Financial Wellbeing

Using quantum machine learning to identify people who are in need of financial support.

Qiskit Hackathon: July 2022

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Coach: Desiree (IBM) and Charles (Physics)

*Thanks to Udaya for support.

Financial Wellbeing

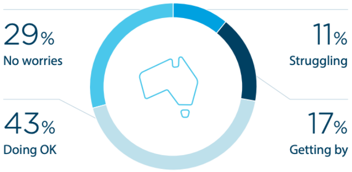
Usefulness and Complexity

FINANCIAL WELLBEING IN AUSTRALIA AT A GLANCE

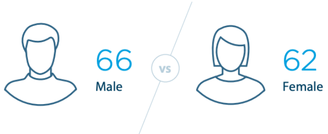
THE FOUR COMPONENTS OF FINANCIAL WELLBEING

- Meeting everyday commitments
- Feeling comfortable
- Financial resilience
- Feeling secure for the future

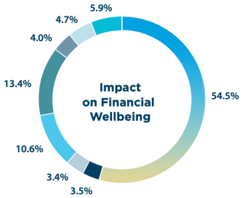
FINANCIAL WELLBEING CATEGORIES IN AUSTRALIA



FINANCIAL WELLBEING SCORE (OUT OF 100)

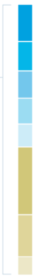


WHAT CAN INFLUENCE FINANCIAL WELLBEING?



- 54.5% Socio-economic conditions
- 3.5% Knowledge & experience
- 3.4% Financial confidence & control
- 10.6% Saving & spending behaviours
- 13.4% Behaviour traits
- 4.0% Money management behaviour
- 4.7% Investment behaviour
- 5.9% Saving & spending attitudes

Socio-economic conditions have the largest influence on financial wellbeing



POSITIVE EFFECT

- 7.5% Earning potential
- 5.9% Life journey
- 5.5% Access to social support
- 5.2% Financial stability
- 4.6% Male gender

NEGATIVE EFFECT

- 13.7% Health concerns
- 8.5% Unemployment
- 3.6% Financial support to a dependent

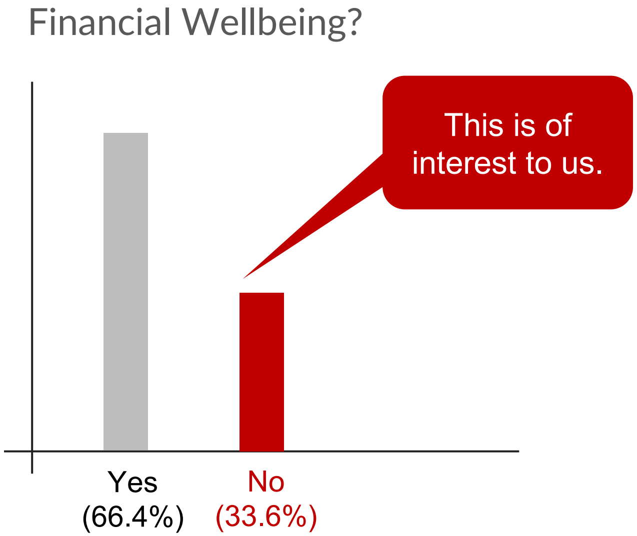
SAVING, SPENDING AND INVESTMENT BEHAVIOURS IMPORTANT FOR FINANCIAL WELLBEING

- Active saving
- Not borrowing for everyday expenses
- Spending restraint
- Investment

Source: ANZ Financial Wellbeing Survey 2021

Classification task on real world data

1. Demographics (62+, minority, general population, etc).
2. Living status (alone, with partner, shared, etc).
3. Financial skill score.
4. Ability to make complex decisions.
5. Understanding of compound interest.
6. Understanding of relation between inflation and savings interest rate.
7. Understanding of difference between stock and mutual fund volatility.



Data available from consumerfinance.gov

Results: Classical vs Quantum

Usefulness and Complexity

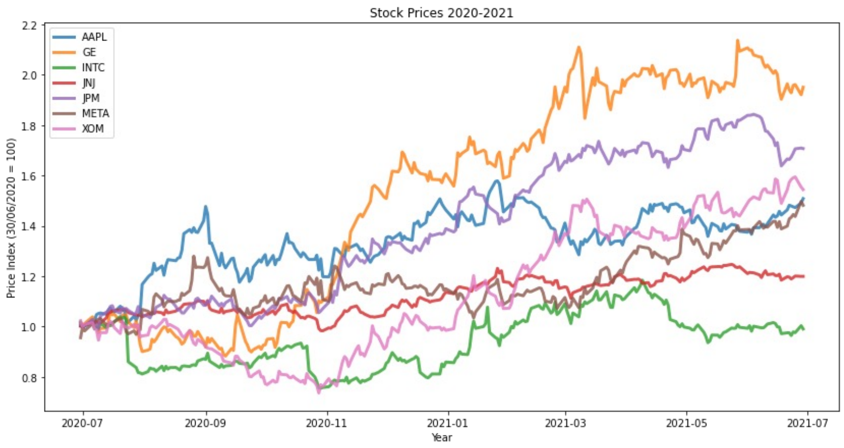
	AUC	Precision	Recall	F1-Score	Time(s)
AdaBoost	0.597	0: 0.45 1: 0.73	0: 0.56 1: 0.64	0: 0.50 1: 0.68	0.006
Neural Networks (3 hidden layers)	0.67	0: 0.79 1: 0.75	0: 0.41 1: 0.94	0: 0.54 1: 0.83	0.06
Logit	0.61	0: 0.73 1: 0.71	0: 0.30 1: 0.94	0: 0.42 1: 0.81	0.016
SVM	0.64	0: 0.89 1: 0.72	0: 0.30 1: 0.98	0: 0.44 1: 0.83	0.007
Quantum VQC (ZZFeature, RealAmplitudes)	0.55	0: 0.41 1: 0.69	0: 0.48 1: 0.62	0: 0.44 1: 0.65	912.5
Quantum Kernel (ZZFeature, linear entl.)	0.55	0: 0.50 1: 0.68	0: 0.22 1: 0.88	0: 0.31 1: 0.77	954.4
Quantum Kernel (ZFeature)	0.60	0: 0.56 1: 0.71	0: 0.37 1: 0.84	0: 0.44 1: 0.77	618.2
Quantum Kernel (PauliFeature)	0.48	0: 0.25 1: 0.64	0: 0.07 1: 0.88	0: 0.11 1: 0.74	2144.75

Ran on 6% of the dataset. Core i9-10900F@4.8Ghz, 64GB DDR4 3466 MHz, Windows 11 Pro under Jupyter Notebook environment. QML was run on a simulator.

Portfolio optimisation on real world data

Just for fun…

Bonus?



Metrics	Expected Return	Expected Risk	Sharpe Ratio
Equally weighted	55.02%	20.94%	2.46
Classical (scipy, slsqp)	71.44%	23.02%	2.95
VQE	63.3%	21.28%	2.81
QAOA	76.34%	25.25%	2.89

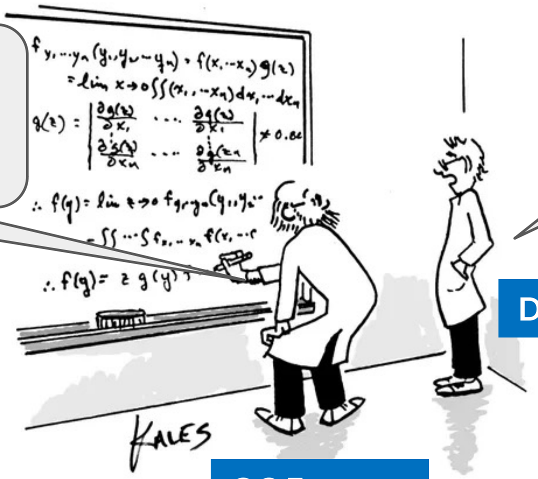
Weights	AAPL	META	XOM	JNJ	JPM	INTC	GE	TSLA
Equally weighted	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Classical	0.00	0.25	0.00	0.05	0.30	0.24	0.16	0.00
VQE	0.10	0.30	0.00	0.10	0.10	0.20	0.10	0.10
QAOA	0.10	0.30	0.00	0.00	0.20	0.20	0.20	0.00

Note: Only one year of past daily data taken and hence Sharpe ratio is high.

What did we learn?

- Hackathons are fun and an *efficient* way to get into something new.
- Double (triple) check the qiskit doc. version and the installed version.
- Inputs to the VQC and Kernel methods may be different.
  - The target variable needed one-hot encoding in VQC but not in kernel methods.
- Different runs of a QML algorithm may yield diverse performance
  - Hyper parameter tuning is based on experience with these methods.
- QML methods are (currently) magnitudes slower than classical ML methods.
  - Implementing parallel processing in simulators can be tricky.
  - One needs patience (a lot of it…)
- QML methods (currently) have a lower performance than classical ML methods.
- One has to be aware of issues arising from using small datasets (in the presence of noise).

Healthy cross-disciplinary collaboration



Thank you to UoM Physics and IBM Quantum group for organizing this event.