ECE 428: Information Theory

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Lecture 1

Outline:

- Logistics/ Course Goals.
- Introduction/ overview.
- Basic information measures and properties.

Introduction

- Information theory is largely based on work on Claude Shannon.

- Originally published in 1948 under title "A Mathematical Theory of Communication"

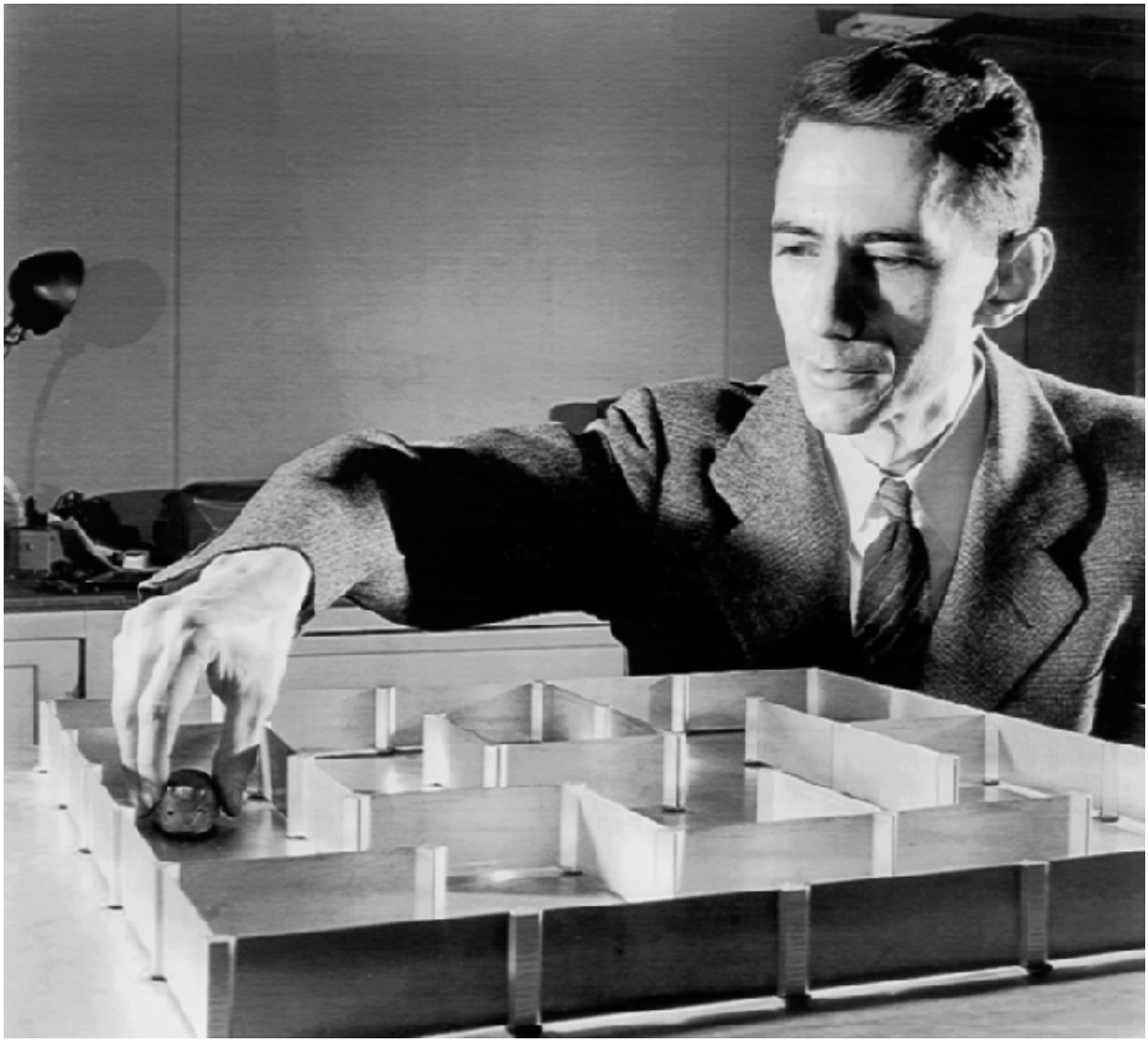
  A link to this paper is available on the course web site.

- Shannon was interested in fundamental properties of communication systems.

- Since then information theory has been used in many other areas, e.g. mathematics, computer science, physics.

  Many examples discussed in Chap. 1 of text.

- Our emphasis will be on those aspects related to communication theory and closest to Shannon's original work.



Claude Shannon

1916-2001

This picture shows Shannon with a maze solving mouse named Theseus that he built in 1950.

Claude Shannon

- M.S. in Electrical Engineering and PhD in Mathematics from MIT (1940)
- M.S Thesis "A Symbolic Analysis of Relay and Switching Circuits".
- PhD Thesis on theoretical genetics.
- Worked for Bell Labs and in 1957 became professor at MIT.
- Also did work in many other areas including artificial intelligence, cryptography, and wrote a paper on "the scientific aspects of juggling".

Links to two brief biographies of Shannon are provided on the course web page.

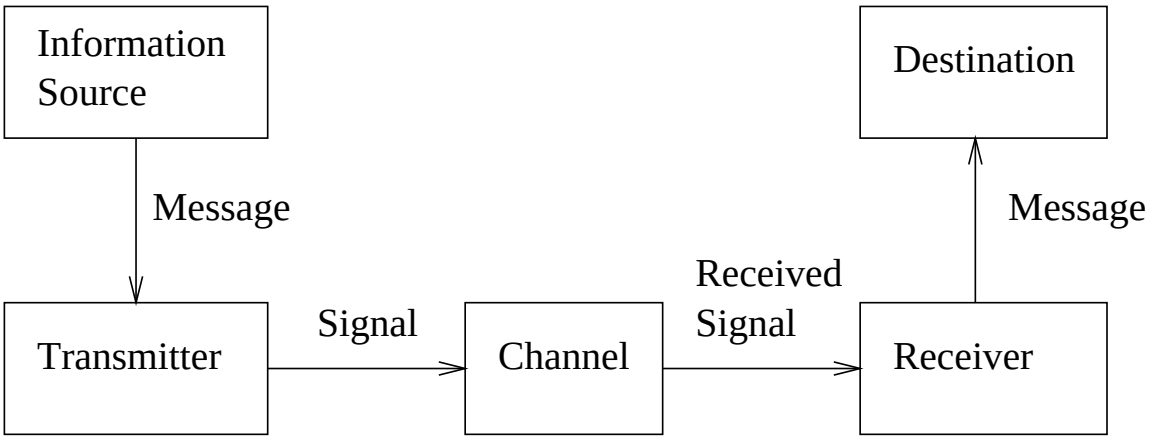
History

communication systems $\approx$ 1940's

- Mostly analog systems (TV, radio, telephone).
- Various modulation schemes had been discovered (e.g. AM, FM); trade-offs between bandwidth and fidelity were known, but not well understood.
- The use of probabilistic models for information sources was in its infancy.

Shannon's work completely revolutionized communication engineering. He realized that communication should be viewed from a digital perspective and lay the groundwork for the modern information age.

Generic Communication system



Emphasis is on design of Transmitter/Receiver.

Two Basic Questions:

- What is minimum number of bits needed to represent a source?
- What is maximum rate of communication?

Answers rely on various *information measures.*

Rest of lecture

In the remainder of this lecture and the next we will define various information measures and explore some of their mathematical properties.

These quantities include *entropy*, *relative entropy* and *mutual information*.

Initially each quantity will be defined mathematically as functions defined on probability distributions. The true "meanings" of these will become clear in the following weeks as we prove various theorems concerning each