Alternative Ways to Compute: A Roadmap

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Two Types of Alternate Computing

- Commercial. There is a real company and real money behind it, and some evidence that it really works. (There can be variety within this.)
- Emerging technologies. Still in the lab. (There can be variety within this.)

Our Roadmap

For a variety of alternative computing methods we will ask the following questions and perhaps answer them.

- ▶ What is a meaningful measures of how well it's doing? Time and Space may not be adequate. For example, Power and Durability may be considered. **Meaningful measures are the key to the later points.**

- ▶ Is there a Killer App? Something that it can do better than classical.

- ▶ What is the advantage over classical (if there is one)?

- ▶ How close is the alt computing to reality? E.g., Neuromorphic computing is actually being used, where as Chemical is still in the lab.

Commercial

- **GPU's** (not alternative but good for comparisons)
- **Optical Adv:** Less power, Less heat. **DisAdv:** Optics hard to integrate into current tech. Components expensive.
- **Spintronics Adv:** Low power, low cost, high density. Can integrate with current systems. **DisAdv:** Tradeoffs of Retention of spin, Endurance of components, Speed of processing, Low Power.
- **Neuromorphic** (uses Memristors). **Adv:** Faster training and less power consumption than conventional ML. **DisAdv:** ML is only application.
- **Quantum Computing Adv:** Killer Apps: Factoring and Quantum Systems. **DisAdv:** Limited Applications. Hard to get to really work.
- **Analog Adv:** Good on continuous problems, diff eq, **DisAdv:** Time and space lags being digital.

Emerging

For all of these disadv is does not work yet.

- ▶ **Chemical:** Chemical reactions do the computation. Some Data Storage Advs.
- ▶ **DNA:** Encoding info into DNA.
- ▶ **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.
- ▶ **Peptide:** Similar to DNA but peptides have 20 diff blocks instead of 4.
- ▶ **Membrane:** Code a problem in a cell membrane.