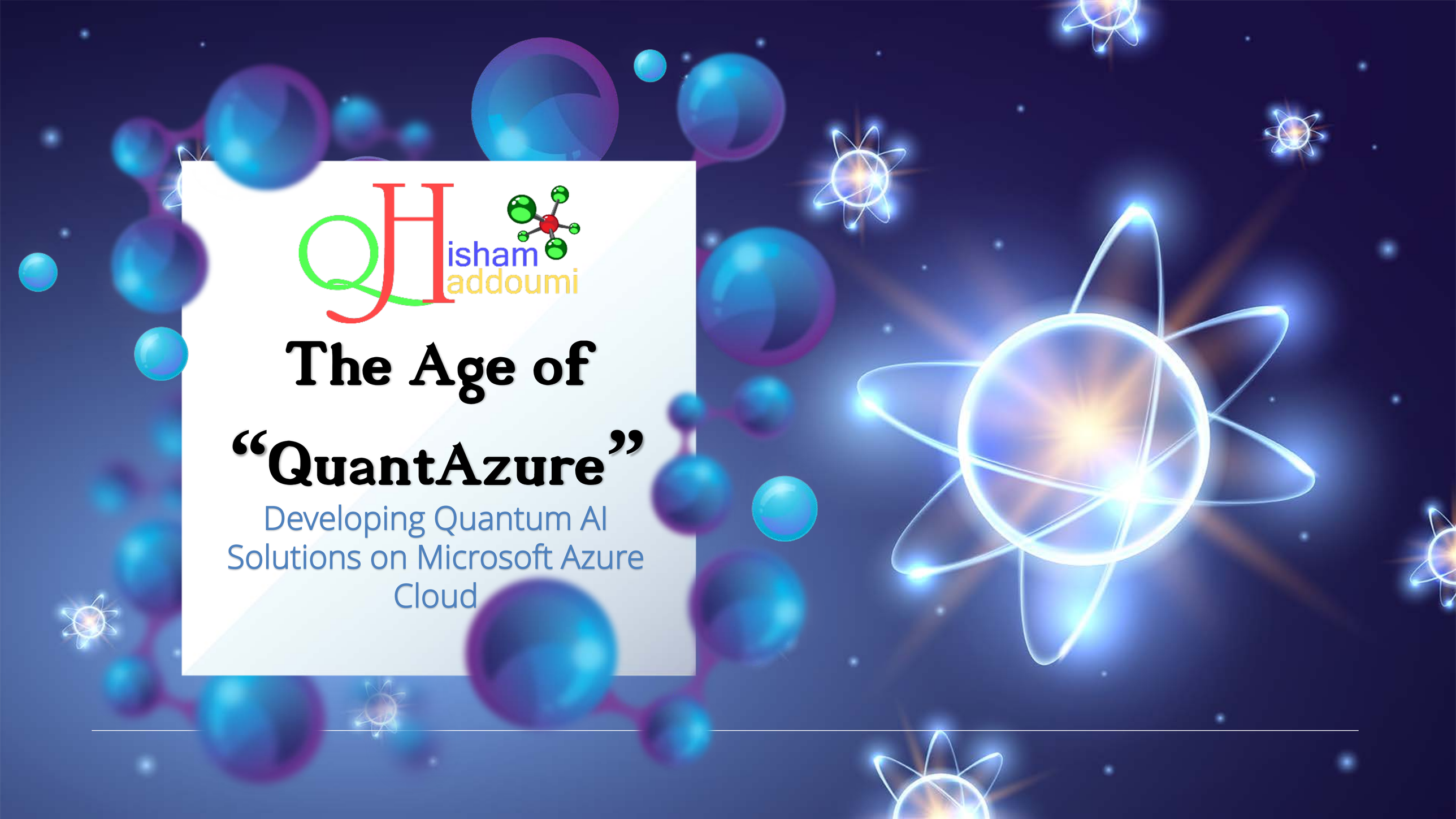
Empowering the quantum revolution

Watch the Video here

https://www.microsoft.com/en-ca/videoplayer/embed/RE2rzi5?autoplay=true



The Age of "QuantAzure"

Developing Quantum AI Solutions on Microsoft Azure Cloud

The Age of "QnautAzure"

About the Speaker

- Started Programming when I was 10.
- Programming since I was 9 (33 years in a row).
- Got my Ph.D. in Information Technology in 2012 (Social Media thesis).
- Started with SharePoint 0n 2001.
- Started with AI on 2009.
- Recently got myself involved in Quantum Computing (*Yes, I'm THAT crazy!*).

hqaddomi

Quantum in Real Life

Climate Change

Agriculture

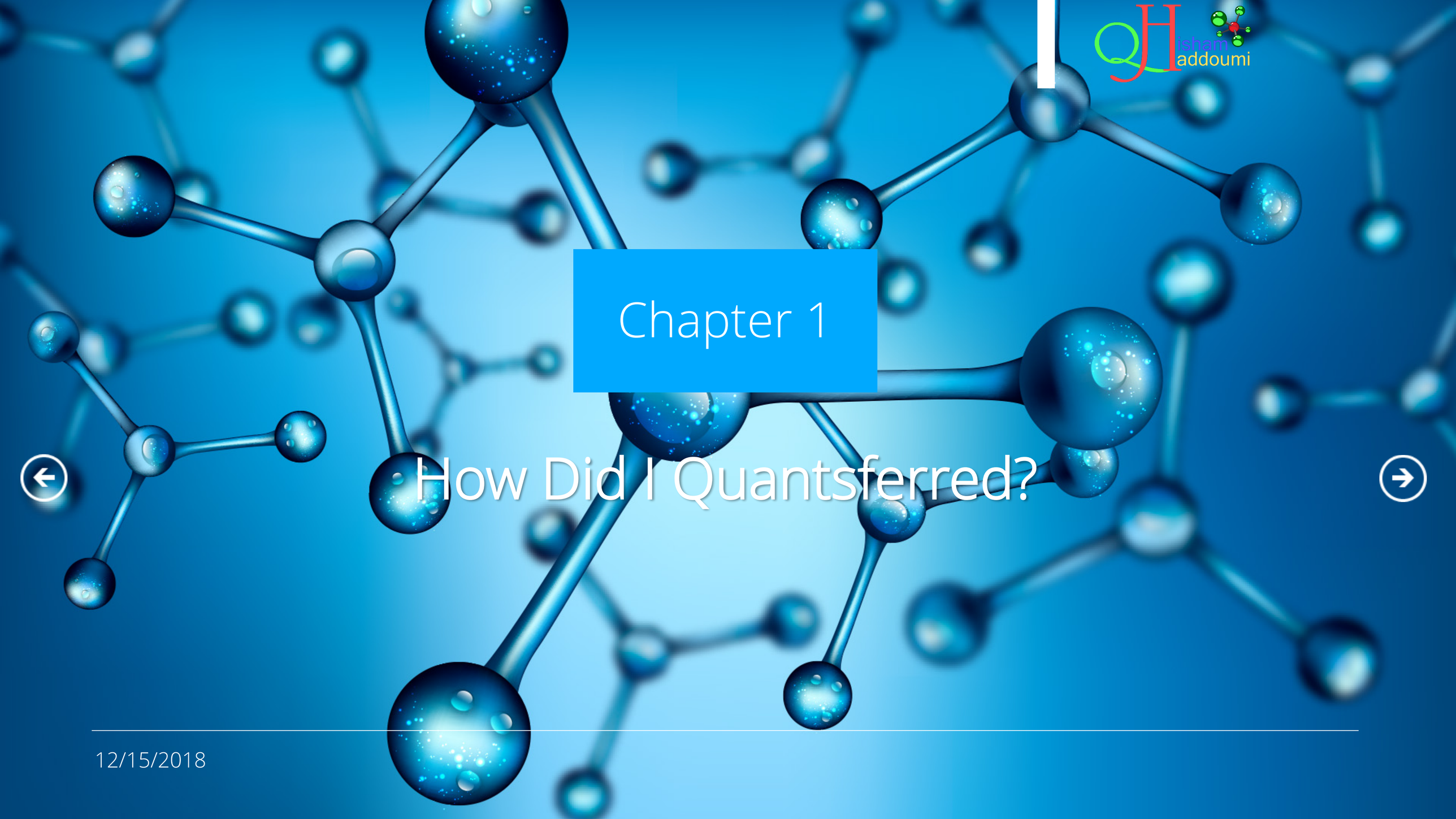
Education

Healthcare

Cybersecurity

Machine Learning

Table of Contents


Chapter 1
How Did I Quantsferred?

2012 Genome Center Project

12/15/2018

2012 Genome Center Project

- Cancer treatment research
- Analyze human Genome to understand the unique traits of each race:
  - ❑ What defines a race?
  - ❑ Why are specific races are susceptible to specific diseases?
  - ❑ Why are specific races are allergic to specific medications?
  - ❑ Why are specific individuals are susceptible to specific diseases and allergic to specific medications based or genetic traits.

Use AI to find relations between diseases, medication chemical compositions and genetic traits.

My job was to design the solution for AI software and Data Center

The Shocking Facts

A single human Gnome map is 30 Terabytes

IN TEXT FILES

7,500 files with 30,000,000,000,000 (30 Trillion) characters

Me: Sorry guys ☹ No budget can help you doing that kind of extraction!
Client: We don’t need Genome data extraction! We are already doing that.
Me: How?????
Client: Using our Quantum Machine!

The Great Depression ☹

Quan… WHAT?

Photo: Quantum Machine Works LTD. www.quantummachine.ca

Chapter 2

Why Quantum Computing? Why NOW?

Why Quantum Computing?

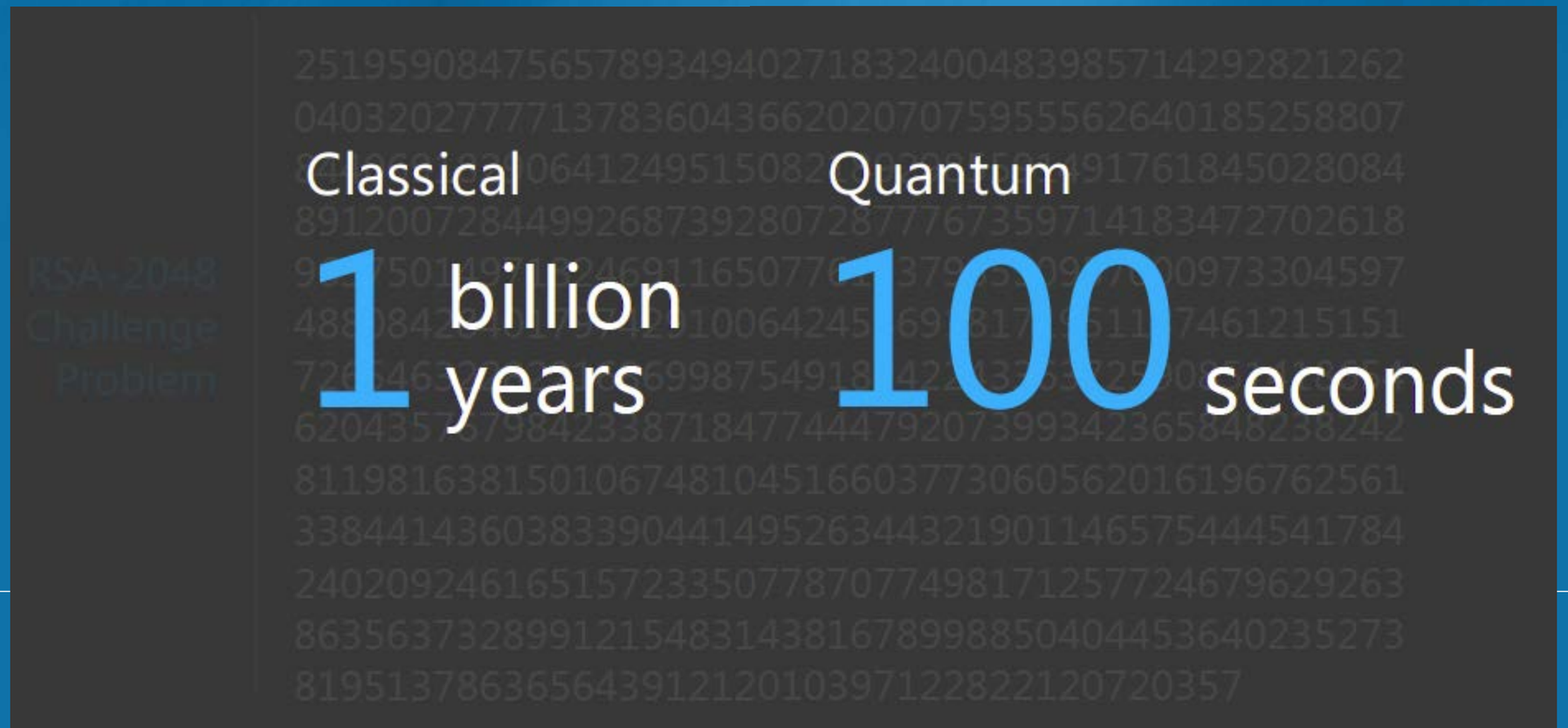
- It’s the future of computing and if you didn’t start you won’t catch-up and you’re out of business in few years.
- A quantum machine is more adept at solving quantum mechanics problems than classical computers, even when classical computers are able to simulate quantum computers
- The nature of the problem is so difficult that it can't be solved using classical computers at all, or it can't be solved using classical computers within a reasonable amount of time, at a reasonable cost.
- Availability of a hybrid use cases in which parts of a problem are best solved by classical computers and other parts of the problem are best solved by quantum computers

Why NOW?

- It’s best to start understanding anything when it’s in the beginning.
- There are a lot of problems and challenges out there that need immediate fix and can’t be fixed with classic computing.
- The learning cycle takes time so it’s best to start early.

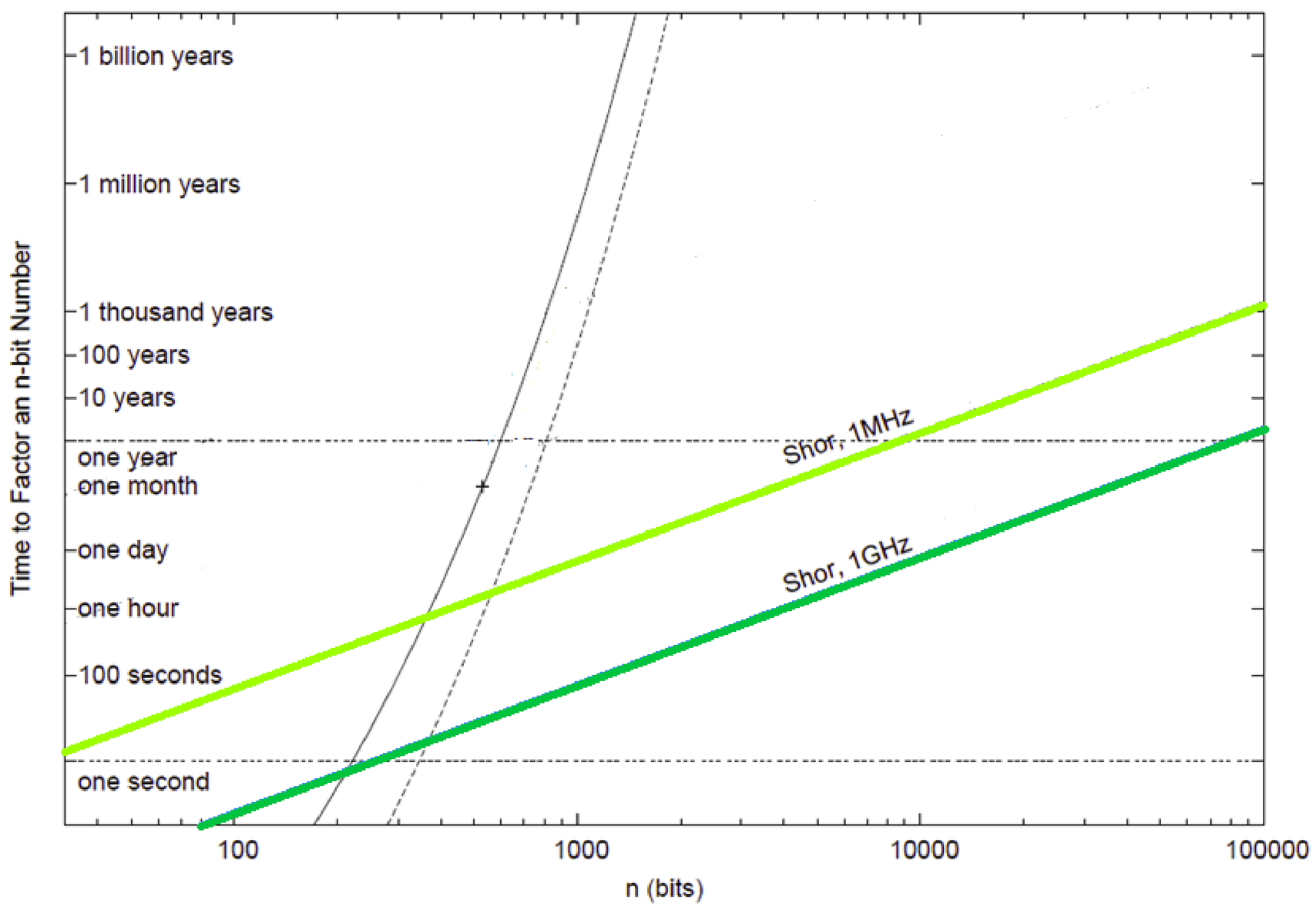
Why Quantum Computing? Why NOW?

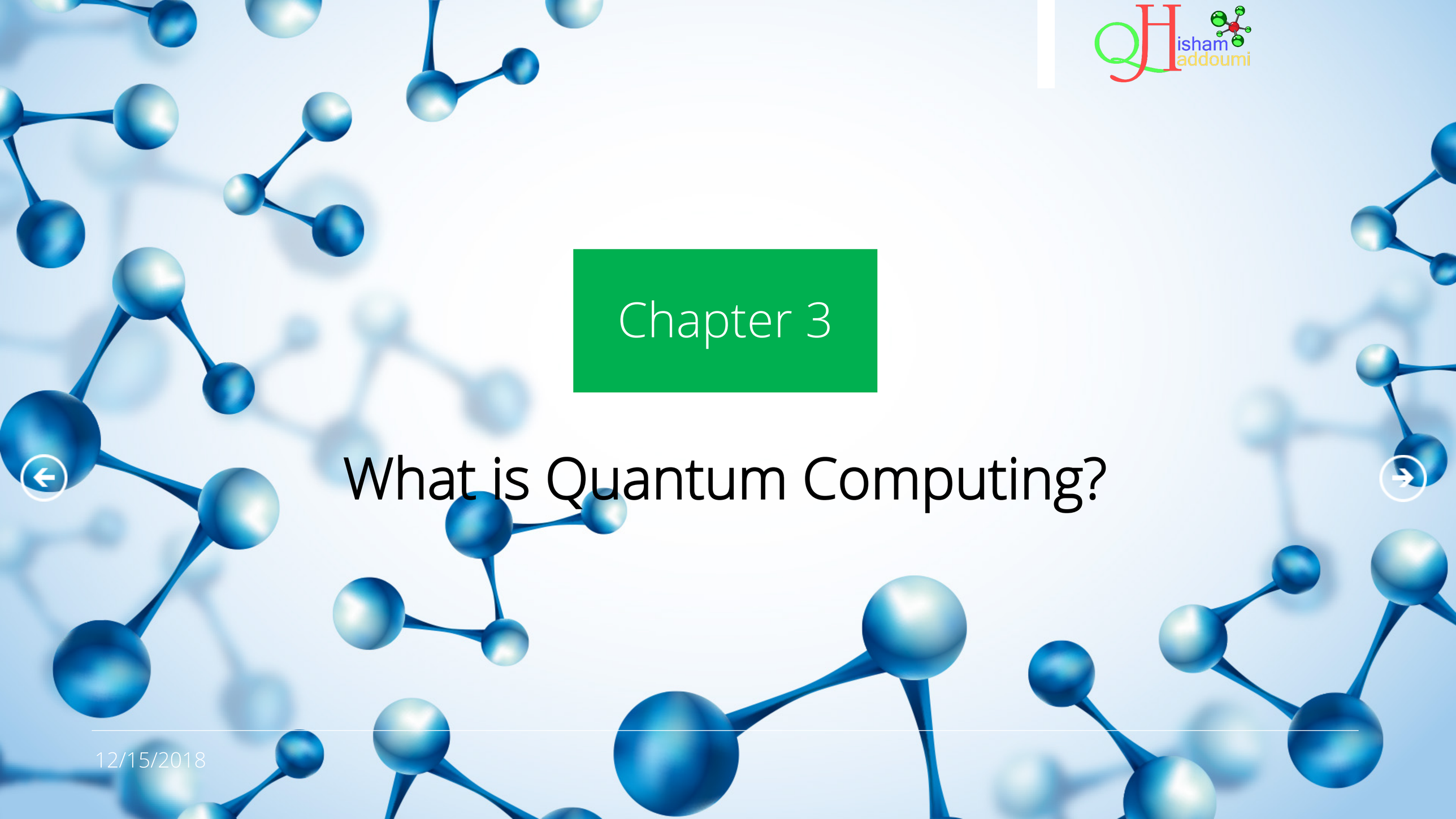
Problem solving is the key! (*The RSA Breaking Challenge*)



Why Q

Problem so

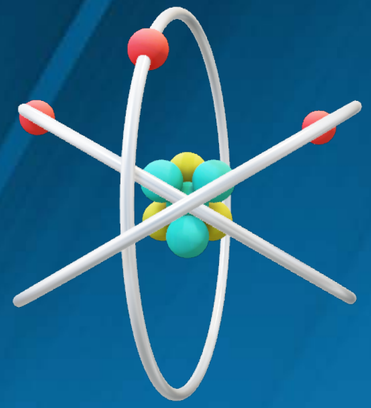




Chapter 3

What is Quantum Computing?

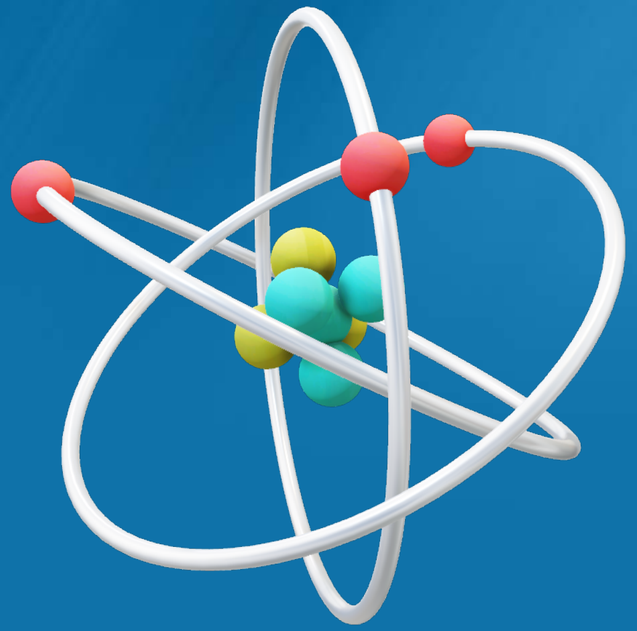
What is Quantum Computing?



Quantum computing is computing using quantum-mechanical phenomena, such as *superposition* and *entanglement*. A quantum computer is a device that performs quantum computing. Such a computer is different from binary digital electronic computers based on transistors. Whereas common digital computing requires that the data be encoded into binary digits (bits), each of which is always in one of two definite states (0 or 1), quantum computation uses quantum bits or qubits, which can be in superpositions of states. A quantum Turing machine is a theoretical model of such a computer, and is also known as the universal quantum computer. The field of quantum computing was initiated by the work of Paul Benioff and Yuri Manin in 1980, Richard Feynman in 1982, and David Deutsch in 1985.

What is Quantum Computing?

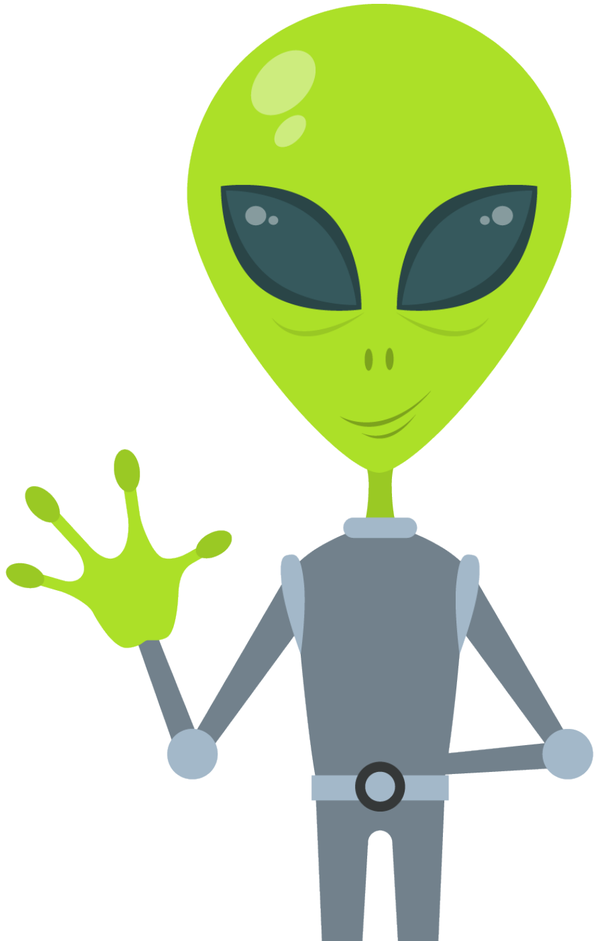
Earthian vs Alien Explanation Concept



Developed by: Dr. Hisham Qaddoumi

Earthian vs Alien Explanation Concept

Alien: Sees only in 2D



Earthian: Sees in 3D

Earthian vs Alien Explanation Concept

The Alien have no clue what the distances between people are while the Earthian can estimate the distances accurately by eye in A fraction of a second.

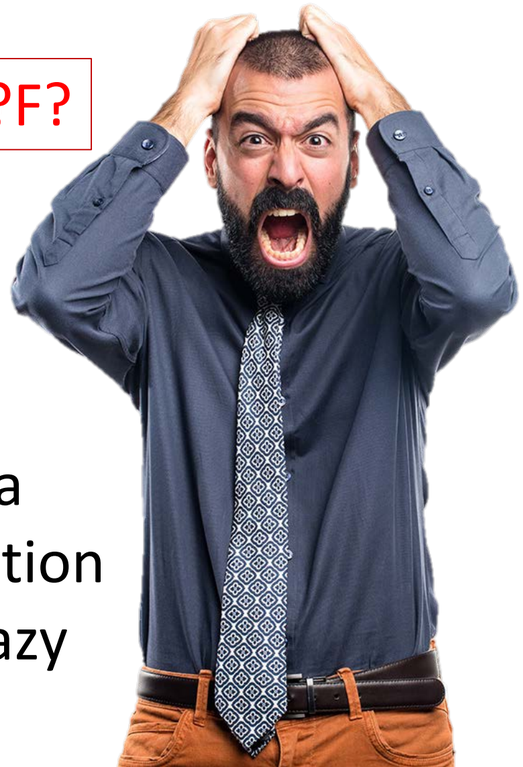
Earthian vs Alien Explanation Concept

138,798,765 x 64,789 = ?

8,992,633,185,585

On the other hand the Alien can solve a pretty complicated mathematical equation immediately while an Earthian goes crazy trying to solve it with no tool.

???&^*$%^#$@?WT?F?

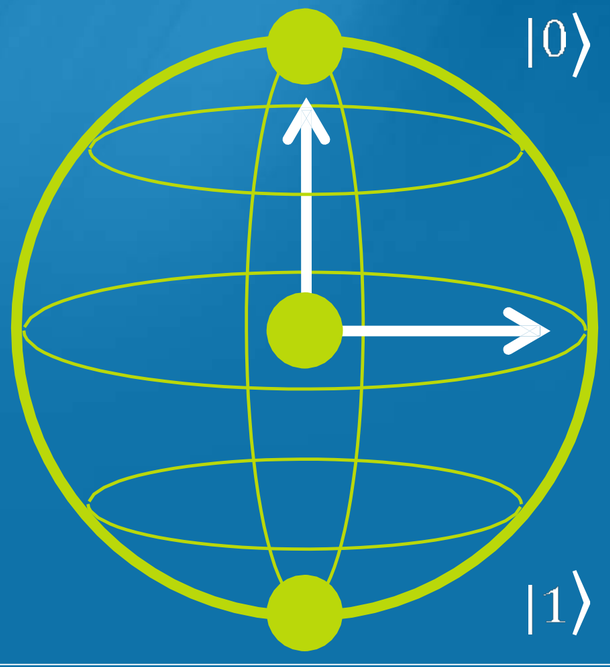


From Bit to Qubit

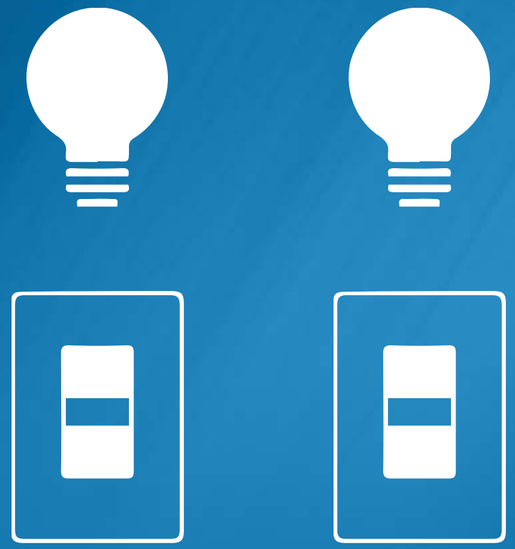
Classic Bit

- 0
- 1

Qubit

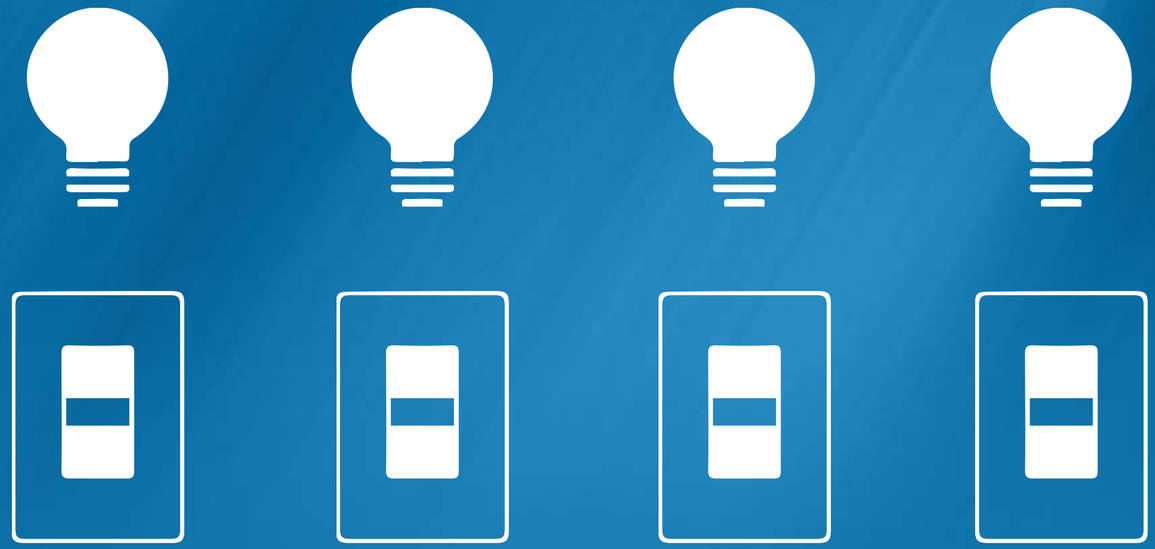


$$\frac{|0\rangle + |1\rangle}{\sqrt{2}}$$



0 1

1 0



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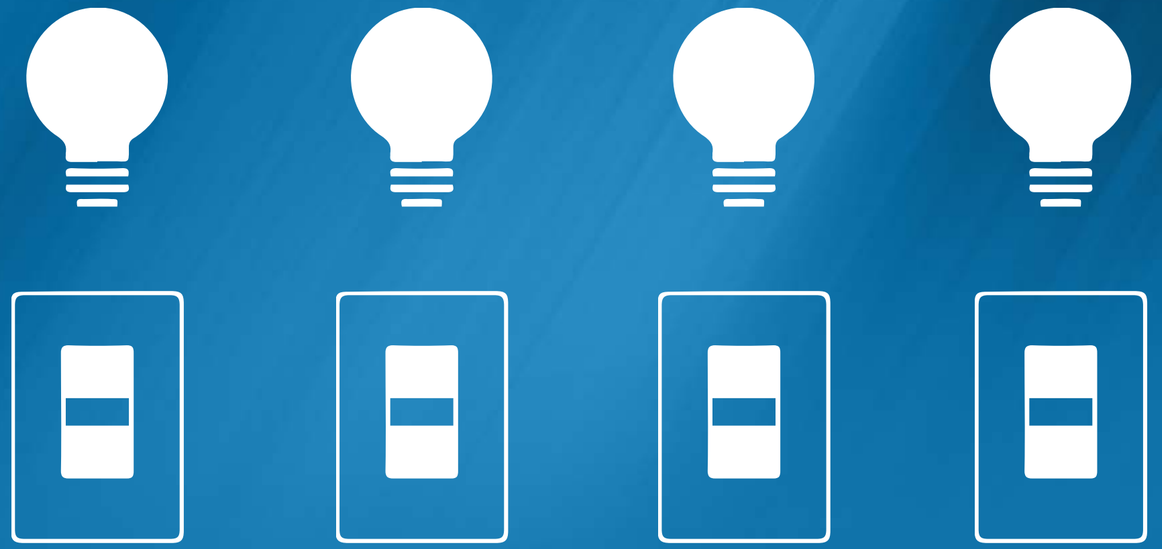

What Are Quantum Gates?

In quantum computing and specifically the quantum circuit model of computation, a quantum logic gate (or simply quantum gate) is a basic quantum circuit operating on a small number of qubits. They are the building blocks of quantum circuits, like classical logic gates are for conventional digital circuits.

Unlike many classical logic gates, quantum logic gates are reversible. However, it is possible to perform classical computing using only reversible gates. For example, the reversible Toffoli gate can implement all Boolean functions, often at the cost of having to use ancillary bits. The Toffoli gate has a direct quantum equivalent, showing that quantum circuits can perform all operations performed by classical circuits.

Source: Wikipedia

What Are Quantum Gates?

In quantum computing and sp
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Unlike many classical logic gat
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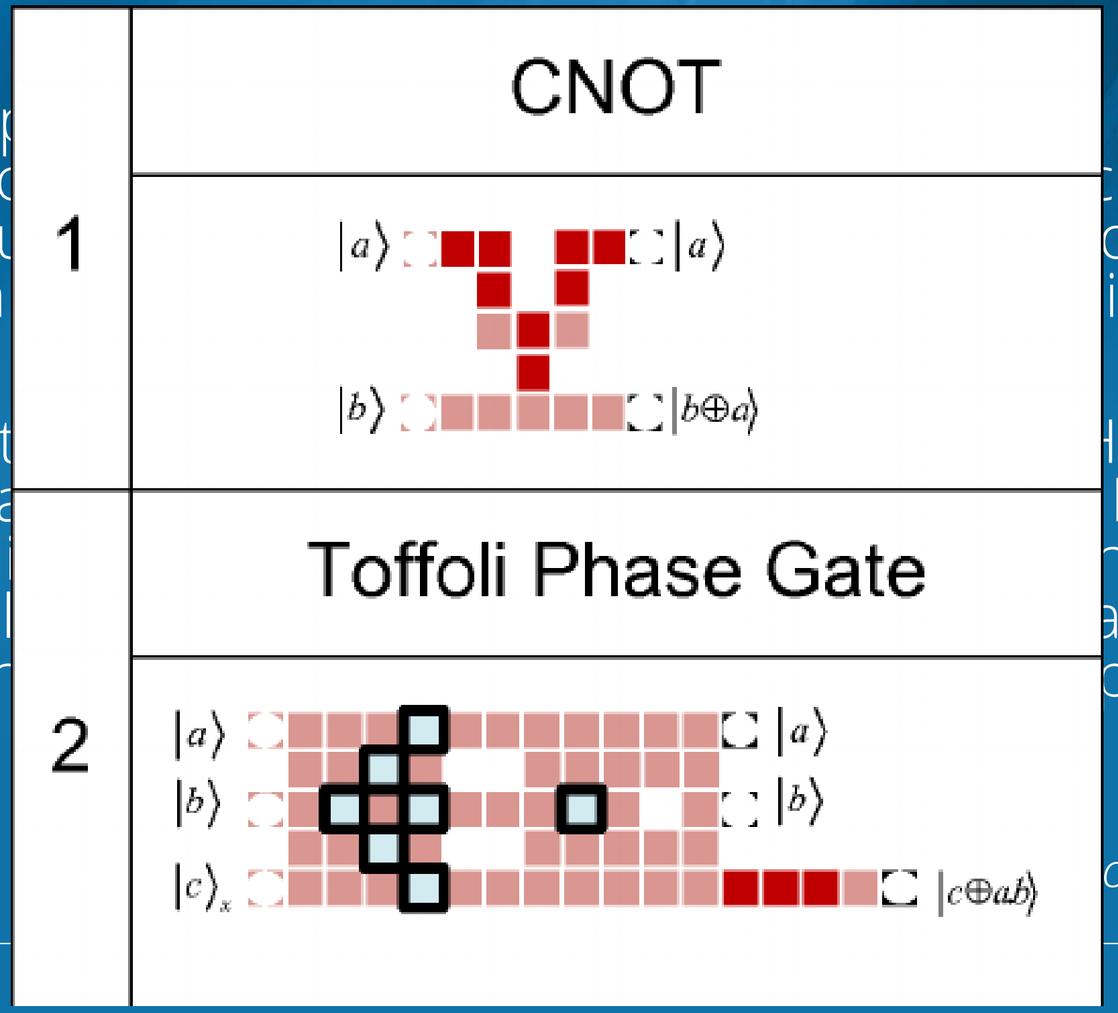

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However, it
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performed

ource: Wikipedia

Quantum Gates

Hadamard (H)	*CNOT (controlled NOT)*	*Z (Pauli Z)*	*X (NOT)*
Hadamard Gate	**CNOT Gate**	**Z Gate**	**X Gate**
Name: Hadamard, H **Role**: Create superposition state.	**Name**: CNOT, Controlled NOT **Role**: Exist on the X axe, yet, some exist on Y and Z also.	**Name**: Pauli Z, Z, phase flip, σ_z **Role**: Makes it easier to measure the results.	**Name**: Pauli X, X, NOT, bit flip, σ_x **Role**: Perform equivalent of NOT gate in classic computing.

Chapter 4

Quantum Computing Basics and Challenges

Quantum Computing Basics

- An atom, not an electron, is the physical bit
  - An electron is 0 or 1
  - Quantum mechanics: at atom is 0, 1, or *both*
  - “coherent superposition”
- The bit in quantum mechanics is called qubit
- Difference between bits and qubits
  - n bits can store one of 2^n numbers at any time
  - n qubits can store all 2^n numbers at once

What is Superposition

- An atom can be excited and not excited at the same time.
- It can be at two positions at the same time.
- It can be applied to any quantum particle e.g. a molecule, a photon or a spin.

What is Quantum Entanglement?

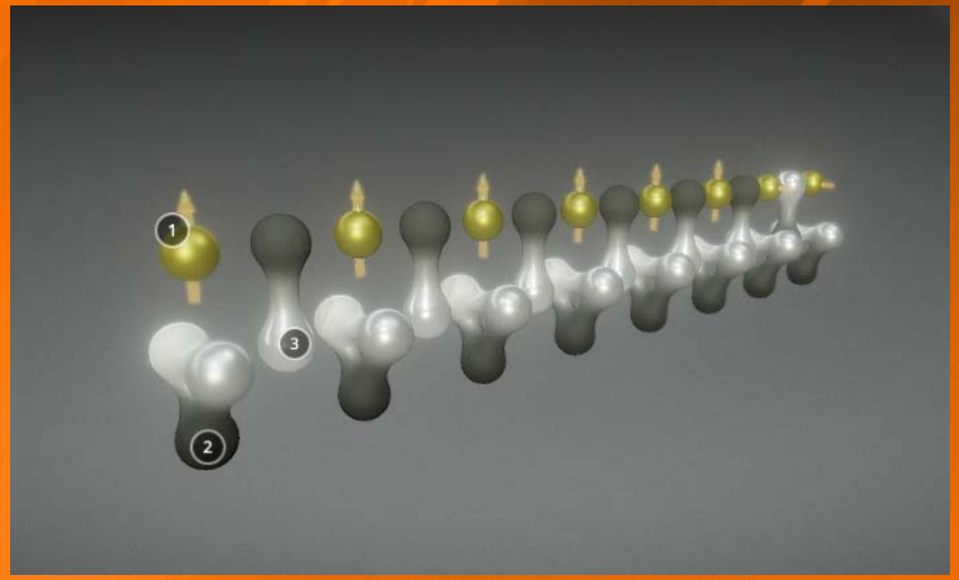
- When two particles become completely linked.
- Once you measure the spin of a particle you can automatically measure the spin of its partner (*even if it's on the other side of the universe*).
- Particles can be connected to give specific outputs (*happens at the speed of light*) example two entangled coins.

Light's speed is: 299 792 458 m / s

Light particle can spin around the globe
7.5 times in a second

Quantum Challenges & Limitations

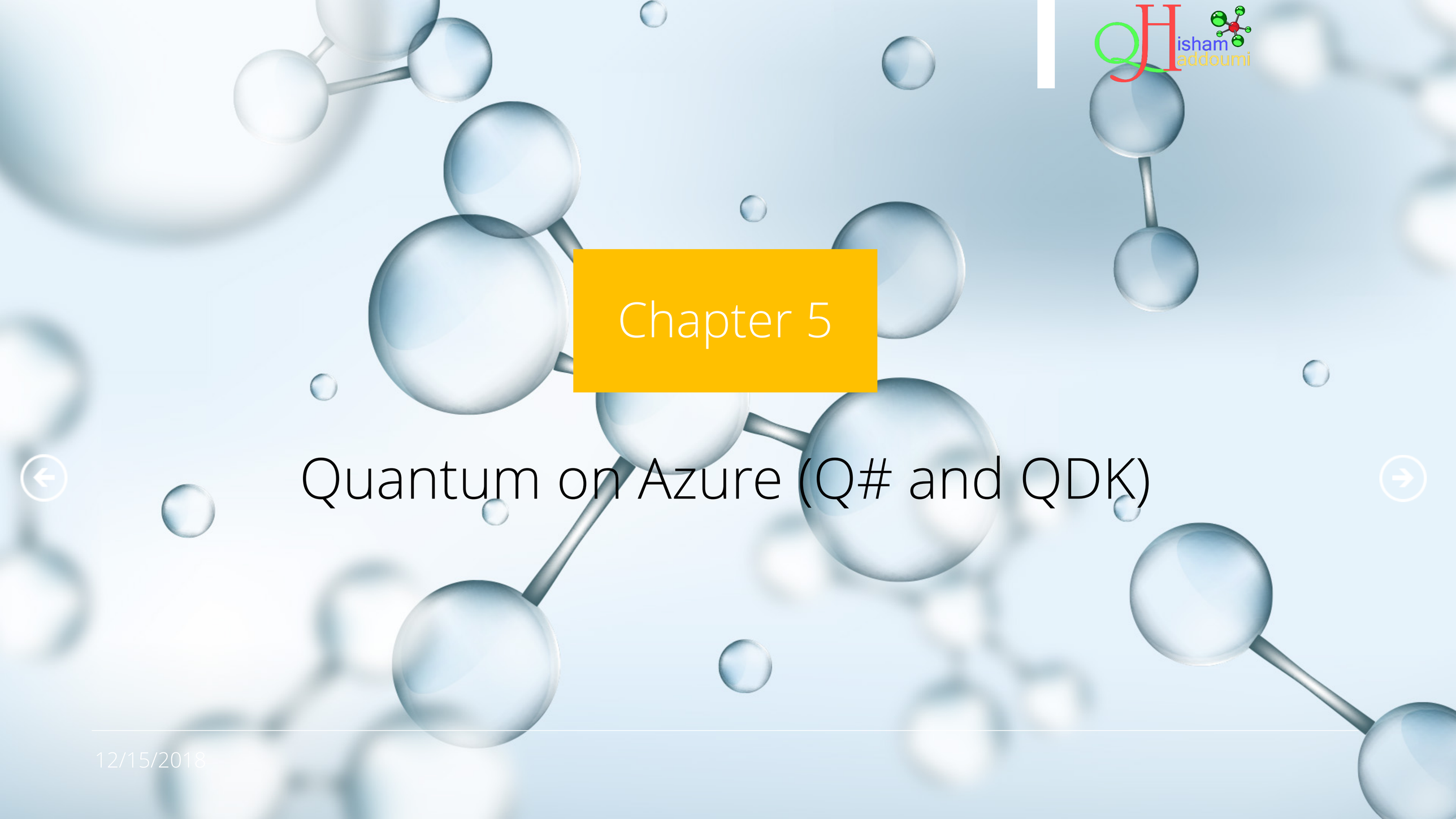
- Cost of build, power and cooling.
- Qubit quality, especially when adding more and more qubits.
- Coherence maximum time is pretty short.
- Majorly works for solving complicated mathematical issues.
- Doesn’t solve speed issues (Big Data, Analytics… etc.)
- Does NOT replace classic computing (at least not yet)



Demo

QUBITS IN 3D ACTION

Sketchfab 3d Demo at:
https://sketchfab.com/models/f763e5ba223c46199f85a6c5bb079a4c


Chapter 5
Quantum on Azure (Q# and QDK)

What's Q#?

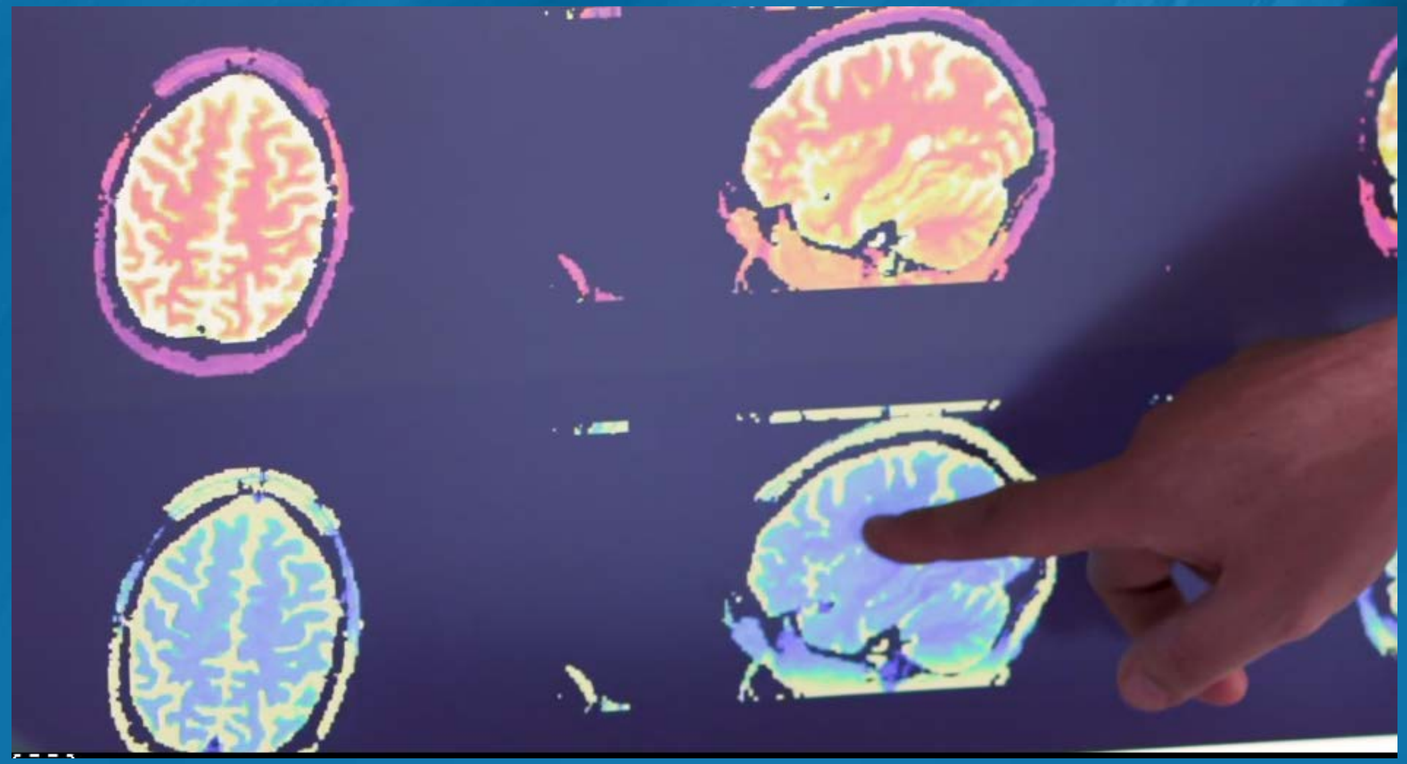
Q# (pronounced as Q sharp) is a domain-specific programming language used for expressing quantum algorithms. It was initially released to the public by Microsoft as part of the Quantum Development Kit.

Source: Wikipedia

Why Microsoft?

In order to empower the quantum revolution and widely welcome customers, developers, and enthusiasts, we need a system that scales. Unlike other quantum systems built on a fragile, error-prone foundation, every component of our infrastructure is designed for scalability. Our approach uses topological qubits specifically for their higher accuracy, lower cost, and ability to perform long enough to solve complex real-world problems.

Source: Microsoft



Microsoft is leading the way (Azure Quantum in Healthcare)

Watch the Video here

https://www.microsoft.com/en-ca/videoplayer/embed/RE2rzi5?autoplay=true

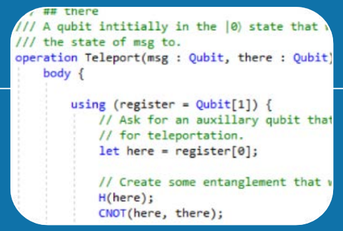
Use Q# to…

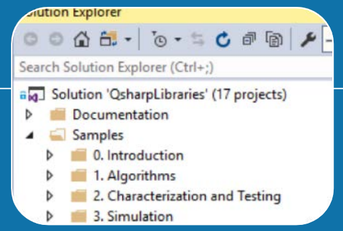
- Explore Quantum application
- Invent new quantum algorithms
- Optimize quantum code

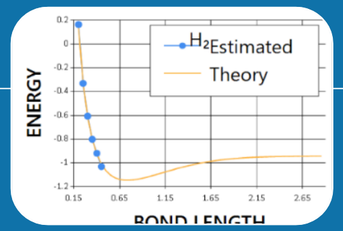
Quantum Development Kit

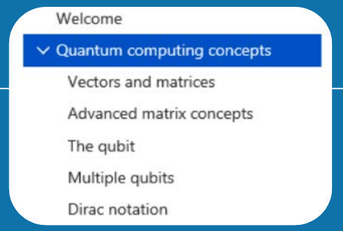
With QDK you can:

- Build with a Quantum-focused language.
- Optimize your code with local and Azure simulators.
- Learn from many Experts with code samples and libraries.

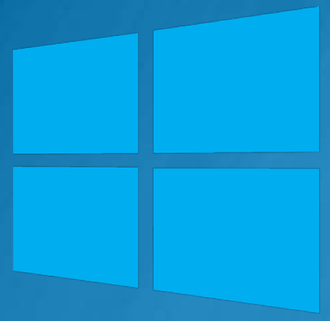








Downloadable Quantum Development Kit



For Windows

For macOS and Linux

Q# Language Features

- Familiar Block Style Syntax
- Functional Programming Inspired
  - Immutability By Default (*I call it ImBD*)
  - First Class Functions
  - Partial Application
- Strong Type System: Generics
- Quantum Specific Concepts
  - Functors (adjoint, controlled)
  - Resource Management (allocate, borrow)

Q# Langu

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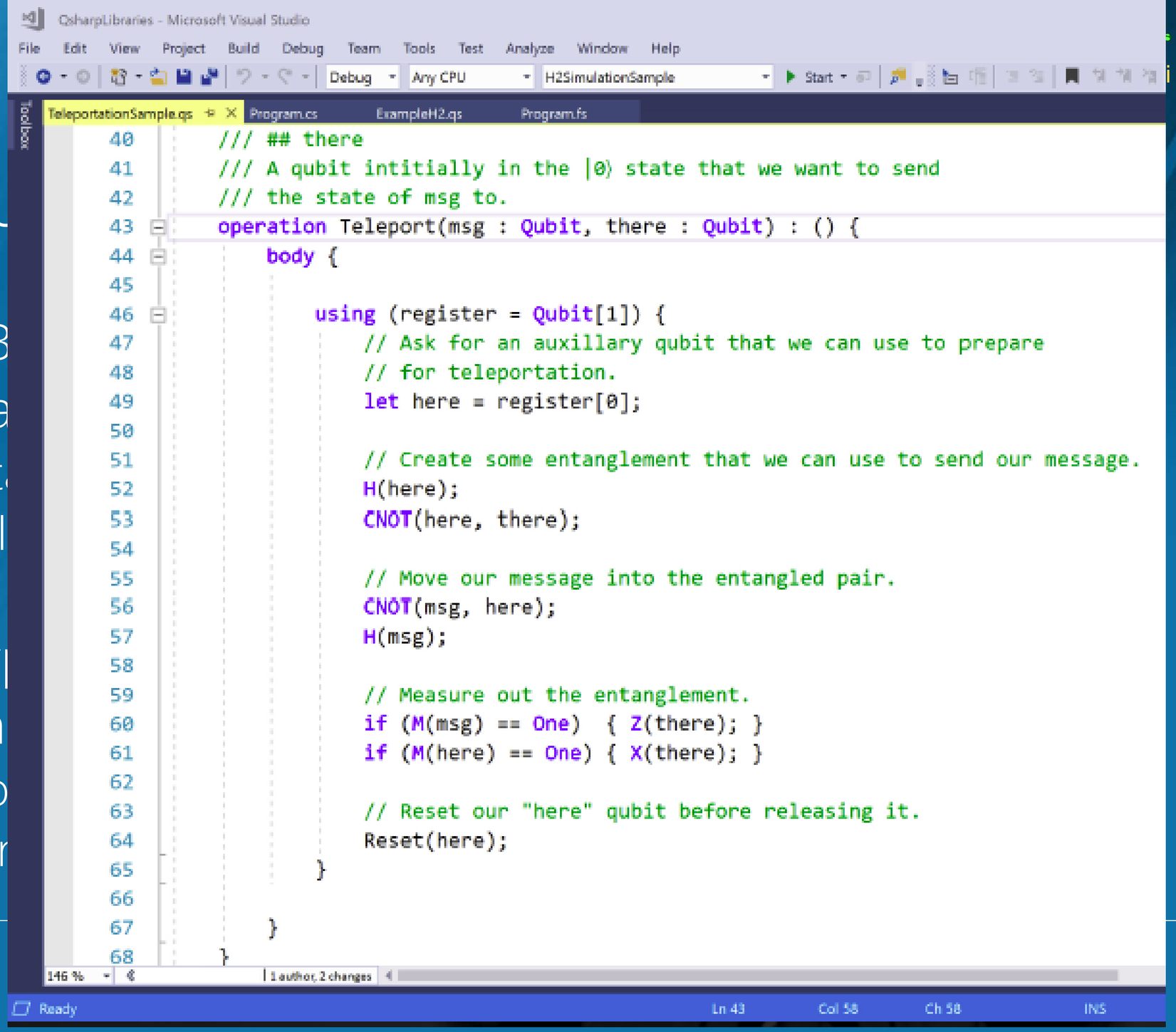
  - Resour

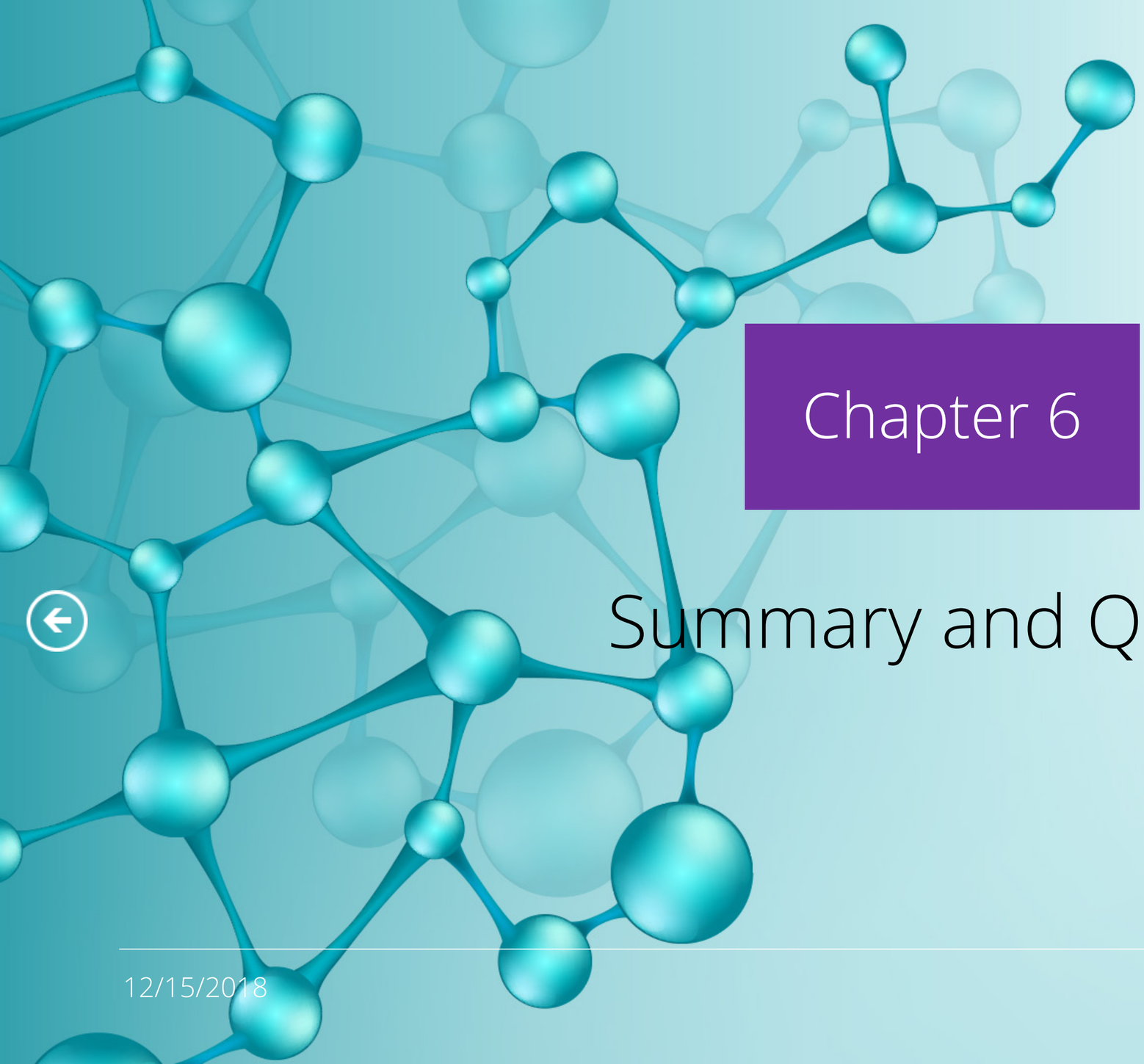


Demo

QUANTUM CODE IN ACTION

Resourses

- Comprehensive Documentation
  https://docs.microsoft.com/quantum/
- Download MS Quantum Development Kit
  https://microsoft.com/quantum
- Learn More
  https://github.com/microsoft/quantum/
- Code Samples
  https://github.com/Microsoft/Quantum/tree/master/Samples



Chapter 6

Summary and Q & A

Summary

- Quantum Computing is the future.
- Quantum might not be available for personal use but it’s available on the cloud by multiple providers.
- You can develop Quantum solutions on Azure using Q# language and Quantum Development Kit.
- Whether you will work on Quantum or not, it’s important to know the possibilities of this new world.

Contact Me

Dr. Hisham Qaddoumi

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http://bit.ly/2LnJ46w

hqaddomi