# A QUANTUM APPROACH FOR DIFFUSING GOOGLE BOMBS – USING ADIABATIC QUANTUM ALGORITHM

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1)World Wide Web – Over the years the impact of world wide web has globally witnessed field of Information Retrieval (IR) . The deciding factor in this IR process depends on the successful search done by the SEARCH ENGINE. (like Google).

As data and information are abundantly being fetched every second, the size of the Web Graph increases for the knock of a single web page.
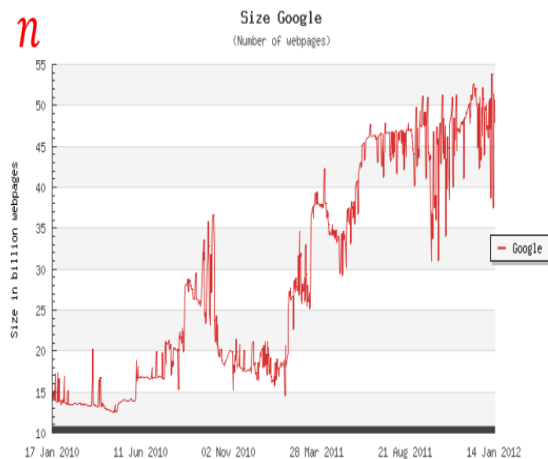
The above picture represents the Size of Google(with respected to number of webpages)as reported on January 2012. [www.worldwidewebsize.com].

2)Page Rank Algorithm: The PageRank algorithm is a specific algorithm for conducting link analysis .Originally developed in the 1990s as a research project for Stanford University, it was later licensed exclusively to Google as a core part of its Internet indexing system. PageRank analyzes the links between web pages and uses them to recursively score each page, assigning it a page rank.

PAGE RANK EQUATION: $G=\alpha S+\frac{1}{n}(1-\alpha)$

SCALING FACTOR: O(n log n) at best case.

3)GOOGLE BOMBS : A Google-bomb is the result of an intentional set of actions whereby a target page is linked to by many different pages with the same link text, or key phrase, thereby associating the target with the key phrase in Google's Page Rank algorithm. A Google bomb is a cooperative endeavour undertaken to manipulate the Google search engine into returning a particular web site as the first result when a specific word or phrase is searched for.

The first ever Google bomb came about back in 1999 when many people were still on dial-up connections and sites like Facebook and Twitter were a mere twinkle in cyberspace's future. It was Microsoft's homepage that provided the target for virtual bombers, becoming the number one result when a search for "**More evil than Satan himself**" was entered.
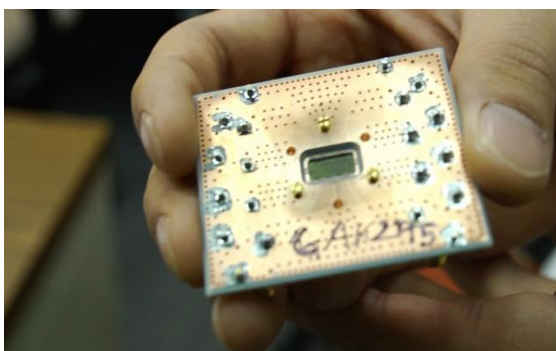
Google

4)DIFFUSING A BOMB:

Several Methods like linker reputability and link text analysis were primarily used for diffusing a google bomb. But these methods did not work out with strategies as it involved more manual calculations.. Moreover the complexity was more than expected.

5) HERE COMES THE QUANTUM WAY OF DIFFUSING THIS BOMB:

As daunting technical challenges keep the dream at bay, theorists are increasingly putting the ideas and techniques of quantum computing to work solving deep, long-standing problems in classical computer science, mathematics and cryptography. Quantum computers may be able to solve complex optimization problems, quickly mine huge data sets, simulate the kind of physics experiments that currently require billion-dollar particle accelerators.

Quantum Computing depends on the magic of the qubits with the two dazzling concepts – superposition and entanglement

6)IMPACT OF AN ADIABATIC QUANTUM ALGORITHM:

In a classical page ranking algorithm , What the Google actually does:?

It calculates the **EigenVector:**

$$G\vec{\Pi} = \vec{\Pi}$$

Where $\vec{\Pi}$ is the stationary state of a surfer hopping randomly on the web graph during a web search .
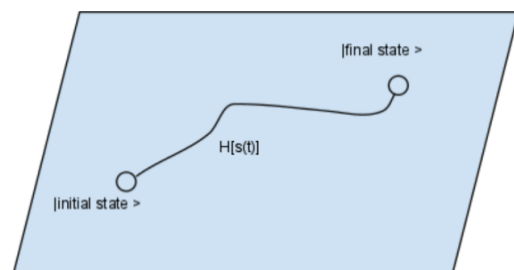
But the drawback in classical page rank is the complexity since G is probalisitic stochastic matrix and the walk converges in O(log n) per node.

7)WHY DO WE NEED AN ADIABATIC QUANTUM ALGORITHM:

Adiabatic Quantum algorithm makes use of Power Speed – Up method. The scaling factor in this method measures to**:**

Time $\dfrac{\sim S\, n \log(\epsilon)}{(\alpha)}$

Complexity: O[poly(log n)].

An Adiabatic Quantum Algorithm leads to the generation of Up-To-Date Page Ranks.
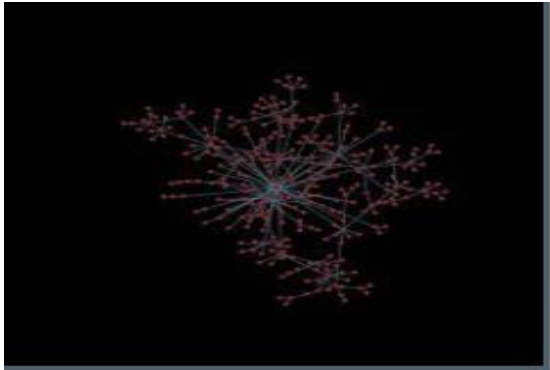It makes use of the Eigen Values of Hamiltonian States.(Initial and Solution Hamiltonians)

$$H(s) = \sum_{i=1}^{n} h(s)_{ii}\, \sigma_i^+ \sigma_i^- + H(s) \sum_{i=1}^{n} h(s)_{ij}\, \sigma_i^+ \sigma_j^- + \sigma_j^+ \sigma_i^-$$

H(s) is the effective adiabatic Hamiltonian at the highest excitation state.

The probability of finding excitation at site i gives Page Rank of page i.

8)AN ADIABATIC WAY OF DIFFUSING THE GOOGLE BOMB:

An intermediate state is obtained within the adiabatic system which determines the web links to the target page.

$$h^m \ = \ h^p - h^i + | \eta_i \rangle$$

$| \eta_i \rangle$ represents the relevant web links associated with the target page i.

From the copying –model of page ranking

1. The probability of adding a new web link vertex to the previous vertex is given (1-p)
2. The probability of adding a link form a newly added vertex to a uniformly random link is p

Where 'p' represents the turing parameter which requires local knowledge of the web graph. p is assumed to have a degree distribution equivalent to $| \eta_i \rangle$ as it takes the highest excitation state.
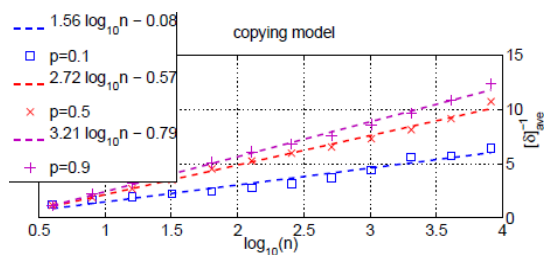
Efficiency of adiabatic algorithm –Copying Model

When p takes a positive value or zero. As quantum states can also be negative. The indication of p being negative will state that the links are irrelevant to the target page and so p can be made disable(or made to the 0) thus diffusing the induction of a new Google Bomb.

9)RESULTS:

i)Polynomial speed-up for top-log n set of nodes

ii)Exponential speedup in preparation of PageRank compared to classical diffusing of the Google Bomb

10)CONCLUSION:

- By using this adiabatic quantum algorithm, the efficiency is increased and the complexity is in polylogarithmic order of **(polylog(n)).**

- Given the existence of efficient classical algorithms it is non-trivial that QC can provide some form of speedup for diffusing the google bombs.