A SIMPLE QUANTUM ALGORITHM FOR EXPONENTIALLY FAST TARGET SEARCHING IN THE UNSTRUCTURED DATABASE

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Abstract

We present an exponentially fast simple quantum algorithm to run on a quantum computer for searching the unknown target in the unstructured database. This algorithm provides an eloquent example that clearly demonstrates the enormous advantage of quantum parallalism. This novel quantum algorithm is based on the idea of simultaneously utilising $(n/2)$ oracles or black-box functions followed by $(n/2)$ diffusion transforms for searching target in the unordered data set of size $N = 2^n$. We show that we can attain the (explicitly unknown) target in the unstructured database of size $N = 2^n$ by giving only one call, simultaneously (parallely) and independently, to just $(n/2)$ oracles or black-box functions followed by $(n/2)$ diffusion transforms that we define and implement using a quantum computer. This algorithm thus demonstrates the exponential speedup that can be achieved in obtaining the desired target from unstructed data set of size $N = 2^n$ which is indeed amazing! For a typical $NP-$complete problem in which one has to find an assignment of one of some b values to each of some m variables, the number of candidate solutions, $N = b^m$, grows exponentially with m. Hence a classical exhaustive algorithm would take $O(b^m)$ operations, Grover's quantum algorithm would take $O(b^{m/2})$ operations, while the algorithm that we propose in this paper does this job in just a single operation!! Thus, using our quantum algorithm on a quantum computer one can establish the validity of $NP = P$ through a quantum mechanical procedure run on a quantum computer!!

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We present exponentially fast quantum method to be worked on a quantum computer for solving unstructured search problems. This exponentially fast new quantum algorithm will be applicable to a wider range of computational problems for which we will be able to reach the solution almost instantaneously. This new quantum algorithm will thus tame the problems which are otherwise impossible to solve on a classical computer. Throughout the paper we will adopt standard Dirac notation used in standard quantum physics. We will denote a vector v in the vector space V by $|v\rangle$. The inner product of two vectors v and w will be denoted by $\langle v|w\rangle$. We can interpret a linear operator O either as simply acting on a vector v, as $O|v\rangle$ or by acting as $\langle v|O^\dagger$, where $O^\dagger$ is Hermitian adjoint of O.

Preliminaries

We begin with some useful definitions. For this we use [1, 2]. Suppose V and W are vector spaces. Let $|a_1\rangle, |a_2\rangle, \dots |a_n\rangle$ and $|b_1\rangle, |b_2\rangle, \dots |b_k\rangle$ be bases for V and W such that for any $|v\rangle$ in V and for any $|w\rangle$ in W, we have $|v\rangle = \sum_{i=1}^{n} v_i|a_i\rangle$ and $|w\rangle = \sum_{j=1}^{k} w_j|b_j\rangle$, where all v_i and w_j are scalars from the associated fields. Then we define the *tensor product* of V and W as a space $U = V \otimes W$ whose basis elements are given by pairs $(|a_i\rangle, |b_j\rangle)$ and are denoted by

$$|a_i\rangle \otimes |b_j\rangle : i = 1, 2, \dots, n; j = 1, 2, \dots, k.$$

For vectors $|v\rangle$ in V and $|w\rangle$ in W, we define the map

$$\otimes : (|v\rangle, |w\rangle) \to |v\rangle \otimes |w\rangle$$

by

$$|v\rangle \otimes |w\rangle = \sum_{i=1}^{n} \sum_{j=1}^{k} (v_i w_j)|a_i\rangle \otimes |b_j\rangle.$$

We can easily varify following simple properties:

(i)For $|u\rangle, |v\rangle$ in V and $|w\rangle$ in W we have

$$(|u\rangle + |v\rangle) \otimes |w\rangle = |u\rangle \otimes |w\rangle + |v\rangle \otimes |w\rangle$$

(ii)Similarly, For $|u\rangle$ in V and $|v\rangle$, $|w\rangle$ in W we have

$$|u\rangle \otimes (|v\rangle) + |w\rangle) = |u\rangle \otimes |v\rangle + |u\rangle \otimes |w\rangle$$

Let A and B be linear transformations or *operators* from vector spaces V and W respectively. Then the action of operator $A \otimes B$ is defined by

$$(A \otimes B)(|v\rangle \otimes |w\rangle) = A|v\rangle \otimes B|w\rangle.$$

To generalize, let $A_i, i = 1, 2, \cdots, n$ be linear transformations or *operators* from vector spaces $V_i, i = 1, 2, \cdots, n$ respectively. Then the action of operator $A_1 \otimes A_2 \otimes \cdots \otimes A_n$ is defined by

$$(A_1 \otimes A_2 \otimes \cdots \otimes A_n)(|v_1\rangle \otimes |v_2\rangle \otimes \cdots \otimes |v_n\rangle) = A_1|v_1\rangle \otimes A_2|v_2\rangle \otimes \cdots \otimes A_n|v_n\rangle$$

where $|v_i\rangle \epsilon V_i$ for all $i = 1, 2, \cdots, n$.

This definition appears very natural, but it is not at first clear why we can define the action of the operator in this way. Is this definition even unique? It turns out that it is, and this observation is at the heart of quantum computation. It allows us to decompose an operation on an entire quantum system into operations on individual components and makes the construction of quantum algorithms much simpler. To prove that this definition is unique, we must first abstract ourselves from our first definition of tensor product as follows:

Suppose V and W are vector spaces. Then the *tensor product* of V and W is a pair $(U, \otimes)$ where $U = V \otimes W$ is a vector space and $\otimes : V \times W \to U$ is a bilinear map which satisfies the following property:

For any space F and any bilinear function $f : V \times W \to F$ there is a unique linear function $g : V \times W \to F$ such that $f(|v\rangle, |w\rangle) = g(|v\rangle \otimes |w\rangle)$.

Proposition 1: Both the definitions of *tensor product* are equivalent.

Proposition 2: Let $A : V \to V'$ and $B : W \to W'$ be linear operators. Then there is a unique linear operators $A \otimes B : V \otimes W \to V' \otimes W'$ such that for any $|v\rangle$ in V and $|w\rangle$ in W, we have $(A \otimes B)(|v\rangle \otimes |w\rangle) = A|v\rangle \otimes B|w\rangle$.

For proofs of these propositions one can refer to [3].

A qubit is routinely described up to a phase factor by a unit vector in C^2. By convention, we always take as basis vectors of this vector space the vectors $|0\rangle$ and $|1\rangle$. In this basis a state of qubit can be written in the form $|\psi\rangle = a|0\rangle + b|1\rangle$, where a, b are complex numbers satisfying $|a|^2 + |b|^2 = 1$. The requirement that $|a|^2 + |b|^2 = 1$. comes from the fact that in quantum mechanics, if we measure a vector $|\psi\rangle = a|0\rangle + b|1\rangle$, we obtain the state $|0\rangle$ with probability $|a|^2$ and the state $|1\rangle$ with probability $|b|^2$, and those probabilities must sum to one.

Now we can proceed to consider a systems with multiple qubits. Such systems are defined in natural way as follows:

An *n-qubit system* is described by a unit vector in $C^2 \otimes C^2 \otimes \ldots \otimes C^2$ where each of the factors C^2 corresponds to the vector space for single qubit. We denote this space for n-qubit system by $(C^2)^{\otimes n}$ or $B^{\otimes n}$, where B equal to space C^2 with $\{|0\rangle, |1\rangle\}$ basis. By definition of the tensor product, the basis states for $B^{\otimes n}$, are therefore all possible products of the form

$$|x_1\rangle \otimes |x_2\rangle \otimes \cdots \otimes |x_n\rangle$$

where $x_j \in \{0, 1\}$, which we often write simply as $|x_1.x_2.\ldots x_n\rangle$ or simply $|x\rangle$, where $x \in \{0, 1\}^n$. Given these basis states, the quantum state of an arbitrary n-qubit system can be written in the form

$$\sum_{x \in \{0,1\}^n} a_x |x\rangle$$

, where

$$\sum_{x \in \{0,1\}^n} |a_x|^2 = 1.$$

Once again, the requirement that amplitudes squared of all of the basis states sum to one is because the vector is defined having unit length. A *quantum gate* on an n-qubit system is an arbitrary operator U acting on an ordered set M, $|M| \leq n$ of qubits and the identity operator acting on the remaining qubits, and is denoted by $U[M]$. It is easy to check that only unitary quantum operators are valid quantum gates. Since unitary operators preserve the inner product, they preserve the length of unit vectors. This is a necessity for any quantum mechanical system since any state vector of a system must have a unit length.

We can draw *quantum circuits* using quantum circuit diagrams. We let each qubit of the system reside in a row of the diagram and move left to right acting with quantum gates, which we denote with operator name. We surround each gate with a box and connect all gates with wires. For a list of all different components of quantum circuit diagrams, one can consult [4].

The problem of searching in an unstructured database can be described through following simple example. Suppose we are given an address book of N names, and we wish to find and contact one individual in the book. Classically, the obvious algorithm to employ is to search from the beginning of the book to the end. We will need to browse through at least $(N/2)$ entries to have 50 percent chance of finding the one we want. In other words, the algorithm takes $O(N)$ operations. On a quantum computer, we can make use of Grover's algorithm [5], which searches an N-object unsorted database for an object in $O(\sqrt{N})$ operations, offering a quadratic speedup over its classical counterpart. The new quantum algorithm that is proposed in this paper searches an N-object unsorted database for an object in just *one operation* and is offering an exponential speedup over its classical and quantum (Grover's algorithm) counterparts! Thus, our algorithm performs search over an unordered data set of size $N = 2^n$ items to find the unique element that satisfies some condition and while well known classical algorithm requires $O(N)$ operations and Grover's quantum algorithm requires $O(\sqrt{N})$ operations our quantum algorithm requires only one operation! With these preliminaries we now proceed with the discussion of our exponentially fast quantum algorithm to pick out the desired item from an unordered data set containing $N = 2^n$ items.

Algorithm

We begin our algorithm by simultaneously giving call to $(n/2)$ oracles that will modify the system depending on whether it is in the configaration we are searching for. An oracle is basically a black-box function, and a quantum oracle is a quantum black-box function, meaning it can observe and modify the system without collapsing it to a classical state, that will recognize if the system is in correct state. If the system is indeed in the correct state then the oracle will rotate the phase by π radians, otherwise it will do nothing, effectively *marking* the correct state for further modification by subsequent operations. Remember that such a phase shift leaves the probability of the system being in correct state the same, although the amplitude is neglected. The quantum oracle implementations will often use an extra scrath qubit (ancilla), but in our implementation the extra qubit remains unaffected by the action of operator representing the oracle and so can be neglected and the effect of the operator O representing the oracle, expressed using the oracle or black-box function $f_t(x)$ where $f_t(x) = 1$ if $x = t$ and $f_t(x) = 0$ otherwise, is depicted simply as $O(|x\rangle) = (-1)^{f_t(x)}|x\rangle$.

Let us see briefly [6] how the extra qubit (ancilla), which we choose here as $H|1\rangle$, where H represents usual Hadamard transform, remains unaffected under the action of oracle represented by operator O and so can be neglected. As stated let the operator representing oracle be $O = I - 2|t\rangle\langle t|$, which is built using oracle or black-box function $f_t(x)$ where $f_t(x) = 1$ if $x = t$ and $f_t(x) = 0$ otherwise. To create operator O we create an $(n+1)-$ qubit unitary transformation

$$\omega_f : \omega_f|x\rangle|y\rangle = |x\rangle|y \oplus f_t(x)\rangle$$

where $|x\rangle = |x_1 x_2 \cdots x_n\rangle$, $x_i \,\epsilon\, \{0, 1\}$, and where we choose $|y\rangle = H|1\rangle = \frac{1}{\sqrt{2}}[|0\rangle - |1\rangle]$. We can now easily see that

$$\omega_f|x\rangle|y\rangle = (-1)^{f_t(x)}|x\rangle|y\rangle$$

when we choose the ancilla qubit $|y\rangle$ as given above. Thus this ancilla qubit remains unaffected and we can ignore it in our calculations and simply have operator $O = (I - 2|t\rangle\langle t|)$ for some target state $|t\rangle$ which performs the same action that of oracle or black-box function, namely,

$$O|x\rangle = (I - 2|t\rangle\langle t|)|x\rangle = -|x\rangle$$

if $x = t$ and

$$O|x\rangle = (I - 2|t\rangle\langle t|)|x\rangle = |x\rangle$$

if $x \neq t$.

We now proceed with the steps of the algorithm:

(i) Let $D = \{0, 1, 2, \cdots, N-1\}$ be the unordered data set containing $N = 2^n$ items labeled by numbers $0, 1, 2, \cdots, N-1$ and let item labeled by label t be our target item which we want to find out from the set. We associate quantum states, which are computational basis states, with these items. Thus we represent item labeled by number 0 by computational basis state $|00\cdots 0\rangle$, we represent item labeled by number 1 by computational basis state $|00\cdots 1\rangle$, we represent item labeled by number 2 by computational basis state $|00\cdots 10\rangle$, $\cdots$, we represent item labeled by number x by computational basis state $|x_1 x_2 \cdots x_n\rangle$, $\cdots$, finally, we represent item labeled by number $(N-1)$ by computational basis state $|11\cdots 1\rangle$. It is clear to see that the length of all these computational basis states associated with items have length equal to n.

(ii) We prepare a quantum state, $|\psi\rangle$, which is equally weighted superposition of all computational basis states associated with items as above from the unstructured bag of items. Thus:

$$|\psi\rangle = \frac{1}{\sqrt{N}} \sum_{i_1, i_2, \ldots i_N} |i_1 i_2 \ldots i_N\rangle,$$

where each of $i_1, i_2 \ldots, i_N$ takes values in $\{0, 1\}$. This superposition state is representing a quantum register of n qubits where n is the number of qubits that are necessary to represent the entire search space of size $N = 2^n$. Thus, the quantum state $|\psi\rangle$ representing quantum bag containing N items out of which any computational basis state will result as an outcome of measurement (i.e. all computational basis states are equally probable as an outcome of measurement), therefore, this state $|\psi\rangle$ is correctly representing the unordered set of items.

Now, let us emphasize a very simple but important fact useful for our algorithm. This simple but very useful fact is that the above quantum state $|\psi\rangle$ can be expressed as below:

$$|\psi\rangle = H^{\otimes n}|0\rangle^{\otimes n} = \prod^{\otimes n}\left(\frac{1}{\sqrt{2}}[|0\rangle + |1\rangle]\right)$$

Thus, $|\psi\rangle$ is a *Completely Separable* state having n single qubit identical factors, each equal to $|\phi\rangle = \frac{1}{\sqrt{2}}[|0\rangle + |1\rangle]$. Once we understand the completely separable nature of the above quantum state $|\psi\rangle$ then it is easy to follow that we can infact give any suitable form to this state! For example, we can express

$$|\psi\rangle = (\prod^{\otimes r_1} |\phi\rangle) \otimes (\prod^{\otimes r_2} |\phi\rangle) \otimes \cdots \otimes (\prod^{\otimes r_k} |\phi\rangle)$$

where $r_1, r_2, \cdots, r_k$ are some positive integers such that $r_1 + r_2 + \cdots + r_k = n$. And further we can explicitely work out the tensor product of each factor like $(\prod^{\otimes r_j} |\phi\rangle)$ inside the bracket in the above product representation for $|\psi\rangle$. We call such representation in terms of suitable factors the *tensor product representation* for the quantum state $|\psi\rangle$ representing quantum bag of data.

(iii) We choose the following simple tensor product representation for the quantum state $|\psi\rangle$ in which we choose $r_1 = r_2 = \cdots = r_k = 2$, and for the sake of simplicity we assume without any loss of generality that n is an even number. Therefore, we have

$$|\psi\rangle = (\prod^{\otimes (n/2)} |\Theta\rangle)$$

where $|\Theta\rangle = \frac{1}{2}[|00\rangle + |01\rangle + |10\rangle + |11\rangle]$.

Let the target state be $|t\rangle = |t_1 t_2 \cdots t_n\rangle = |t_1 t_2\rangle |t_3 t_4\rangle |t_5 t_6\rangle \cdots |t_{n-1} t_n\rangle$. We choose to denote $|T_k\rangle = |t_{2k-1} t_{2k}\rangle$, therefore, we have $|T_1\rangle = |t_1 t_2\rangle$, $|T_2\rangle = |t_3 t_4\rangle$, $\cdots$, $|T_{(n/2)}\rangle = |t_{n-1} t_n\rangle$. Thus, we can denote target state by $|t\rangle = |T_1 T_2 T_3 \cdots T_{(n/2)}\rangle = |T_1\rangle |T_2\rangle |T_3\rangle \cdots |T_{(n/2)}\rangle$.

(iv)We now define $(n/2)$ oracles or black-box functions, $f_{T_1}, f_{T_2}, \cdots, f_{T_{(n/2)}}$ whose actions are defined through creating $(n/2)$ 3−qubit unitary transformations

$$\omega_{f_{T_i}} : \omega_{f_{T_i}} |x\rangle |y\rangle = |x\rangle |y \oplus f_{T_i}(x)\rangle,$$

$i = 1, 2, \cdots, (n/2)$, where $|x\rangle \epsilon \{|00\rangle, |01\rangle, |10\rangle, |11\rangle\}$, and we choose

$$|y\rangle = H|1\rangle = \frac{1}{\sqrt{2}}[|0\rangle - |1\rangle].$$

We can now easily see that

$$\omega_{f_{T_i}} |x\rangle |y\rangle = (-1)^{f_{T_i}(x)} |x\rangle |y\rangle$$

where the ancilla qubit $|y\rangle$ is as given above. Thus all the ancilla qubits remain unaffected and we can ignore them all in our calculations and simply define operators O_i,

$i = 1, 2, \cdots, (n/2)$, as $O_i = (I - 2|T_i\rangle\langle T_i|)$ and these operators perform the same action as that of oracles or black-box functions, namely, $O_i(|x\rangle) = -|x\rangle$ if $|x\rangle = |T_i\rangle$ and $O_i(|x\rangle) = |x\rangle$ otherwise, where $|x\rangle \, \epsilon \, \{|00\rangle, |01\rangle, |10\rangle, |11\rangle\}$. Thus, the actions of oracles or black-box functions can be performed through defining $(n/2)$ unitary quantum operators, $O_i = I_2 - 2|T_i\rangle\langle T_i|$.

(v)The next step of ours is to create $(n/2)$ identical operators W, the so called *Diffusion Transforms*, all equal to $[2|\Theta\rangle\langle\Theta| - I_2]$ and we carry out the following final operation simultaneously and independently(parallely). We operate $(WO_1) \otimes (WO_2) \otimes (WO_3) \otimes \cdots \otimes (WO_{(n/2)})$ on $|\psi\rangle$, where we convenietly choose the above given form for $|\psi\rangle$, namely, $|\psi\rangle = (\prod^{\otimes(n/2)} |\Theta\rangle)$. It is easy to check that this operation will produce the following state: $(WO_1)|\Theta\rangle \otimes (WO_2)|\Theta\rangle \otimes (WO_3)|\Theta\rangle \otimes \cdots \otimes (WO_{(n/2)})|\Theta\rangle)$ which is equal to

$|T_1\rangle \otimes |T_2\rangle \otimes |T_3\rangle \otimes \cdots \otimes |T_{(n/2)}\rangle = |T_1\rangle|T_2\rangle|T_3\rangle \cdots |T_{(n/2)}\rangle = |t_1 t_2\rangle|t_3 t_4\rangle|t_5 t_6\rangle \cdots |t_{n-1} t_n\rangle = |t_1 t_2 \cdots t_n\rangle = |t\rangle$. The desired target state is thus obtained in this single operation!

Remarks

(1) *The quantum bag of items:* In physical terms the formation of the quantum bag of items can be described in terms of a combined state of the system of n particles as follows:

(a)We can start with a system of n particles, each having two spin states. Thus, each particle can be either in (spin) state $|0\rangle$ or $|1\rangle$ or their superposition.

(b)We prepare initially all the particles in state $|0\rangle$ so that the combined system of these particles will be in the state $|S\rangle = \prod^{\otimes n} |0\rangle = |0\rangle^{\otimes n}$.

(c)We then transfer each particle, initially in the state $|0\rangle$, into the state which is equally weighted superposition of the states $\{|0\rangle, |1\rangle\}$. This is achieved by operating by Hadamard operator H on this intial state of each particle in the system. When we carry out explicitely the tensor product of these new states obtained by operating by Hadamard operator H on the intial states $|0\rangle$ of each of these particles in the system then the required quantum bag of database, $|\psi\rangle$, in terms of equally weighted superposition of computational basis states appears and each computational basis state of length n represents some item among the distinct items in this quantum bag. The quantum bag containing different items

$$|\psi\rangle = H^{\otimes n}|0\rangle^{\otimes n} = \frac{1}{\sqrt{N}} \sum_{i_1,i_2,\ldots i_N} |i_1 i_2 \ldots i_N\rangle,$$

thus becomes ready.

(2)*Ancillae in implementations of (n/2) oracles:* In the implementations of $(n/2)$ oracles mentioned above we start with the state $[|00\rangle|1\rangle]^{\otimes(n/2)}$. We then operate by operator $H^{\otimes(3n/2)}$ on this state as given below: Thus, we get

$$H^{\otimes(3n/2)}[|00\rangle|1\rangle]^{\otimes(n/2)} = \prod^{\otimes(n/2)} [1/2(|00\rangle + |01\rangle + |10\rangle + |11\rangle)\frac{1}{\sqrt{2}}(|0\rangle - |1\rangle)]$$

We then apply $(n/2)$ oracles or black-box functions simultaneously and parallely. We see that by the action of these $(n/2)$ oracles or black-box functions carried out simultaneously and parallely perform phase inversion, i.e. rotate the phase by π radians, of the corresponding correct states among the states $\{|00\rangle, |01\rangle, |10\rangle, |11\rangle\}$ and leave other states unaffected. Also, we see that these $(n/2)$ oracles or black-box functions leave all the ancillae qubits $|y\rangle = \frac{1}{\sqrt{2}}(|0\rangle - |1\rangle)$ unaffected and so they all become ignorable, i.e. can be ignored, and so we ignore them.

(3)*Speeding up solutions of NP-complete problems:* For solving Hamiltonian cycle (HC) problem ([4], page 264), best classical algorithm requires $O(p(n)2^{n[log(n)]})$ operations, Grover's quantum algorithm requires $O(p(n)2^{n[log(n)]/2})$ operations, while our quantum algorithm will require only $O(p(n))$ operations where $p(n)$ is a polynomial factor.

Example Suppose we are given an unordered database in terms of $2^{10} = 1024$ labeled items kept inside a bag and items are labeled by numbers $0, 1, 2, \cdots 1023$. Our aim is to pick out item labeled by number 727. We solve quantum version of this problem using new quantum algorithm.

(1)We prepare quantum bag in terms of quantum state

$$|\psi\rangle = \frac{1}{\sqrt{2^{10}}} \sum_{i_1,i_2,\ldots,i_{10}} |i_1 i_2 \ldots i_{10}\rangle,$$

where each of $i_1, i_2 \ldots, i_{10}$ takes values in $\{0, 1\}$.

(2)The target item is labeled by number $(727)_{10} = (1011010111)_2$.

(3)Thus, the target state is $|t\rangle = |1011010111\rangle = |10\rangle|11\rangle|01\rangle|01\rangle|11\rangle$.

(4)We take operators, $O_i, i = 1, 2, \cdots, 5$ representing $(n/2) = 5$ oracles, namely, $O_1 = I_2 - 2|10\rangle\langle 10|$, $O_2 = I_2 - 2|11\rangle\langle 11|$, $O_3 = I_2 - 2|01\rangle\langle 01|$, $O_4 = I_2 - 2|01\rangle\langle 01|$, $O_5 = I_2 - 2|11\rangle\langle 11|$, and take five identical diffusion transforms $W = [2|\Theta\rangle\langle\Theta| - I_2]$, where $|\Theta\rangle = \frac{1}{2}[|00\rangle + |01\rangle + |10\rangle + |11\rangle]$.

(5)We evaluate $((WO_1)\otimes(WO_2)\otimes(WO_3)\otimes(WO_4)\otimes(WO_5))\ (((|\Theta\rangle)\otimes(|\Theta\rangle)\otimes(|\Theta\rangle)\otimes(|\Theta\rangle)\otimes(|\Theta\rangle)) = (WO_1)|\Theta\rangle \otimes (WO_2)|\Theta\rangle \otimes (WO_3)|\Theta\rangle \otimes (WO_4)|\Theta\rangle \otimes (WO_5)|\Theta\rangle = |10\rangle \otimes |11\rangle \otimes |01\rangle \otimes |01\rangle \otimes |11\rangle = |10\rangle|11\rangle|01\rangle|01\rangle|11\rangle = |1011010111\rangle = |t\rangle$.

Note that best classical algorithm in the worst case will require 1024 iterations, Grover's quantum algorithm [5] will require 32 iterations, while our new quantum algorithm that we proposed here requires just *one* iteration!

Conclusion

Our algorithm provides exponentially fast quantum algorithm for searching in the unstructured database and further also establishes that $NP = P$ at least by *quantum mechanical* considerations!!

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