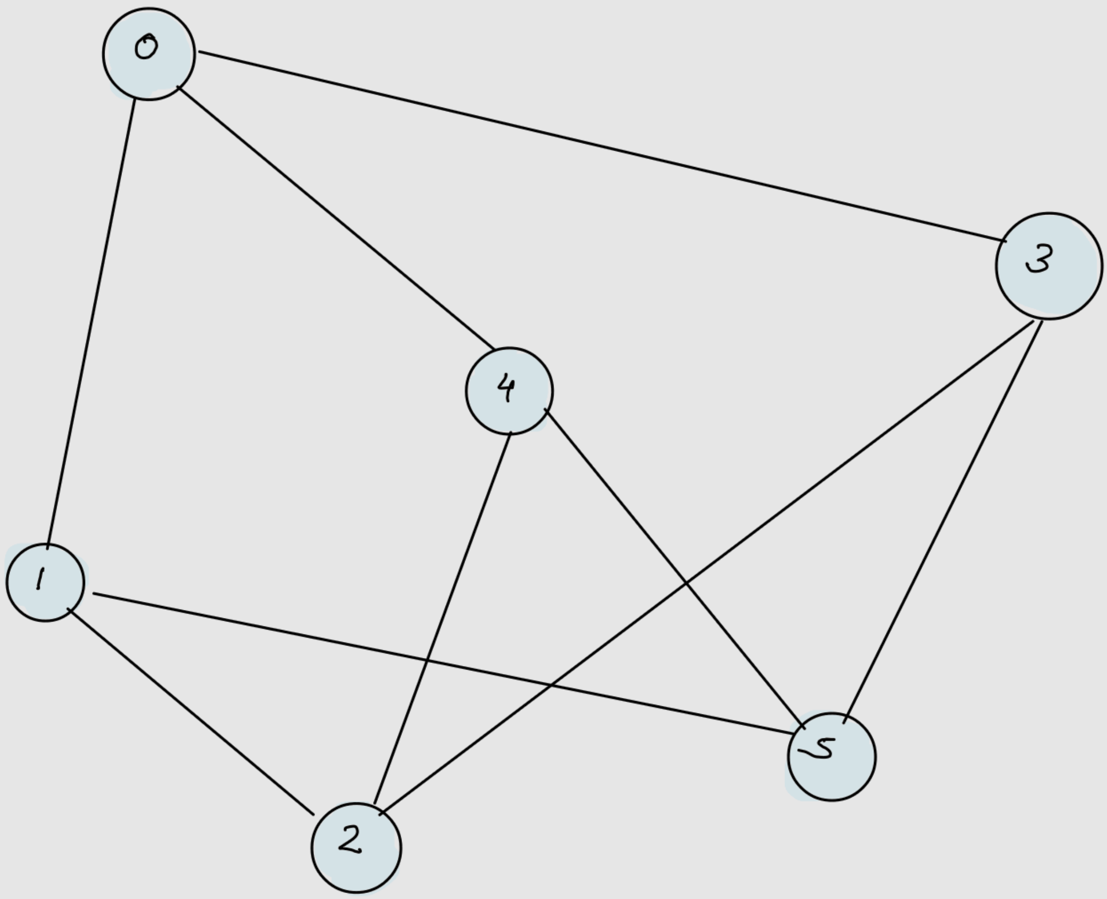
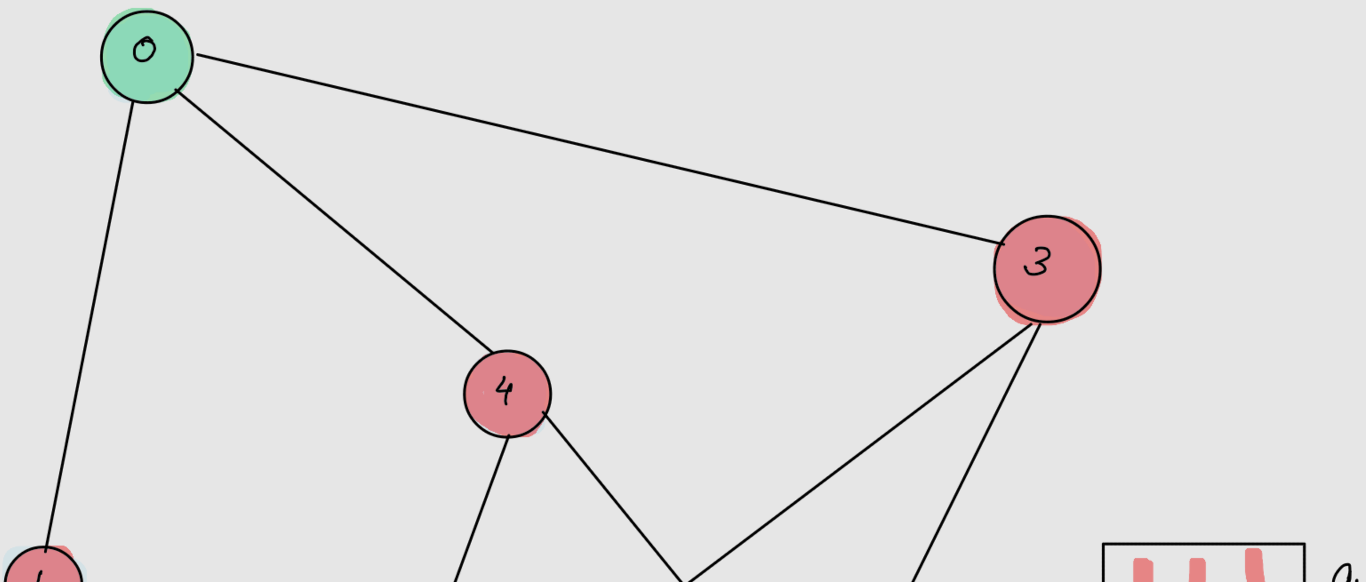
Quantum Random Access Code

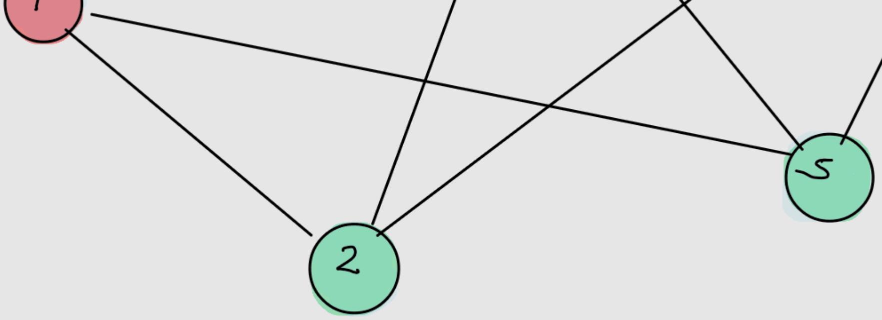
Problem: $-2x_0x_1 - 2x_0x_3 - 2x_0x_4 - 2x_1x_2 - 2x_1x_5 - 2x_2x_3 - 2x_2x_4 - 2x_3x_5 - 2x_4x_5 + 3x_0 + 3x_1 + 3x_2 + 3x_3 + 3x_4 + 3x_5$

Binary Variables : $x_0 \quad x_1 \quad x_2 \quad x_3 \quad x_4 \quad x_5$



Encoding in Relaxed problem





$q_1 \to \underline{1,3,4}$

$q_2 \to \underline{0,2,5}$

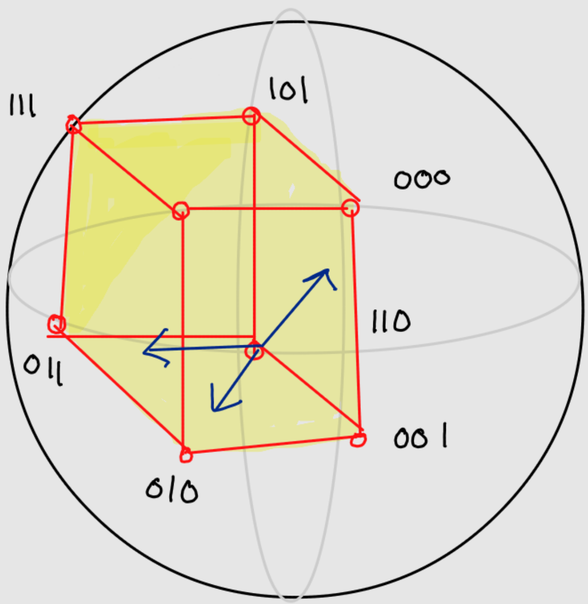
6 binary variables in 2 qubits

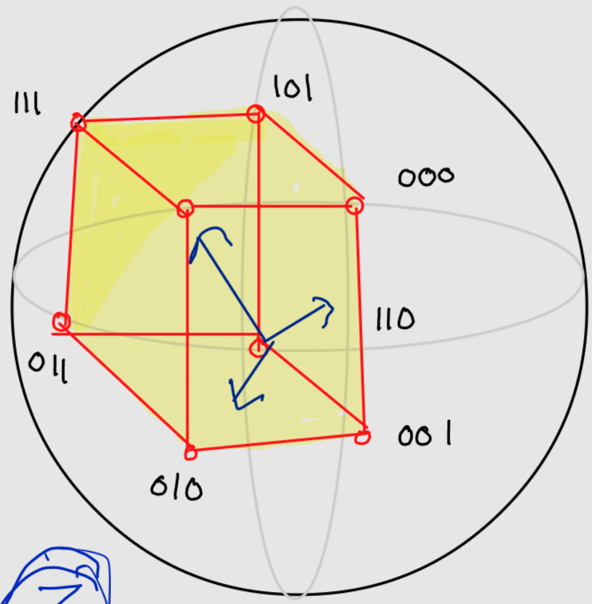
$0 - |000\rangle$

$1 - |001\rangle$

$7 = |111\rangle$

Encoded Hamiltonian

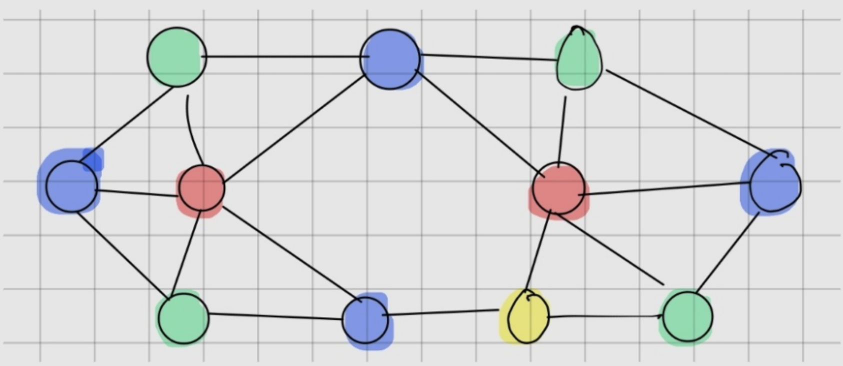




$m_1 \; m_2$

$\underline{X}\,\underline{Y} = Z \quad m_3$

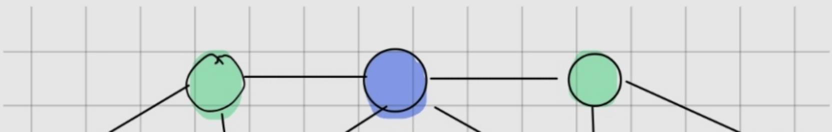
$$\boxed{\text{1.) A better encoding scheme for graphs like theese.}}$$



$\to$ 4 colors

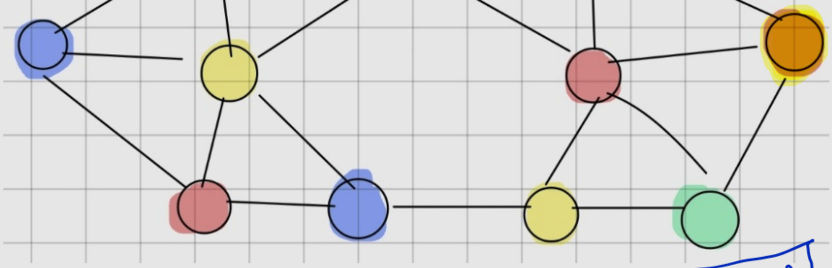
11 vertices

6 qubits



4 colors

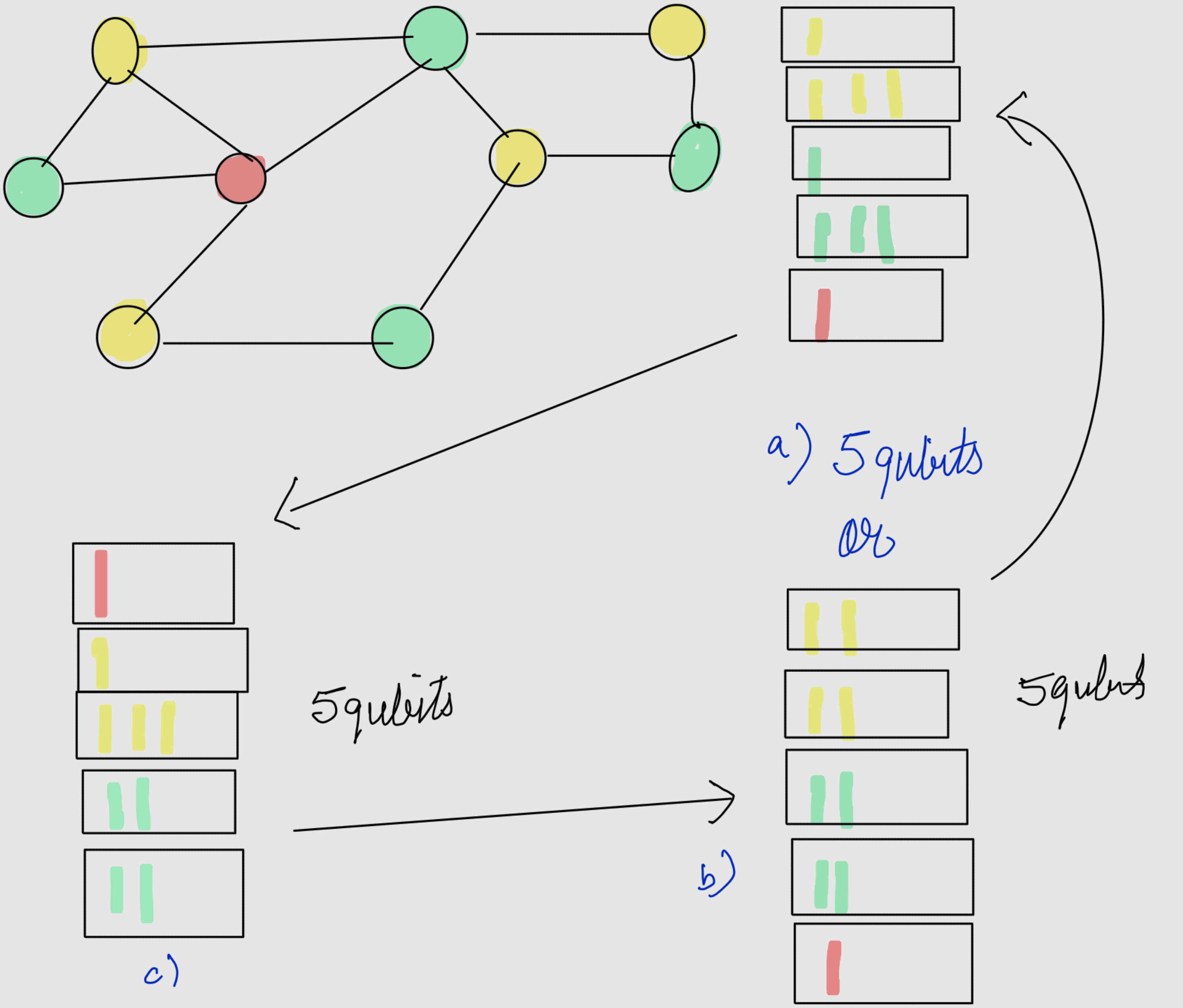
11 vertices



→ 11 vertices
4 qubits

2.) An implementation of $\boxed{(3,2\text{-}p)}$ ORAC, they have higher probability of recovery of (0.902). Although it ends up taking more qubits than $(\underline{3,1,p})$ but results will be better. How to decide the trade off between solutions quality and hardware requirement.

3) Can we implement a separate / multiple encoding in a single problem? Eg



→ max 2 bits on one qubit

a) max 3 bits on one qubit

b) max 2 bits on one qubit

c) Mixture of 3 bits and 2 bits on one qubit.

4) Importance of binary variables:

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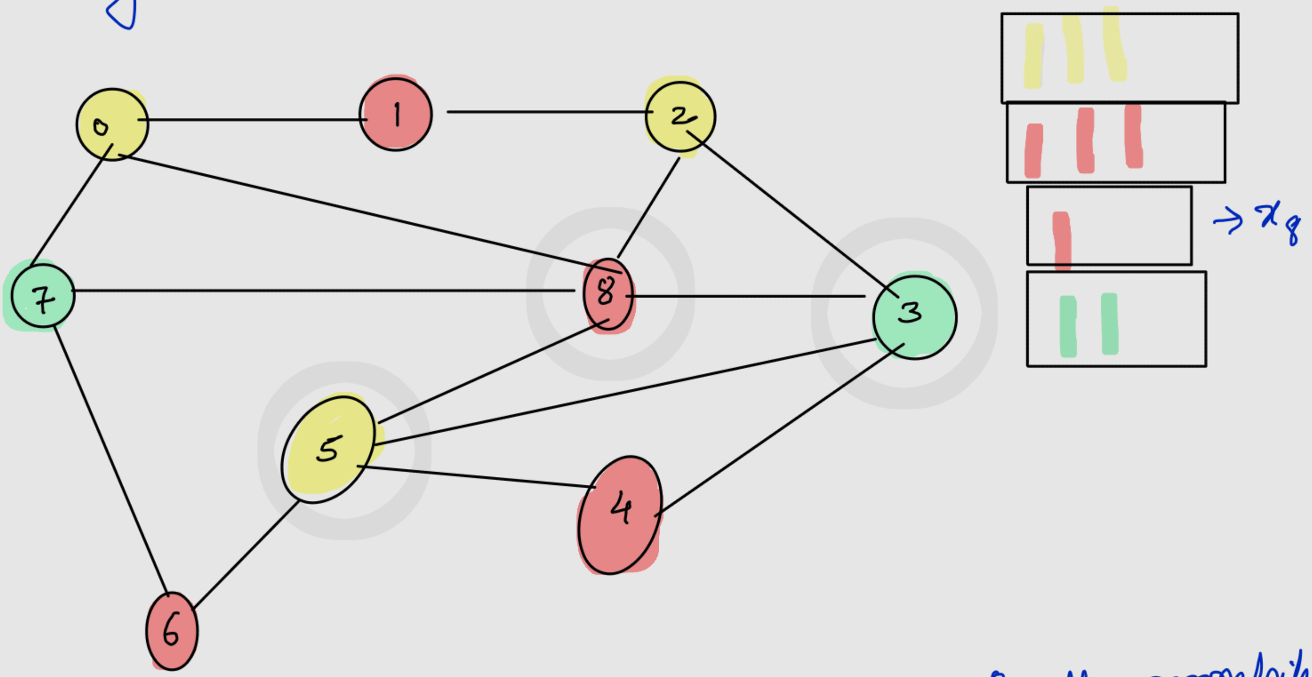
$- 2x_2x_4 - 2x_3x_5 - 2x_4x_5 + 3x_0 + 3x_1 + 3x_2 + 3x_3 + 3x_4 + 3x_5$

We can encode important variable such that they are recovered with higher probability?

Will It work? I don't know

How to describe a binary variable, or a set of binary variable important?

→ maybe look at the constraints, that it has to follow!



Are x_8, x_3, x_5 important? Since they are maximally correlated?

Can we decide (in above case) which binary bits to encode together in a qubit, and which to give a separate one of its own?

5) Measurement: Can we do anything better than Magic Rounding?

a) Measure in some other basis, or separate measurement.

(This requires a very deep level mathematical thinking)