

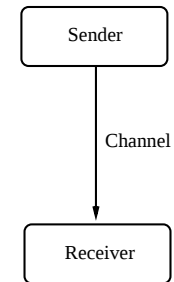
Foundations of Computer Security

Lecture 28: Information Theory

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What is Information?

The fundamental paradigm of information theory is represented here: A sender conveys information to a receiver across a communication channel.



Information is any content to be conveyed. It is sent in the form of one or more *messages*.

Information theory attempts to quantify the *content* of messages and the *capacity* of channels on which information may flow.

Lecture 28: 1 Information Theory

Some Questions

Information theory asks questions such as the following:

- 1 How much information is encoded in a particular message?
- 2 How efficiently can a given alphabet/language be transmitted?
- 3 What is the maximum capacity of a given transmission medium?
- 4 How is that capacity or efficiency reduced by interference/noise?

These questions all have very precise and deep answers, that are beyond our scope here. We'll only scratch the surface.

Lecture 28: 2 Information Theory

Why Do We Care?

Information theory is very important in computer science. It affects all communication, hardware design, protocol design, cryptography, fault-tolerance, etc.

For example, in our current context it is useful to know how much information can be transmitted over a specific covert channel. This is the “bandwidth” of the channel.

A useful way of measuring bandwidth is *bits per second*.

Lecture 28: 3 Information Theory

Lecture 28: 4 Information Theory

How do you quantify the information content of a response to a “yes” or “no” question?

What does that even mean? Maybe it means the following:

- 1 Sender has either a “yes” or a “no.”
- 2 Receiver knows that Sender has one of those two possibilities, but not which.
- 3 Sender wants to transmit enough data, but no more, to resolve entirely Receiver’s uncertainty.
- 4 How much data must Sender transmit?

In those terms the answer is pretty clear: One bit of data. *But what must be true for Receiver to interpret the answer?*

This suggests:

- 1 In some cases, *it is possible* to quantify the information content of a message.
- 2 Maybe an appropriate unit of information content is *bits*.
- 3 Sender and receiver must have some shared knowledge, included an agreed encoding scheme.

Lessons

- Information is any content that can be conveyed from a sender to a receiver across a communication channel.
- Information theory attempts to quantify the amount of information in a message and the capacity of the channel.
- Communication requires some shared knowledge.

Next lecture: Information Content