Creating Cluster States

Simulations of One Way Model Algorithms

Josh Kettlewell

Sheffield University

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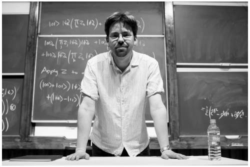
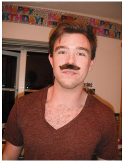


Supervisor: Dr Pieter Kok



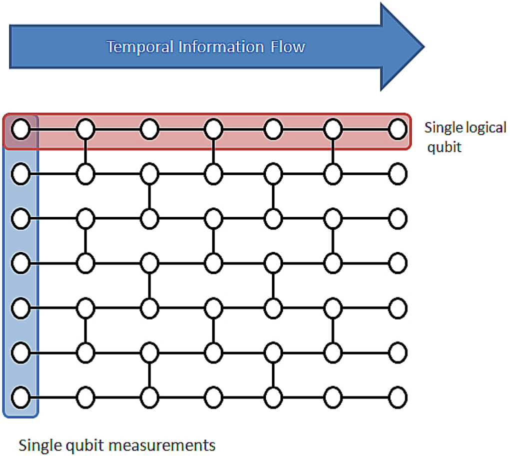
Partner: Joshua Waddington

Introduction

Motivation for One Way Model

- Quantum computers would allow efficient solutions to some problems.
- The one way model has become very popular.
- BUT we don't know how many resources would be required in order to make one work.

Measurement Based Computation



Just-in-Time Method

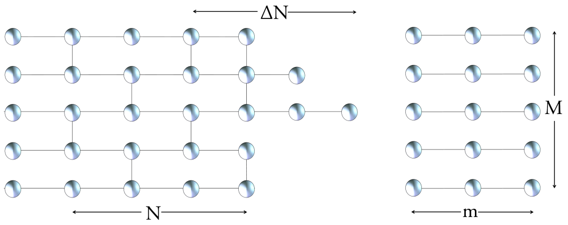
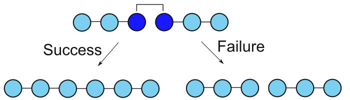


Figure: *Just-in-time* computing. A typical cluster state. Every circle represents a logical qubit, and the vertices represent CZ operations.

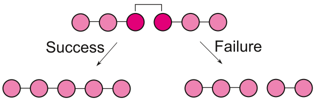
$R = p(m - c_1) - (1 - p)c_2 - 1$, by setting $R = 0$ we find

$$m = \frac{1 + pc_1 + (1 - p)c_2}{p}. \tag{0.1}$$

Different Qubit Gates



(a) Broker Client



(b) Double Heralding

Entangling Procedure	c_1	c_2
Type-I fusion	2	2
Type-II fusion	3	1
Double-heralding fusion	1	1
Repeat-until-success	1	0
Broker-client model	0	0

Table: The entangling procedures and the respective values of c_1 and c_2

Analytical

$$T_2 = \alpha(\tau + \beta\Delta N + m)$$
$$= \alpha(\tau + \beta\sqrt{\frac{(1+c_2)^2}{p} - c_2(2-c_2)} + \frac{1 + pc_1 + (1-p)c_2}{p}) \tag{0.2}$$

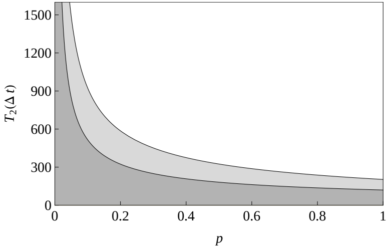


Figure: Threshold of T_2 lifetime in the linear cluster state as a function of entangling procedure with $\alpha = \beta = 10$ for double heralding (upper curve) and broker-client (lower curve)

Simulation - Qubits as Objects

Question: Given an entanglement probability p how large a qubit pool would we need to make a cluster of size m?

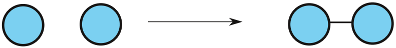


Figure: Qubits forming a Cluster

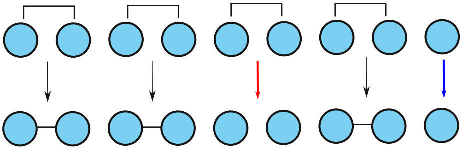
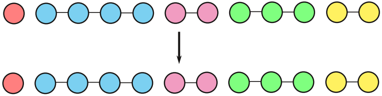
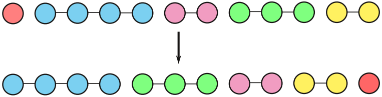


Figure: Qubits forming a Cluster

Algorithms



Random algorithm (no sorting)



Greed Algorithm

Simulation Data

Simulation for Algorithm:Greed and Gate:Double Heralding

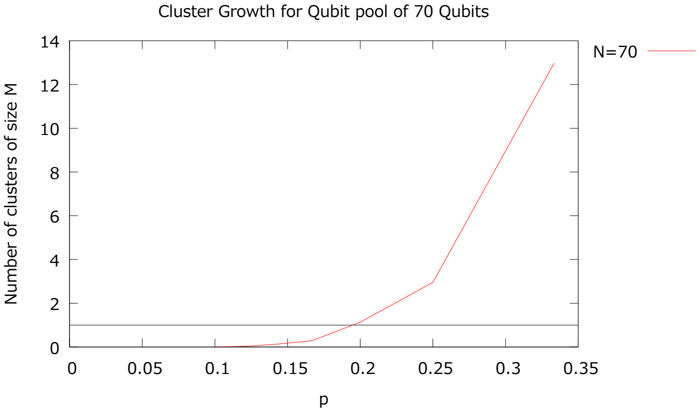


Figure: Number of Clusters of length m that are creates in number of timesteps $t = \frac{1}{p}$ for a given p. The grey line denotes *number of clusters of length* $m = 1$

Simulation Data

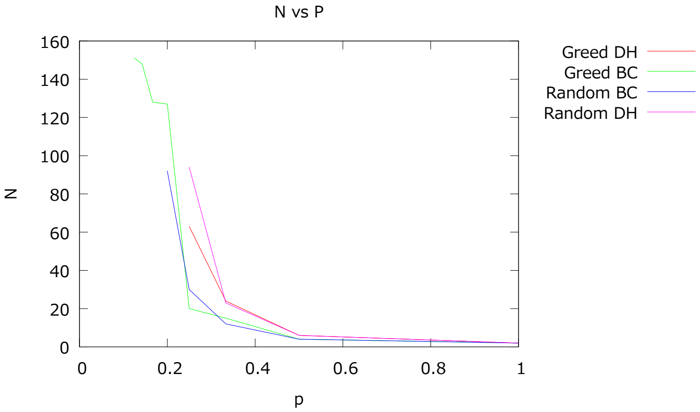


Figure: N vs p for all possible combinations. This shows that Greed may be an optimal solution in the case of a Broker Client entanglement regime. Note that this is not a final result as is not run over enough trials.

Conclusions

- Broker Client is quantifiably better.
- The number of qubits required increases exponentially and below $p = 0.2$ we see a rapid increase.
- Our results are currently unclear to whether we agree with the current consensus that greed in an inferior algorithm.

Conclusions

END