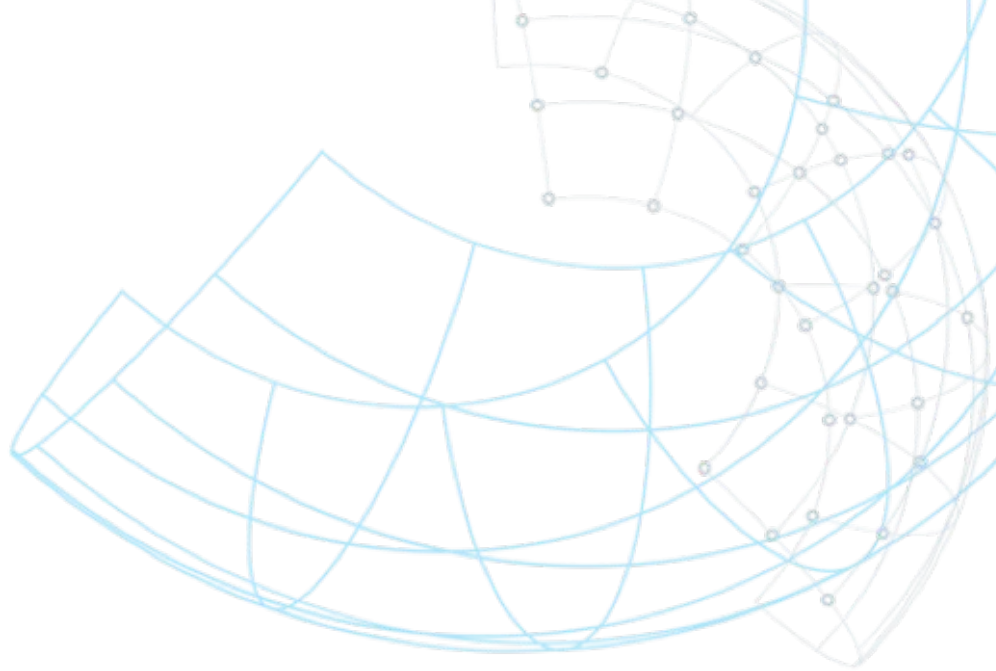
Redefining Financial Problems with Quantum Applications

Maxwell Rounds,
Industry Applications – Finance
maxwell.rounds@1QBit.com

1QBit

Overview

1. Introduction to 1QBit
2. The quantum hardware market
3. Why is quantum software needed
4. Applications in Finance
5. Quantum-Ready Software Development



1QBit

An Introduction to 1QBit

1QBit

1QBit

Company Overview

- Founded in 2012 as the first dedicated quantum software company
- Team of 50 scientists and software developers
- World Economic Forum Technology Pioneer
- Privately held company backed by international finance firms
- Fortune 100 client base

1QBit

Our Products and Services

1QBit™ Quantum-Ready™ platforms are compatible with both classical and quantum processors

Software Development Kit

Micro-Services

Custom Software

1QBit

The Quantum Computing Market

1QBit

Computational paradigms

We've been here before

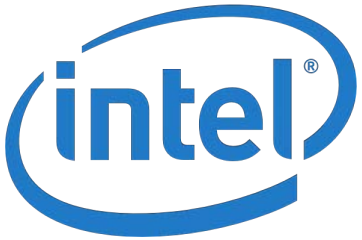




Vacuum Tube Transistor Integrated Circuit Microprocessor Quantum Processor

1QBit

The quantum ecosystem in 2016



The future quantum industry players

#	Company	Country HQ	$ software	$ total revenue	Software / Total	SaaS / Software	SaaS revenue
1	Microsoft	United States	$58,432.71	$72,930.00	80.10%	2.50%	$1,463.00
2	IBM	United States	$28,846.32	$104,507.00	27.60%	2.60%	$742.50
3	Oracle	United States	$27,710.27	$37,341.00	74.20%	3.50%	$972.00
4	SAP	Germany	$16,616.79	$21,282.00	78.10%	6.70%	$1,117.00
5	Ericsson*	Sweden	$8,048.60	$34,993.93	23.00%	0.00%	$0.00
6	Symantec	United States	$6,417.74	$6,839.00	93.80%	9.30%	$595.00
7	HP	United States	$5,512.50	$119,239.00	4.60%	1.70%	$94.00
8	EMC	United States	$5,128.82	$17,118.00	30.00%	1.60%	$80.00
9	Adobe	United States	$4,334.77	$4,405.00	98.40%	15.20%	$661.00
10	CA	United States	$4,304.41	$4,680.00	92.00%	1.90%	$80.00
11	VMware EMC	United States	$4,239.82	$4,605.00	92.10%	0.70%	$30.00
12	Fujitsu	Japan	$3,130.97	$55,366.00	5.70%	14.00%	$438.00
13	Salesforce	United States	$2,805.61	$2,982.70	94.10%	98.60%	$2,766.00
14	SAS	United States	$2,662.30	$2,870.00	92.80%	4.60%	$123.41
15	Hitachi	Japan	$2,528.23	$116,580.00	2.20% 4	.70%	$119.69
16	Intuit	United States	$2,464.75	$4,170.00	59.10%	49.20%	$1,213.00
17	Infor	United States	$2,464.40	$2,659.03	92.70%	1.10%	$27.00
18	Siemens	Germany	$2,441.15	$100,610.05	2.40% 6	.10%	$150.00
19	Dassault	France	$2,368.98	$2,606.94	90.90%	6.30%	$150.00
20	Autodesk	United States	$2,263.01	$2,307.37	98.10%	3.90%	$88.00
21	Citrix	United States	$2,088.55	$2,586.12	80.80%	24.50%	$511.00
22	Cisco	United States	$1,997.79	$47,061.67	4.20%	40.00%	$800.00
23	BMC	United States	$1,972.72	$2,198.00	89.80%	1.20%	$23.30
24	NEC	Japan	$1,942.16	$38,484.11	5.00%	4.00%	$77.31
25	Sage	United Kingdom	$1,751.81	$2,151.05	81.40%	2.30%	$40.00
26	Intel	United States	$1,674.53	$53,341.00	3.10%	6.40%	$106.40
27	Synopsys	United States	$1,646.45	$1,789.12	92.00%	1.20%	$20.00
28	Apple	United States	$1,600.75	$164,687.00	1.00%	0.10%	$2.00
29	Wolters Kluwer	Netherlands	$1,435.25	$4,629.84	31.00%	1.80%	$25.36
30	SunGard	United States	$1,393.39	$4,263.00	32.70%	3.60%	$50.00
31	McKesson	United States	$1,332.06	$3,348.00	39.80%	5.60%	$75.00
32	ADP	United States	$1,257.51	$10,945.00	11.50%	95.00%	$1,194.63
33	NetApp	United States	$1,250.90	$6,296.87	19.90%	0.00%	$0.00
34	Hexagon	Sweden	$1,205.62	$3,059.44	39.40%	0.00%	$0.00
35	Cadence	United States	$1,174.55	$1,326.42	88.50%	1.00%	$12.00
36	Attachmate Group	United States	$1,174.43	$1,260.03	93.20%	0.00%	$0.00
37	Trend Micro	Japan	$1,170.62	$1,175.71	99.60%	11.30%	$132.78
38	ESRI	United States	$1,168.33	$1,476.41	79.10%	11.70%	$137.00
39	Teradata	United States	$1,153.78	$2,665.00	43.30%	4.30%	$50.00
40	Red Hat	United States	$1,115.54	$1,294.94	86.10%	0.00%	$0.00
41	Nuance Inc.	United States	$1,018.47	$1,753.13	58.10%	1.00%	$10.00
42	PTC	United States	$960.17	$1,256.00	76.40%	0.00%	$0.00
43	DATEV	Germany	$957.02	$998.55	95.80%	46.10%	$441.40
44	OpenText	Canada	$943.65	$1,276.40	73.90%	3.20%	$30.00 44
45	Software A44G	Germany	$915.26	$1,333.46	68.60%	0.00%	$0.00
46	Avaya Inc.	United States	$894.23	$5,024.00	17.80%	1.10%	$10.00
47	Mentor Graphics	United States	$877.13	$1,085.10	80.80%	0.00%	$0.00
48	Cerner	United States	$854.12	$2,665.44	32.00%	26.90%	$230.00
49	TIBCO	United States	$780.36	$1,032.00	75.60%	4.20%	$33.00
50	Compuware	United States	$776.01	$969.11	80.10%	31.10% $	241.00
51	ANSYS	United States	$756.26	$798.02	94.80%	0.00%	$0.00
52	Google	United States	$755.18	$50,175.00	1.50%	90.60%	$684.00
53	Informatics	United States	$688.31	$812.00	84.80%	2.80%	$19.00
54	Kaspersky Lab	Russia	$627.80	$750.00	83.70%	6.90%	$43.18
55	Kronos Inc.	United States	$596.10	$923.30	64.60%	0.30%	$1.85
56	Constellation Inc.	Canada	$582.70	$891.23	65.40%	5.10%	$30.00
57	TOTVS	Brazil	$579.68	$722.96	80.20%	3.50%	$20.00
58	Fidelity National	United States	$578.10	$5,807.60	10.00%	3.50%	$20.00
59	NCR	United States	$575.25	$5,730.00	10.00%	20.30%	$116.78
60	Wincor Nixdorf	Germany	$568.16	$3,088.49	18.40%	0.00%	$0.00
61	FICO	United States	$567.48	$716.09	79.20%	36.10%	$204.80
62	MICROS Systems	United States	$565.11	$1,204.94	46.90%	1.80%	$10.00
63	Misys	UK	$561.63	$682.49	82.30%	17.80%	$100.00
64	Dell	United States	$561.62	$57,512.33	1.00%	17.80%	$100.00
65	Fiserv	United States	$560.47	$4,482.00	12.50%	10.70%	$60.00
66	SWIFT	Belgium	$542.36	$767.11	70.70%	0.00%	$0.00
67	MEDITECH	United States	$534.55	$597.83	89.40%	0.00%	$0.00
68	Verint Systems	United States	$527.82	$828.60	63.70%	11.50%	$60.59
69	NICE Systems	Israel	$501.04	$879.01	57.00%	7.60%	$38.00
70	Bentley Systems	United States	$494.71	$550.00	89.90%	14.10%	$70.00
71	Neusoft	China	$473.57	$1,101.32	43.00%	5.00%	$23.70
72	JDA Software	United States	$469.94	$689.13	68.20%	4.30%	$20.00
73	Acision	UK	$465.95	$698.93	66.70%	3.20%	$14.80
74	amazon.com	United States	$460.94	$61,093.00	0.80%	100.00%	$461.00
75	Genesys	United States	$459.99	$620.00	74.20%	2.90%	$13.27
76	Visma	Norway	$448.69	$987.12	45.50%	4.00%	$18.00
77	Concur Tech.	United States	$448.37	$462.24	97.00%	100.00%	$448.37
78	GXS	United States	$439.51	$487.52	90.20%	83.70%	$368.00
79	Northgate Solutions	UK	$435.93	$1,556.00	28.00%	35.70%	$155.60
80	CommVault	United States	$433.98	$471.59	92.00%	38.20%	$165.95
81	Pitney Bowes	United States	$424.50	$4,904.02	8.70%	11.00%	$46.80
82	Blackboard	United States	$423.26	$530.00	79.90%	96.20%	$407.17
83	MicroStrategy	United States	$412.51	$594.61	69.40%	3.90%	$16.10
84	Unit4	Netherlands	$412.10	$603.69	68.30%	17.90%	$73.85
85	athenahealth	United States	$408.50	$422.27	96.70%	66.10%	$270.00
86	Micro Focus	UK	$407.44	$421.77	96.60%	2.70%	$11.00
87	Allscripts	United States	$404.43	$1,446.33	28.00%	23.50%	$95.00
88	InterSystems Corp.	United States	$402.98	$457.37	88.10%	0.00%	$0.00
89	Unisys	United States	$401.06	$3,706.40	10.80%	45.10%	$180.69
90	CompuGroup	Germany	$394.71	$579.53	68.10%	13.00%	$51.33
91	Progress Software	United States	$388.05	$426.00	91.10%	0.00%	$0.00
92	Sophos	UK	$384.78	$410.00	93.80%	0.00%	$0.00
93	Invensys	UK	$381.45	$2,773.50	13.80%	2.60%	$10.00
94	Qualcomm	United States	$375.60	$20,458.00	1.80%	3.00%	$11.27
95	Aspect Software	United States	$375.35	$442.71	84.80%	1.30%	$5.00
96	QlikTech	United States	$359.19	$388.50	92.50%	0.00%	$0.00
97	ACI Worldwide	United States	$358.34	$666.58	53.80%	5.20%	$18.60
98	Amdocs	Israel	$356.58	$3,266.25	10.90%	0.00%	$0.00
99	Yonyou	China	$347.88	$666.20	52.20%	1.00%	$3.48
100	ABB Ltd.	Switzerland	$335.82	$39,336.00	0.90%	0.00%	$0.00

1QBit

Why Quantum Software?

1QBit

1. Quantum hardware requires software that is designed for its architecture.

1QBit

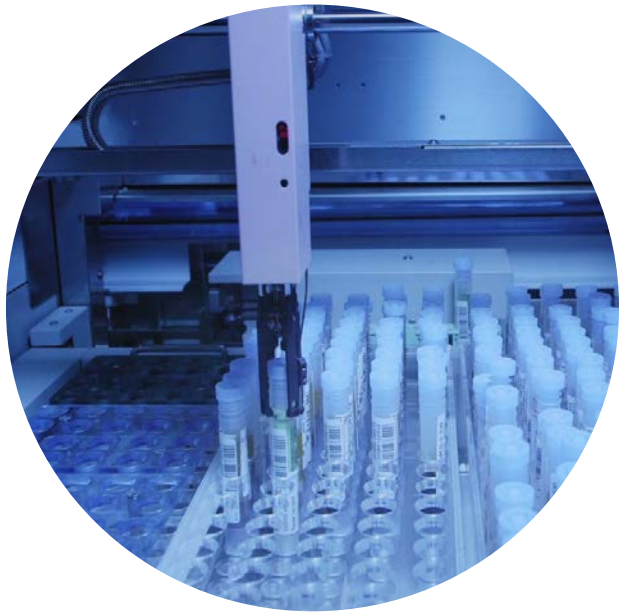
2. Quantum software insulates users from the complexities of quantum computers.

1QBit

3. Quantum software allows developers to use familiar programming languages to build applications for quantum computers.

Industries of Focus for 1QBit

Finance



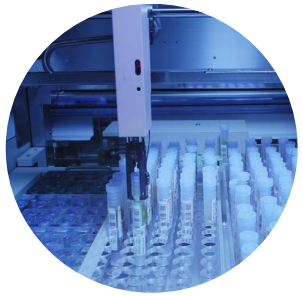
Health Sciences

Energy

1QBit

Applicable Industries for 1QBit's Platforms

Finance



Health Sciences

Energy

Security

Logistics

Defence

Urban Planning

Retail

Information Tech

Construction

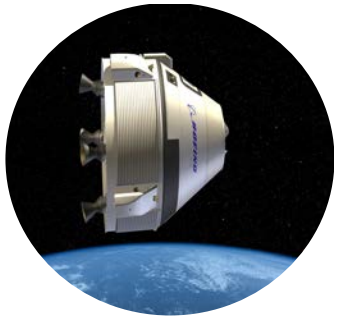
Travel

Research

Agriculture

Marketing

Automotive



Aerospace

Telecommunications

Health Care

Quantum Applications in Finance

1QBit

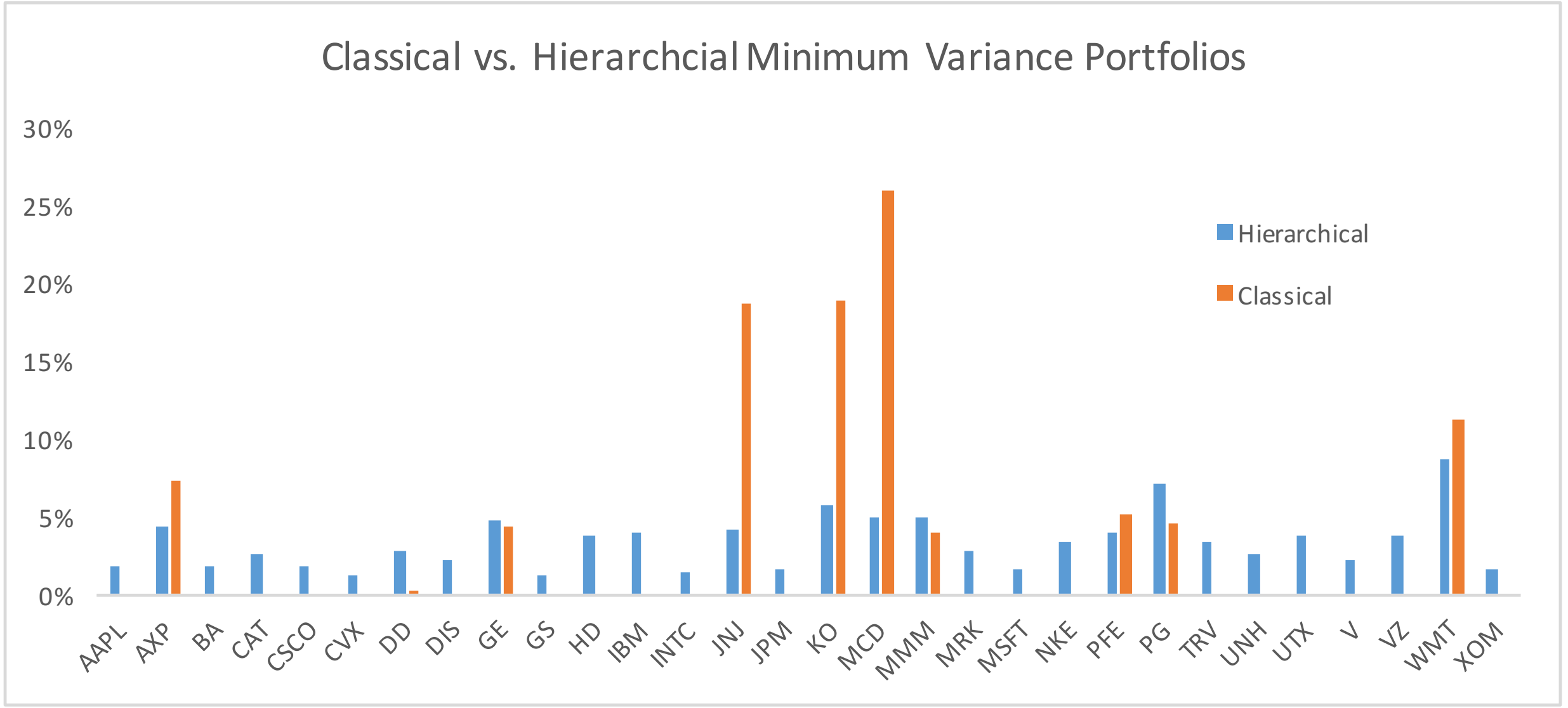
Sample of 1QBit Quantum-Ready Applications for Finance

- Quantum-Ready Hierarchical Risk Parity (QHRP)
- Optimal Trading Trajectories
- Real-Time Optimization Framework
- Tax Loss Harvesting
- Portfolio Management with Q-Learning
- Swap Collateral Optimization

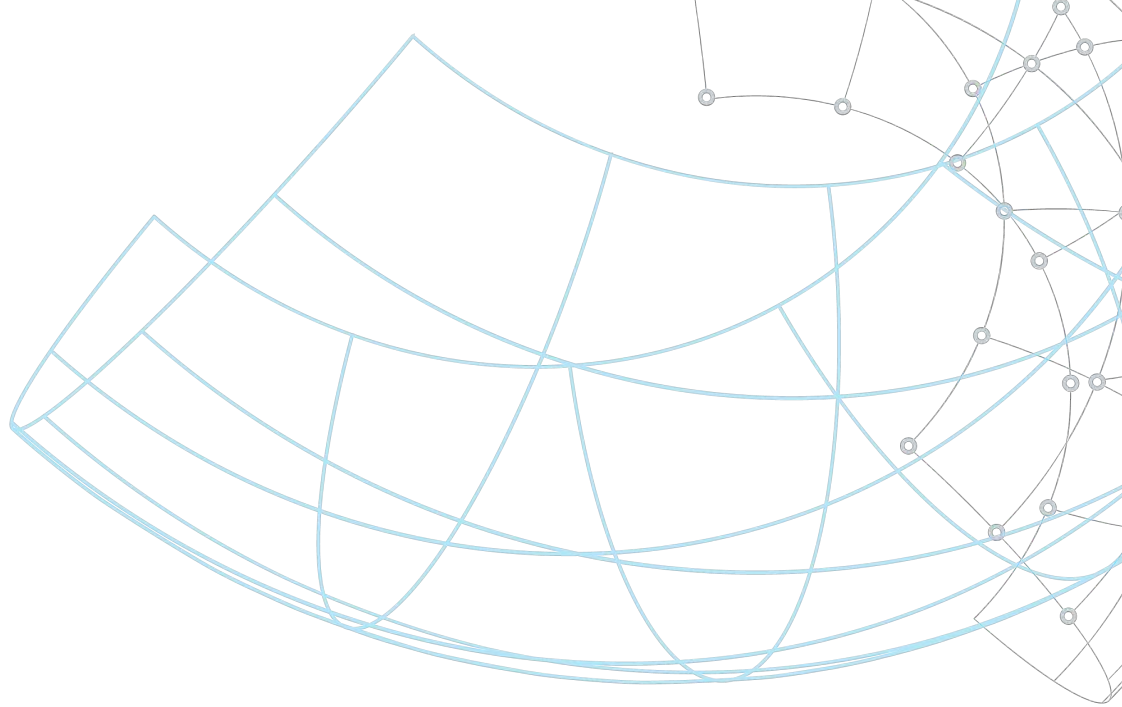
Quantum-Ready Hierarchical Risk Parity

1QBit

QHRP: Portfolio Weight Comparison



1QBit



Risk Improvement in Simulations

Out-of-sample volatility is reduced by 20% in simulated examples using 10 assets with 10% volatility each, random shocks, random correlations.

1QBit

Quantum-Ready Software Development Kit

1QBit

Why a Quantum-Ready SDK?

1. Broadens access to quantum computing.
2. Shields users from the quantum “machine code”.
3. Utilizes standard coding environments that people are familiar with.
4. Builds software that is compatible with both classical and quantum hardware.
5. Reduces the time required to develop new applications for quantum hardware.
6. Enables users to leverage a pre-built library of algorithms and solvers.
7. Creates a collaboration platform for quantum software development.

Quantum-Ready Application Development

Manual Build

SDK Build

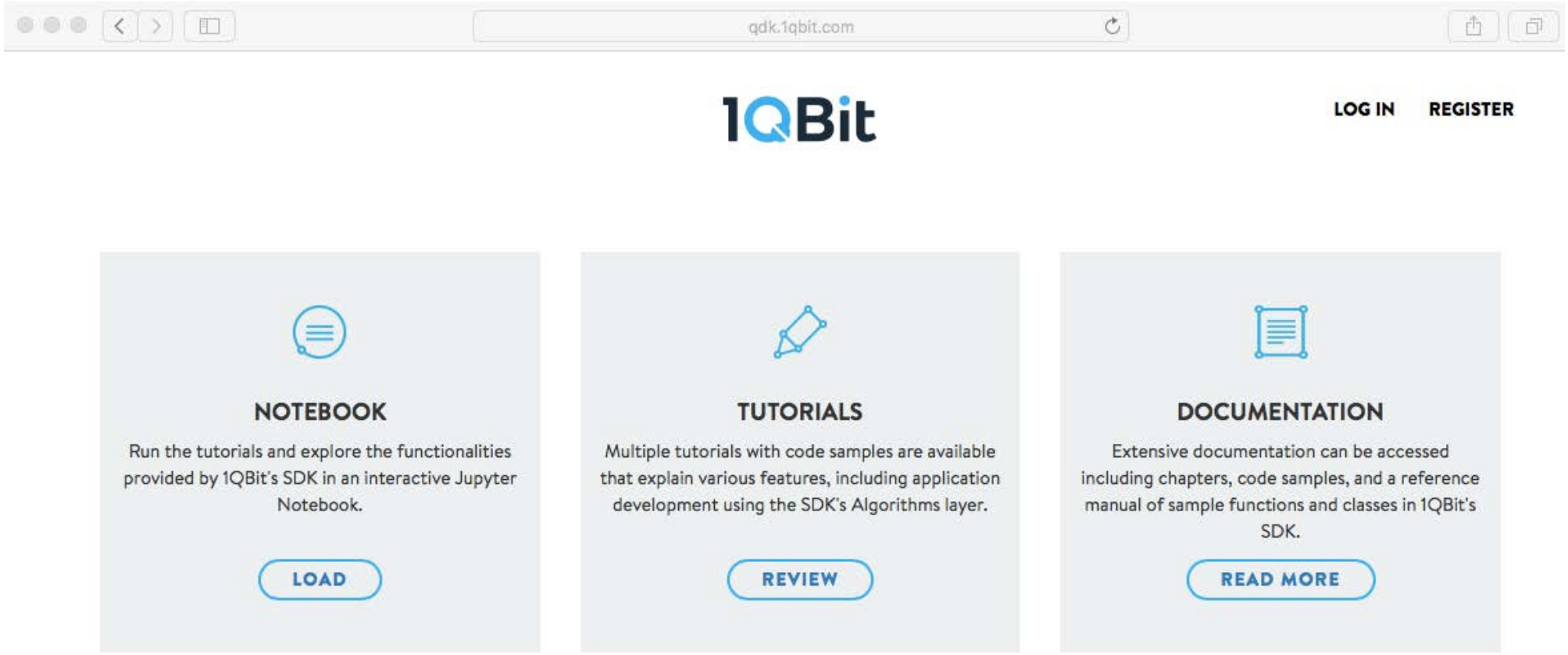
```
#Load Graphs
import networkx as nx
g = nx.Graph()
g1 = nx.Graph()
g.add_edges_from([(7,2),(1,2),(2,4),(4,3),(1,3),(1,4),
                  (2,3),(3,5),(4,9),(5,4),(3,6),(2,5)])
g1.add_edges_from([(7,1),(1,2),(2,3),(3,4),(1,4),(1,3)
                   ,(2,4),(3,9),(3,6),(6,9),(1,10),(7,10)])

from qdk.algorithms import *
from qdk.common_solver_interface import *
gsa = GraphSimilarityAgent()
gsa.solver = DWaveSolver(ConnectionKey())
gsa.qmis_finder.k_quasi = 0
sol_bundle = gsa.run(g, g1)
print sol_bundle
```


1QBit

Exploring Quantum Software Applications

Access to a limited version of 1QBit's quantum-ready SDK is available through an interactive notebook which includes tutorials and documentation to solves problems now using quantum annealers as well as classical processors.

QDK.1QBit.com



1QBit

Quantumforquants.org

www.quantumforquants.org

QUANTUM FOR QUANTS

Search Forum

Home Forum Mission Quantum Computing Resources Open Challenges Blog Log in or Register

+ ASK A QUESTION

Recent Posts

A Finance at the service of society
Q&A on Financial Quantum Computing with Marcos Lopez de Prado
Redefining problems with quantum computers
Why Quantum Finance?

Archives

May 2016
April 2016

Categories

Quantum Computing
Tools
Uncategorized

Welcome to Quantum for Quants

Quantum computers have the potential to provide an entirely different approach to solving very hard finance problems. Quantumforquants.org has been created to foster education, discussion, and collaboration to advance our identification and understanding of solutions to open industry problems.

Mission

Foster education, discussion, and industry collaboration on open industry problems.
>Learn more.

Quantum Computing

Quantum computers have the potential to address very hard problems in an entirely different way - letting "physics solve math problems".
>Learn more.

New Challenges

Watch this space for new challenges.
>Learn more.

From the Blog

A Finance at the service of society

Redefining problems with quantum

Latest Questions

- Presentation of myself + Question about future studies
- Complexity Classes: Are we on the cusp of change?
- Extracting binary variables from economic data: Is there a quantum view?
- Can a binary graph model be used to model information flow in CDS trading?
- Can clique analysis tell us something new about time series?
- How does QC help apply machine learning techniques?
- What is the best academic background for learning about QC?

Quantum solvers allow 1QBit to see traditional problems and solutions differently.

Radically different ways of looking at a problem can foster radically large changes in the solutions we can uncover.

1QBit

Maxwell Rounds

maxwell.rounds@1qbit.com

1QBit