1 3-SAT Solution Report

This report contains solutions for the 3-SAT problem reduced from original independent set problem,executed on Qiskit Aer Simulators.
Report generated on: 2025-06-25 15:30:37

1.1 3-SAT Formula

The 3-SAT formula consists of the following clauses:

$$(\neg x_1 \vee \neg x_2) \wedge (\neg x_1 \vee \neg x_3) \wedge (\neg x_2 \vee \neg x_3) \wedge (\neg x_2 \vee \neg x_4) \wedge (x_2 \vee x_3 \vee x_1) \wedge (\neg x_5 \vee x_1 \vee x_3) \wedge (x_5 \vee \neg x_1) \wedge (x_5 \vee \neg x_3) \wedge (x_5 \vee x_4 \vee x$$

1.2 QUBO Matrix Visualization

Converted QUBO matrix visualization:

$$
\begin{bmatrix}
-4.0 & 3.0 & 4.0 & 0.0 & -1.0 & 0.0 & 0.0 & 0.0 & 0.0 & 1.0 \\
1.0 & 0.0 & 0.0 & 0.0 & 1.0 \\
0.0 & -7.0 & 3.0 & 4.0 & 1.0 & 0.0 & 0.0 & 0.0 & 0.0 & 1.0 \\
0.0 & 0.0 & 0.0 & 1.0 & 1.0 \\
0.0 & 0.0 & -4.0 & 0.0 & -1.0 & 0.0 & 0.0 & 0.0 & 0.0 & 1.0 \\
1.0 & 0.0 & 0.0 & 0.0 & 1.0 \\
0.0 & 0.0 & 0.0 & -3.0 & 1.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\
0.0 & 0.0 & 0.0 & 1.0 & 0.0 \\
0.0 & 0.0 & 0.0 & 0.0 & -2.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\
1.0 & 0.0 & 0.0 & 1.0 & 0.0 \\
0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\
0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\
0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\
0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\
0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\
0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\
0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\
0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\
0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & -2.0 \\
0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\
0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\
-1.0 & 0.0 & 0.0 & 0.0 & 0.0 \\
0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\
0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\
0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\
0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\
0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\
0.0 & 0.0 & 0.0 & -2.0 & 0.0 \\
0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\
0.0 & 0.0 & 0.0 & 0.0 & -2.0
\end{bmatrix}
$$

1.3 QAOA Configurations

QAOA is configured with the following parameters:

- Layers: 3
- Maximizer Hamiltonian: Standard mixing Hamiltonian $H_M = \sum_i X_i$
- Classical Optimizer: Powell's Method
- Maximum Iterations: 500
- Initialization: $\gamma = 2\pi$, $\beta = \pi$

1.4 QAOA Solution

The most probable solution obtained from the QAOA optimization is as follows:

- Variable x_1 is set to true
- Variable x_2 is set to true
- Variable x_3 is set to false
- Variable x_4 is set to false
- Variable x_5 is set to true
- Variable x_6 is set to true
- Variable x_7 is set to false
- Variable x_8 is set to true
- Variable x_9 is set to false
- Variable $x_1 0$ is set to true
- Variable $x_1 1$ is set to false
- Variable $x_1 2$ is set to false
- Variable $x_1 3$ is set to false
- Variable $x_1 4$ is set to true
- Variable $x_1 5$ is set to false

1.5 VQE Configurations

VQE is configured with the following parameters:

- Layers: 3

- Ansatz: Two-local

- Classical Optimizer: Powell's Method

- Maximum Iterations: 500

- Initialization: $\theta = \pi$

1.6 VQE Solution

The most probable solution obtained from the VQE optimization is as follows:

- Variable x_1 is set to true

- Variable x_2 is set to true

- Variable x_3 is set to false

- Variable x_4 is set to true

- Variable x_5 is set to false

- Variable x_6 is set to true

- Variable x_7 is set to true

- Variable x_8 is set to false

- Variable x_9 is set to false

- Variable $x_1 0$ is set to true

- Variable $x_1 1$ is set to true

- Variable $x_1 2$ is set to true

- Variable $x_1 3$ is set to true

- Variable $x_1 4$ is set to false

- Variable $x_1 5$ is set to false

1.7 Grover's algorithm Configurations

Grover is configured with the following parameters:

- Iterations: 1

1.8 Grover's Algorithm Solution

The most probable solution obtained from the Grover optimization is as follows:

- Variable x_1 is set to true

- Variable x_2 is set to true

- Variable x_3 is set to true

- Variable x_4 is set to true
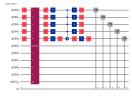
- Variable x_5 is set to true

5

Figure 2: VQE Circuit Visualization

Figure 3: Grover's Algorithm Circuit Visualization