

Purpose of Course: To promote understanding of current research in quantum **computing widgets**.

1. Mathematical fundamentals with attention to physics (4-6 weeks, blending into...).
2. Quantum Circuits --- as examples of quantum systems.
3. Quantum Walks.
4. Quantum Communication. What and how much to do depends on interests. Certainly quantum teleportation, basic security protocols, and quantum "paradoxes" from the viewpoint of communication.
5. Quantum physical systems: formulation via Hamiltonians, "Boson Sampling", lots of etc...
6. How much computational complexity theory to involve is an open question. (The Lipton-Regan text on-purpose avoids naming complexity classes until the last main chapter.)

As-such, computer science theory background not presupposed, nor physics background, beyond some (negotiable) basics---e.g., deterministic and nondeterministic finite automata (DFAs and NFAs), the notion of universal computation (whether via Turing machines or random-access machines or high-level programming languages), and "P vs. NP" with factoring and much of classical cryptography in the middle.

Organization: As a 6xx course with graded assignments, take-home final, and project option.

Philosophy I: "Simple Realism"

- Show polarizing filters.
- Show part of talk <https://cse.buffalo.edu/~regan/Talks/UnionCollege52115.pdf>

Philosophy II: Is Nature *Lexical*?

- The idea of *Logos* from 500 BCE. Identified, perhaps incorrectly, with "word".
- The possible meaning of the final sentence of Umberto Eco's novel *The Name of the Rose*, quoting Bernard of Cluny, 1100s:

Stat rosa pristina nomine; nomina nuda tenemus

This means: The rose stands by its original name; we hold the bare name. It is possibly a misquote of "Stat *Roma*..." meaning that we (in the 1100s or 2000s) only know the glory of ancient Rome through recorded memory of it. I, however, believe that a deeper reading treats "pristina" as meaning "unsullied" rather than "original" and taking some liberties of grammar:

The rose abides unsullied by a name; we hold only the bare name.

Regarding the rose as representing Nature, the issue is whether Nature's workings must be read as paying heed to the symbolic way we describe them. The (theoretically-)efficient quantum factoring

algorithm is a real challenge to the idea that nature is symbolically mathematical.

Philosophy III: Evolution of the Lipton-Regan text.

- The original intent of a 60-page "Springer Brief".
- The "physics-free" first edition.
- The overlay nature of the current edition.

Discussion...