

# Exercise Sheet 5

Kastoryano: Quantum Error Correction

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## 1 Exercise 1: Minimal failing configurations.

What are the (minimal) weight  $d/2$  error configurations leading to a failure under the optimal decoder for the Toric code. How many such error configurations are there (as a function of  $d$  or  $n$ )?

## 2 Exercise 2: Smallest toric code

Argue that an  $L = 3$  Toric code can protect against arbitrary single qubit errors. Discuss how one would construct an optimal decoder for this code (no need to give a full table).

## 3 Bonus: Syndromes as Anyons.

Braiding two particles is the process of moving two particles around each other without having them touch in such a way that they return to their initial position. Show that the action of braiding an isolated  $Z$  syndrome (the endpoint of a string) and an isolated  $X$  syndrome is non-trivial. Is the braiding abelian; i.e. does it make a difference what direction the syndromes are braided in (clockwise or anti-clockwise)?