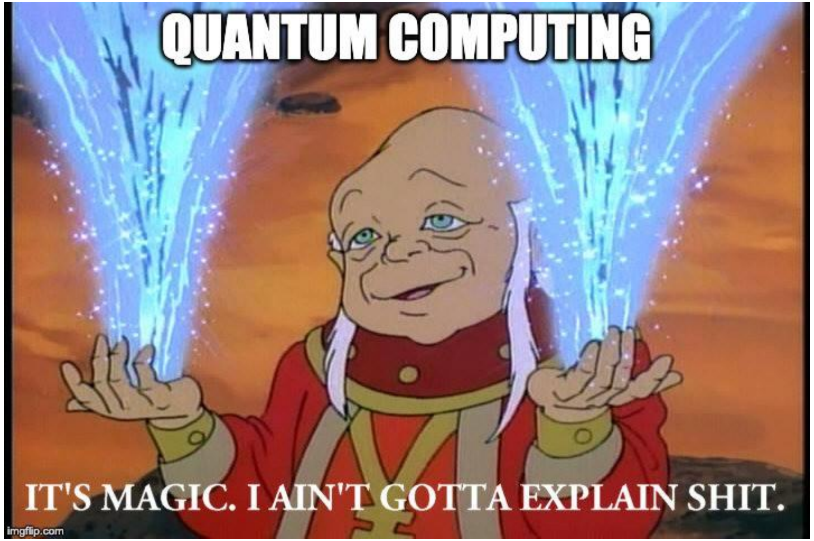
QisKittens

Solving optimization problems with Quantum Computers

Our Approach:

Go into superposition and try everything!

Different Repetitions
Trying different optimizers
QAOA with warm start
QAOA with Annealing Initialization
Recursive QAOA
Pulse-efficient circuit transpilation
Circuit Optimization

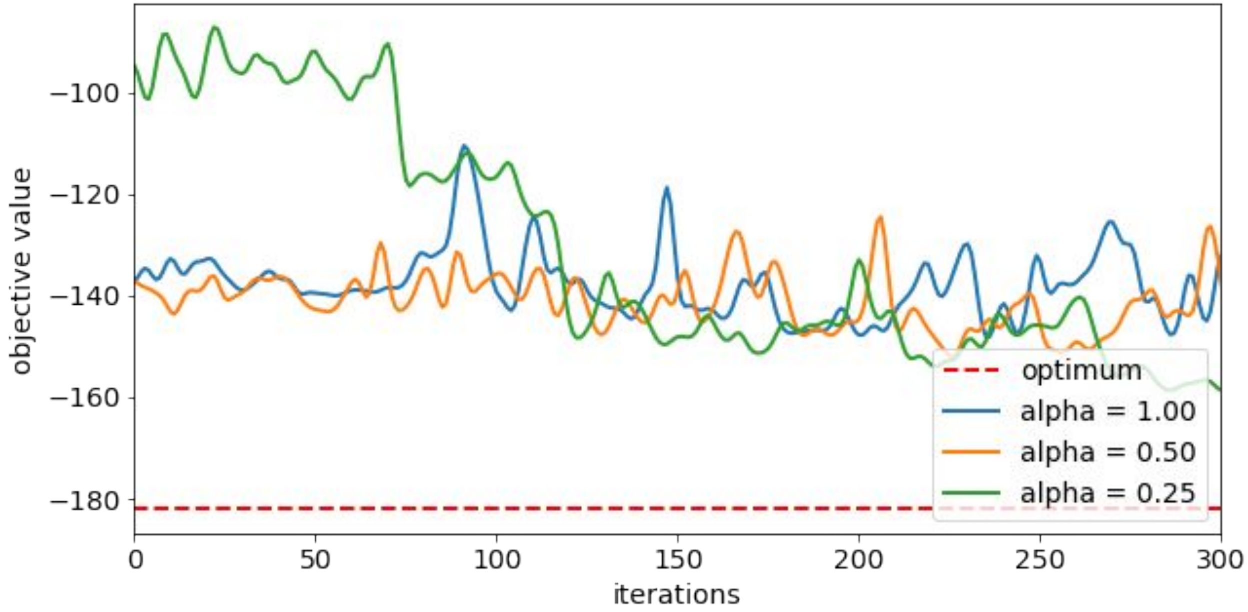


CVaR + VQE + QNSPSA

Conditional **Va**lue at **R**isk:
➔ average over α-fraction of best observed samples

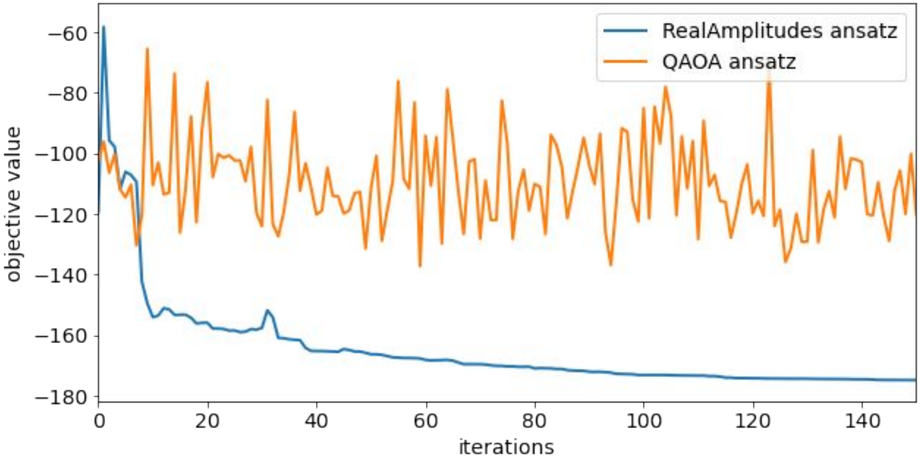
Variational **Q**uantum **E**igensolver

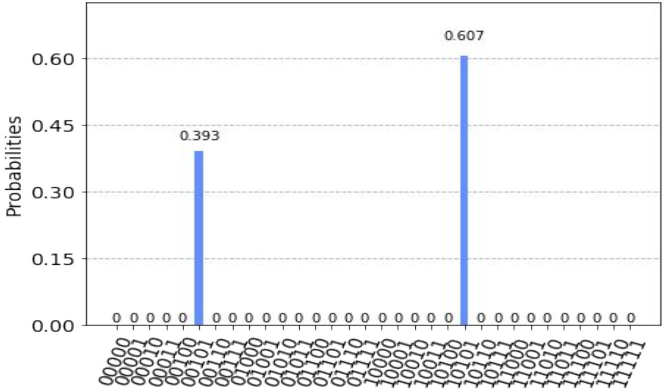
Quantum **N**atural **S**imultaneous **P**erturbation **S**tochastic **A**pproximation

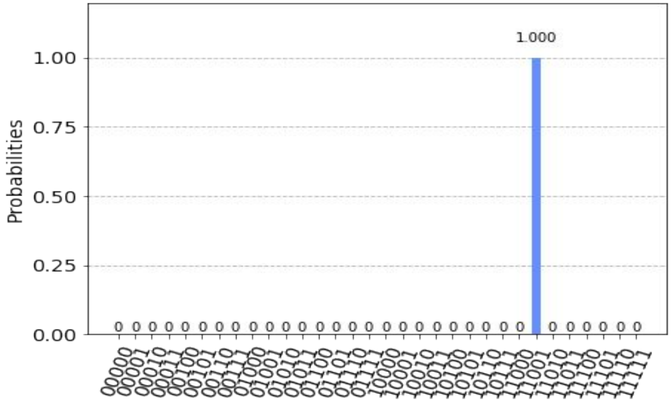


Results - Real Amplitudes is all you need!

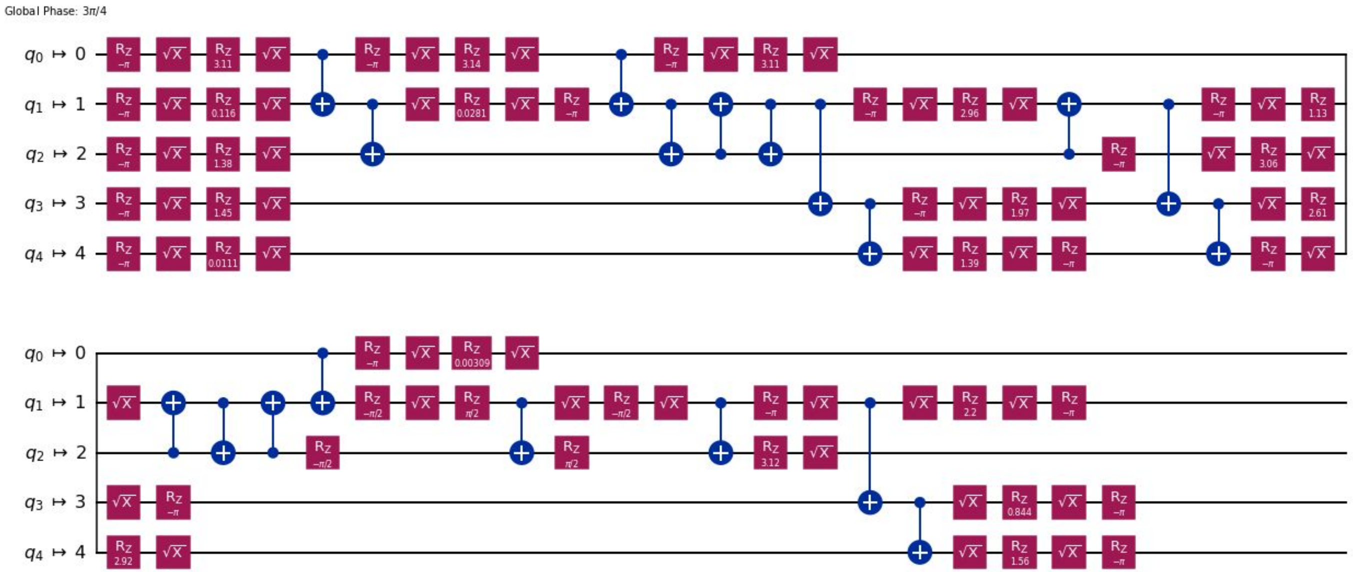
Problem	Optimizer	cx	fidelity	nfev
Simple	SLSQP	21	0.79	559
Hard	SLSQP	27	0.74	1493







Circuit Optimization

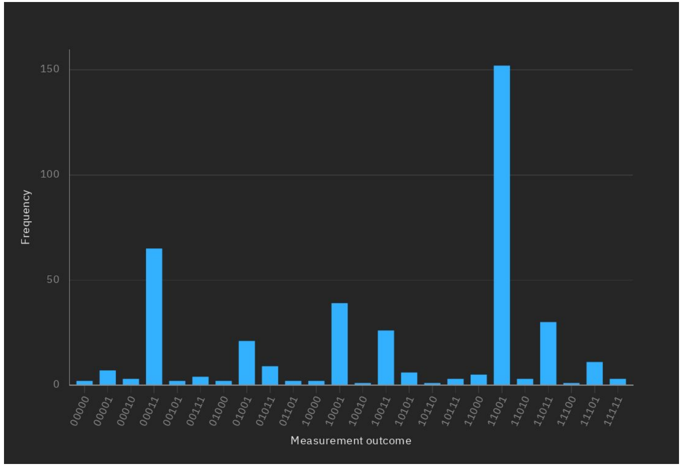


Scheduling Duration	No decomposition	With decomoposition (RZZ)
QAOA reps = 3, op_level = 3	158080	143168

Real Amplitude on a **real** device

Problem	Optimizer	cx	fidelity	shots	nfev	shots * cx * nfev	Probability
Hard	SLSQP	19	0.8	400	2165	16454000	152/400
Hard	SLSQP	19	0.8	16	2165	658160	5/16

400



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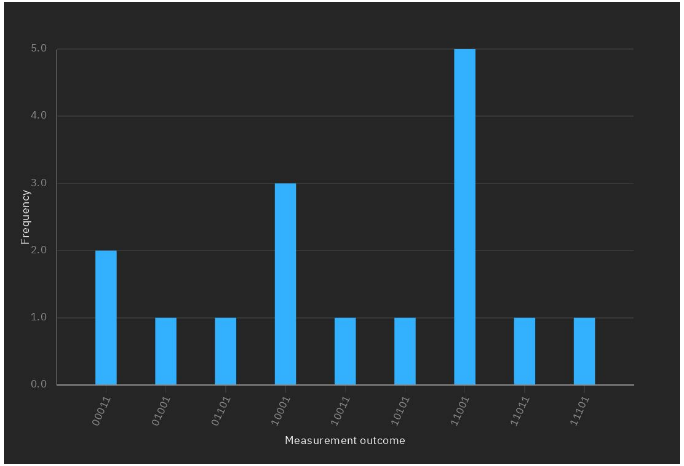
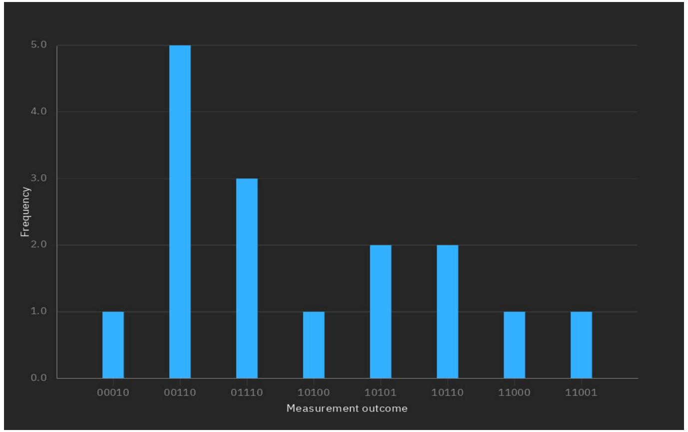


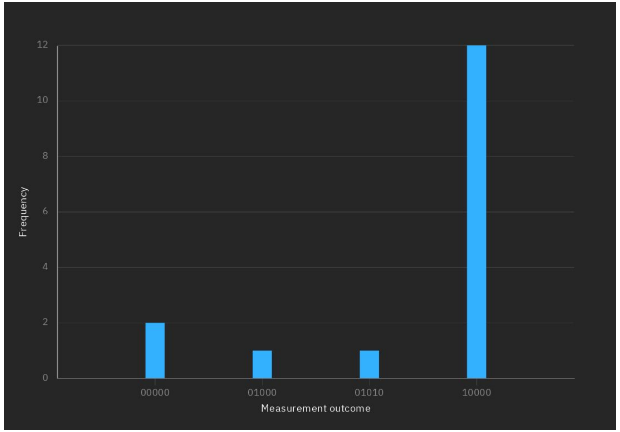
But can that even be real?

Construction of new dataset with T=10, M=1500:

Pilatus	Säntis	Eiger	Rigi	S. Salvatore
2128	2502	3970	1798	912
3320	6000	12000	11000	3400

Uetliberg	Zürichberg	Hönggerberg	Chäferberg	Irchel
870	676	541	571	530
8600	6200	2000	930	4200





Collapse our wave function to be the winning team!

What we learned:

Physics behind quantum optimization methods.

Initialization might help!

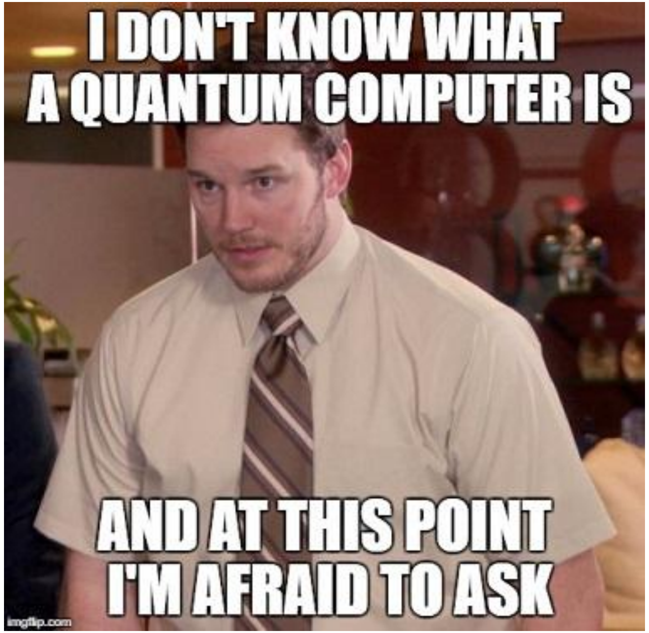
Optimizers matter a lot!

Ansatz is decisive!

Peak into implemetations on hardware.

Kitten Teamwork!

QisKittens



➔ **Check out our code at https://github.com/gongaa/Qiskittens**