be executed on quantum computers to accomplish specified tasks with potential advantages over classical implementations." (Du, et. Al 2025)
- IBM's Qiskit software allows users to run and simulate quantum algorithms despite limited access to real hardware.

Computational and Mathematical Methods



Results

- The quantum model underperformed (~54% accuracy) compared to the classical model, which was over 90% accurate.
- The best quantum model also took longer to train than the classical model.
- Best SVM: C=0.1, kernel=linear, gamma=0.01
- Best VQC: ExcitationPreserving ansatz with 3 repetitions
- During cross-validation, the most complex SVM configuration took over 1.5 hours, while the most complex VQC configuration took under 41 minutes.

Model	Training Time	Accuracy	Precision	Recall	F1 Score
SVM	0.012 seconds	91.26%	91.64%	98.87%	95.12%
VQC	13.16 minutes	54.09%	82.47%	47.74%	60.48%

Discussion

- The classical model performed well, correctly classifying relationship satisfaction over 90% of the time.
- The quantum model performed poorly, but its lower training time for complex configurations suggests potential efficiency advantages.
- Exploring alternative QML models may improve results on this dataset.
- Future fault-tolerant quantum computers could handle higher-dimensional problems more effectively, potentially boosting performance.

Conclusions & Future Work

- My project showcases quantum computing's value in the human behavior domain.
- While the chosen algorithm and dataset were not a great match, the training-time advantage of more complicated quantum models motivates further exploration with different quantum algorithms and datasets.
- Future work could apply quantum algorithms to broader areas of human behavior and relationship science, possibly using regression or clustering instead of classification.

References

GitHub