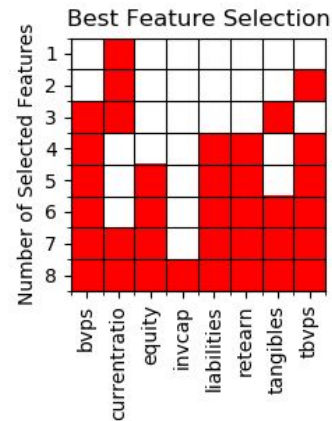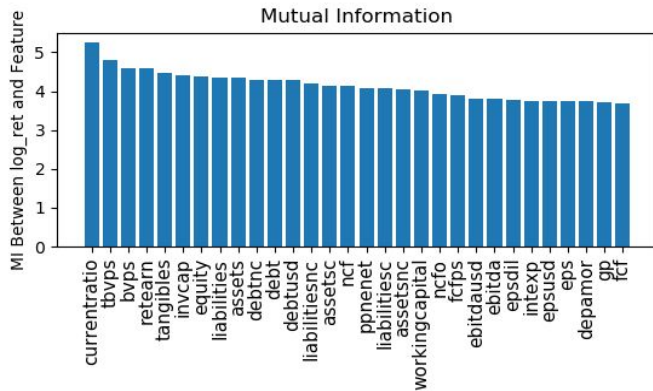# Quantum Baked ETFs (QBE)

yiyaniQ

What is QBE?

- Near term quantum devices provide a chance for creating a new ETF that takes advantage of the speed of optimization in NISQ devices.

- QBE utilizes:
    - Mutual Information QUBO (MIQUBO) scoring for portfolio composition
    - D-wave's LeapHybridSolver for dynamic portfolio optimization

Quantum Feature Selection (MIQUBO)

Static Portfolio Optimization

SIMULATED ANNEALING RESUTLS

	Number of stocks	Sharpe Ratio	Profits (in %)	Runtimes (in s)	Number of parameters	Hilbert space
0	5	**0.07156421463857290**	**0.0382027384557147**	**0.04610896110534670**	15	2^15
1	10	0.7357157588484570	0.46137550698317200	**0.08736991882324220**	30	2^30
2	20	2.81922960766307	**2.044118545307860**	**0.1944589614868160**	60	2^60
3	50	3.145239234219270	**1.7805423923596200**	**1.0075957775116000**	150	2^150
4	100	-0.1587934946536610	-0.08768256039747570	**2.8797991275787400**	300	2^300
5	200	**0.6975258686071230**	0.39360494144168400	11.240008354187000	600	2^600
6	450	**0.4526074444327920**	**0.3793172189157180**	58.82443904876710	1350	2^1350

DWave LEAP SOLVER RESULTS

	Number of stocks	Sharpe ratio	Profits (in %)	Runtimes (in s)	Number of parameters	Hilbert space
0	5	0.014380602384134100	0.007642709261836910	2.942355155944820	15	2^15
1	10	**0.9196806018278030**	**0.4938532023041790**	2.779998779296880	30	2^30
2	20	**2.82409488902355**	1.7306967951455400	3.270850658416750	60	2^60
3	50	**3.530689528371310**	1.6140734235491800	3.251215934753420	150	2^150
4	100	**1.3423067501601700**	**0.871275465341886**	4.139371156692510	300	2^300
5	200	0.6856007646261490	**0.4297511584858870**	8.839293241500850	600	2^600
6	450	0.42015618949075700	0.3768118326420830	**22.277909994125400**	1350	2^1350

Dynamic portfolio optimization

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Results from the Hybrid Solver

The 100 assets in the portfolio are: ['AES', 'BDX', 'VRSK', 'ADM', 'VRTX', 'TDY', 'BIO', 'BR', 'ALGN', 'AJG', 'WEC', 'CAT', 'AVY', 'TYL', 'ITW', 'HII', 'FTNT', 'PENN', 'GOOGL', 'IPGP', 'INTU', 'LYB', 'PCAR', 'EL', 'GNRC', 'DXC
M', 'ENPH', 'ETR', 'NVDA', 'NTAP', 'CME', 'MLM', 'IEX', 'IDXX', 'MNST', 'FOXA', 'ILMN', 'MCK', 'HPE', 'PKI', 'SNPS', 'CMS', 'CNC', 'CNP', 'JNJ', 'COO', 'ROST', 'ROL', 'PKG', 'CPRT', 'K', 'REGN', 'KHC', 'PWR', 'DFS', 'PNR', 'DT
E', 'CRL', 'ICE', 'FAST', 'LEN', 'DHR', 'DRI', 'KO', 'TXN', 'MU', 'HOLX', 'SPGI', 'LH', 'INCY', 'ABT', 'ABMD', 'KLAC', 'ZBRA', 'WLTW', 'WY', 'UPS', 'AKAM', 'SWK', 'COG', 'ROK', 'TER', 'PH', 'PFE', 'BF.B', 'PEG', 'TTWO', 'HES',
'EIX', 'EMR', 'EOG', 'FB', 'APA', 'AON', 'FBHS', 'VIAC', 'GM', 'MCO', 'EMN', 'ZTS'] and are traded for 100 days.
The trading trajectory is :
[[0.  0.  0.  ... 0.  0.  0. ]
 [0.  0.1 0.  ... 0.  0.  0. ]
 [0.  0.  0.  ... 0.  0.  0. ]
 ...
 [0.  0.  0.  ... 0.  0.  0. ]
 [0.  0.  0.3 ... 0.  0.  0.1]
 [0.  0.  0.  ... 0.  0.  0. ]]
The trajectory normalization is : [1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
 1. 1. 1. 1.] and the energy is -100.02749470062554
The hybrid solver ran for 102.92326188087463 s.
Hybrid solver Sharpe ratio is -0.7735583658033727, and the profits are -5.137044265162761%


Results from the SA Solver

The 100 assets in the portfolio are: ['AES', 'BDX', 'VRSK', 'ADM', 'VRTX', 'TDY', 'BIO', 'BR', 'ALGN', 'AJG', 'WEC', 'CAT', 'AVY', 'TYL', 'ITW', 'HII', 'FTNT', 'PENN', 'GOOGL', 'IPGP', 'INTU', 'LYB', 'PCAR', 'EL', 'GNRC', 'DXC
M', 'ENPH', 'ETR', 'NVDA', 'NTAP', 'CME', 'MLM', 'IEX', 'IDXX', 'MNST', 'FOXA', 'ILMN', 'MCK', 'HPE', 'PKI', 'SNPS', 'CMS', 'CNC', 'CNP', 'JNJ', 'COO', 'ROST', 'ROL', 'PKG', 'CPRT', 'K', 'REGN', 'KHC', 'PWR', 'DFS', 'PNR', 'DT
E', 'CRL', 'ICE', 'FAST', 'LEN', 'DHR', 'DRI', 'KO', 'TXN', 'MU', 'HOLX', 'SPGI', 'LH', 'INCY', 'ABT', 'ABMD', 'KLAC', 'ZBRA', 'WLTW', 'WY', 'UPS', 'AKAM', 'SWK', 'COG', 'ROK', 'TER', 'PH', 'PFE', 'BF.B', 'PEG', 'TTWO', 'HES',
'EIX', 'EMR', 'EOG', 'FB', 'APA', 'AON', 'FBHS', 'VIAC', 'GM', 'MCO', 'EMN', 'ZTS'] and are traded for 100 days.
The trading trajectory is :
[[0.  0.  0.  ... 0.  0.1 0. ]
 [0.  0.  0.  ... 0.  0.1 0. ]
 [0.2 0.  0.1 ... 0.  0.  0. ]
 ...
 [0.  0.  0.  ... 0.  0.  0. ]
 [0.  0.  0.3 ... 0.  0.  0. ]
 [0.  0.  0.  ... 0.  0.  0. ]]
The trajectory normalization is : [1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.
 1. 1. 1. 1.] and the energy is -99.55802377338114
The SA solver ran for 333.3997542858124 s.
SA solver Sharpe ratio is -1.9787230913105445, and the profits are -12.293086528856362%
```

Why QBE?

- QBE can be tailored to value or growth investment strategy

- QBE advantage: optimization speed and state-of-the-art feature selection signals great market performance

- QBE will be the hot cake of the ETF market