CMPT 440 – Spring 2020: Quantum Finite Automata

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Introduction

The transfer from regular binary machines to quantum computing has been only a theory first considered by Moore and Crutchfield originating in the year 2000. However, IBM has created the first quantum computer utilizing the idea of qubits or quantum bits. Originally, we have only been exposed to binary machines consisting of 0s and 1s. Now we have reached a new understanding of computing technologies that allows a machine to have bits that are either 1, 0,anywhere in between, or even both at the same exact time. This has allowed us to introduce the concept of the transfer from DFA's and NFA's to the idea of QFA's, or Quantum Finite Automata.

Theoretical Background

The quantum finite automata is defined by the 5-tuple that is: $T = (\Sigma, Q, q_0, P, \alpha)$.

$$P = \frac{1}{R}\sum_{i-0}^{N} x - \delta(1, 0) \qquad (1)$$

The basis for a QFA can be described as having 3 basis states consisting of the original accepting and rejecting states with the addition of non halting states. Similarly to regular DFA's the inputs to a QFA would be a finite set alphabet Σ in conjunction with two symbols that are not included in Σ to define left and right end markers. For each $\sigma \in \Sigma$ there consists a 'superoperator' Uσ to describe the sequence of transformations and measurements of the defined regular language Ł$_M$. Therefore we can describe the contents of a QFA as:

$$Q, Q_{acc}, Q_{rej}, Q_{non}, q_0, \Sigma, and, U_\sigma \in L$$

An Example

The transformation to obatain the reversible language L can be portrayed in two defined steps. First apply the superoperator to the current state. Then that individual state can be compared to $\{Q_{acc}, Q_{rej}, Q_{non}\}$. Then we decide wether that individual state is accepted or rejected, if neither then the computation of the Language continues until we have reached an end state.

References

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