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Towards Conscious AI with Quantum Sampling

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What Does Conscious AI Mean to You?

Think of your favorite AI tool—maybe ChatGPT.

Does it have any consciousness at all? If not, why?

Which of following system possess consciousness?

1. A **rock**–simple, totally predictable system

2. A **Flipped coin**–we often use probabilistic model, due to our own ignorance to some “hidden variables”.

3. A **“perfect coin”**–we can ONLY use probabilistic model even if we know all its history and environment.

My $0.02: A system might be more likely to possess consciousness if there exist a possibility that it could “chose it own state”, no matter how hard we probe it.

How quantum mechanics allows a “perfect coin”

Bell test: Experimental result shows there is (almost) no room for qubits to have hidden variables – Nobel prize 2022.

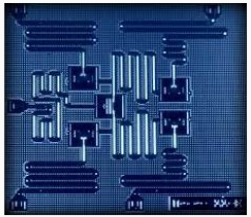
Free will theorem: If human experimenters possess a form of free will, so does some *element particles*. – Conway and Kochen

3B1B Explanation on Bell’s Theorem

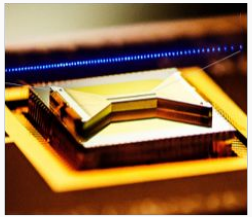
Conway’s Lecture serie at Princeton

Harnessing “elemental particles”, i.e. qubits

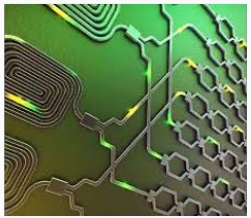
Popular quantum computer modalities today:



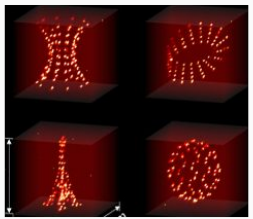
Superconducting Qubits



Ion Traps



Integrated Photonics



Rydberg Atoms

- Starting last decade, we are trying to control those “elemental particles” as C&K described, we call those machines as “quantum computers”.
- Today these machines are still not as great as we imagined, but they might serve the purpose to simulate “free will”.
- Quantum computer could also accelerate certain types of computation, but not all.

How should we add “quantumness” to AI?

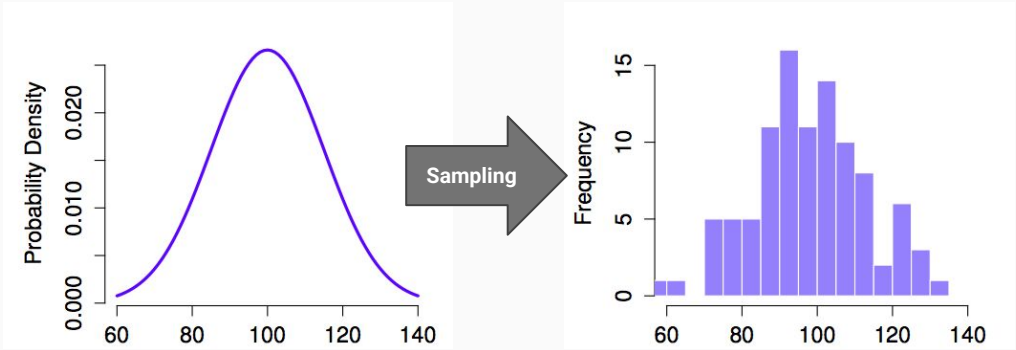
Well, glue them together and call such a thing “conscious” is easy…

Here, we want take a more practical angle: Such a “conscious AI” must be capable to outperform its counterparts, at least in specific tasks.

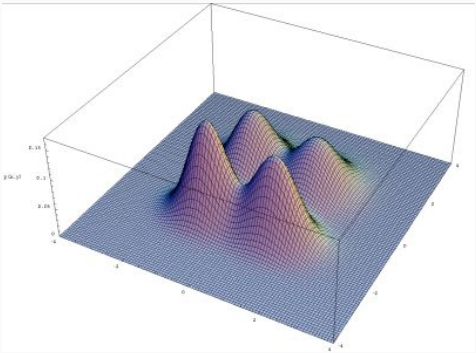
So....

What task can quantum computer **today** can do better?

Quantum Sampling: Generate sample from a complex probability distribution is a hard task for HPC clusters but natural for quantum computer. Experimental demonstration from: Google, USTC, Quantinuum & JPMC



This simple task (sampling) gets hard very fast as our distribution gets more dimensions and “peaks”, like this:

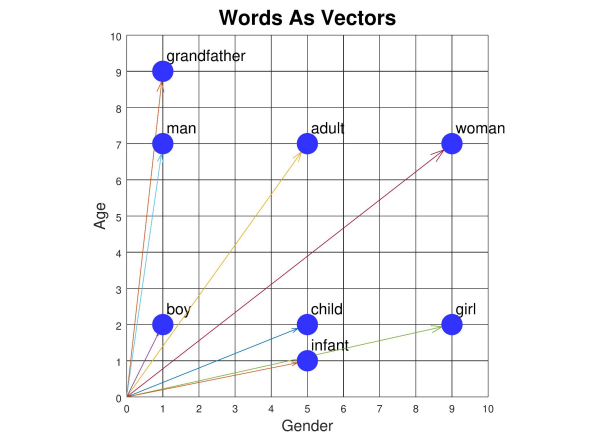


But why this is quantum-easy?
A hand-waving heuristic: A quantum system has “freedom to choose its own state”.

Adding quantum sampling to the building block of LLM: Word Embedding

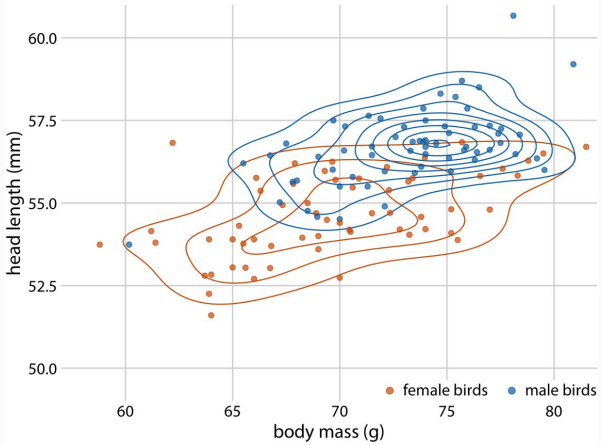
Word Embedding:

Mapping word to a point in semantic space.



Quantum Word Embedding:

Mapping word to a sampled point draw from distribution.

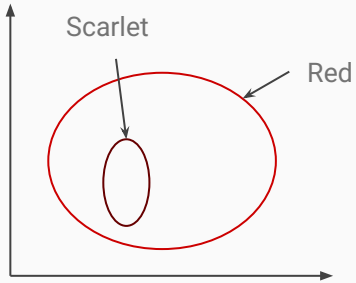


Key Benefits of Quantum Word Embedding

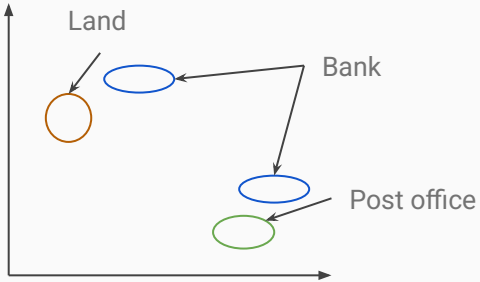
1. Natural representation for semantic relations like hypernymy and polysemy.

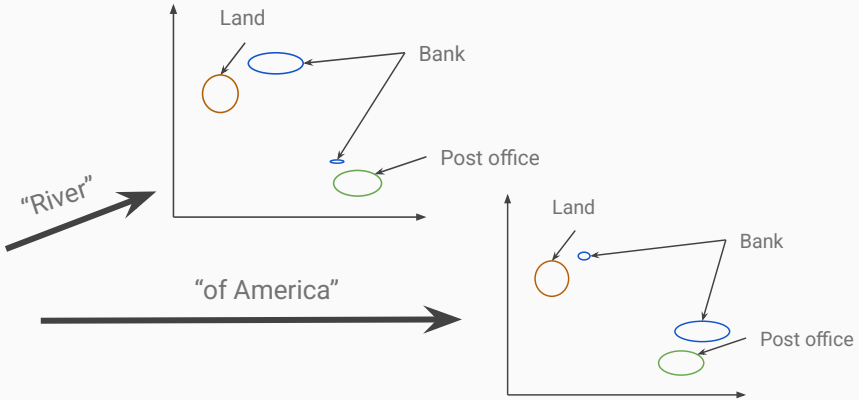
2. Contextual adaptability via Bayesian conditioning.

Hypernymy:



Polysemy:



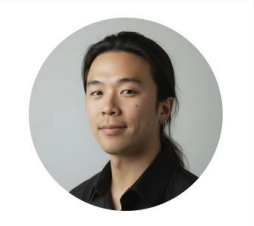


But more importantly: It seems more like how I process words and assign meanings.

Remarks

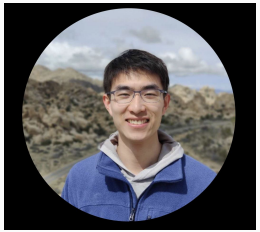
Special Thanks:

Collaborators:



Yidong Zhou, RPI

Jiaqi Leng, UCB



Anze Xie, UCSD

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FinQ Tech Quantum Lab

FinQ Tech Inc. is a 501(c)(3) non-profit community built for quantum computing technologists and those who interested to learn more.

Interested to get involved in this work?

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