Quantum Computing

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CWI

QuSoft

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Quantum-mechanical computers

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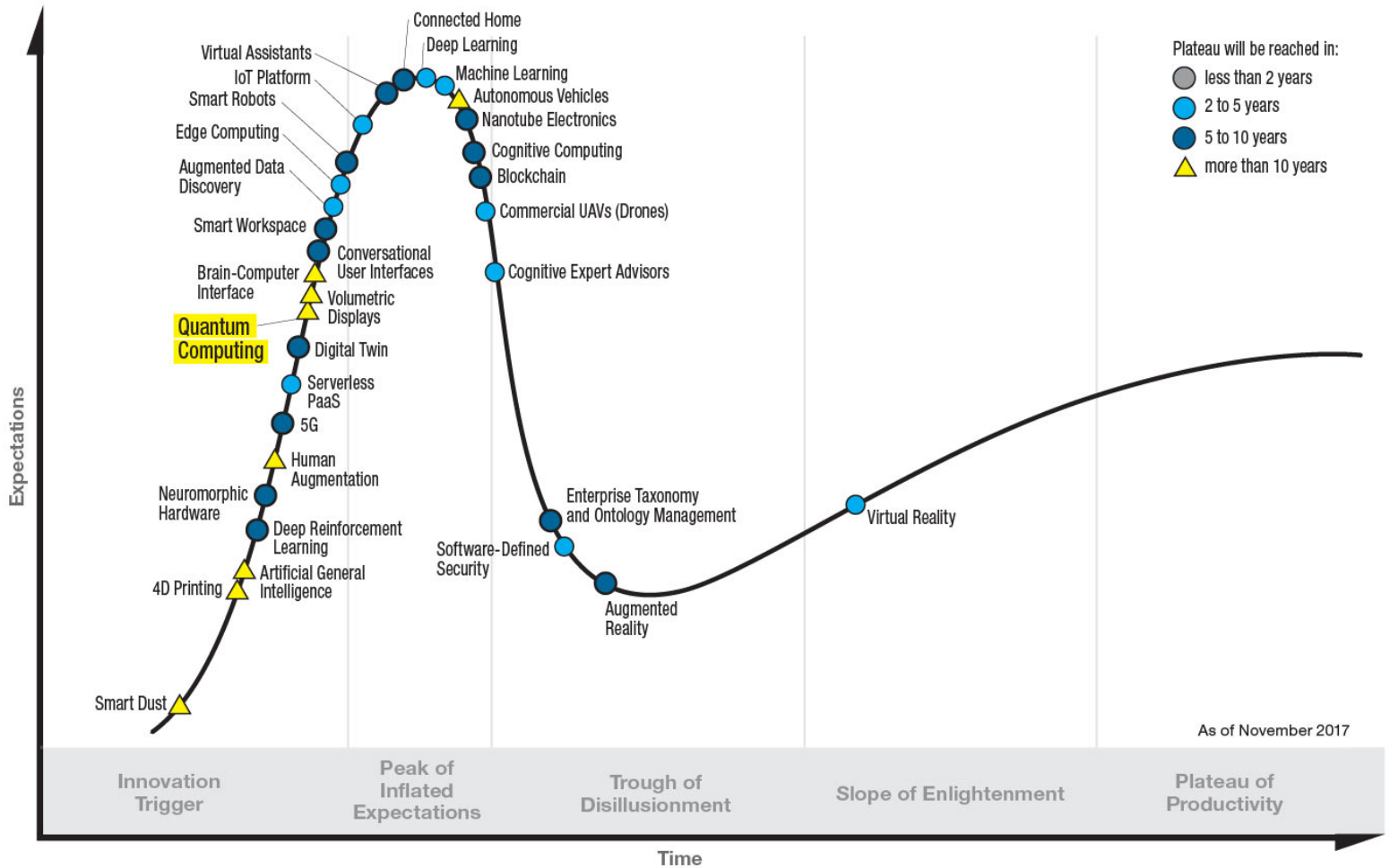
  3. The goal of computer science is to study the power
     of the best computing machines that Nature allows us

Gartner Hype Cycle for Emerging Technologies



gartner.com/SmarterWithGartner

Source: Gartner (November 2017)

Gartner

Quantum computers: hype vs substance

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Assume large quantum computers will be built in the next decades.

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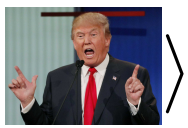
  electron spin, photon polarization, $|$  $\rangle + |$  $\rangle$

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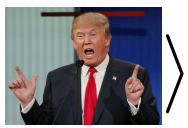
  electron spin, photon polarization, $|$  $\rangle + |$  $\rangle$

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  Described by a "wavefunction": vector of all 2^n amplitudes

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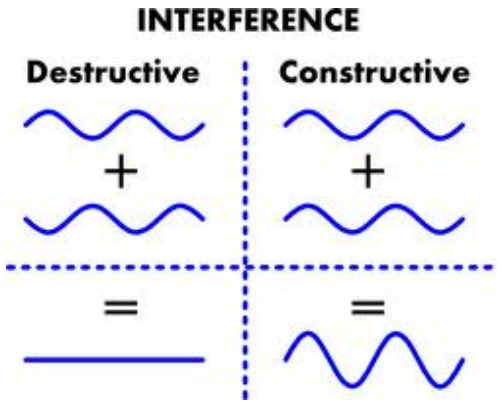

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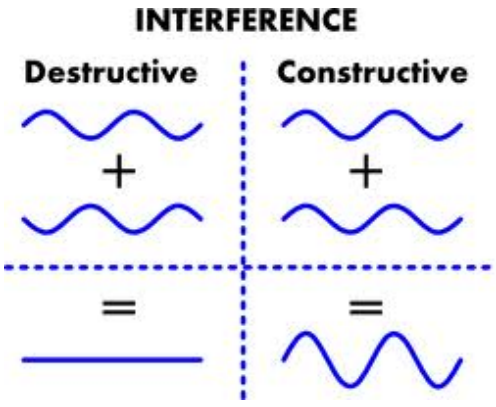

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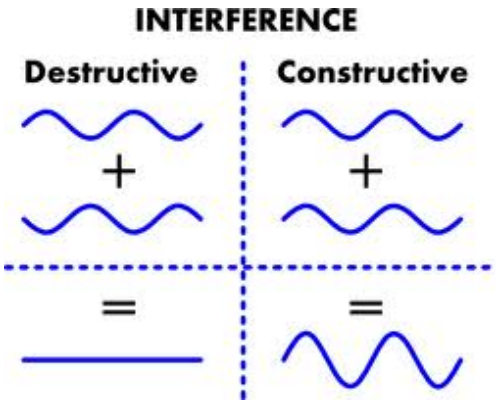

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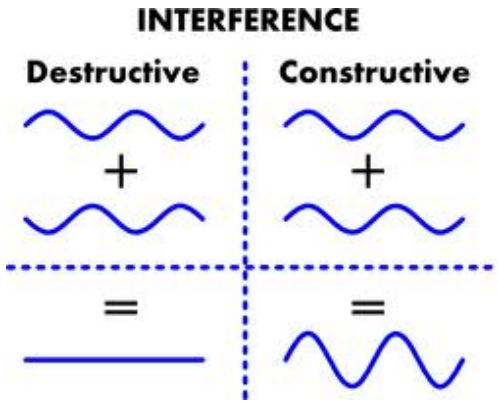

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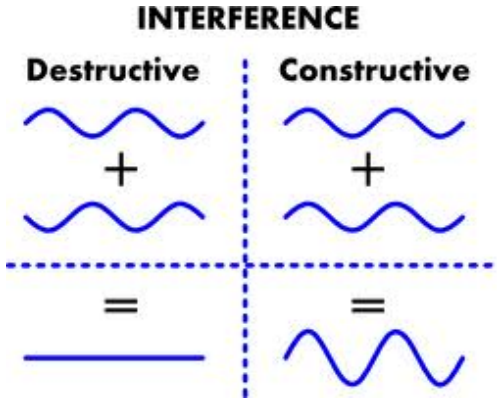

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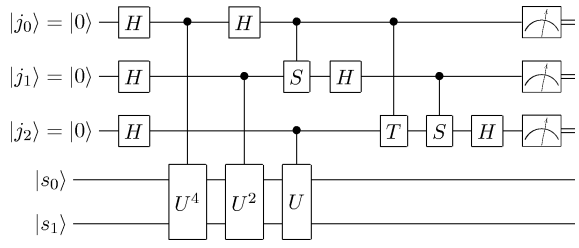

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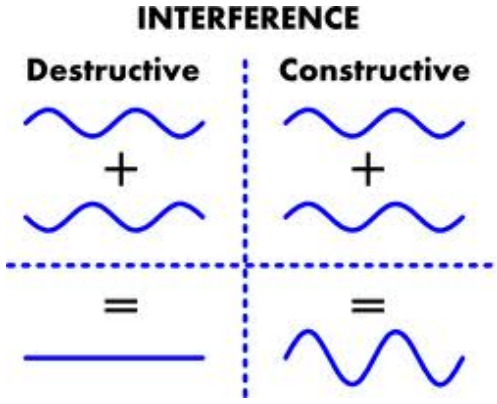

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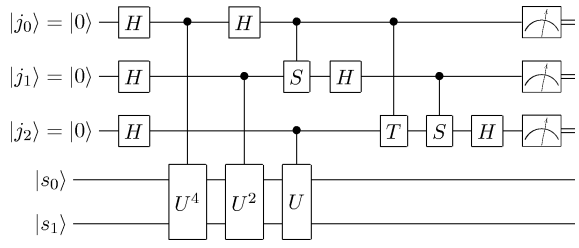

3. Measuring the final state then gives solution

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- But useful quantum supremacy is still years away

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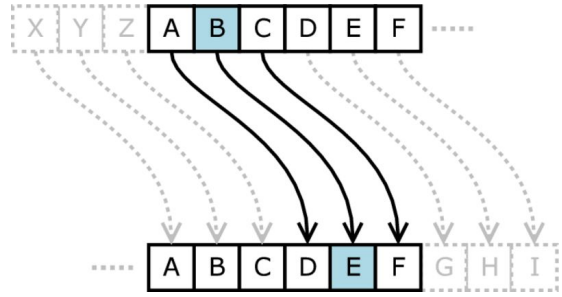

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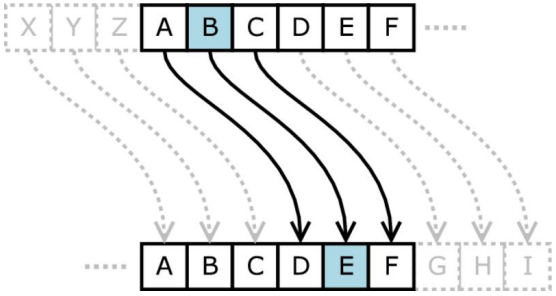

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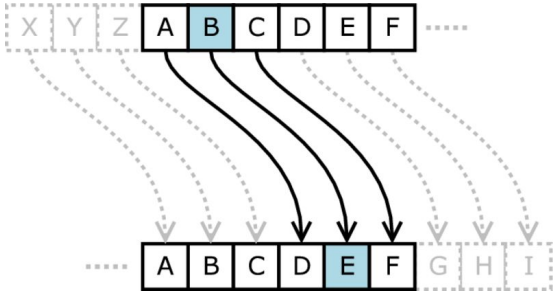

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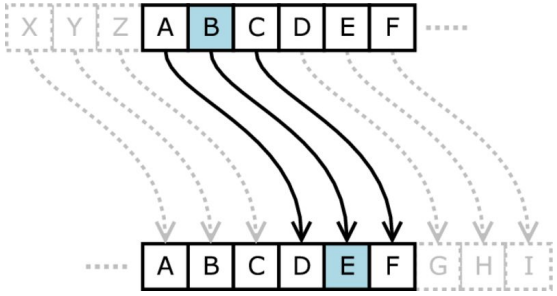

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- Two branches: codemakers and codebreakers

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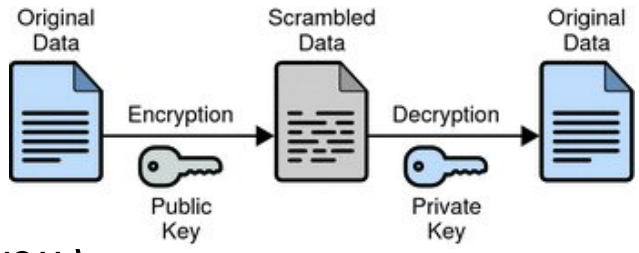

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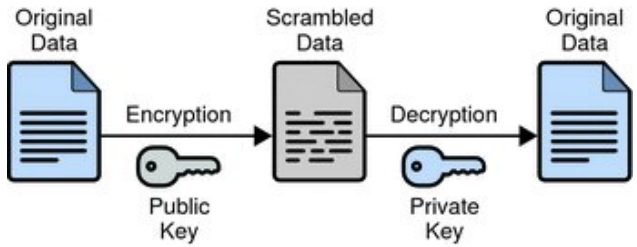

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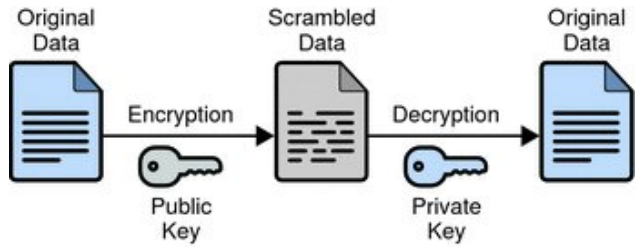

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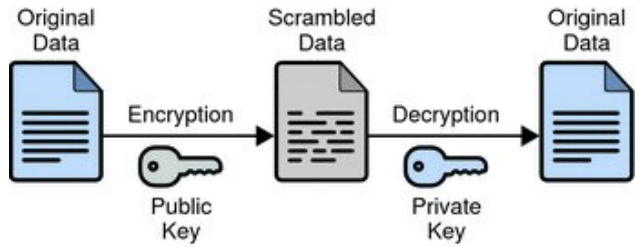

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- Shor's algorithm breaks this using a few thousand good qubits

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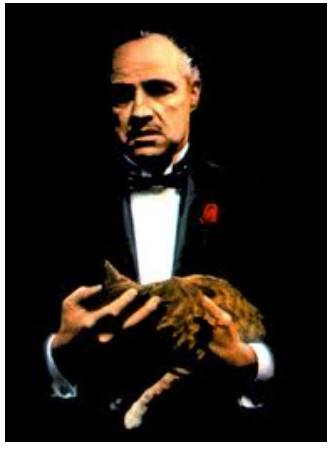

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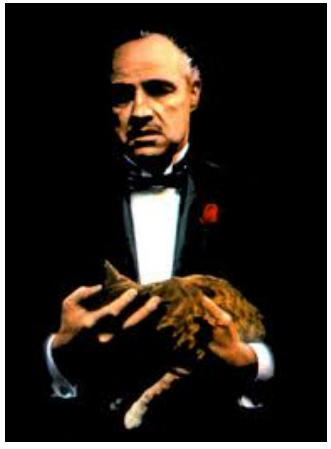

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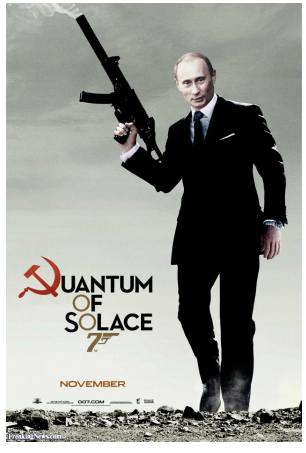

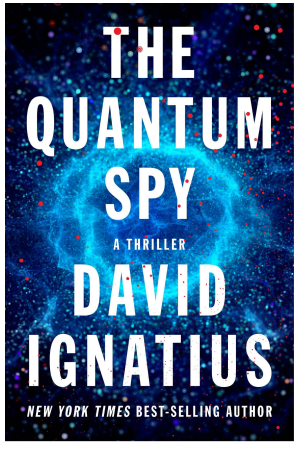

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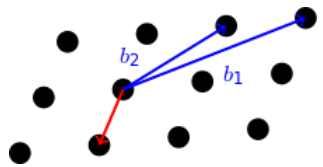
  Prominent examples: lattice problems, error-correcting code problems, ...



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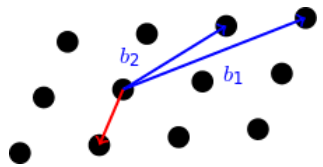

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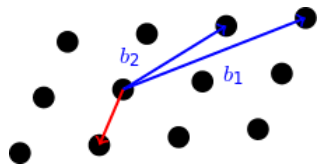

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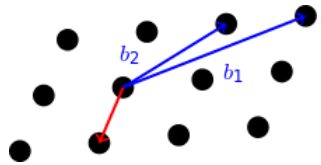

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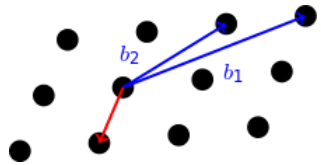

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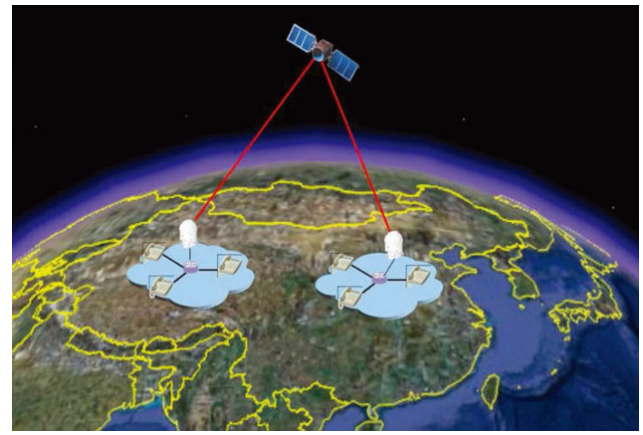

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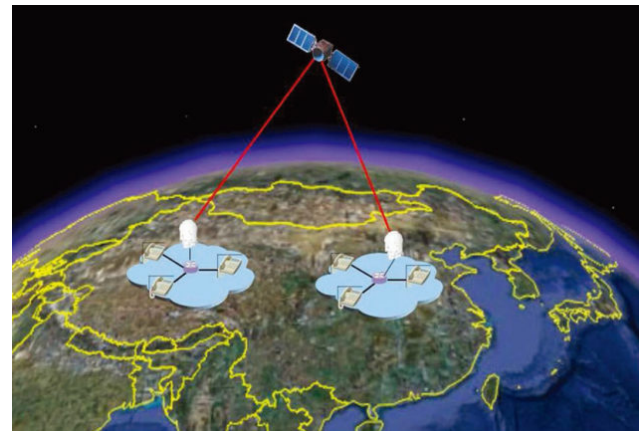

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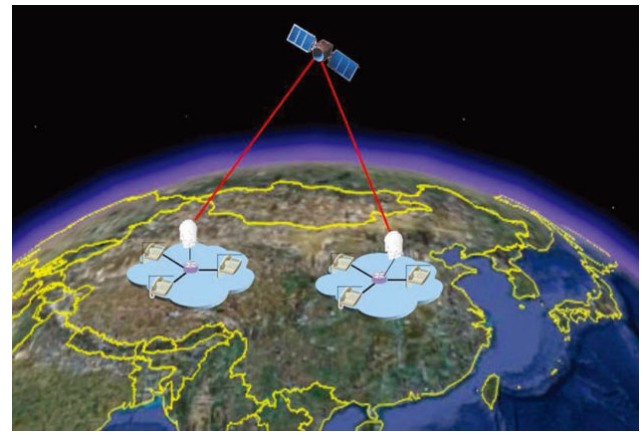

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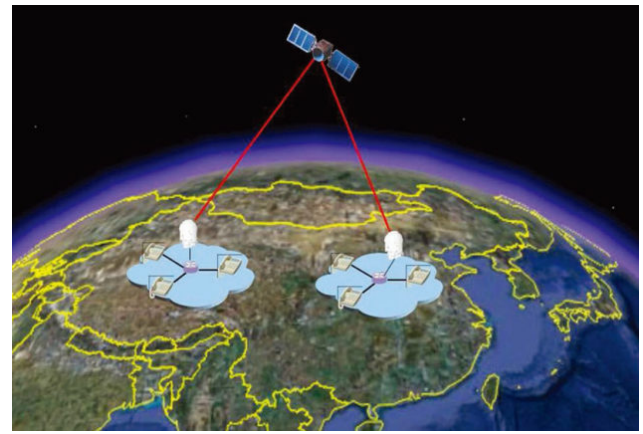

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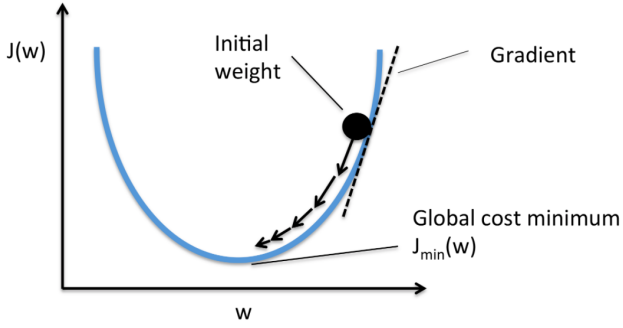

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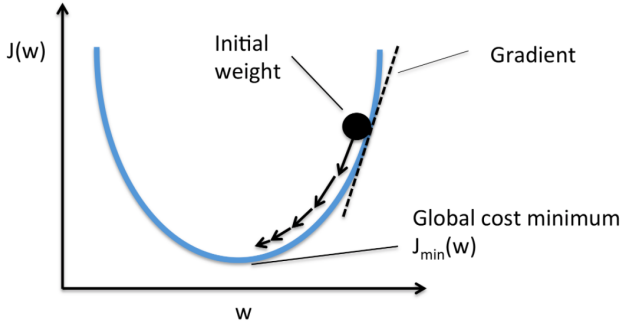

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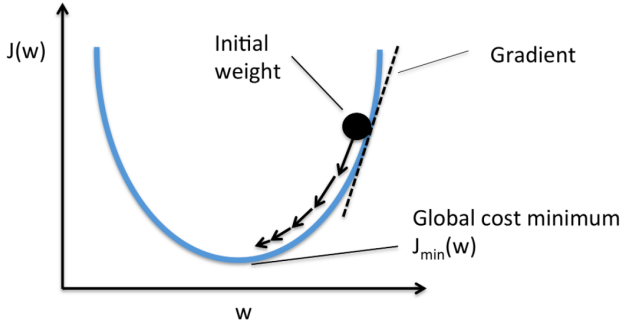

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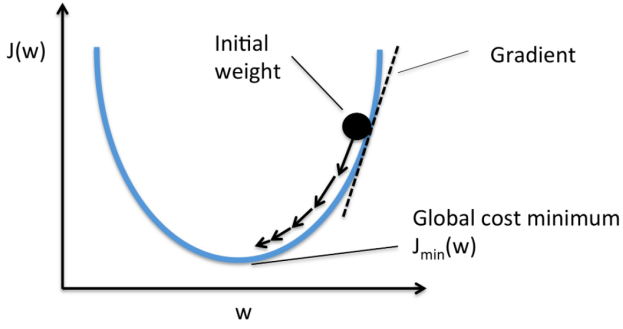

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- Could already be useful with 100s good qubits (unlike Shor)

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- What will this mean in practice?

  We'll see. . . though we are still far from a large-scale quantum computer