# Thoughts on Chemical Computing From Darpa Meeting

William Gasarch - University of MD
Yaelle Goldschlag - University of MD

# Darpa Meeting

This talk is based on the **Molecular Informatics Review Meeting** that took place on Thursday Feb 21, 2019. Most of the people there were Chemists who work on chemical computing. We (William Gasarch and Yaelle Golschlag) were there.
We are not chemists; however William Gasarch has seen every episode of **Breaking Bad**.
In this talk we will

- Look at Quantum Computing (which was not discussed) to see PROS and CONS of an alternative mode of computing.
- Look at Chemical Computing for what it might do and problems it might face.

# Quantum Computing: PROS

- **potential** Killer App: Factoring
- **potential** Killer App: Simulating Quantum Systems.
- Factoring $\rightarrow$ Crypto $\rightarrow$ Funding.
- Scott Aaronson: if we try to build QC's than either
  - We'll get fast computers! Exciting!
  - We'll find out QM is wrong! Even more exciting!, or
  - We'll learn stuff about Quantum Mechanics!
- There have **already** been interesting math and CS from studying Quantum Computing, including classical Theorems with Quantum Proofs.

# Quantum Computing: CONS

- Quantum Computers may be hard to build **without** giving any insight into quantum mechanics.
- While there have been **some** proofs of classical theorems with quantum techniques, this may be limited.
- Scott Aaronson's viewpoint is the minority view — more people push Quantum Comp for its future "applications."

# Chemical Computing: Potential Killer Apps

Chemical Computing does not have as clean a killer app as Quantum does. But here are some thoughts:
**Guiding principle:** Try to what tasks that digital can't do well.

- Data Storage. Durable, envi-friendly, and does not need electricity. Competitors: Cold Storage and Paper.
- Continuous problems.
- Problems where approximations are fine.
- Problems where can have multiple outputs.
- Parallel and Analog Computing.

**Example:** Modelling how a fire spreads. Other complex systems of diff equations. Digital computers do okay here but are not inherently suited to these problems.

# Fire!

**Idea!:** In last slide we speculated that Chem Computing could be used to solve the complex system of diff equations that come from modeling fire.

Turn that around!

Can a controlled fire act as a calculator?

This is Yaelle's idea, not one at meeting. It would be another alt model of comp!

# Killer App Trap

Chem computing:

- **IF** had more money/time/researchers **THEN** could develop a Killer App.
- **IF** had a killer App **THEN** could attract more money/time/researchers.

# Other Types of Computing

What I've said here applies to other types of computing, e.g., Bio-computing or DNA-computing.

- Need Killer App.
- Killer App should be something classical is not suited for.

# Skeptical: What Would it Take to Convince Me?

1. A well defined Killer app.
2. A measure (time? space? durability? envi-friendly?) of why this would be better done by Chem computing than digital.
3. A model of chem comp that takes advantage of the inherent properties of molecular reactions and is powerful enough (in theory) to build a meaningful computer. Bonus if there is a reason to think it can do things **better** than digital for some definition of **better**.
4. Evidence that **even if chemical computers never do much the study of them will yield scientific insights.**
   (I understand why this might not be a good sentence in grants.)