Maxcut Comparisons

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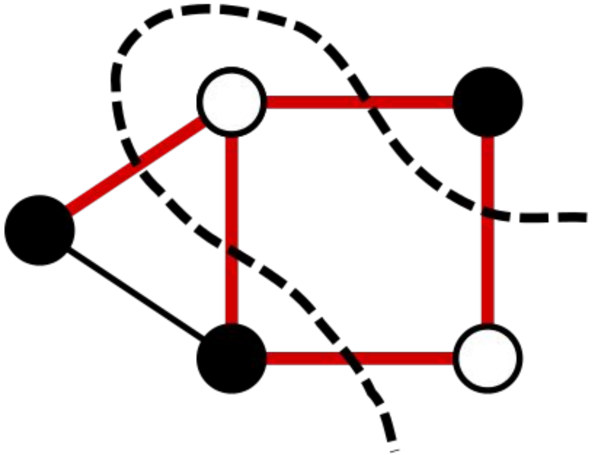
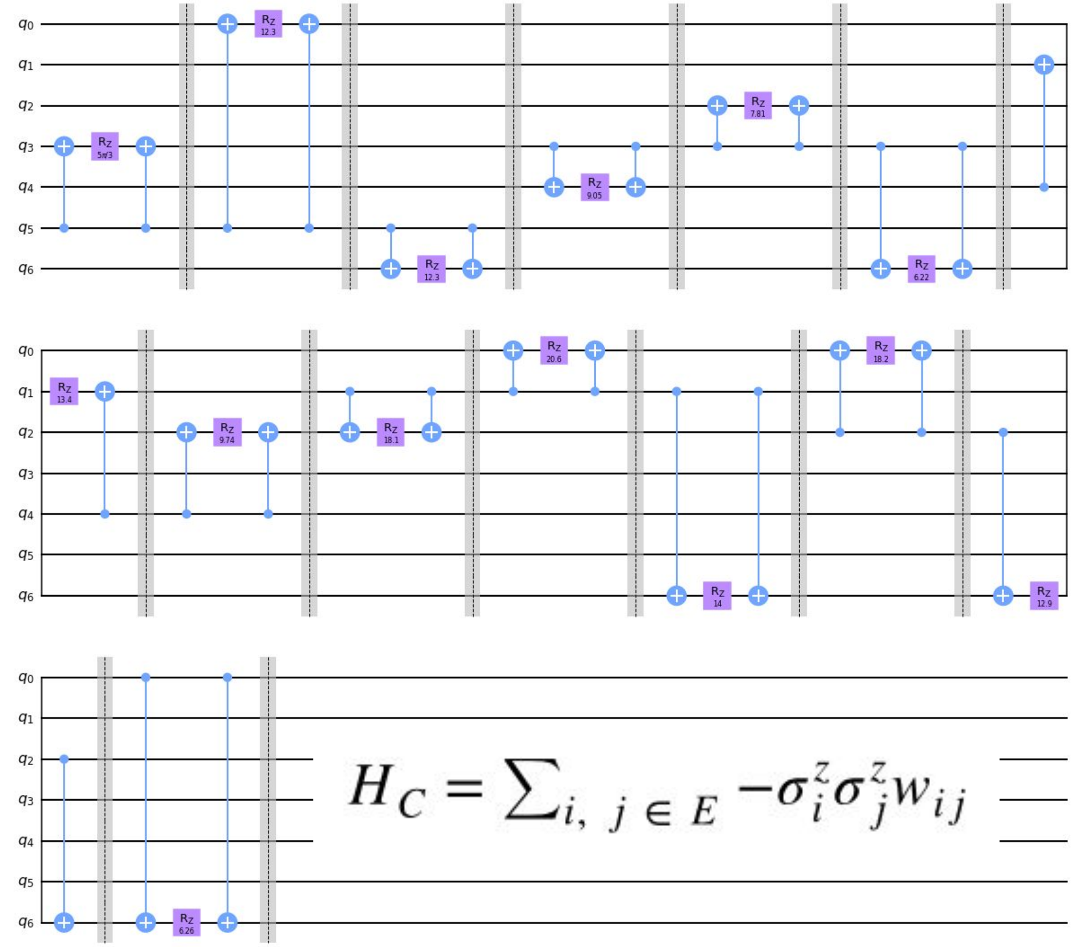
Maxcut

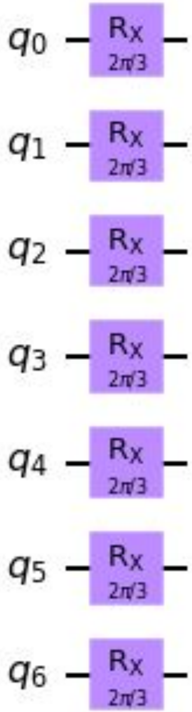
- **Objective:** Divide the set of nodes into two subsets, such that the number of edges between nodes of opposite subsets can be maximized.
- In other words, find a way to paint the nodes using a black and white paint brush, and maximize the number of edges between black and white nodes.
- Can be generalized to a weighted case, where each edge is given a certain weight.



$$H_B = \sum_{i \in V} \sigma_i^x$$

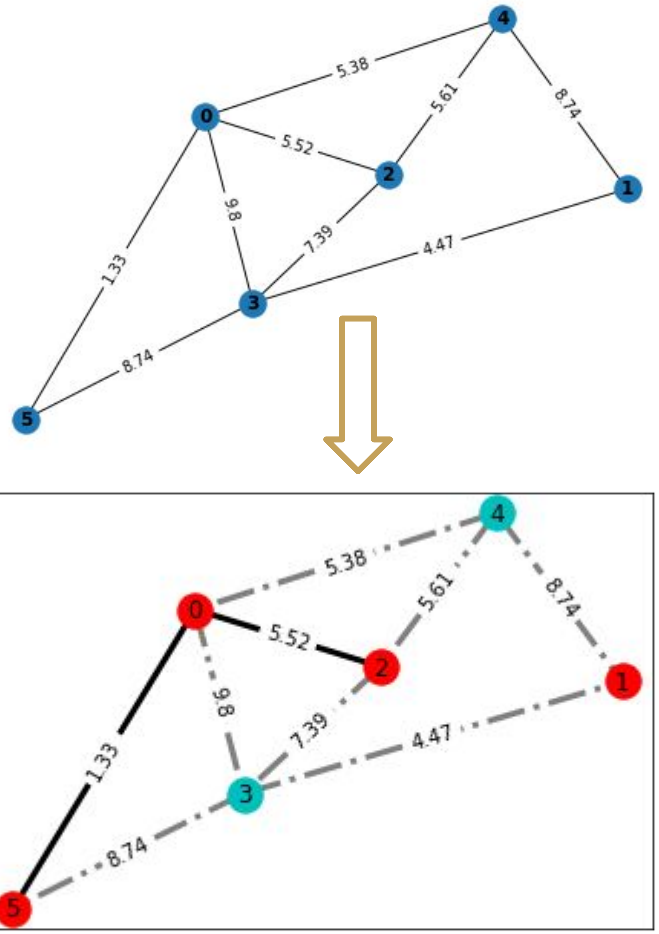


$$H_C = \sum_{i,\ j \in E} -\sigma_i^z \sigma_j^z w_{ij}$$



Process

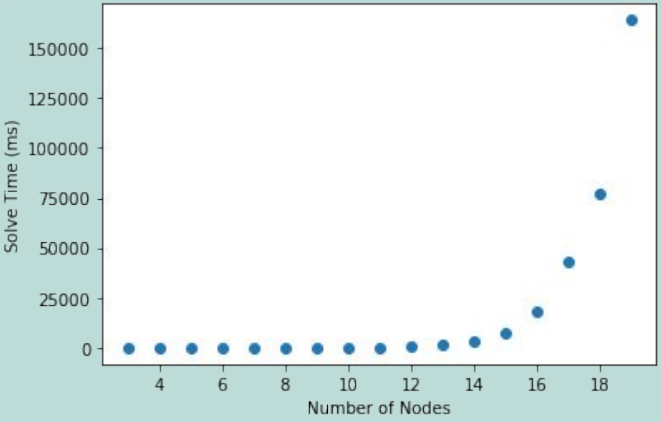
1. Generate an array of graphs, ranging from 3-20 nodes.
2. Use brute-force classical computation to find the exact solution.
3. Build QUBO to solve with D-Wave
4. Generate Circuit to Solve with Qiskit
5. Compare runtimes.

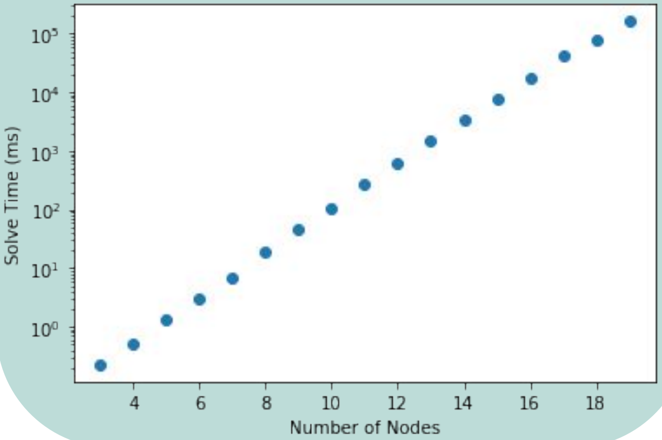


D-WAVE Formulation

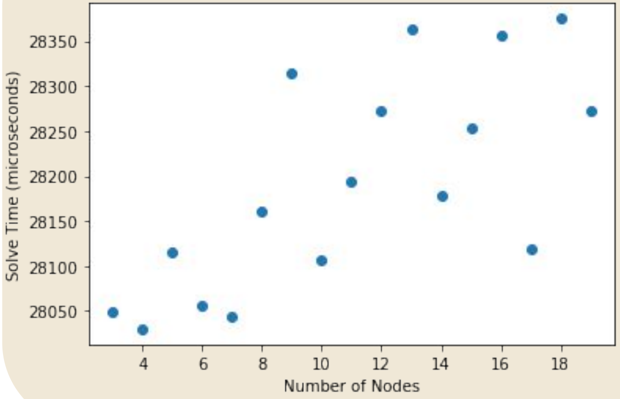
```
# Update Q matrix for every edge in the graph
for edge, weight in zip(self.edges, self.weights):
    Q[(edge[0], edge[0])] += -1*weight
    Q[(edge[1], edge[1])] += -1*weight
    Q[(edge[0], edge[1])] += 2*weight
```

Classical Runtimes



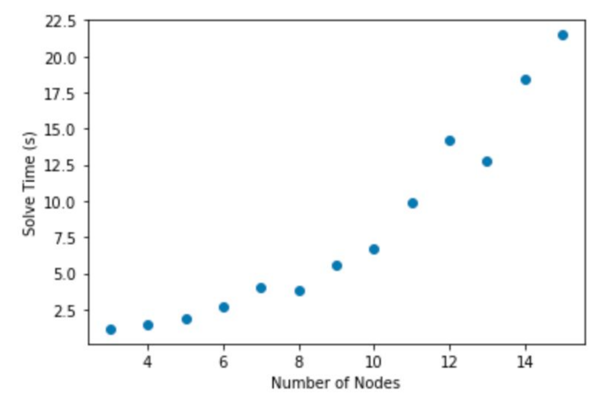


D-Wave Runtimes




```
1.0
1.0
1.0
1.0
1.0
1.0
1.0
1.0
1.0
1.0
1.0
0.9852459663103083
1.0
1.0
1.0
1.0
0.904763022606164
```

Qiskit (Qasm Simulator)




```
1.0
0.8345250255362614
0.7145882975906804
0.6200139958012596
0.537231298366294
0.6851159311892296
0.5349421368978201
0.6698457641010357
0.6687413136745425
0.7995365005793741
0.7852047667002351
0.6572806307416142
0.6216935674091045
```