Quantum Adiabatic Algorithm and Trotterization

J. Bus

May 5, 2020

1 Quantum Adiabatic Algorithm

Have a look at the following resources

- Paper by Farhi, Goldstone, Gutmann, and Sisper
- Lecture on Hamiltonians by Aaronson
- Lecture on the Adiabatic Algorithm by Aaronson

2 Trotterization

From `https://www.scottaaronson.com/qclec/25.pdf`, slightly adapted

Once adding Hamiltonians, one faces a mathematical question, namely: If A and B are matrices, is it generally the case that $e^{A+B} = e^A e^B$? The answer is **no**. In the special case that A and B commute however, we find that the equality holds. What to do when they don't? Fortunately, there's a special trick for this, known as **Trotterization**. It uses the following approximation

$$e^{A+B} \approx e^{\epsilon A} e^{\epsilon B} e^{\epsilon A} e^{\epsilon B} \dots e^{\epsilon A} e^{\epsilon B} \tag{1}$$

each step $e^{\epsilon A} e^{\epsilon B}$ is repeated $1/\epsilon$ times. This basically means that we can achieve the same effect as A and B occurring simultaneously, by repeatedly switching between doing a tiny bit of A and a tiny bit of B. We wont do it here, but its possible to prove that the approximation improves as ϵ decreases, becoming an exact equality in the limit $\epsilon \to \infty$