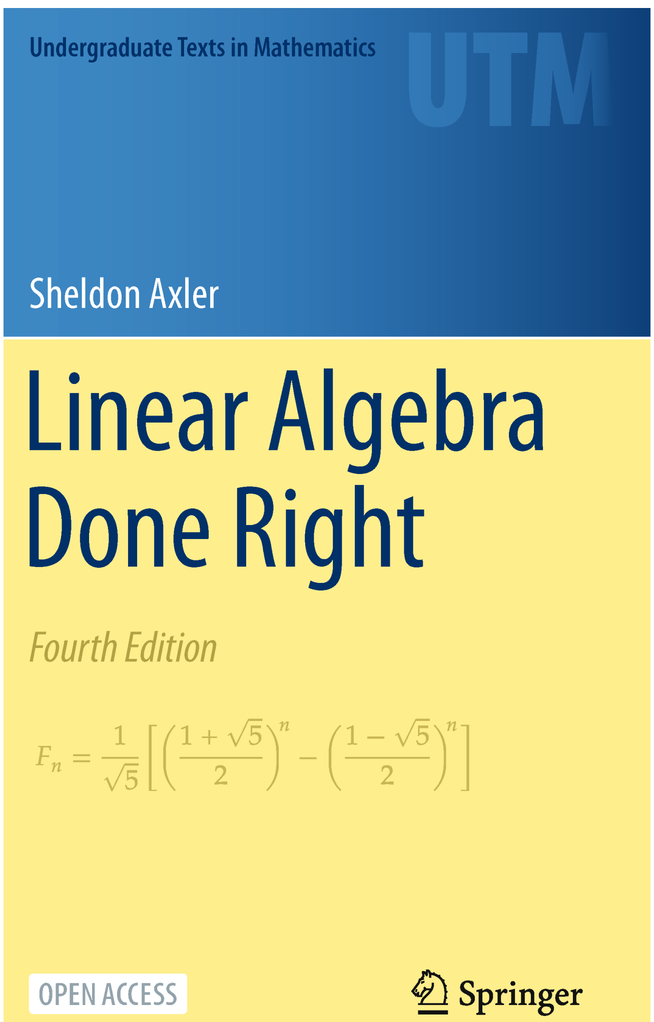
Welcome to

Math 416: Abstract Linear Algebra

Fall 2025

Instructor: Jacob Beckey

Textbook



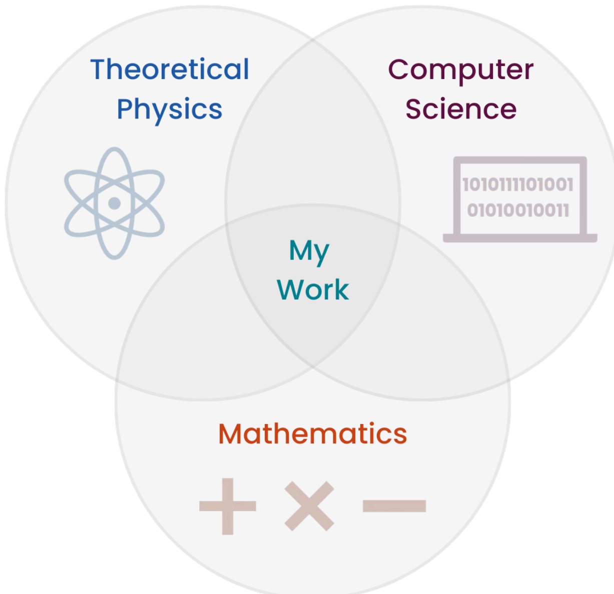
A bit about me

Name: Jacob Beckey

Role: NSF & IQUIST postdoc in the math department

Research interests:

- quantum learning theory
- entanglement theory
- representation theoretic methods in quantum info



Background:

- Ph.D. Physics from Univ. of Colorado, Boulder

my office

A bit about the course

Lets review the syllabus together.

* If you missed the first lecture, please review the syllabus on Canvas or the course website

www.jacobbeckey.com/teaching

Discussion: what is linear algebra useful for?

Form small groups, introduce yourselves, and discuss the above question.

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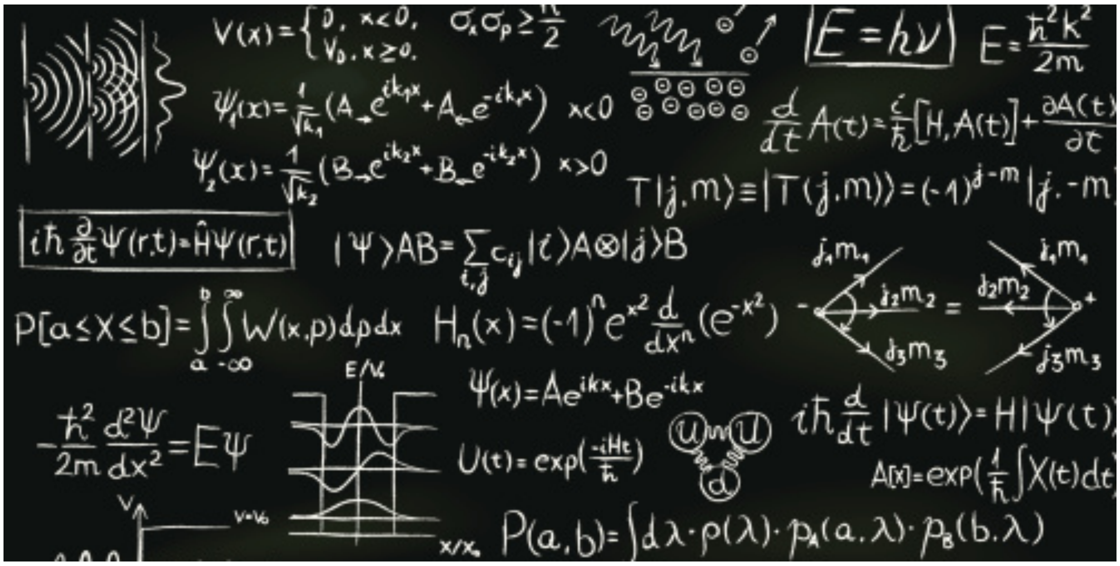
1. Quantum mechanics



Exactly 100 years ago, physicists began to uncover the rules of quantum mechanics...

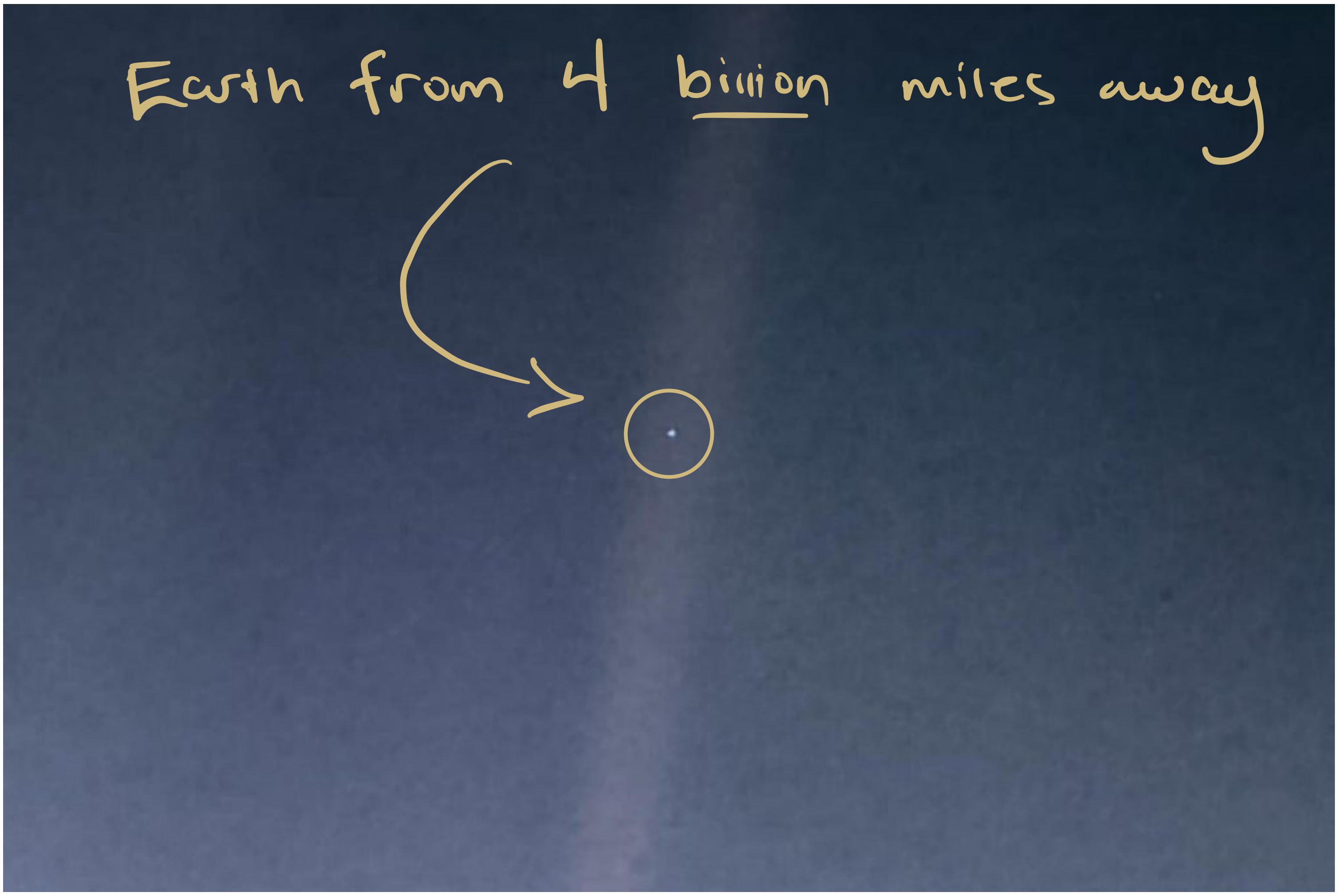
To their surprise, a natural language to describe quantum systems was the language of linear algebra!

States $\longleftrightarrow$ unit vectors

Measurements $\longleftrightarrow$ linear operators

Measurement outcomes $\longleftrightarrow$ eigenvalues

2. Error correction



- In 1990, as Voyager 1 was leaving our solar system, it snapped the famous "pale blue dot" photo
- Without error correction, this data never would have made it back to earth!

codeword ⟷ vector in codespace

error ⟷ vector

syndrome measurement ⟷ linear operator

3. Machine learning

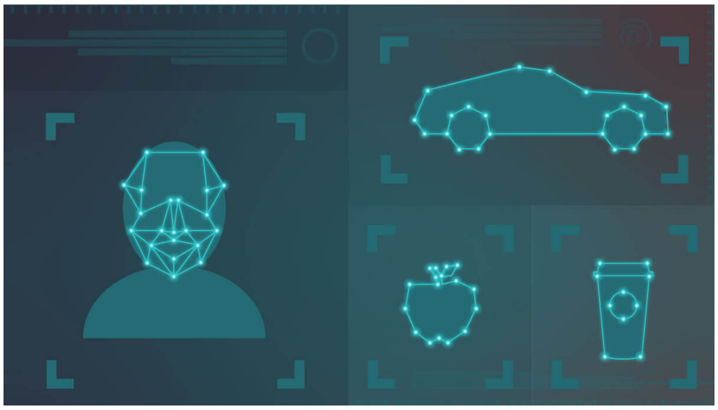
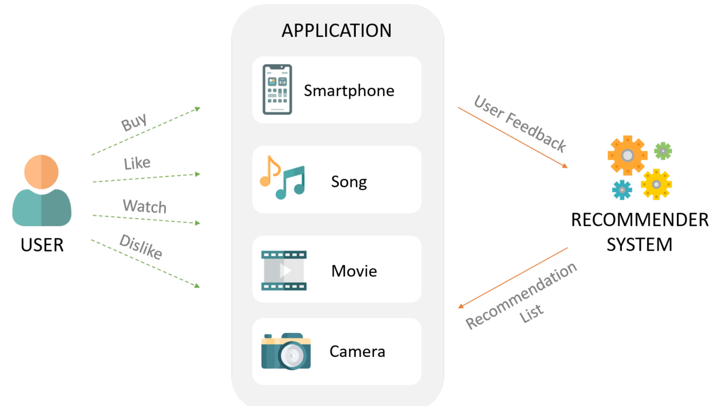


Image recognition

recommendation algorithms



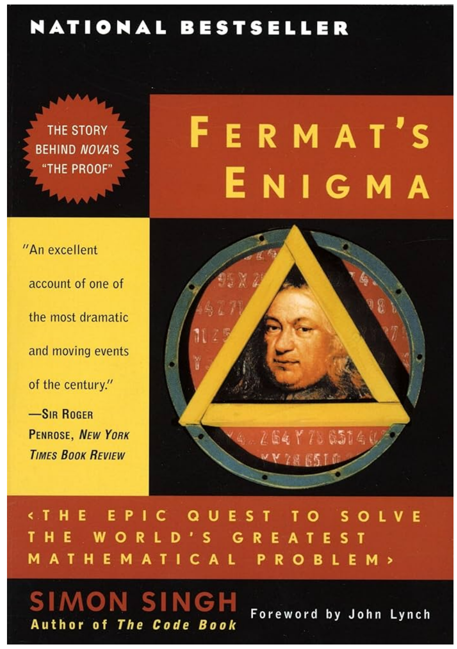
natural language processing

- All of these applications utilize vectors, matrices, and tools from linear algebra

4. Modern Mathematics

$$a^n + b^n = c^n$$

has no integer solutions when $n > 2$.



- Linear algebra is essential for representation theory, without which Andrew Wiles could not have proved Fermat's last theorem — a problem that stumped mathematicians for 350 years!

Clicker Question

Linear algebra as a field didn't appear overnight. When do think the first seeds of linear algebra were planted?

A) ~200 BCE

B) ~800 CE

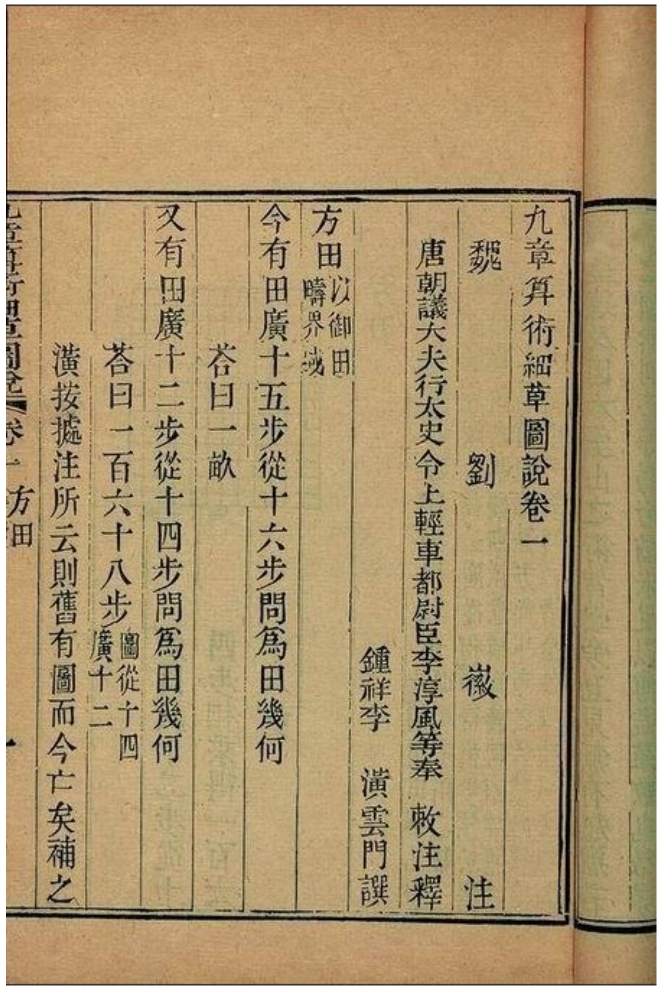
C) ~1600 CE

D) ~1900 CE

"Nine chapters on the mathematica art"

from ~200 BCE

is a book written by many Chinese scholars


九章算術細草圖說卷一
魏 劉 徽 注
唐朝議大夫行太史令上輕車都尉臣李淳風等奉 敕注釋
鍾祥李 潢雲門譔
方田以御田疇界域
今有田廣十五步從十六步問爲田幾何
荅曰一畝
又有田廣十二步從十四步問爲田幾何
荅曰一百六十八步 圖從十四廣十二
潢按據注所云則舊有圖而今亡矣補之
九章算術細草圖說 卷一 方田

- contains a method for solving linear equations that is nearly identical to Gaussian elimination (~1700s)

We will pick up here Wed.