

## 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.

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### 1.1 3-SAT Formula

The 3-SAT formula consists of the following clauses:

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

## 1.2 QUBO Matrix Visualization

Converted QUBO matrix visualization:

-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	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					

### 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 false
- Variable  $x_3$  is set to true
- Variable  $x_4$  is set to false
- Variable  $x_5$  is set to true
- Variable  $x_6$  is set to false
- Variable  $x_7$  is set to true
- Variable  $x_8$  is set to false
- Variable  $x_9$  is set to true
- Variable  $x_{10}$  is set to false
- Variable  $x_{11}$  is set to false
- Variable  $x_{12}$  is set to true
- Variable  $x_{13}$  is set to false
- Variable  $x_{14}$  is set to true
- Variable  $x_{15}$  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 false
- Variable  $x_2$  is set to false
- Variable  $x_3$  is set to true
- Variable  $x_4$  is set to true
- Variable  $x_5$  is set to true
- Variable  $x_6$  is set to false
- Variable  $x_7$  is set to true
- Variable  $x_8$  is set to false
- Variable  $x_9$  is set to false
- Variable  $x_{10}$  is set to true
- Variable  $x_{11}$  is set to false
- Variable  $x_{12}$  is set to false
- Variable  $x_{13}$  is set to false
- Variable  $x_{14}$  is set to true
- Variable  $x_{15}$  is set to true

## 1.7 Grover's algorithm Configurations

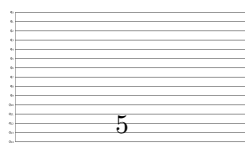
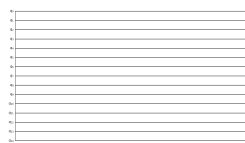
Grover is configured with the following parameters:

- 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 false
- Variable  $x_2$  is set to false
- Variable  $x_3$  is set to true
- Variable  $x_4$  is set to false
- Variable  $x_5$  is set to false



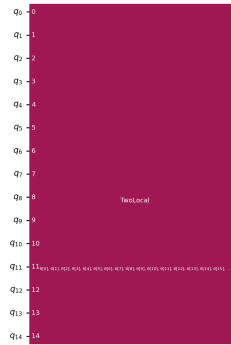


Figure 2: VQE Circuit Visualization

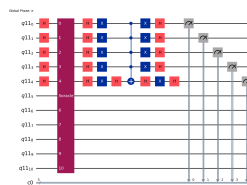


Figure 3: Grover's Algorithm Circuit Visualization