

Title: Session 1 - Feng Pan

Speakers:

Collection: POSTDOC WELCOME 2022

Date: October 24, 2022 - 9:50 AM

URL: <https://pirsa.org/22100127>

Abstract: Virtual

About me







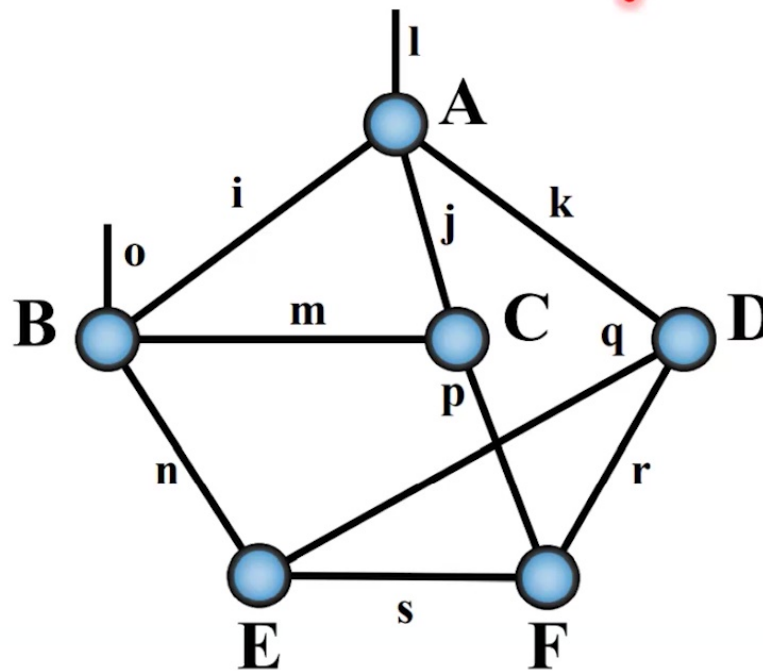
Feng Pan, a numerical guy who keeps staying in the theoretical physics institutes (from ITP, CAS to PITP)

Research background: Statistical Mechanics, with special focus on physical models defined on complex graphs, mostly used tools are tensor network algorithms and neural network models (mostly generative models)

Background – Tensor Network Notations

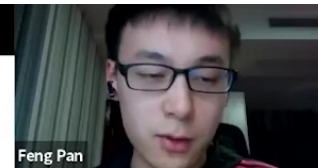


-  **Scalar**
-  **Vector**
-  **Matrix**
-  **Tensor**

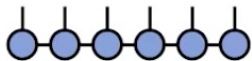


$$\sum_{ijklmnpqrs} A_{ijkl} B_{imno} C_{jmp} D_{kqr} E_{nqs} F_{prs} = R_{ol}$$

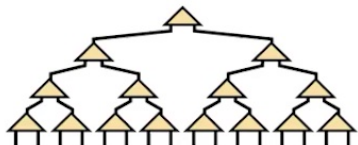
Motivation



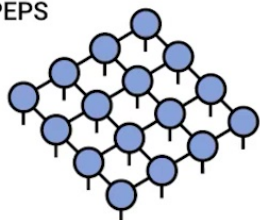
Matrix Product State /
Tensor Train



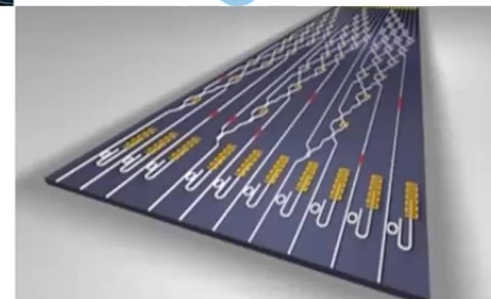
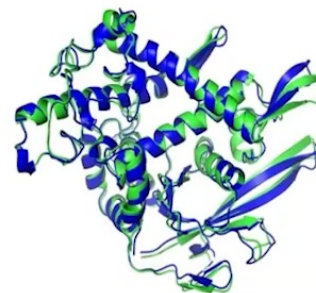
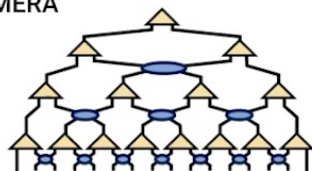
Tree Tensor Network /
Hierarchical Tucker



PEPS



MERA



**Goal: design arbitrary
tensor network algorithm**



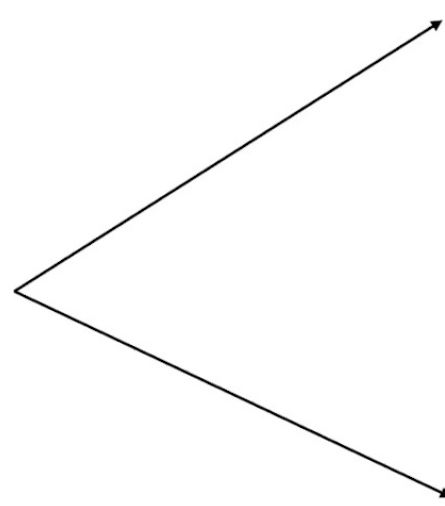
Summary of my current work



**Arbitrary tensor
network algorithm**

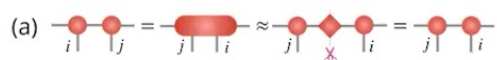
**Approximate:
MPS calculus**

**Exact:
big-batch,
sparse-state**

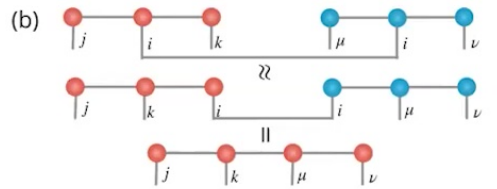




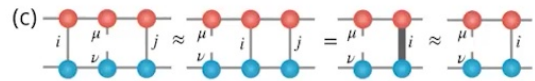
MPS calculus



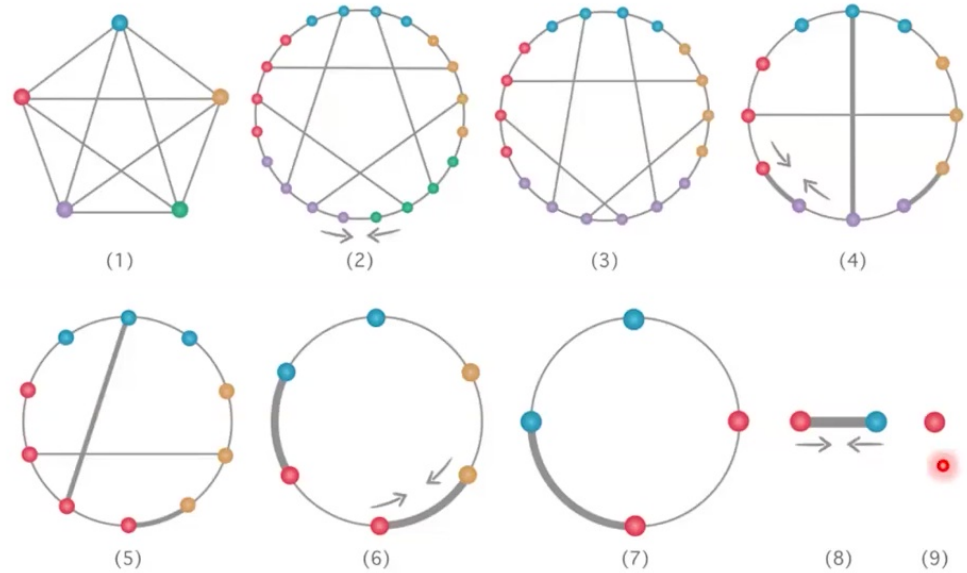
Swap



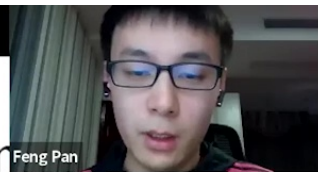
Contract



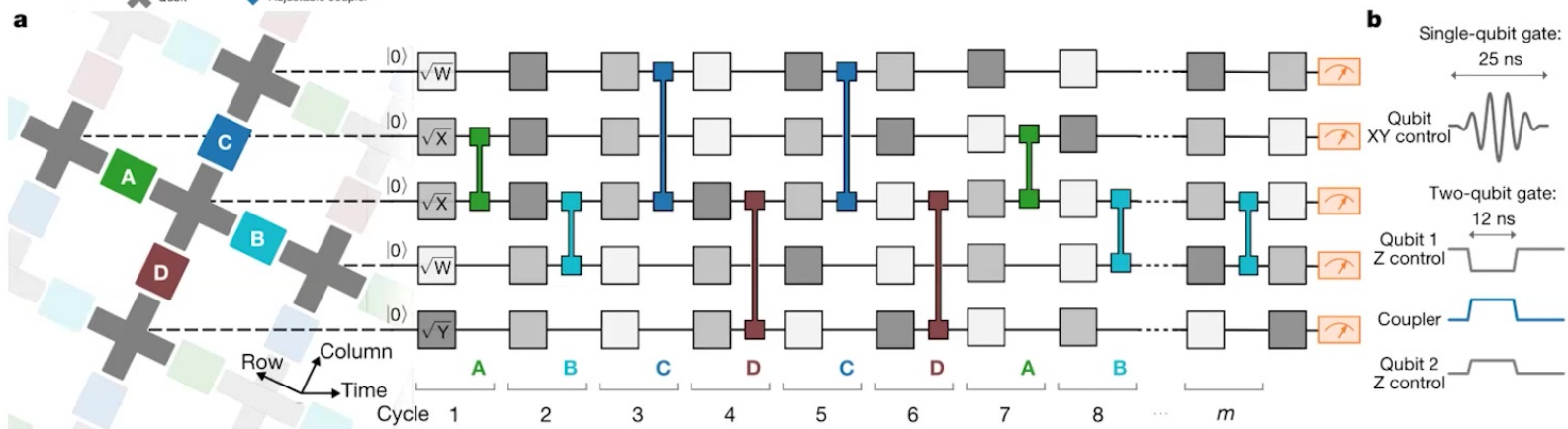
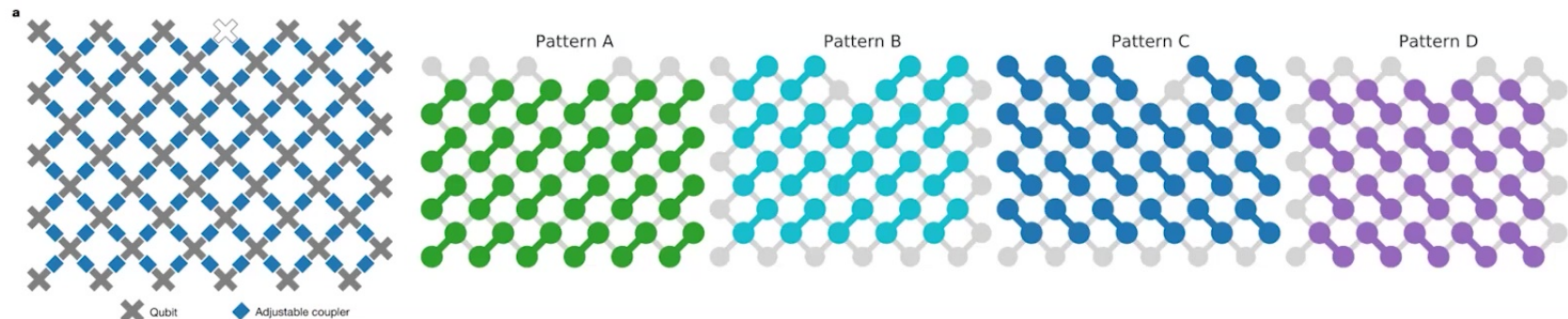
Merge



Pan, et al. *Phys. Rev. Lett.* 125.060503 (2020)



Sycamore quantum circuits and RQC sampling



200 seconds 1,000,000 bistrings 0.2% XEB fidelity

Arute, et al. *Nature* 574.7779 (2019): 505-510.



Classical simulation of RQC sampling experiments

	# bitstrings	Time complexity	Space complexity	Computational time	Hardware
Google' estimate	10^6	$\sim 4^{33}$	2^{26}	10,000 years	Summit supercomputer
cotengra[1]	1	$3.1 \cdot 10^{22}$	2^{27}	3088 years	One Quadro P2000
Alibaba[2]	64	$6.66 \cdot 10^{18}$	2^{29}	267 days	One V100 GPU
Bigbatch[3]	10^6 (correlated)	$4.51 \cdot 10^{18}$	2^{30}	149 days	One A100 GPU
sparse-state[4]	10^6	$3.49 \cdot 10^{18}$	2^{30}	320 days (~ 30 seconds for a supercomputer)	One V100 GPU

[1] Gray, and Kourtis. *Quantum* 5 (2021): 410.

[3] Pan, and Zhang. *Phys. Rev. Lett.* 128.030501 (2022).

[2] Huang, et al. *Nature Computational Science* 1.9 (2021): 578-587.

[4] Pan, Chen and Zhang. *Phys. Rev. Lett.* 129, 090502 (2022).



Thanks for your attention!