Surface codes

The SC is constructed from the HGP of the rep code.

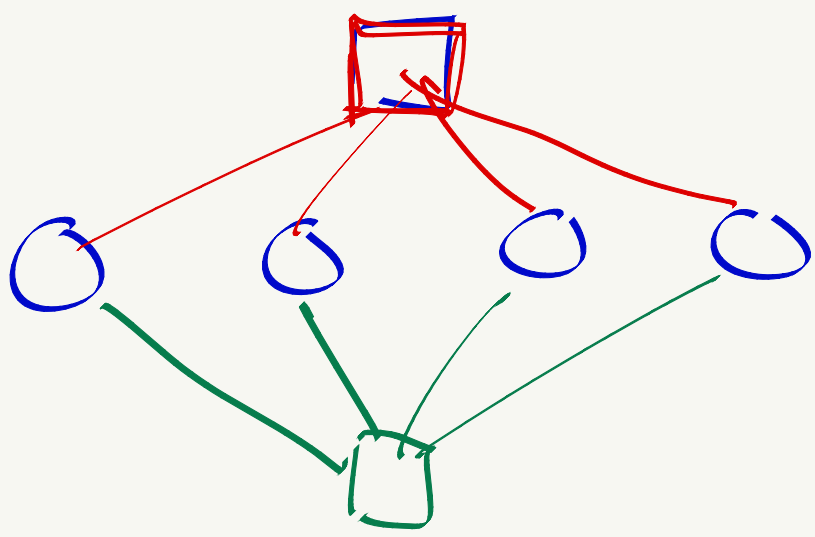
eg. $d=3$ rep code is

$$H = \begin{bmatrix} 1 & 1 & 0 \\ 0 & 1 & 1 \end{bmatrix}$$

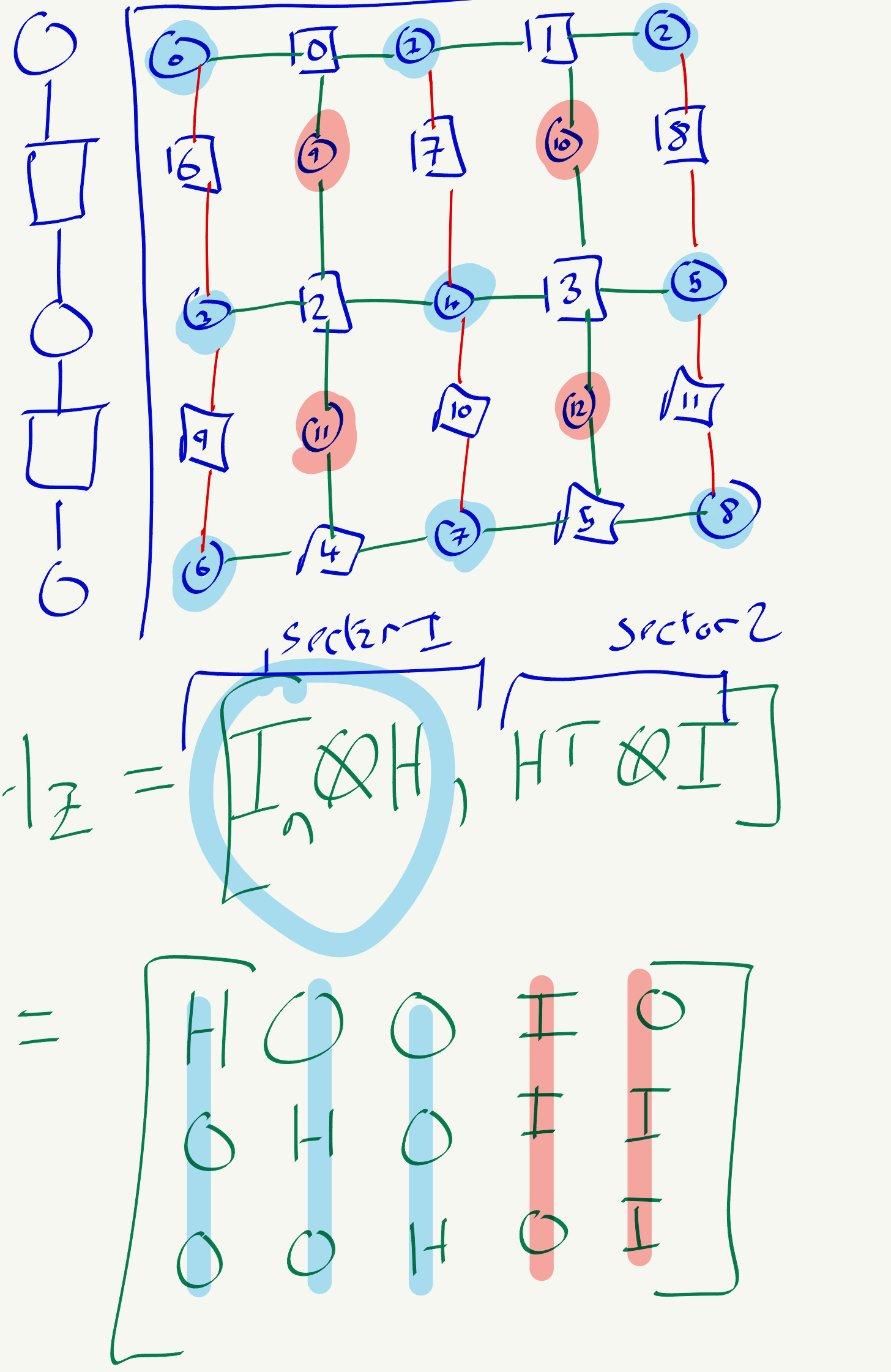
Side note: Quantum factor graphs.

- We need edge types: one for X-Paulis and one for Z-Paulis.

eg- $[[4,2,2]]$ code



Drawing the lattice



$$H_x = \left[H \otimes I_n \,,\, I_m \otimes H^T \right]$$

$$= \left[\begin{array}{cc|cc} I & I & O & H^T \\ O & I & I & O \\ \end{array}\right]$$

Exercises

- Create a class called SurfaceCode.
- Create a method that draws a surface code of dimensions dxd for any d.
- Add functionality to draw error on output.
- Also display syndrome.

- Draw logical operators on surface code.
- What properties do X/Z logicals have. eg. what do they look like on the lattice.
- Derive a relation for the surface code distance.

Challenge.

- Create a rectangular surface code.
- From this, drive a form of the hypergraph product that can accept two different classical codes.