Exercise Sheet 3

Kastoryano: Quantum Error Correction

October 31, 2018

1 Exercise 1: Shor_9 code protection against arbitrary single qubit error.

Exercise 1.1 Let $\mathcal{E}(\rho) = \sum_k E_k \rho E_k^\dagger$ be the error channel. Show that each error E_k can be written as

$$E_k = e_1^k \mathbb{1} + e_X^k X + e_Y^k XZ + e_Z^k Z. \tag{1}$$

What constraints are there on the $\{e_\alpha^k\}$?

Exercise 1.2 Show that the Shor_9 code protects against $\mathcal{E}$, by showing that each error E_k can be protected individually (you may use the Knill-Laflamme theorem).

2 Exercise 2: Depolarizing channel on each qubit.

Exercise 1.1 Calculate the logical error rate of the Shor_9 code against the independent identically distributed depolarizing channel.

Exercise 1.2 (BONUS) Calculate the logical error rate of the Shor_n code against the independent identically distributed depolarizing channel.