Lecture 1. Overview

Where do we come from?

Information Theory studies the processing, storage and communication of information.

1948. Claude Shannon

"A Mathematical Theory of Communication"

What is information? How can we transmit it?

Shannon entropy

A lot of citations. importance in engineering

data compression (ZIP files)

Communication (error correction)

cryptography (encryption)

statistics (data analysis)

Joseph Doob. "It is not clear that author's mathematical intentions are honorable."

2001. Shannon Award

⋮

Active research area

Quantum Mechanic

1900 Max Planck: Black-body radiation

thermal electromagnetic wave

energy is radiated in discrete package "quanta"

Latin "How much"

Einstein, Bohr

1920s Heisenberg, Born, Jordon, Schrödinger

Matrix Mechanic:

1930s Hilbert Paul Dirac John von Neumann

Hilbert space Mathematic Foundations of Quantum Mechanics

von Neumann Entropy

⋮

Today: Quantum Physics: a major branch of Morden physics.

The world is quantum.

Wilde Book

Interaction: Information Theory & Quantum Mechanic

Quantum Information Theory

1950s - 1970s: Mathematics works on Entropies on Quantum systems

1970s: Information transmission via coherent lasers

Alexander. Holevo. (2017 Shannon award)

other important theoretical work

1980s Richard Feynman: Computing with quantum mechanical model for stimulating quantum systems.

1990s Increased activities and intereses

Peter Shor: Quantum algorithm for prime factorization

$4801 \times 35317 = 169556917$

Breaks RSA encryption

after 2000s: expontial growth research on Quantum information

Where we are at Today: Quantum information Science and engineering.

A major task: Build a quantum computer

two leading player: IBM 127 quatum bits (qubits)

Google 72 qubits

"achieved some computional task that can not be done by the best current classical computer in the life of universe" Recently channelged.

Future: Where are wegoing (Probably)?

IBM & Google expect to build "useful" quantum computer in this decade.

Where should we start?

Next time: Probability Theory

Entropy. What is "bit"? The first half of Shannon's 1948 paper.