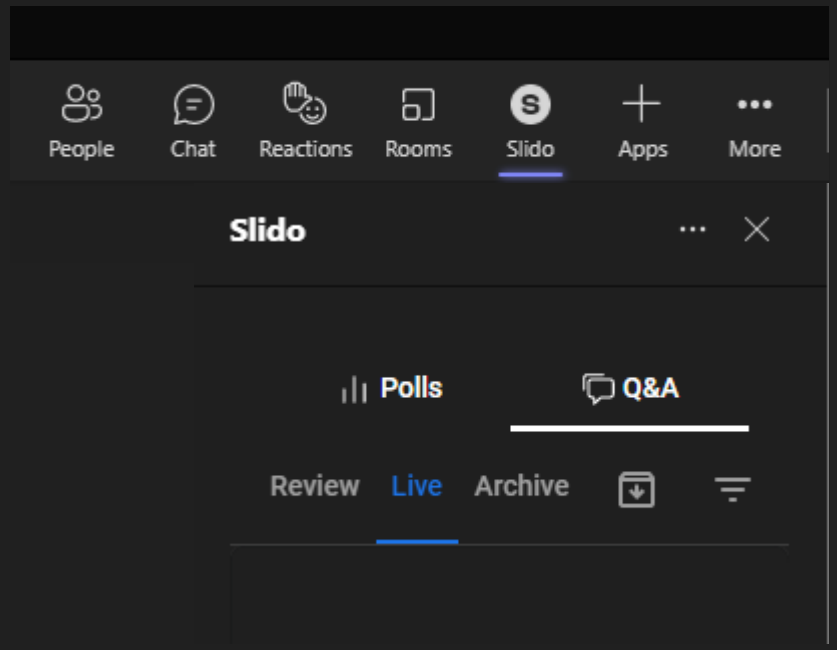
EQUINOX

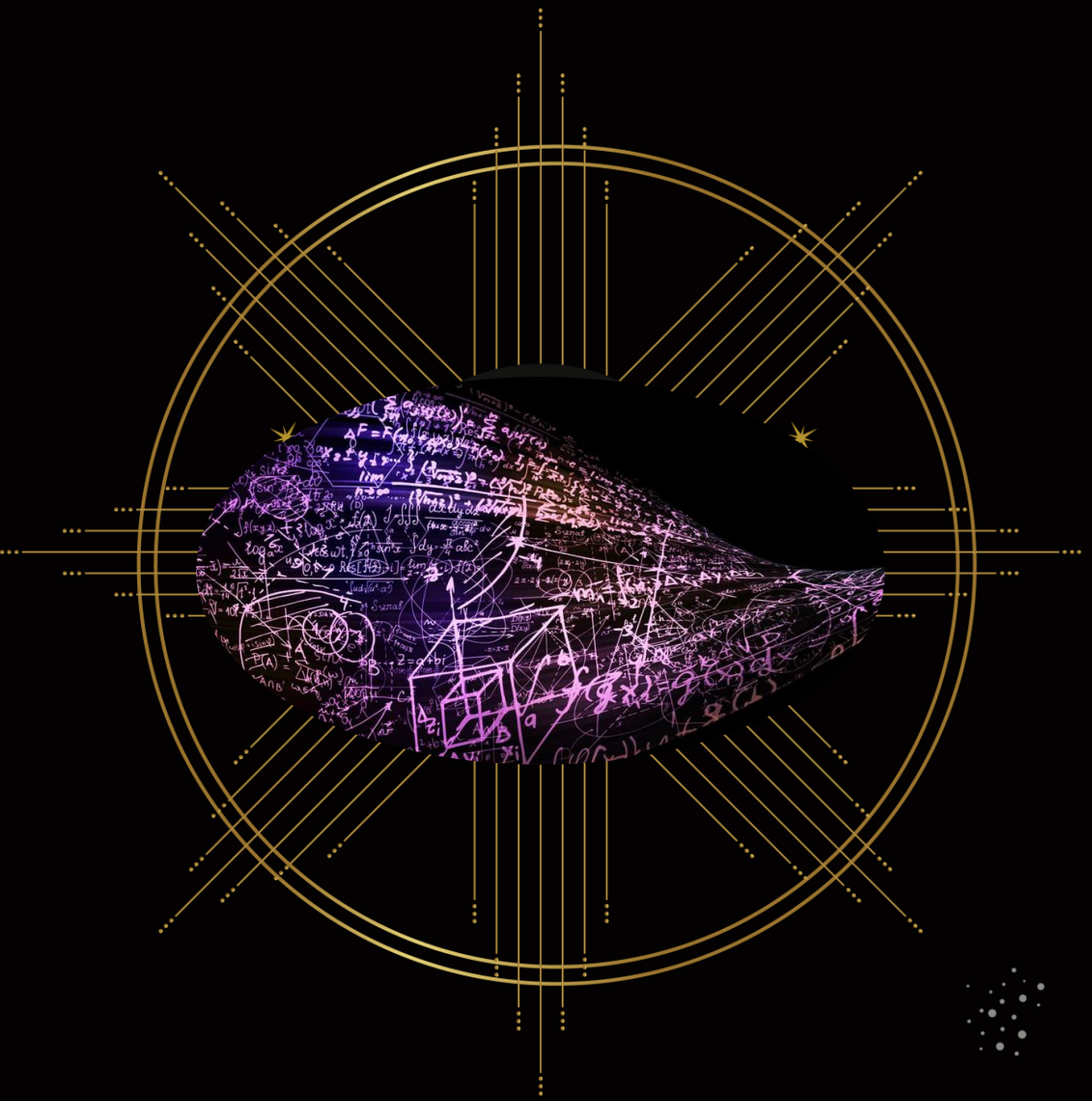
AI&DATA LAB

by ASESOFTWARE

QnA

- We use Slido for Q&As and polls
- Add questions at any time, upvote the ones you like
- Teams app users can see Slido at the bottom of the meeting
- Web users can go to slido.com and enter the number **#8810 353**





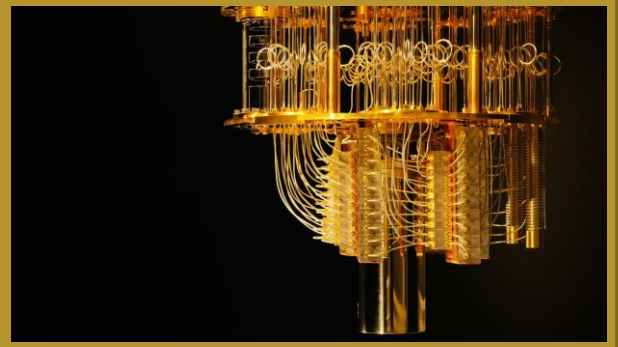
Maths for Quantum Computing

The language of the universe

Technical Course Structure

Introduction to QC

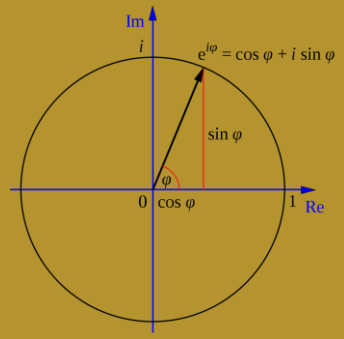
Thursday 25th August



What is QC?
What you should know about QC

Maths for QC

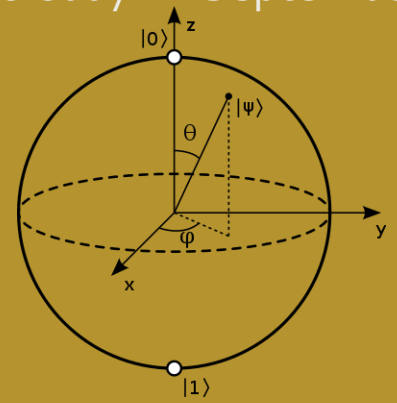
Friday 2nd September



Complex numbers
Linear Algebra

Single Qubits

Thursday 8th September



Bloch Sphere
Operators
Single Qubit gates

Assignment 1 Due Monday 12th

Quantum Country

by Andy Matuschak and Michael Nielsen

A free introduction to quantum computing and quantum mechanics

By working through these essays, you will understand in detail all the basic principles of quantum computing and quantum mechanics, plus two important applications: the quantum search algorithm and quantum teleportation.

You'll need familiarity and comfort with the basics of linear algebra and complex numbers. We'll teach you the rest.

Start reading

From *Introduction to Classical & Quantum Computing* by Thomas G Wong

Course materials

https://github.com/EquinoxAI/YAItQC/tree/main/Chapters

EquinoxAI / YAItQC Public

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tclarke21 Added assignment 1 #6 — 0b876ec 3 minutes ago — History

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Images	Added assignment 1 #6	3 minutes ago
0_Acknowledgements.ipynb	I renamed 1 folder and everyone loses their minds!	8 days ago
10_Grover.ipynb	I renamed 1 folder and everyone loses their minds!	8 days ago
11_Shor.ipynb	Added references, another image #4 #7	4 days ago
12_QML.ipynb	I renamed 1 folder and everyone loses their minds!	8 days ago
1_What_is_quantum.ipynb	Fixed *a lot* of spelling mistakes	4 hours ago
2_What_is_quantum_computing.ipynb	Added assignment 1 #6	3 minutes ago
3.1_Complex_numbers.ipynb	Fixed *a lot* of spelling mistakes	4 hours ago
3.2_Linear_algebra.ipynb	Added assignment 1 #6	3 minutes ago
4_Dirac_Notation.ipynb	Fixed *a lot* of spelling mistakes	4 hours ago

This week's content

Why do we need complex numbers?

$$i\hbar\frac{\partial}{\partial t}|\Psi\rangle = \hat{H}|\Psi\rangle$$

The Schrodinger Equation

$$\hat{p}_x = -i\hbar\frac{\partial}{\partial x}$$

Momentum in quantum mechanics

$$|\Psi\rangle = \cos(\theta/2)|0\rangle + e^{i\phi}\sin(\theta/2)|1\rangle$$

The state of a qubit (explained more next week)

How Quantum Computers Work

Quantum Algorithm: Set of instructions that describes how you change the state of the (quantum) computer

Spin many coins

Many possible coin combinations

Input 1

Input 2

Input N

Quantum Algorithm

Shuffle your coins

Output 1

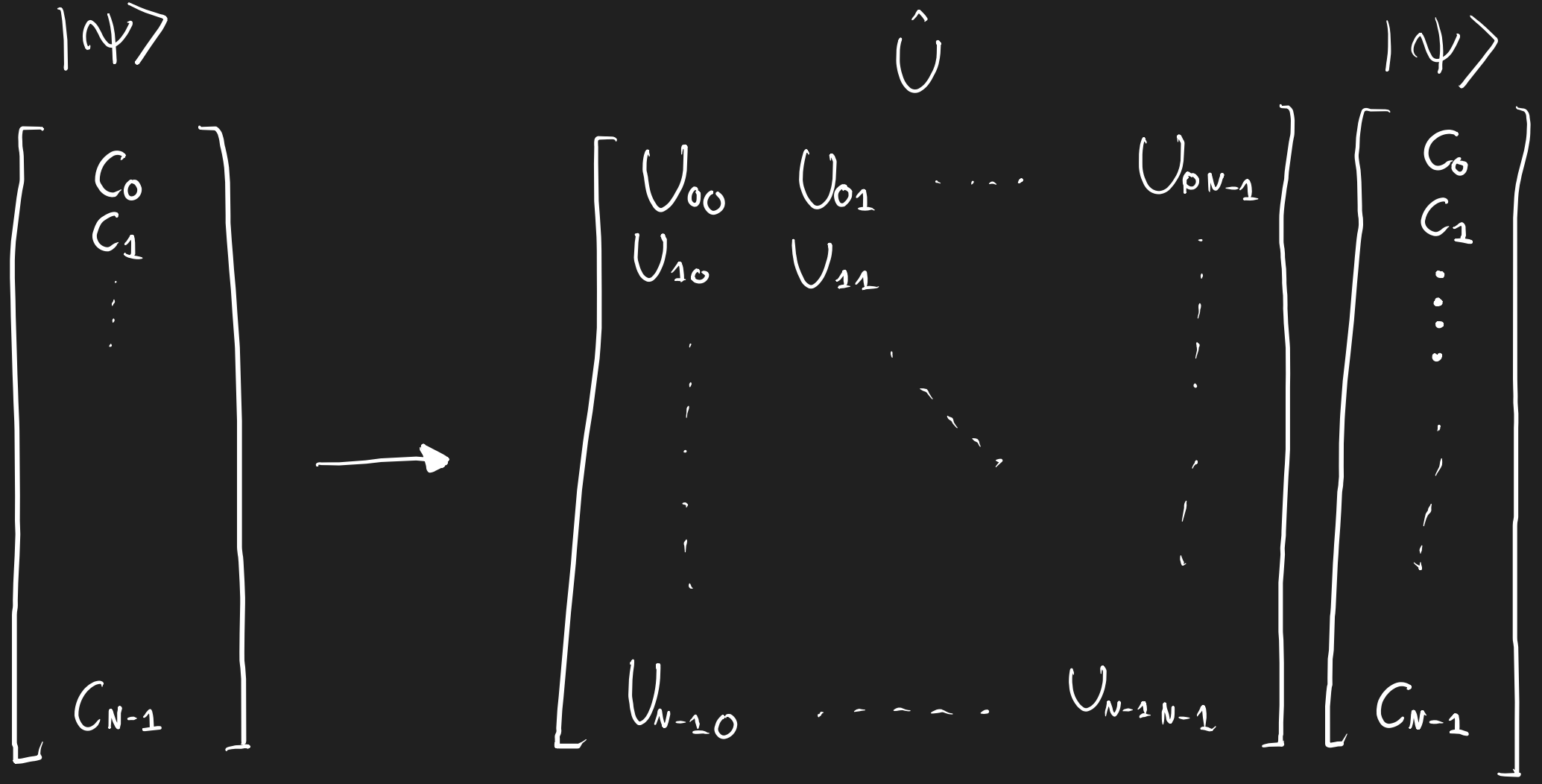
Output 2

Output N

Reveal coins facing up

Particular Output

How Quantum Computers Work



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Select the following you are familiar with

ⓘ Start presenting to display the poll results on this slide.

Summary

- Any point on the unit circle can be described by an angle
- Imaginary numbers are a multiple of $i = \sqrt{-1}$
- Complex numbers have a real and imaginary part
- - Every complex number has a complex conjugate which has the negative imaginary part
- - The magnitude of a complex number is the Euclidean norm of its real and imaginary components
- - Euler's formula allows any complex number to be written as $z = re^{i\phi}$

Summary

- Vectors are a collection of numbers stored in a row or column
- Vectors can be added to each other or multiplied by a scalar
- The inner product of two vectors tells us how aligned they are
- Perpendicular (orthogonal) vectors have an inner product of 0
- Matrices are arrays of numbers that can act on vectors
- Applying a matrix to a vector turns the vector into another vector
- Matrices can have an inverse which does the reverse of the matrix
- Unitary matrices have an inverse equal to their conjugate transpose
- Next time: Single qubits

Assignment 1

- 9 questions
- 2 optional challenge questions
- Due Monday 12th September
- Can write solutions by hand

Thomas Clarke
Quantum Computing Technical Foundations
September 2, 2022

Assignment 1: Maths for Quantum Computing

Assignment Due: Monday 12th September

Solutions can be handwritten on a separate sheet of paper, typed or done on a tablet. You may print this, write the solutions on it, and then scan and upload it.
Send the completed assignment to tclarke@asesoftware.com If you have any questions or difficulties, please do reach out to the same email.
Challenge Questions are Optional

1. Complex Numbers

Question 1. Complex number algebra

Simplify the following into the form $a + bi$

1) $(6 + 4i) + (3 + 5i)$
2) $(-6 + 4i) + (-3 + 5i)$
3) $i(2 + 3i)$
4) $(6 + 4i)(6 - 4i)$

Question 2. Complex conjugate

Find the complex conjugate for your answers to the previous question
Hint: the complex conjugate of $z = a + ib$ is $z^* = a - ib$

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Audience Q&A Session

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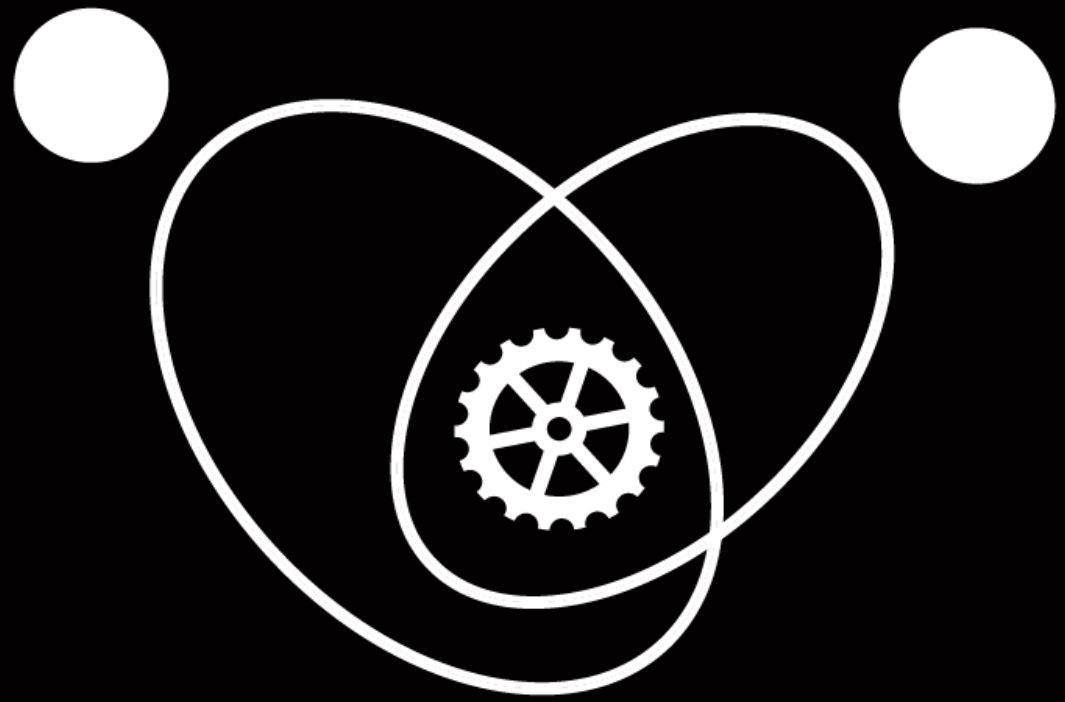

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