0.1 Adiabatic state preparation: squashing the bugs

0.1.1 Definitions

ASP Hamiltonian is

$$H(s) = sH_{problem} + (1-s)H_{mixing} \quad , \quad 0 < s < 1 \tag{1}$$

with

$$H_{problem} = \sum_{z \in \{0,1\}^n} E(z)|z\rangle\langle z| \tag{2}$$

and

$$H_{mixing} = \sum_i X_i \tag{3}$$

0.1.2 Goal

Go from
the ground state of $H(0) = H_{mixing}$ to
the ground state of $H(1) = H_{problem}$.

0.1.3 Procedure

Starting point:

$$|\Psi_0\rangle = |-\rangle^{\otimes n} \quad , \quad |-\rangle = \frac{|0\rangle - |1\rangle}{\sqrt{2}} \tag{4}$$

Initial check:

$$\langle\Psi_0|H_{mixing}|\Psi_0\rangle = -n \quad , \quad \langle\Psi_0|H_{problem}|\Psi_0\rangle = 0 \tag{5}$$

Fixing a time T and a number of time steps m, this gives a time step $\Delta t = \frac{T}{m}$.
We use a Trotter decomposition:

$$U_{T,m} = e^{-i\Delta t H(\frac{m-1}{m})} e^{-i\Delta t H(\frac{m-2}{m})} \dots e^{-i\Delta t H(\frac{2}{m})} e^{-i\Delta t H(\frac{1}{m})} e^{-i\Delta t H(0)} \tag{6}$$

with the following approximation for the evolution under a single step:

$$\begin{aligned} U_{T,m} &= e^{-i\Delta t H(s)} \\ &= e^{-i\Delta t[sH_{problem} + (1-s)H_{mixing}]} \\ &\simeq e^{-i\Delta t s H_{problem}} e^{-i\Delta t(1-s)H_{mixing}} \end{aligned} \tag{7}$$

Qiskit has a command called "evolve" with several options (e.g. 'Trotter'/'Suzuki' expansion order =1,2,3 etc)