Background

• Founded in 1999

• World’s first commercial quantum computer

• Two 512 qubit systems installed
  ▪ Lockheed/USC
  ▪ Google/NASA Ames

• We have demonstrated 10,000 – 100,000x speedups

• 110 U.S. patents

• $160M raised
Mission

To help solve the most challenging problems in the multiverse:

- Optimization
- Machine Learning
- Monte Carlo/Sampling
How it Works
What is a Quantum Computer?

• Exploits quantum mechanical effects
• Built around “qubits” rather than “bits”
• Operates in an extreme environment
• Enables quantum algorithms to solve very hard problems
What It Looks Like – Chip in a Cool SCIF
Environment Inside the Box

- Cooled to 0.02 Kelvin, 150x colder than interstellar space
- Shielded to $50,000 \times$ less than Earth’s magnetic field
- In a high vacuum: pressure is 10 billion times lower than atmospheric pressure
- On low vibration floor
- Superconducting, power consumption is 15.5 kW
A D-Wave Two Quantum Processor
Programming the System

Application Program

QSage

ToQ

C, C++, Python, Fortran, MATLAB interface

Quantum Machine Instruction

Items in italics are under development
Machine Learning: Binary Classification

- Traditional algorithm recognized car about 84% of the time
- Google/D-Wave Qboost algorithm implemented to recognize a car (cars have big shadows!)
- “Quantum Classifier” was more accurate (94%) and more efficient
- Ported quantum classifier back to traditional computer, more accurate and fewer CPU cycles (less power)!
Rose’s Law – Double #Qubits ~ Every Year

Number of Qubits

- 4 qubit
- 16 qubit
- 28 qubit
- 128 qubit
- 512 qubit

Under Test 1000 qubit
Discrete Combinatorial Optimization Benchmarks
Median Time to Find Best Solution

The D-Wave Two won’t solve all problems, but for some important problems it does very well.
Will QCs Make HPCs Obsolete?

• No . . .

• They’re suited to different tasks
  – **HPCs**: Computational fluid dynamics, molecular simulation, weather forecasting, nuclear weapons modeling, etc.
  – **QCs**: discrete combinatorial optimization, artificial intelligence, machine learning, sampling

• But **together** they can enhance each other ...