Lecture 1

INTRODUCTION TO QIC :- 20/11/20

— Elisa Baumer

 overview

① from bits to qubits

↳ basics of qubit, mathematical represe. Diracs, Bloch sphere

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② Quantum Circuits :-

↳ basic single / two qubit, two qubit gates, multipartite quantum table,

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③ Entanglement :- (Bell states, Teleportation, d - sphere)

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part - 1

← from bits to qubits →

classical computation → classical states for computation are '0' or '1'

Quantum mechanics → in quantum mechanics, its different, a state can be in superposition i.e., simultaneously 0 or 1. These superpositions allow us to perform calculations not only on one state but on multiple states at same time. for example:-

in classical computing when you have 3 bits, (_ _ _) then you can have a decimal number between 0 to 7.

If you are on a quantum computer with 3 qubits, in that any qubit can take any value at same time. In this way a quantum computer with 3 qubits can take all values at same time. That is, 0 to 7 any value at same time.

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in this way we can be at all 8 states, superposition of all 8 states at same time. what this means is that, if we calculate all of these at same time, we can get a bit speedup, and we have / We know some quantum algorithms, that can perform exponentially fast than any classical algorithm we have known so far. exponential speedup

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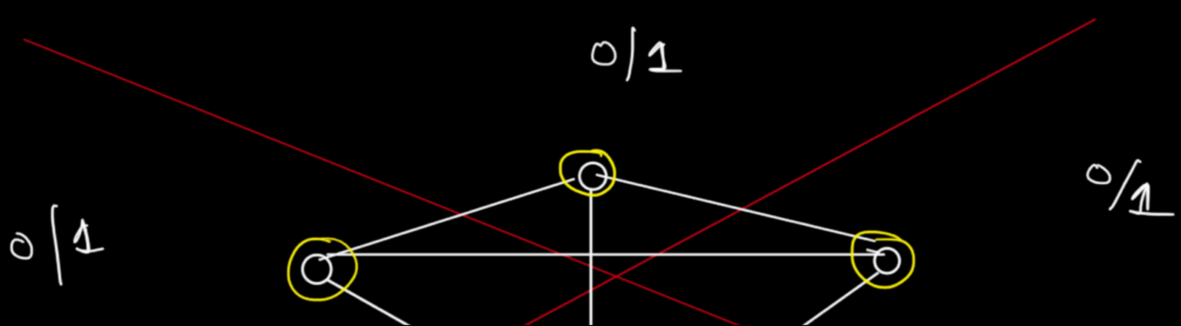
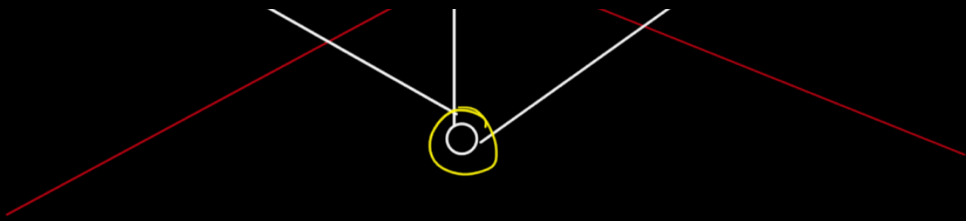


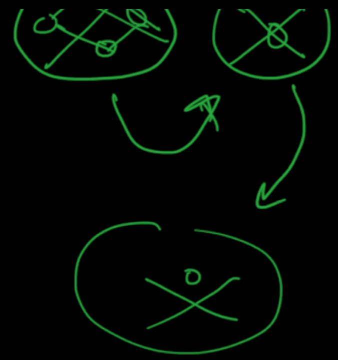


we have 4 bit positions, 0/1
all can be taken at the same time,
with 4 qubits, we can achieve a superposition of $2^4 = 16$ numbers from 0 to 15. EXPONENTIAL SPEEDUP

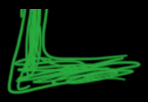
BUT: once we measure the super-position state, it will collapse, it collapses to one of its states.
one of the eigen states on the operator that we are measuring. That means we are only going to get one answer.

That is, when performing operations we may have multiple states, in other words, while performing calculations we can take benefit of superposition of states of all different states at the same time,
But when we do measurement, during this measurement we will only get one answer
ONLY ONE ANSWER

That is the calculations will end upon or converge to only one answer

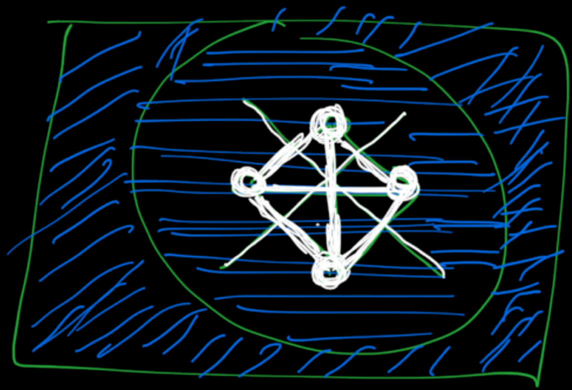


Initially:-



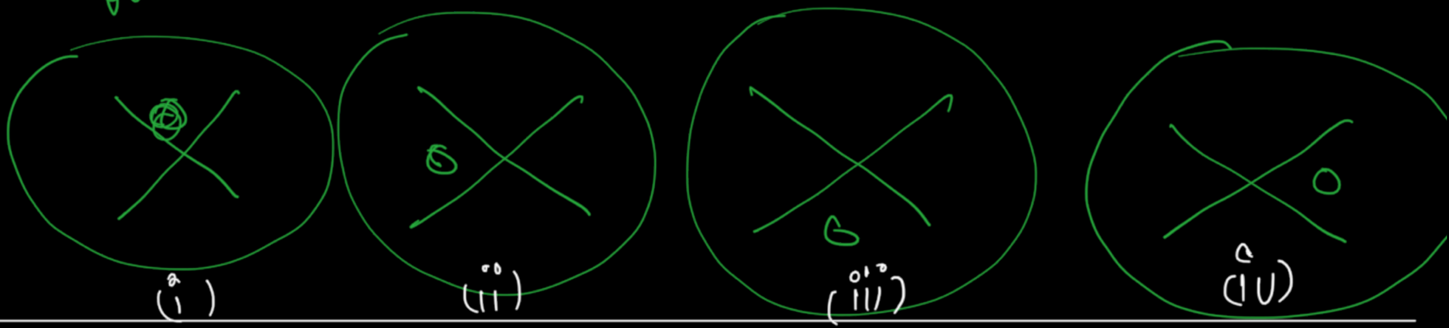
during calculation:

[The states which are not known]



[Black Box]

after calculation:



It is not easy to design quantum algorithms, but we have come up with smaller methods which could theoretically get speedups.

Thus we use,

INTERFERENCE EFFECTS

(example:- double slit experiment)

That is we can always perform calculation on superposition of states, but in the end we are going to get only one state as seen in earlier figures.

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took a break!