Alternative Ways to Compute

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Optical Computing

- **Elevator:** Use Light-based circuits instead of electrical.
- **Potential Killer App:** None, but other adv below.
- **Advantages**: Main: Consumes less power. Secondary: No interference from radio and E+M (this is sometimes a problem for usual computers). Marginally faster, heat much less.
- **Disadvantages:** Optics hard to integrate into current tech. Components expensive.
- **How Far Along:** Optalysys (founded 2013) has an optimal co-processor, the FT X:2000 (released 2019). They claim **Can perform full resolution image and video processing for a fraction of the energy costs.**
- **Caveat:** Google Ventures and Lightelligence (a Chinese Company under Baidu) also interested.

Spintronics

- **Elevator:** Store bits via electron spin.
- **Potential Killer App:** Data Storage. Does not need power and is space-efficient.
- **Advantages**: Chips are low power, low cost, high density. Can integrate with current systems. Cost reasonable and coming down.
- **Disadvantages:** Currently no better than conventional. Retention of spin, Endurance of components, Speed of processing, Low Power — can't have all four.
- **How Far Along:** Everspin (founded 2008), IBM, Samsung all have commercial chips. Not better than conventional but close. Has potential.
- **Caveat:** Storage almost competitive, computing is far away from competitive— thats spin glasses.
- **Acronym:** STT is Spin Transfer Torque. This is basic data storage chip.

Neuromorphic

- **Elevator:** 130,000 artificial Neurons and 130 Million Synapses for an SNN (Spiking Neural Network). (This is Intel Loihi.)
- **Potential Killer App:** Machine Learning.
- **Advantages**: Faster training and less power consumption than conventional ML. Legit!
- **Disadvantages:** ML is only application.
- **How Far Along:** Intel, Google, Neuromen, IBM, Brainchip, and more have made chips. Google and others are actually using them internally. Google rents it out.
- **Caveat:** Uses Memristors.

Quantum Computing

- **Elevator:** Store information as qubits which can be easily manipulated, and get answer at the very end by collapsing a probability wave.
- **Potential Killer App:** Factoring and Quantum Simulation.
- **Advantages**: IF could get it to work then can beat classical on a few things. Factoring is a real application— crypto.
- **Disadvantages:** Hard to get it to actually work. Limited applications. Have to keep supercool.
- **How Far Along:** IBM 20-qubit full quantum computer. They rent it out. To who? Google 72-qubit chip with 99% readout fidelity. Named Bristlecone, Pure Research. D-Wave has 2048-qubits-QA. People in field doubt its really quantum. All three slow.

Chemical Computing

- **Elevator:** Chem Reactions are computing something. With the right chemicals we can control what it does and use it.
- **Potential Killer App:** Data Storage. Possibly Parallelism
- **Advantages**: Data Storage does not need power. Durable.
- **Disadvantages:** Slow. Not competitive with paper (yet).
- **How Far Along:** Seems to only be in the lab.

DNA Computing

- **Elevator:** A DNA molecule is a long string of 4-types of elements. Ideal for Data Processing. DNA in a test tube can be viewed as a parallel computer.
- **Potential Killer App:** TSP? Tic-Tac-Toe? Neural Nets? Diagnosing Cancer?
- **Advantages**: Massive Parallelism. Good Storage.
- **Disadvantages:** Slow. Hard to obtain answers.
- **How Far Along:** In 2009 IBM and Caltech teamed up to get a nucleic-acid chip that can do square roots.

Others to Look Into

- CPU and GPU for comparison purposes.
- Memristor. Transistors that remember their previous states. Good approx exists. True ones may not be able to be built.
- Neurological. Use real neurons. Can do + with leech neurons.
- Atomtronics. Uses Atoms (as opposed to Spintronics using electrons). Can be used to improve quantum computing.
- Fluidics- Computing with a fluid in a physical system. Can simulate circuits. Needs Work.
- Peptide- Similar to DNA but peptides have 20 diff blocks instead of 4. Needs Work.
- Membrane- Code a problem in a cell membrane. Needs Work.
- Analog- Had a past and may have a future for solving diff eq and other continuous problems.