Achieving a universal transversal gate set

One of the central problems in quantum computation is combating the noise manifest in such delicate systems. Quantum error correction has thusly been a burgeoning area of research.

However, encoding the information to protect against local errors is just half the problem. The other half is performing computations on the code in such a way that local errors do not propagate.

The most natural avenue for accomplishing this fault-tolerant computation is through the implementation of transversal gates: logical gates on the encoded information that can be realized as separated gates acting individually on the physical qubits in a code block. This way, one corrupted qubit in a block can only propagate its error within its own subsystem of the code.

Unfortunately, no single code admits a universal transversal gate set. Fortunately there is a way around this: color codes are a type of quantum code which admit a fault-tolerant means of switching between codes, bypassing this no-go result. There are many ingredients to understanding this construction, so my talk will be divided into two parts. The first week, we will speak about:

1. the foundations of quantum error correction
2. stabilizer codes
3. and the technique of gauge-fixing.

In two weeks, we will finish the talk by discussing:

1. topological codes (a subset of stabilizer codes),
2. the particular example of color codes (a subset of topological codes),
3. and using gauge-fixing to implement a universal transversal gate set.