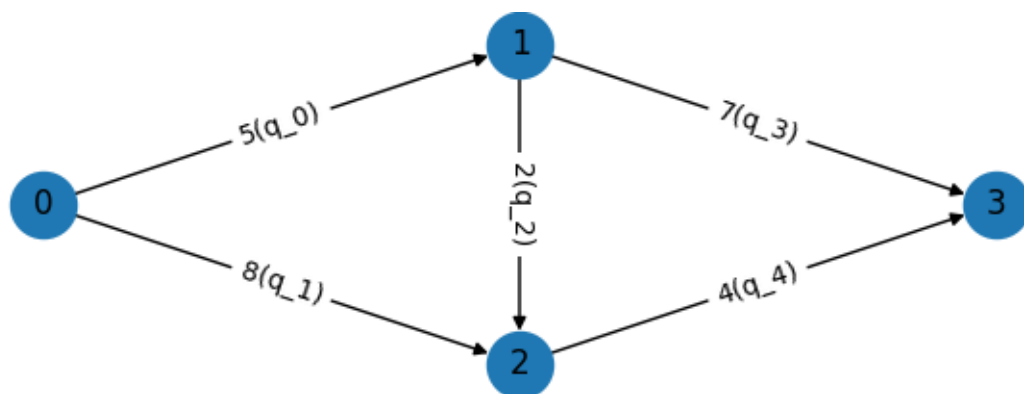


Fórmulas



1 Formulación del problema

- **Objetivo:**

$$\min(5X_{01} + 8X_{02} + 2X_{12} + 7X_{13} + 4X_{23})$$

- **Restricciones:**

$$X_{01} + X_{02} = 1 \quad (1)$$

$$X_{01} = X_{12} + X_{13} \quad (2)$$

$$X_{02} + X_{12} = X_{23} \quad (3)$$

$$X_{13} + X_{23} = 1$$

2 Función de coste (QUBO)

$$C(X) = 5X_{01} + 8X_{02} + 2X_{12} + 7X_{13} + 4X_{23} +$$

$$P(X_{01} + X_{02} - 1)^2$$

$$P(X_{01} - X_{12} - X_{13})^2$$

$$P(X_{02} + X_{12} - X_{23})^2$$

$$P = 1 + \sum_{(i,j) \in E} w_{ij} = 27$$

3 Correspondencia

$$X_{01} \rightarrow z_o$$

$$X_{02} \rightarrow z_1$$

$$X_{12} \rightarrow z_2$$

$$X_{13} \rightarrow z_3$$

$$X_{23} \rightarrow z_4$$

$$z_a = \begin{cases} 1 & \text{si } X_{ij} = 0 \\ -1 & \text{si } X_{ij} = 1 \end{cases}$$

$$X_{ij} \rightarrow \frac{1 - z_a}{2}$$

4 Función de coste (Ising)

$$C(X) \rightarrow g(z) = 5 \frac{1 - z_0}{2} + 8 \frac{1 - z_1}{2} + 2 \frac{1 - z_2}{2} + 7 \frac{1 - z_3}{2} + 4 \frac{1 - z_4}{2} +$$

$$P \left(\frac{1 - z_0}{2} + \frac{1 - z_1}{2} - 1 \right)^2$$

$$P \left(\frac{1 - z_0}{2} - \frac{1 - z_2}{2} - \frac{1 - z_3}{2} \right)^2$$

$$P \left(\frac{1 - z_1}{2} + \frac{1 - z_2}{2} - \frac{1 - z_4}{2} \right)^2$$

$$g(z) = 11z_0 - 17.5z_1 - 28z_2 - 17z_3 + 11.5z_4 +$$

$$13.5(-z_0z_2 + z_1z_2 + z_2z_3 - z_2z_4 + z_0z_1 - z_0z_3 - z_1z_4) +$$

$$(13.5z_0^2 + 13.5z_1^2 + 13.5z_2^2 + 6.75z_3^2 + 6.75z_4^2) +$$

$$26.5$$

5 Hamiltonian problem y mixer

Donde Z es una puerta Pauli-Z y X una puerta Pauli-X

$$H_p = 11Z_0 - 17.5Z_1 - 28Z_2 - 17Z_3 + 11.5Z_4 + \\ 13.5(-Z_0Z_2 + Z_1Z_2 + Z_2Z_3 - Z_2Z_4 + Z_0Z_1 - Z_0Z_3 - Z_1Z_4) + \\ (13.5Z_0^2 + 13.5Z_1^2 + 13.5Z_2^2 + 6.75Z_3^2 + 6.75Z_4^2) + \\ 26.5$$

$$U(H_p, \gamma_i) = e^{-i\gamma_i H_p} = Rz_0(11 * 2\gamma_i) * Rz_1(-17.5 * 2\gamma_i) * Rz_2(-28 * 2\gamma_i) * Rz_3(-17 * 2\gamma_i) * Rz_4(11.5 * 2\gamma_i) * \\ Rz_0z_2(-13.5 * 2\gamma_i) * Rz_1z_2(+13.5 * 2\gamma_i) * Rz_2z_3(+13.5 * 2\gamma_i) * Rz_2z_4(-13.5 * 2\gamma_i) * \\ Rz_0z_1(+13.5 * 2\gamma_i) * Rz_0z_3(-13.5 * 2\gamma_i) * Rz_1z_4(-13.5 * 2\gamma_i)$$

Pero en el paper:

$$U(H_p, \gamma_i) = e^{-i\gamma_i H_p} = Rz_0(11) * Rz_1(-17.5) * Rz_2(-28) * Rz_3(-17) * Rz_4(11.5) * \\ Rz_0z_2(-13.5\gamma_i) * Rz_1z_2(+13.5\gamma_i) * Rz_2z_3(+13.5\gamma_i) * Rz_2z_4(-13.5\gamma_i) * \\ Rz_0z_1(+13.5\gamma_i) * Rz_0z_3(-13.5\gamma_i) * Rz_1z_4(-13.5\gamma_i)$$

$$H_m = \sum_{i=0}^{n-1} X_i$$

$$U(H_m, \beta_i) = e^{i\beta_i H_m} = \prod_{i=0}^{n-1} Rx_i(2\beta_i)$$

5.1 Definiciones

$$Rx_i(\lambda) = \exp(-i\frac{\lambda}{2}X_i)$$

$$Rz_i(\lambda) = \exp(-i\frac{\lambda}{2}Z_i)$$

$$Rz_iz_j(\lambda) = \exp(-i\frac{\lambda}{2}Z_i \otimes Z_j)$$

6 Hamiltonian

- **Parámetros:**

$$\vec{\beta} = [\beta_0, \dots, \beta_{p-1}]$$

$$\vec{\gamma} = [\gamma_0, \dots, \gamma_{p-1}]$$

- **Hamiltonian**

$$H(\vec{\beta}, \vec{\gamma}) = U(H_p, \gamma_0)U(H_m, \beta_0) \dots U(H_p, \gamma_{p-1})U(H_m, \beta_{p-1})$$