CSCI653: High Performance Computing & Simulations

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What we've learned?

What Have We Learned?

- **Metascalable ("design-once, scale-into-future") algorithms:** ***Divide-conquer(-recombine) → data locality!*** *Only one thing*
  - **Optimal *O*(*N*) tree FMM, wavelets, multigrids *vs.* suboptimal *O*(*N*log*N*) hypercube Qsort & FFT**
- **Parallel computing: *Who does what?***
  - **Message (**MPI Send & Recv**) + multithreading (**#pragma omp parallel**) + heterogeneous acceleration (**H2D→kernel→D2H; minimize H2D & D2H**): CUDA, OpenMP target**
- **Visualization: *Data → visual abstracts* as cognitive pathway to discovery**
  - **OpenGL: polygonal rendering, 3D-to-screen mapping**
  - **VMD, VisIt, ParaView, ...**
- **Data mining & machine learning: *Data → knowledge***
  - **Graphs, tensors, AI for science**

Lessons

- **Learn broad (memory** ~ paper discussion + your classmates**), apply to one (focus/attention** ~ final project**); scientific discovery = reconnection of semantic network in your brain**
- **Understand simple things well** *So that you can use them*

Connect Cross-Boundary!

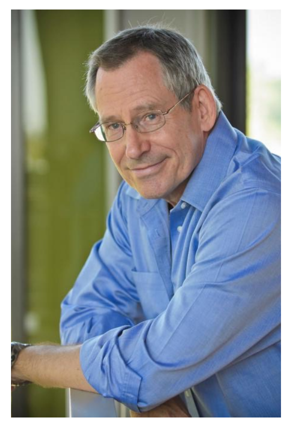
Philip Ball
@philipcball

This comment from John @preskill encapsulates what it is that distinguishes the truly creative scientist (tho' John is surely that too): the ability to see connections that even well-informed others had not noticed.

And what Kitaev had realized is that this was an approach to quantum computing that would be resistant to noise because it was topological. The effect of exchanging a pair of these anyons, because the information is encoded in a very, very nonlocal way, the environment buffeting the system locally doesn't interfere with it. This was a very brilliant idea. And I understood it immediately after 15 minutes of taking about it over coffee because I knew about non-Abelian anyons, and I was very interested in quantum error correction. And it had never occurred to me that these two things that I was very interested in were related. And I guess that shows that I'm not Kitaev.

"Topological quantum computing"

Alexei Kitaev



John Preskill

Final Project

- **Dec. 1 (M) & 3 (W): Final-project presentation (< 3 min); only use your final-project GitHub repository (by updating your assignment 1 repository) as a media**
- **Dec. 12 (F): Final project due; complete the repository by 11:59 pm**

2025 CSCI 653 All-Star Roster

	Dec. 1 (M)	Dec. 3 (W)
1	Huanyu Chen, Zhiyuan Gao, Nan Li https://github.com/HuanyuUSC/PoIntInt	Tsung-Jui Wu https://github.com/tsung-jui-wu/CSCI653
2	DJ Bell https://github.com/djusc/hpc	Yuxiao Hang
3	David Chu https://github.com/Davidchu11381/LLM-battleship-simulation	David Cha https://github.com/David-Cha/CSCI653-Fast-Swept-Volumes
4	Tuan Ngo	Shrey Chowdhary https://github.com/shreychowdhary/CS653-Project
5	Zhangyu Jin https://github.com/JinZhangYu/CSCI653_Project	Pouya Golchin https://github.com/poooyaaa/PetersenLAB.git
6	Bihao Li	Li Yang & Tian Sang https://github.com/Allegro-FM-CAT/Allergo-FM-application-for-materials-property
7	Yoomin Lee	Pranav Jain, Letao Chen https://github.com/Pranav-Jain/CSCI653
8	Changmook Oh, Dahye Hong	Yang(Johnny) Liu https://github.com/LookJohnny/csci653-as1-anita
9		Shriya Gumber
10		Hao Cheng
11		Jon Li, James Robertson https://github.com/jsrlabs/DRL-MPC-in-Plasma-Systems
12		Ao Xu https://github.com/AaronXu9/CSCI653_Project

Scientific Writing Tips

Does your Git README read like this?

Punch-body-kick (three-parts) writing

1. **(1a) What's the problem, why it's important?**

   (1b) (More importantly) What's missing?
2. **What you discovered (if a paper) or what unique method you will use to solve the problem (if a proposal—why you think you can solve what nobody else could before?)**
3. **So what: what's the big deal?**

This is the common narrative of your paper abstract

Final Presentation = Elevator Pitch

- **Elevator pitch:** Crisp presentation of an idea to a busy executive

- Four parts of an elevator pitch
  1. Project title
  2. Problem to solve
  3. Proposed solution
  4. Key benefit

- Make your final presentation a 2-3 minutes elevator pitch!

Refine your skill to distill knowledge