Complexity of recognizing Dyck languages of bounded height with quantum query algorithms.

Maxime CAUTRÈS

Faculty of Computing
University of Latvia

31/08/2022

Sommaire

1. Introduction.
   - Quantum query model and complexity.
   - Dyck languages of bounded height
   - History of the problem
2. State of the art
3. The progress to reduce the $\mathrm{DYCK}_{k,n}$ QQC .
4. New idea to get better quantum query complexity bounds

Classical and quantum computers are both made with simple components.

Figure: A Boolean circuit (Full adder).

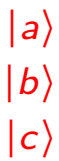

Figure: A Quantum circuit.

Classical and quantum computers are both made with simple components.

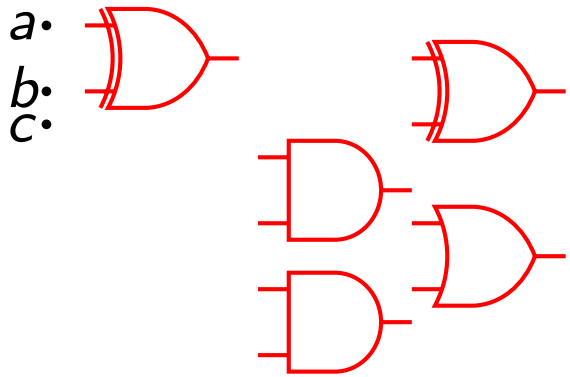

Figure: A Boolean circuit (Full adder).

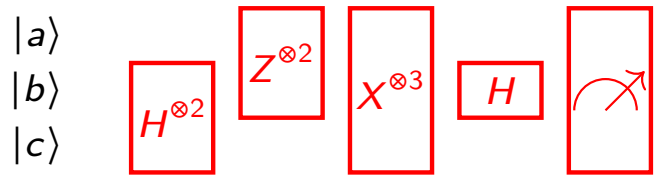

Figure: A Quantum circuit.

Classical and quantum computers are both made with simple components.

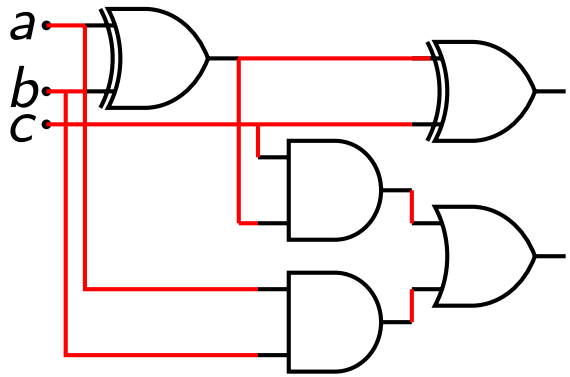

Figure: A Boolean circuit (Full adder).

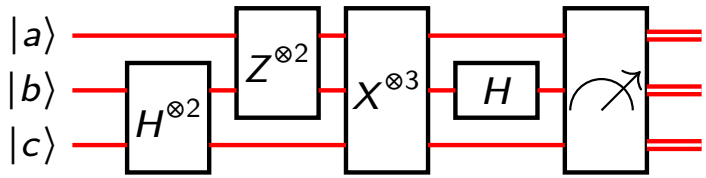

Figure: A Quantum circuit.

Classical and quantum computers are both made with simple components.

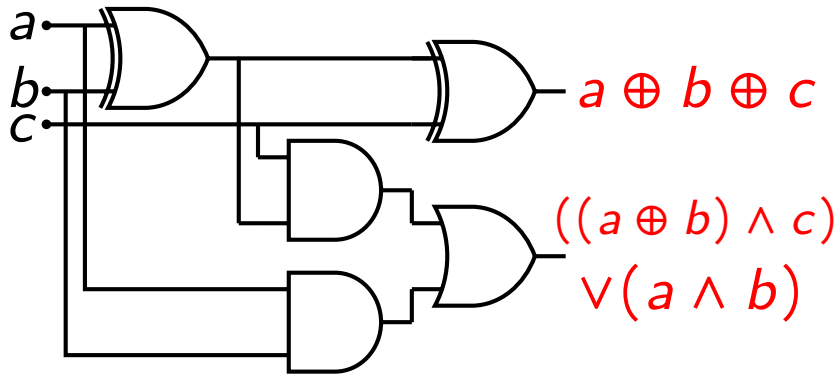

Figure: A Boolean circuit (Full adder).

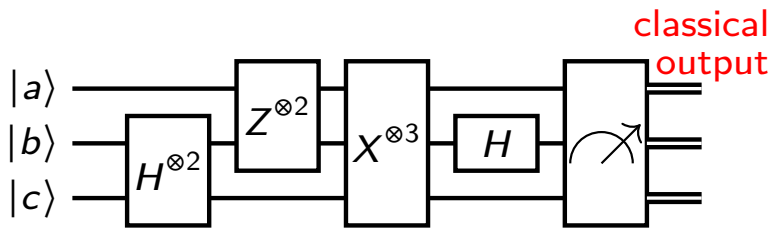

Figure: A Quantum circuit.

Interacting with qubits is more more complexe.

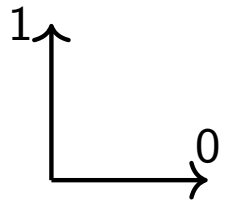

Figure: A classical bit

Interacting with qubits is more more complexe.

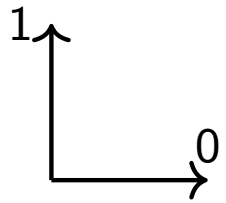

Figure: A classical bit

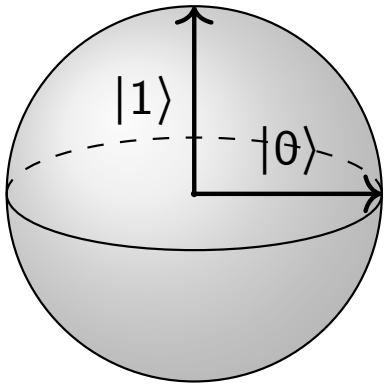

Figure: A quantum bit.

Interacting with qubits is more more complexe.

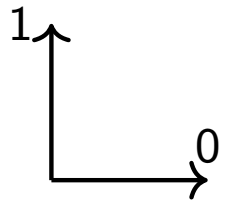

Figure: A classical bit

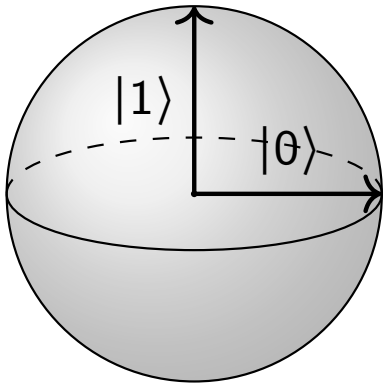

Figure: A quantum bit.

A	B	$A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

Figure: Truth table on 2 bits.

Interacting with qubits is more more complexe.

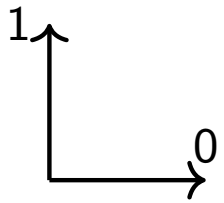

Figure: A classical bit

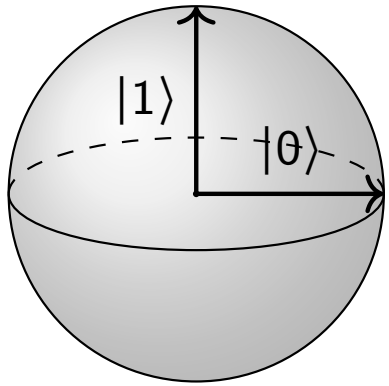

Figure: A quantum bit.

A	B	$A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

Figure: Truth table on 2 bits.

$$H^{\oplus 2} = \frac{1}{2}\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -1 & 1 & -1 \\ 1 & 1 & -1 & -1 \\ 1 & -1 & -1 & 1 \end{bmatrix}$$

Figure: Unitary matrix on 2 qubits.

Quantum query algorithm is just a quantum circuit.

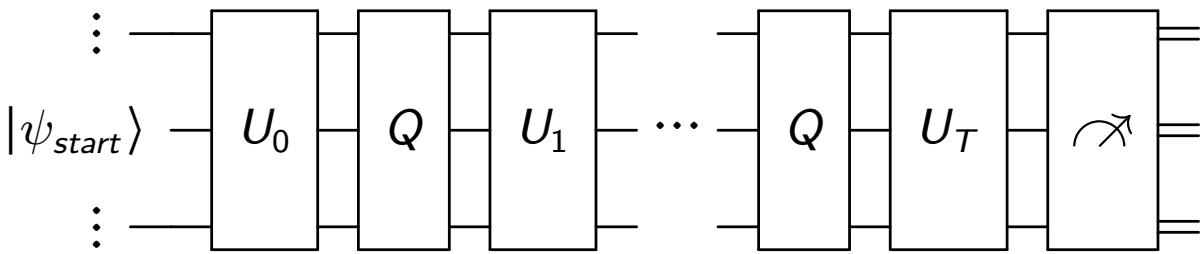

Figure: Structure of a quantum query algorithm.

Dyck words

Dyck word of bounded hight

The trichotomy article

There is two main direction of study

Goal of the internship

Sommaire

1. Introduction.
2. State of the art
   - Lower bounds to the QQC of $\textsc{Dyck}_{k,n}$
   - Upper bounds to the QQC of $\textsc{Dyck}_{k,n}$
3. The progress to reduce the $\textsc{Dyck}_{k,n}$ QQC .
4. New idea to get better quantum query complexity bounds

Dont speak to muck abour it

- **By reduction:**
- **By adversary method:**

MOre information in the report

Algorithms gives QQC upper bounds.

Reduction to transmit the QQC upper bounds .

Sommaire

1. Introduction.
2. State of the art
3. The progress to reduce the $\text{DYCK}_{k,n}$ QQC .
   - Why does the problem is not only a grover search
   - Original algorithm and small revisions
   - A new algorithm for k=2
4. New idea to get better quantum query complexity bounds

FOr k >=2 it is not more easy

presentation of the algorithm

small revision

the new algorithm

can be plug in the big one

Sommaire

1. Introduction.
2. State of the art
3. The progress to reduce the $\textsc{Dyck}_{k,n}$ QQC .
4. New idea to get better quantum query complexity bounds
   - lower bounds: try to do reduction from other problem
   - Upper bounds: Trying not do to every node
   - Conclusion

Conclusion

What as been done:

-

Possible idea to go further:

-