# Odd computers zips through knotty tasks

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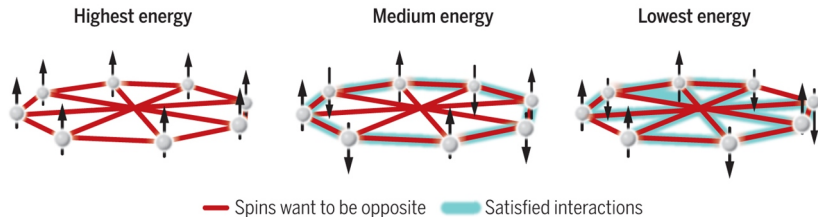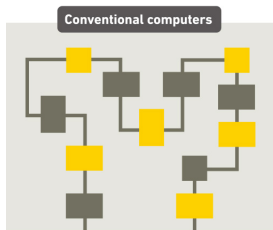
October 29, 2016

- What the Ising model is
- How to solve optimization problems with the Ising model
- How to implemented it in a device
- What this device can do

# Ising model

- Is developed by Lenz and Ising in 1920
- Describes magnetic materials
- Can be used for optimization problems



Highest energy      Medium energy      Lowest energy

Spins want to be opposite    Satisfied interactions

Conventional computers

Conventional computer processing performs calculations one at a time in order, observing the results

The new quantum artificial brain will perform multiple calculations simultaneously in parallel, without observation

Quantum artificial brain

INPUT    OUTPUT

OUTPUT
INPUT

**100**
seconds

Computation time for a complete graph (MAX-CUT)
with 20,000 nodes

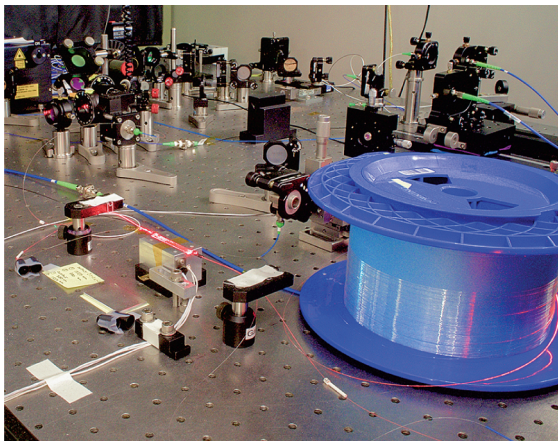**Calculation time will be reduced by 5 orders of magnitude**
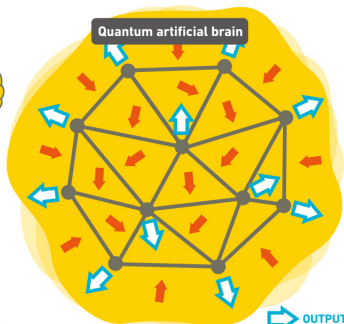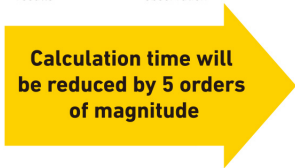
**1**
millisecond

Computation time for a complete graph (MAX-CUT)
with 20,000 nodes

- Optical parametric oscillator
- Long loop of optical fiber
- Fast processor
- Squeezed state of pulse

- Ising machine at Stanford University, Palo Alto, CA

# Features and applications

- 100 spins — 50 times faster
- 2000 spins — can be applied for practical use
- Any two spins can be connected

# Summary

- Using Ising model to solve optimization tasks
- Machine in California
- Capabilities of the device

# Conclusion

- Quantum mechanics is awesome