QxBranch Applications, Research, and Opportunities

QxBranch (www.qxbranch.com) develops and deploys advanced data analytics models for global companies in finance, technology, and entertainment. We have a diverse team of professionals in systems and software engineering, machine learning, quantum computing, and cyber security.

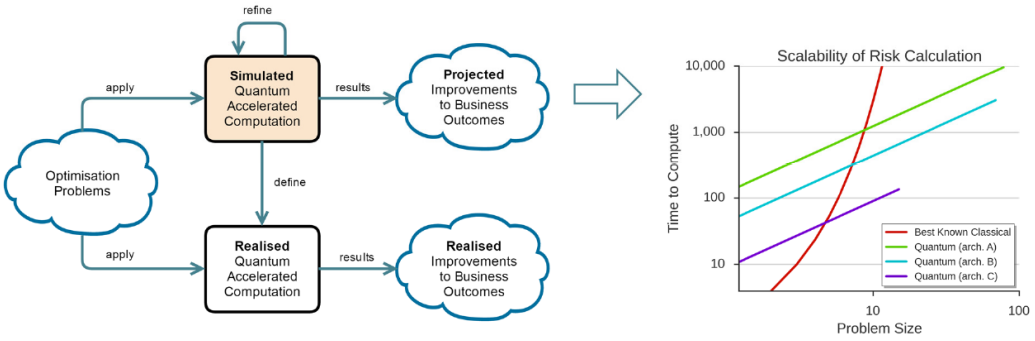
QxBranch is headquartered in Washington, D.C., with offices in London and Australia.

Quantum Computing Simulation and Software Development

Enabled by in-house expertise and partnerships with leading quantum computing (QC) hardware developers, we are developing software and packages that drive QC application development. We focus on creating the tools needed to identify, characterize, and realize the opportunities that emerging QC technology will offer. Our work in QC falls primarily into the areas below.

Simulation

We are developing software for simulating universal and adiabatic QC architectures. These simulators allow algorithms to be tested and characterized before the hardware is fully mature, determining their timeline, scalability, and value.

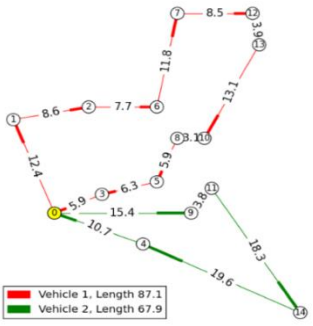


Application identification

We work with organizations to identify their computational problems that will benefit from QC. These problems include applications of machine learning, combinatorial optimization (e.g. job shop scheduling, portfolio optimization), and Monte Carlo methods. We also leverage our background in aerospace and defense to solve hard engineering problems in areas such as computational fluid dynamics.

Algorithm development

Capturing the benefits of quantum computing requires new algorithms that map to the hardware. We are creating and testing algorithms for problems that are classically intractable, such as the multi-vehicle traveling salesman problem (right), or that are solved sub-optimally using simplified formulations or approaches. Our simulators enable efficient algorithm development, and our applications leverage the resulting solutions to create value.



Advanced Data Analytics

QxBranch's analytics solutions focus on probabilistic optimization of complex systems and decisions, blending machine learning with established parametric models and domain expertise. While we work with a variety of sizes and types of data, we are more interested in how much value data has than how "big" it is. The solutions we create drive value by accurately predicting outcomes, prescribing specific actions to optimize outcomes, and adapting to changing data.

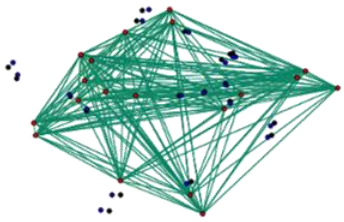
Our technology is enabled by core capabilities that cut across domains:

- Information retrieval and text mining
- Probabilistic modeling and risk analysis
- Time series analysis and forecasting
- Anomaly detection
- Behavioral analytics
- Causal analysis and statistical validation
- Deep learning
- Data visualization

Some example applications are described below. Other opportunities include financial algorithm modeling, crime forecasting, control systems modeling, and fraud detection.

Assessment of organizational cyber risk

Accurately and objectively assessing an organization's cyber risk, including their vulnerabilities, threats, and their assets that could be exposed in a breach is a complex problem and a major business need. QxBranch is integrating a diverse set of data sources and capabilities to build a leading analytics model for quantifying companies' cyber risk.



Identification of leading indicators in open data

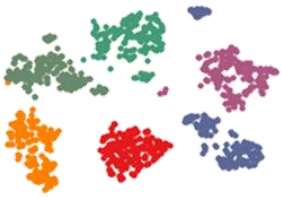
Open data, such as social media and news, contains a vast amount of information. We are analyzing this unstructured data to identify sources of influence and information and map its propagation across networks. This work has broad applications in finance, cyber security, and gaming.

Sports analytics

We are using machine learning to understand and optimize player performance in a number of big-market international sports. These models require identifying and extracting relevant historical data, and are used to process real-time data during competitions. Use cases of this capability include fantasy sports, gaming, the fan experience, and player training and strategy.

Market segmentation and customer profiling

Clustering consumers into distinct groups for marketing purposes is a highly popular use of machine learning. Our solutions target individual customers, allowing companies to tailor product offerings to increase adoption and improve the customer experience.



Anomaly detection for mobile device integrity

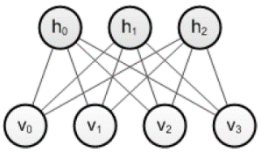
We created models that use encrypted, local data on mobile phones to assess their risk of compromise and to automatically adapt security postures to maximize protection and usability. This same capability extends to other work in finance, cyber security, and system monitoring.

Quantum Machine Learning

Machine learning is proposed as one of the first 'killer apps' for quantum computing. We are developing and applying methods to evaluate and realize that potential. In the long term, quantum machine learning algorithms will be integrated into our existing analytics solutions to accelerate and expand their capabilities.

Boltzmann machines for deep learning

Research has shown promising results for training restricted Boltzmann machines (right) using a quantum annealing machine. We are building on this work to further improve and validate results and to investigate extensions to unrestricted Boltzmann machines and Hopfield networks.



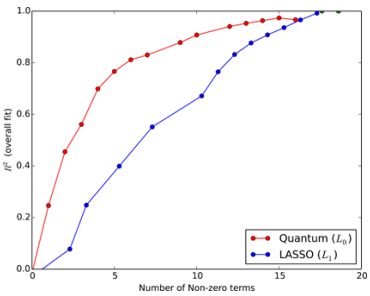
Adachi and Henderson 2015

Graph analysis problems

Many theoretical QC graph analysis algorithms exist, as some hardware architectures natively behave as graph-based optimizers. We are characterizing the performance of these algorithms on real applications, such as frequent subgraph mining.

Inherent ensemble modeling

The probabilistic output of quantum computing maps well to machine learning and noisy optimization problems. Multiple good models can be produced in finite time, enabling robust solutions and an additional optimization step for selecting models based on their cost or viability.



Feature selection

Feature selection is an important capability that identifies the most meaningful variables in large datasets that contain many irrelevant features. L_0 regularization is known to be an effective method, but is intractable on classical computers. We have designed and tested a quantum L_0 regularization algorithm that has shown promising initial results (left).

Causal entropic quantum forces

The causal entropic model revolves around the novel idea that a system is truly intelligent if it maximizes its long term entropy. A limiting factor in creating such systems is that the required calculations rely on slow sampling techniques. QC could be used to more efficiently probe these landscapes and allow for faster intelligent learning.