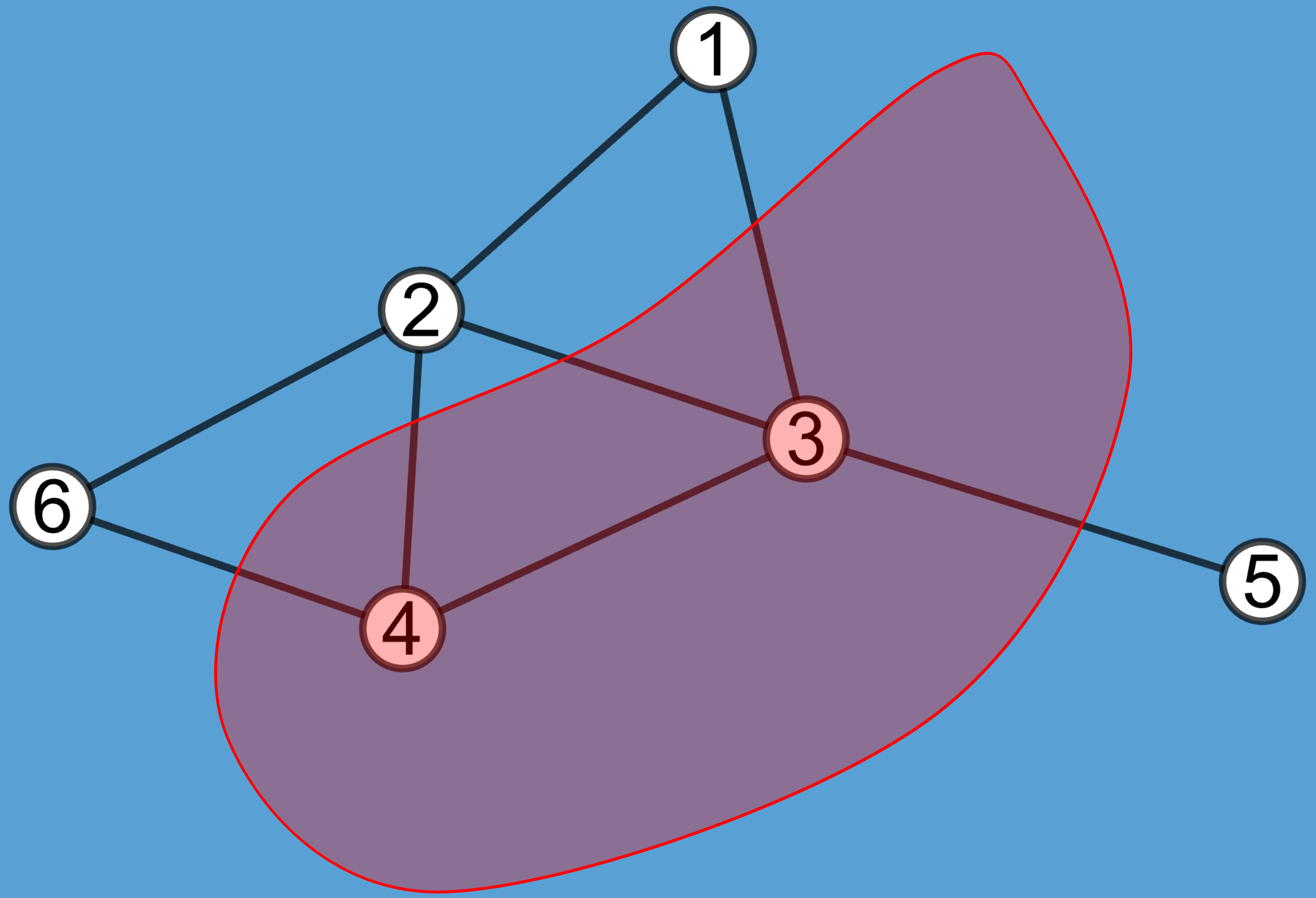
Solving Max Cut Problem with QAOA

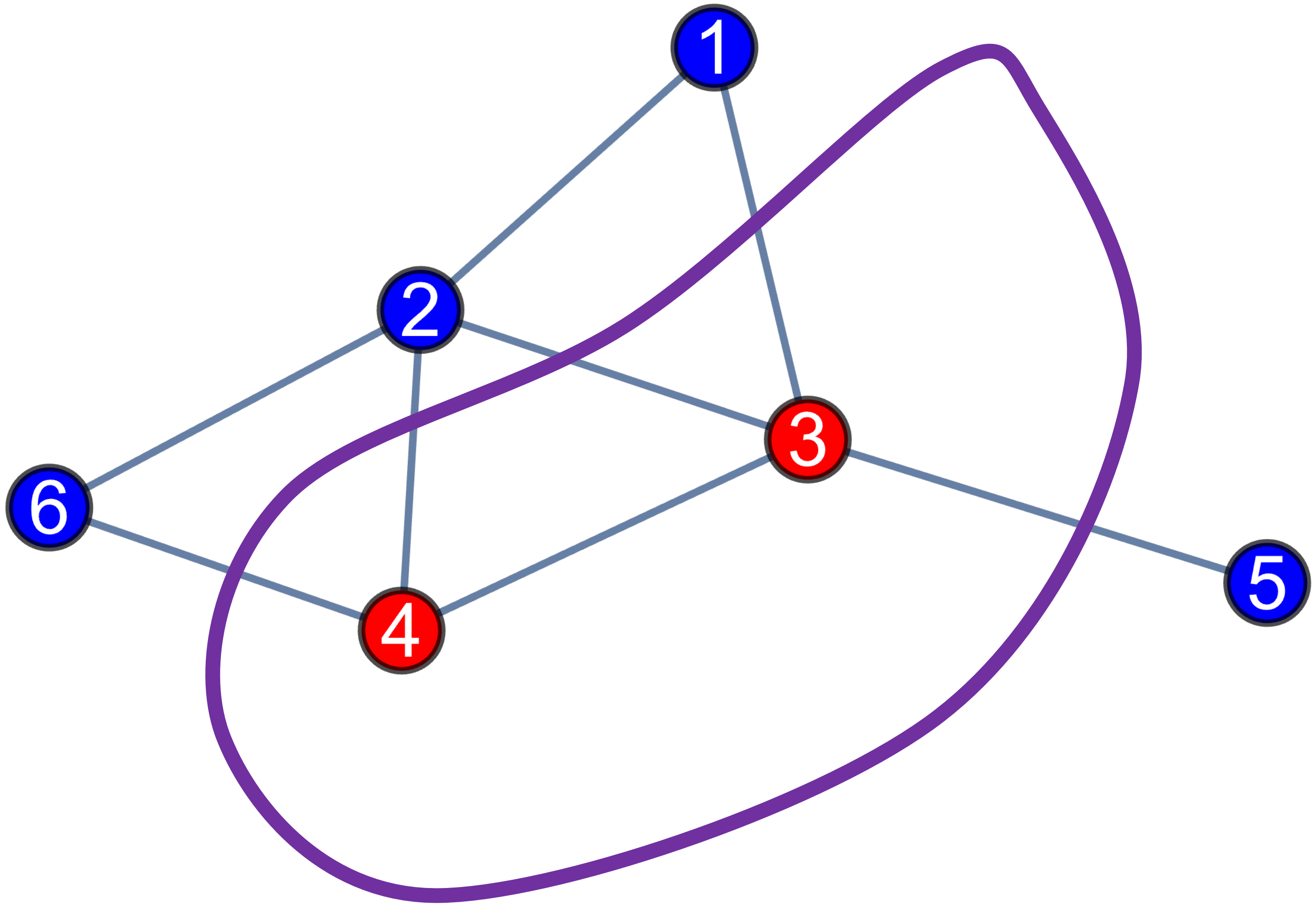
Kyeong-min Kim

Max Cut Problem

Max Cut Problem



Max Cut Problem

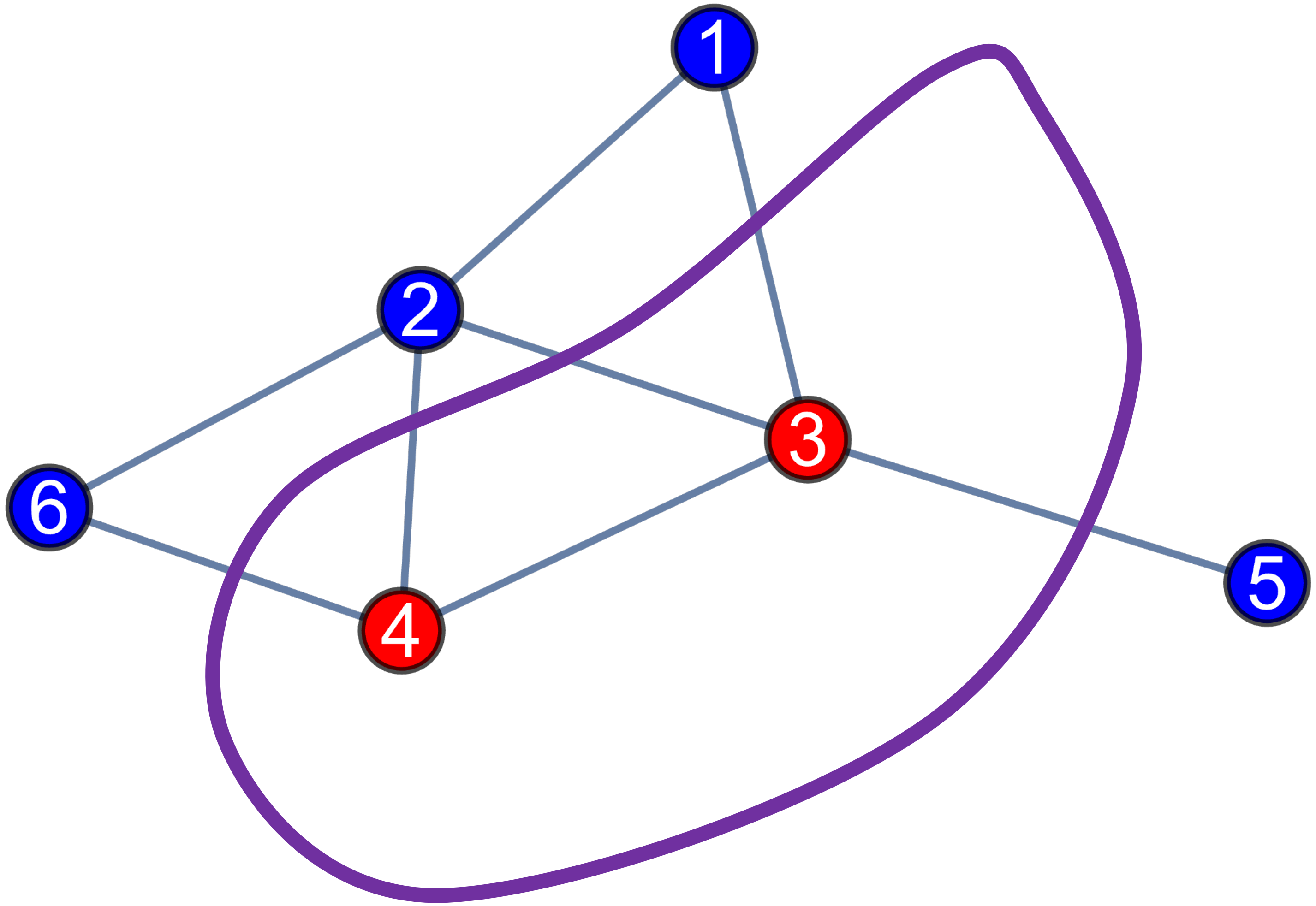


$$\hat{H}_p = \frac{1}{2}\sum_{i,j}(1 - \hat{Z}_i\hat{Z}_j)$$

$$\hat{Z}_i \in \{-1, 1\}$$

$$MAX_Z\,\{\hat{H}\}$$

Max Cut Problem
Change into physic problem



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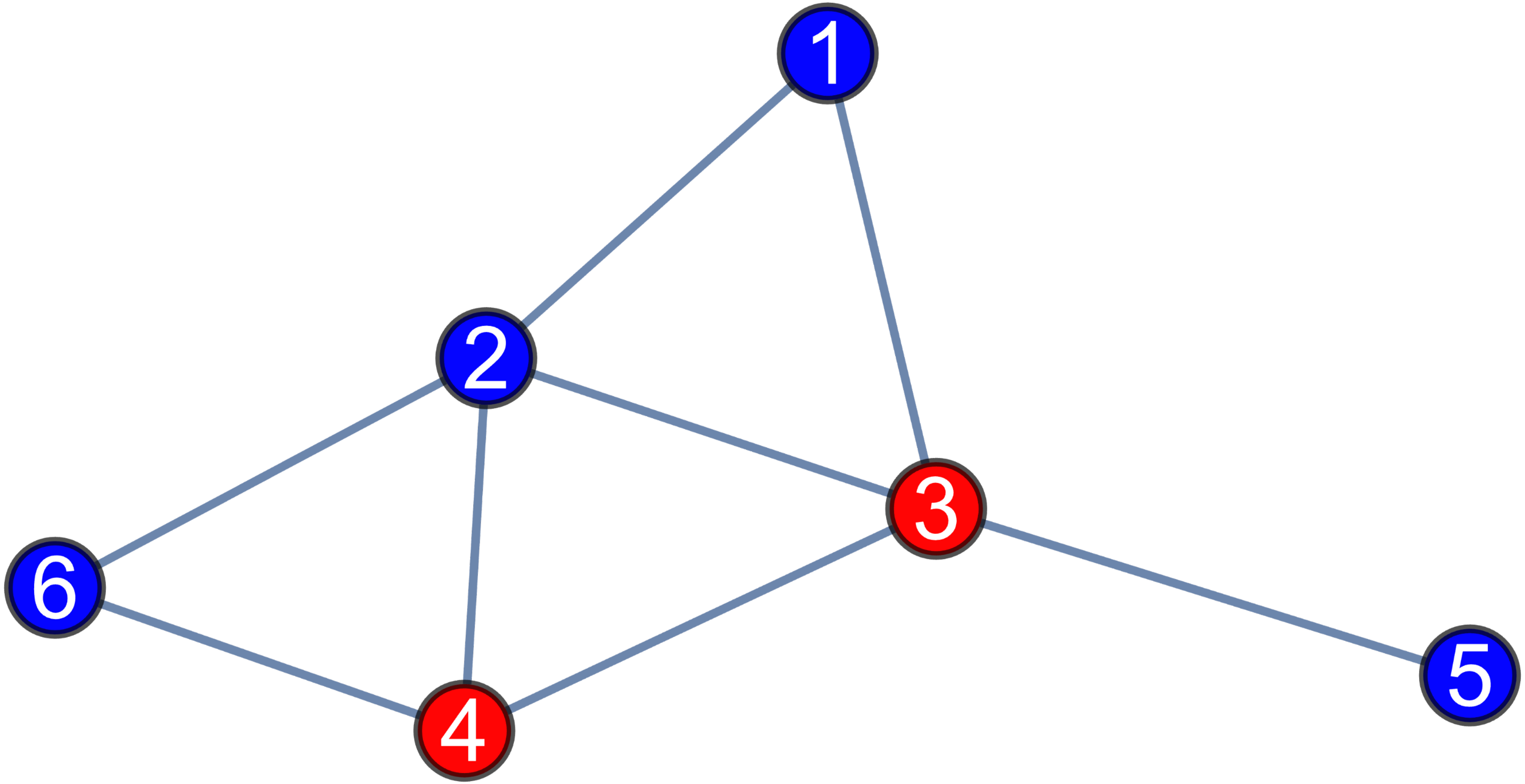
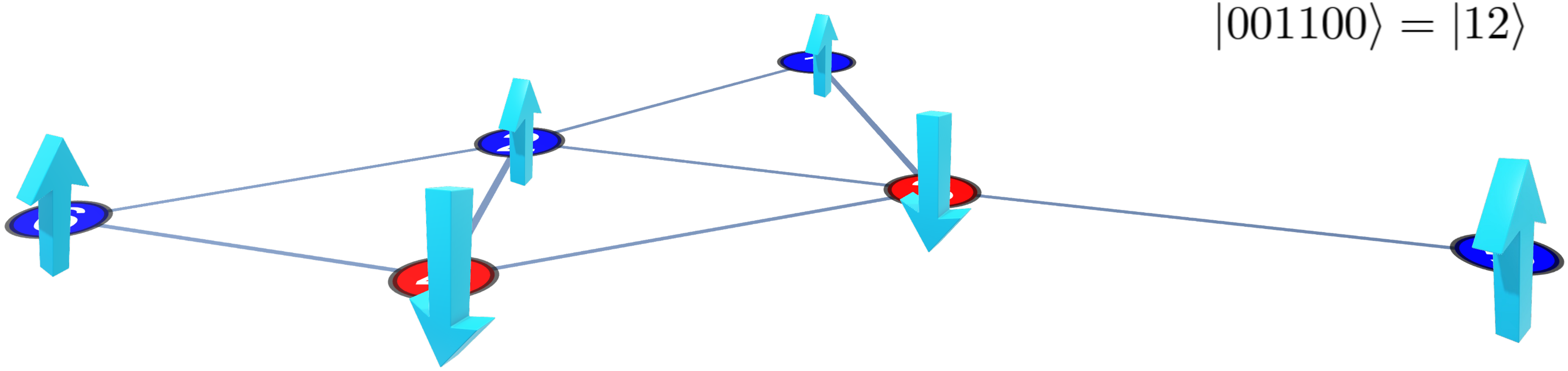


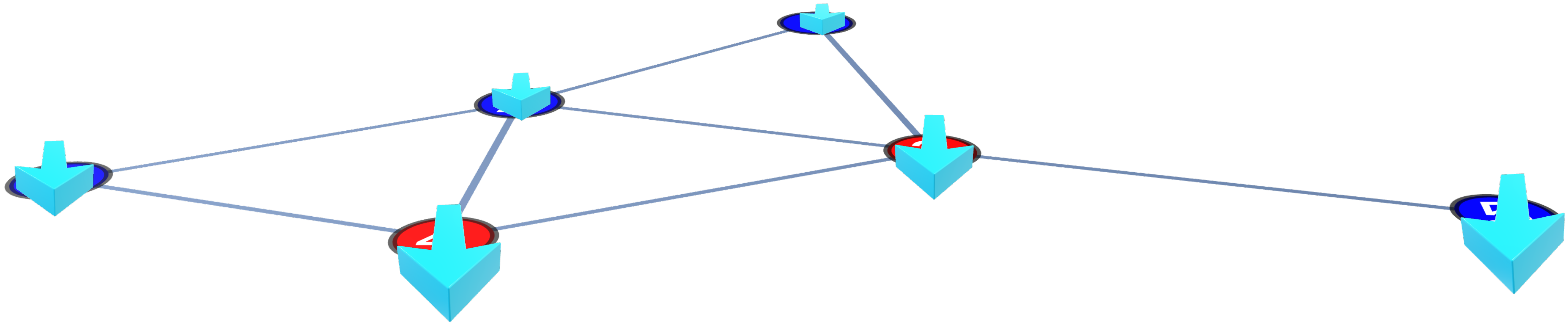
$$\hat{H}_p = \frac{1}{2}\sum_{i,j}(1 - \hat{Z}_i\hat{Z}_j)$$



$$|001100\rangle = |12\rangle$$

$$\hat{H}_I = \sum_i \hat{X}_i$$

$$\hat{H}_p = \frac{1}{2}\sum_{i,j}(1 - \hat{Z}_i\hat{Z}_j)$$



$$\hat{H}_I = \sum_i \hat{X}_i$$

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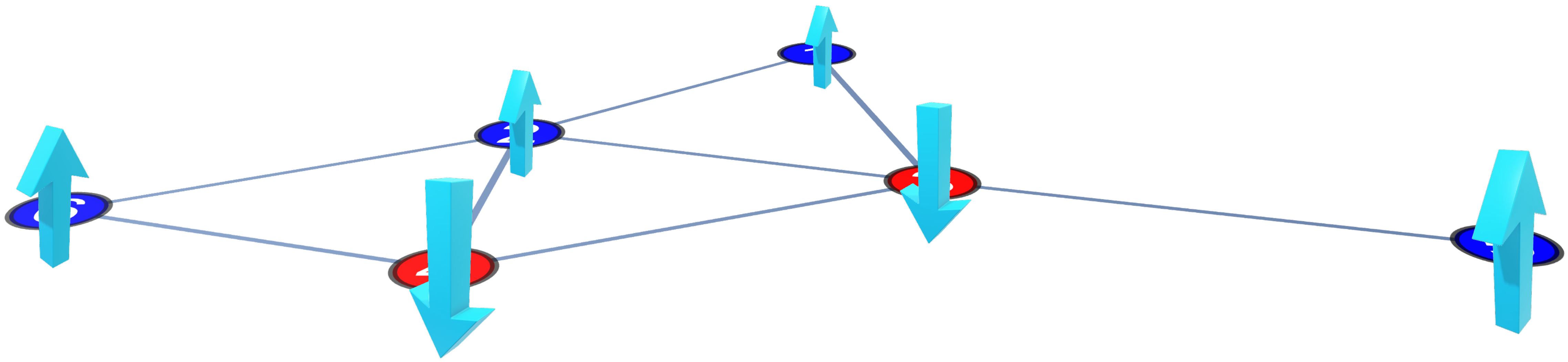


$$\hat{H}_I = \sum_i \hat{X}_i$$

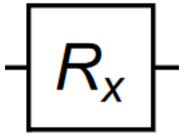
$$\hat{H}(\tau) = (1-\tau)\hat{H}_I + \tau\hat{H}_p \;\; ;\tau = \frac{t}{T}$$

$$\hat{H}_p = \frac{1}{2}\sum_{i,j}(1 - \hat{Z}_i\hat{Z}_j)$$

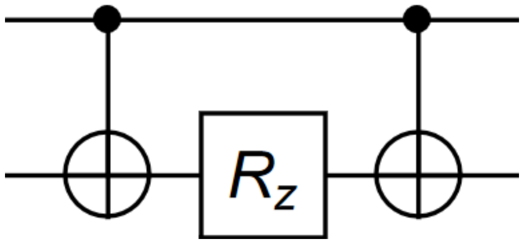
Quantum Approximate Optimization Algorithm(QAOA)

$$\hat{U} = e^{-i\hat{H}t} \qquad e^{\hat{A}+\hat{B}} \approx (e^{\hat{A}/n}e^{\hat{B}/n})^n$$

$$e^{-i\beta_l \hat{X}_i}$$ =



$$e^{-i\gamma_l(1-\hat{Z}_i\hat{Z}_j)/2}$$ =



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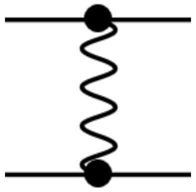

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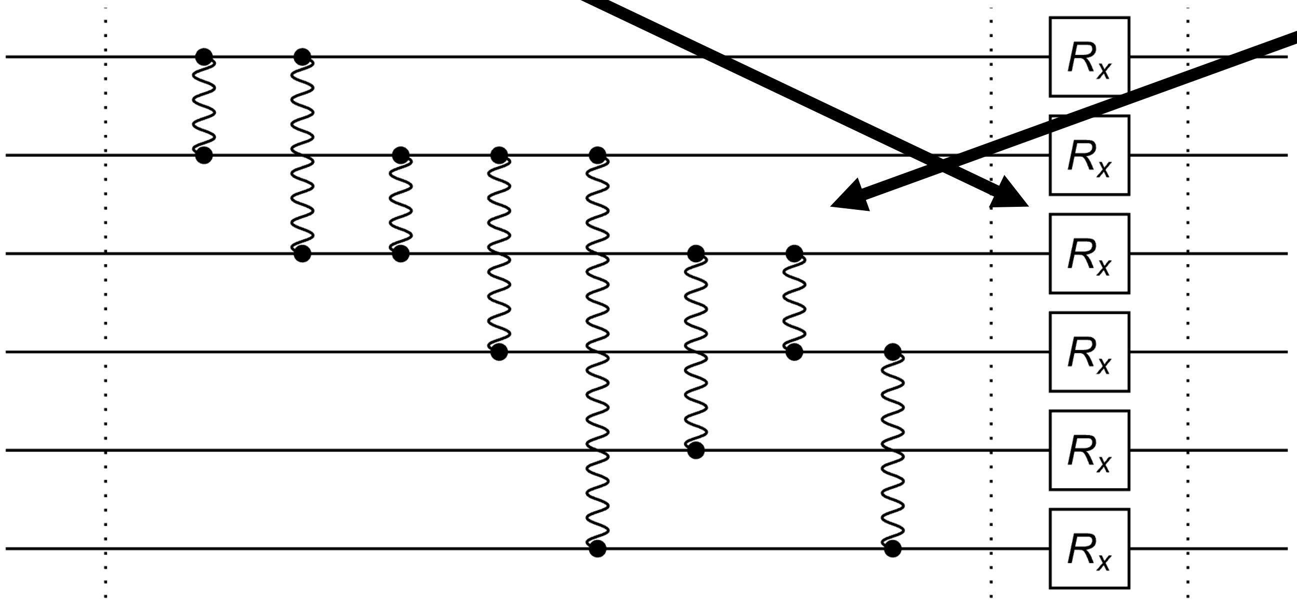
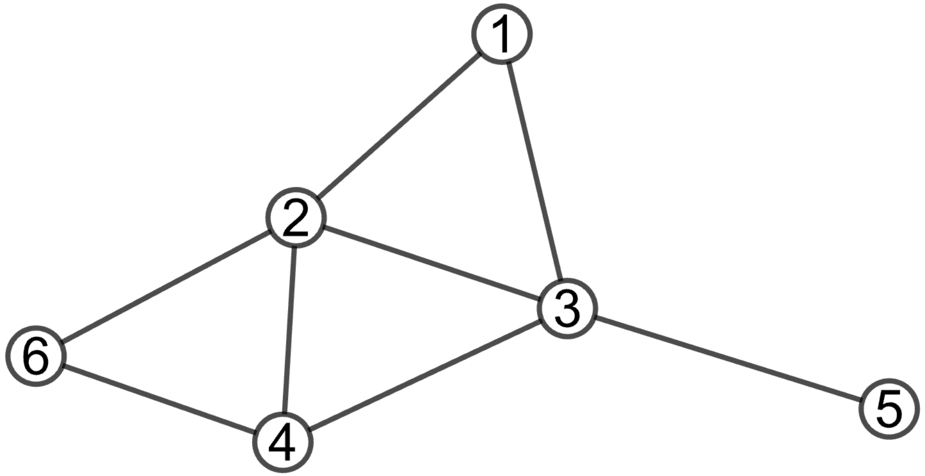
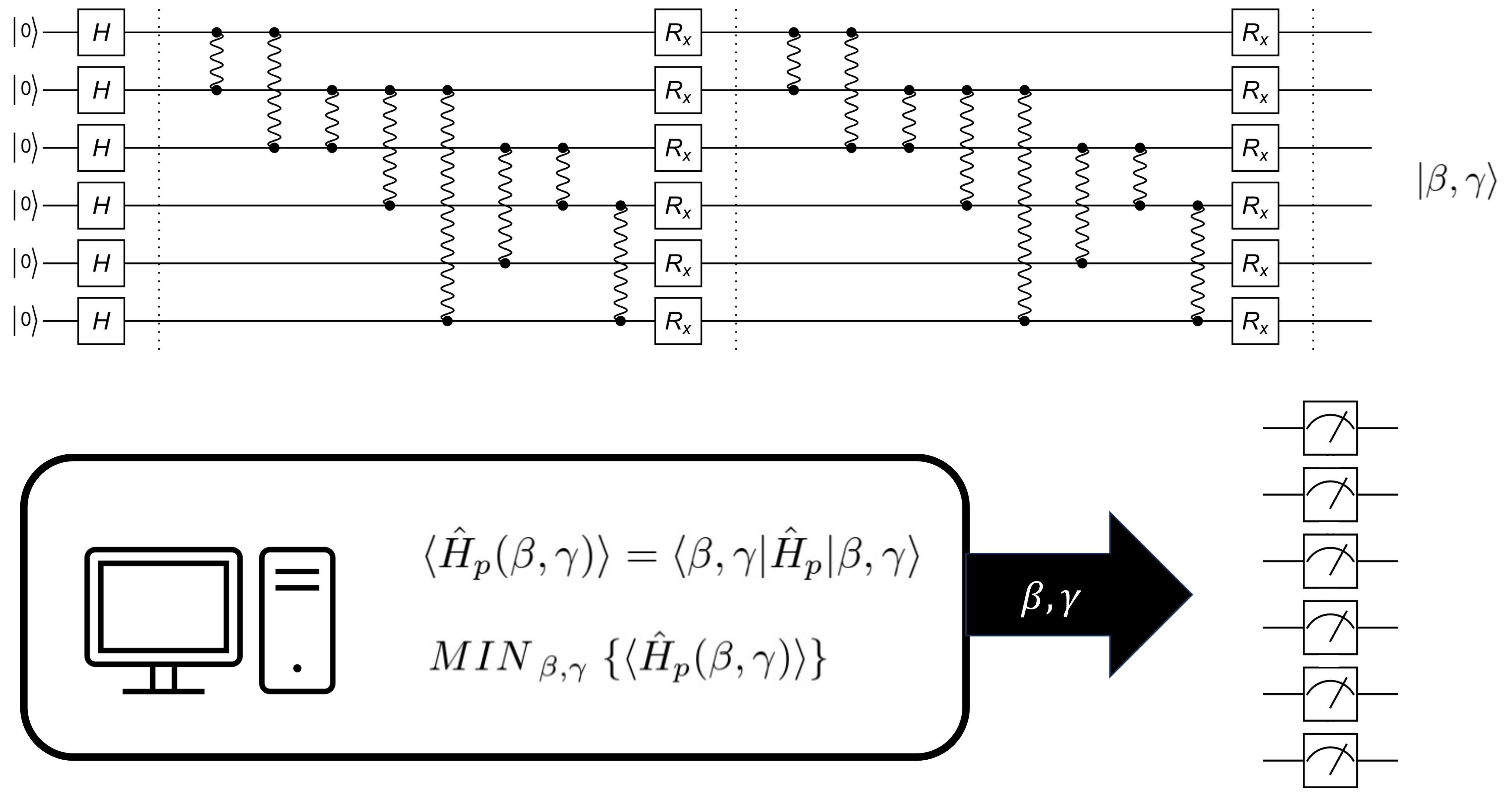
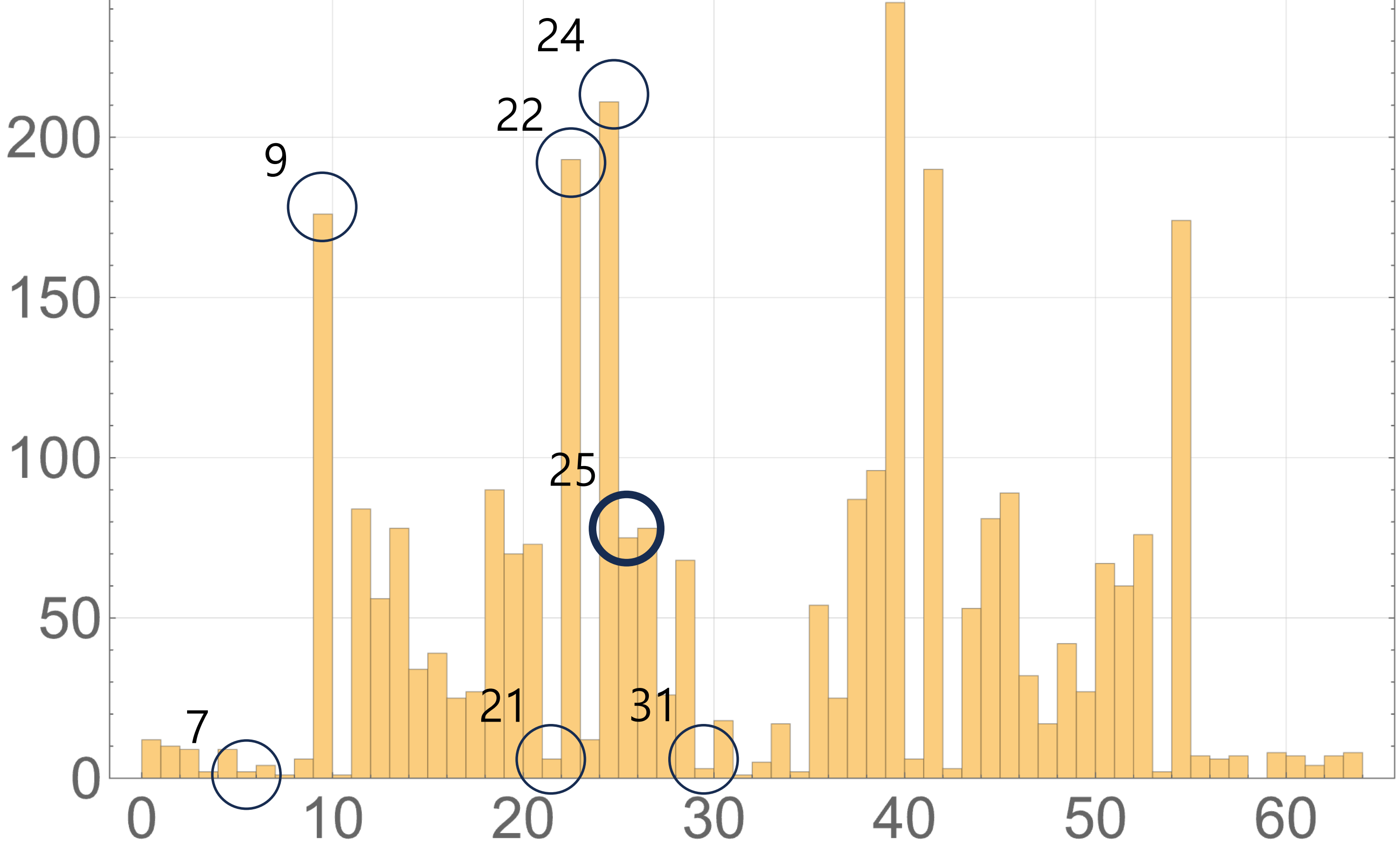
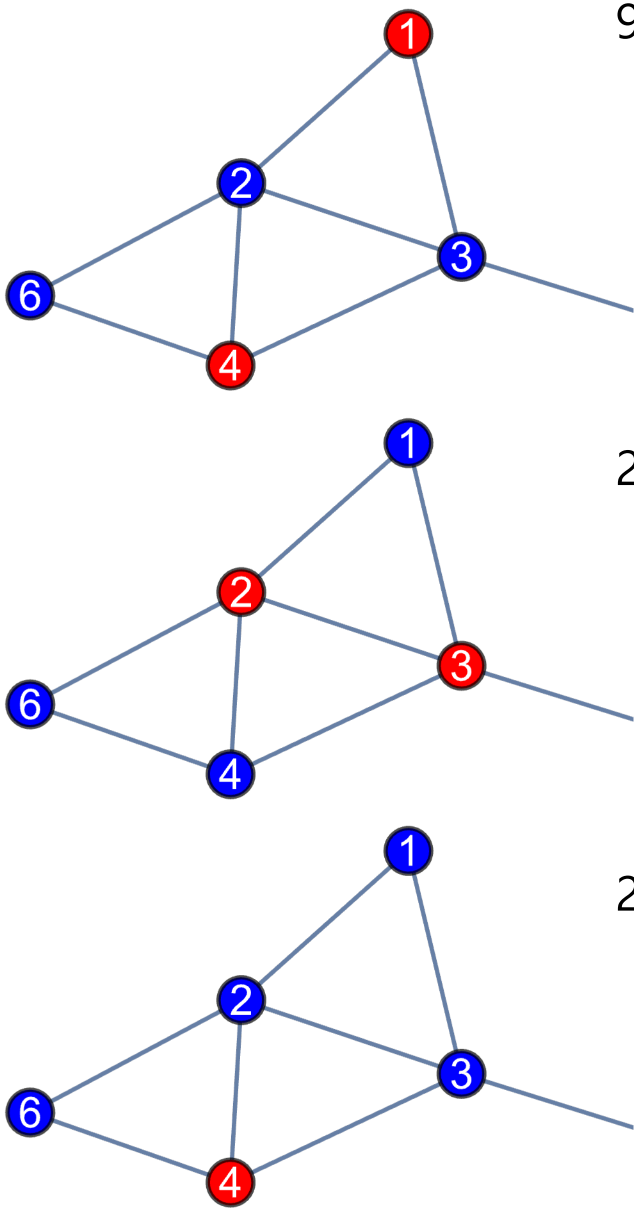


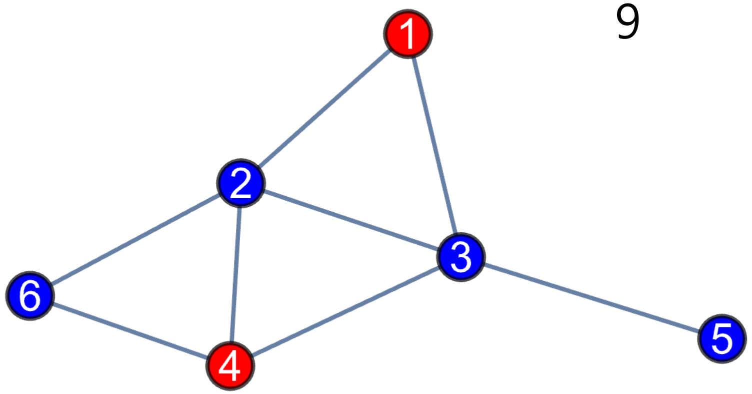



|0⟩
H
R_x
$|\beta, \gamma\rangle$
$\langle \hat{H}_p(\beta, \gamma) \rangle = \langle \beta, \gamma | \hat{H}_p | \beta, \gamma \rangle$
$MIN_{\beta,\gamma} \{\langle \hat{H}_p(\beta, \gamma) \rangle\}$
β, γ

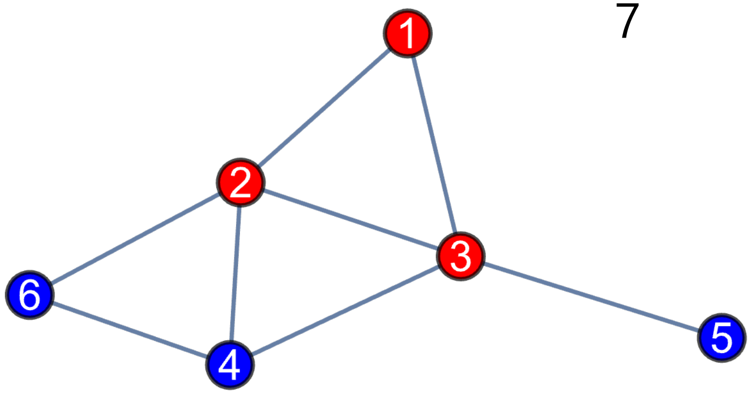
Measurement







9



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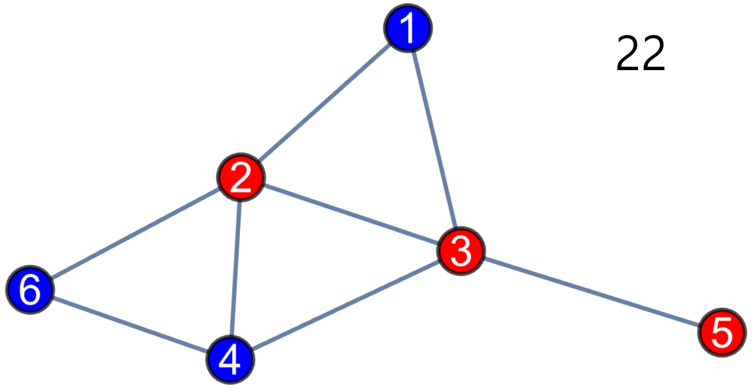
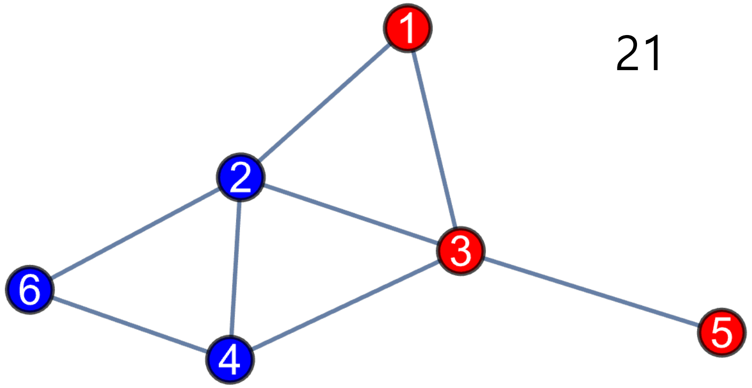
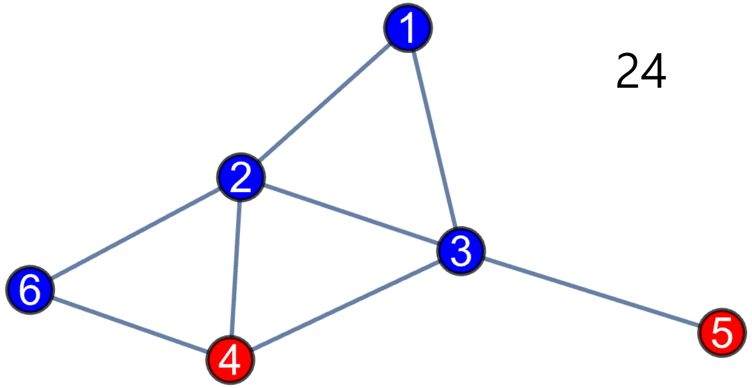


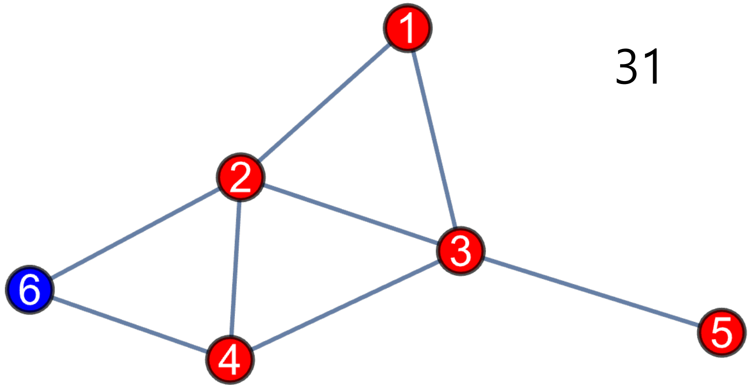
22



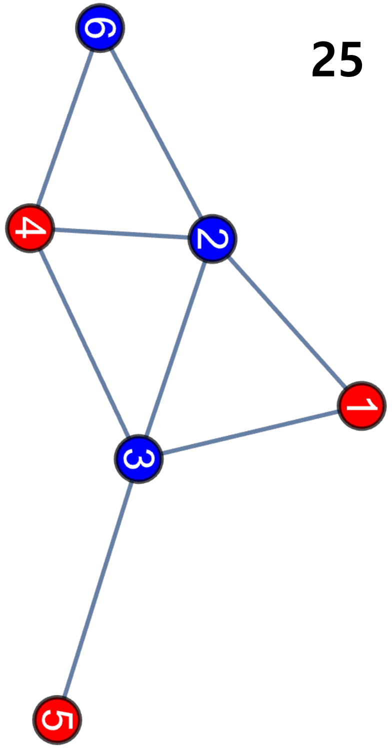
21



24



31



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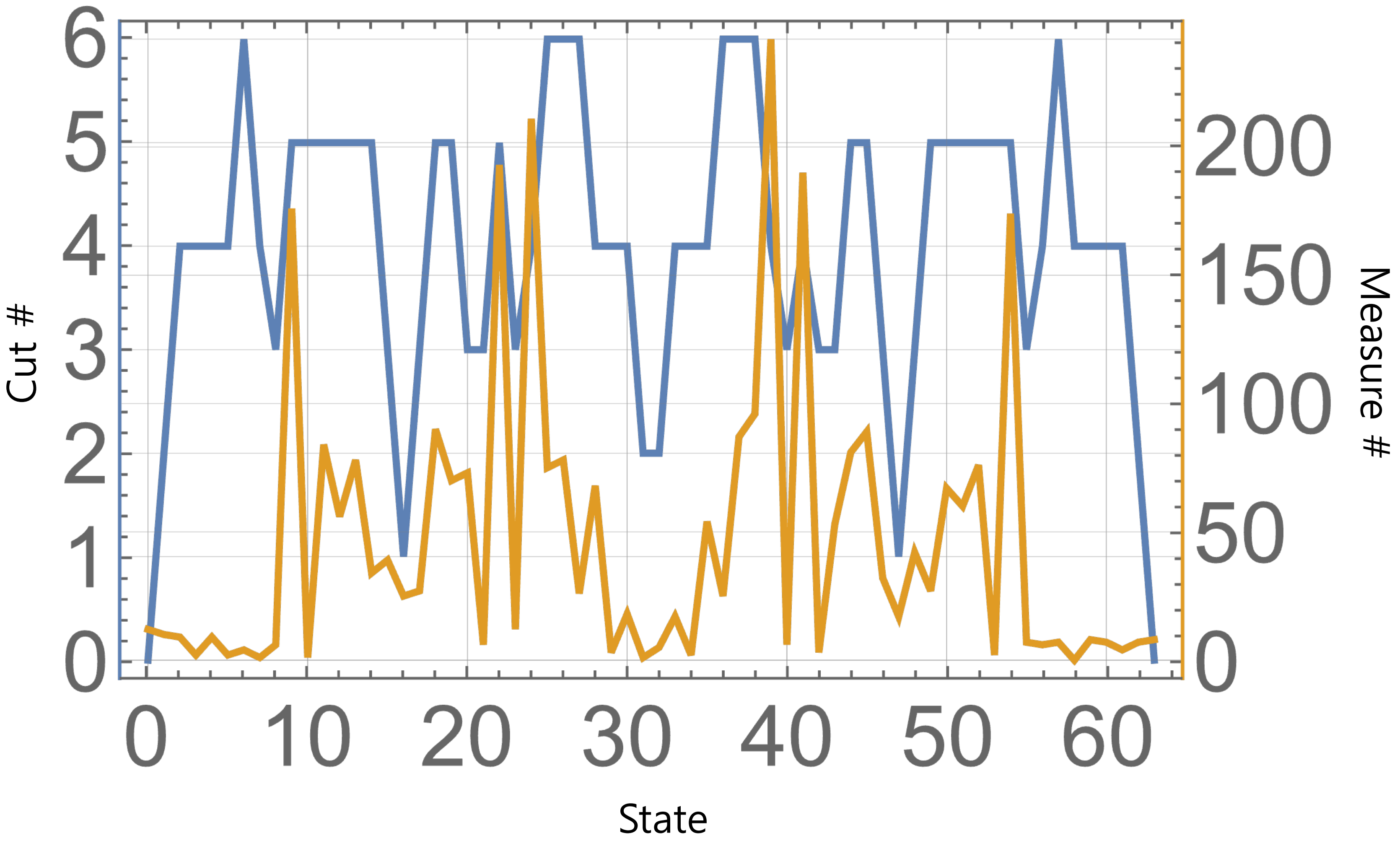

6
5
4
3
2
1
0
Cut #
200
150
100
50
0
Measure #
0
10
20
30
40
50
60
State

Reference

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