Digital communications

Information and Entropy

Course Syllabus

-Information and entropy
-Encodings
-Errors (detect, correct)
-LTI systems
-Bits to World
-World to Bits
-Combining it all

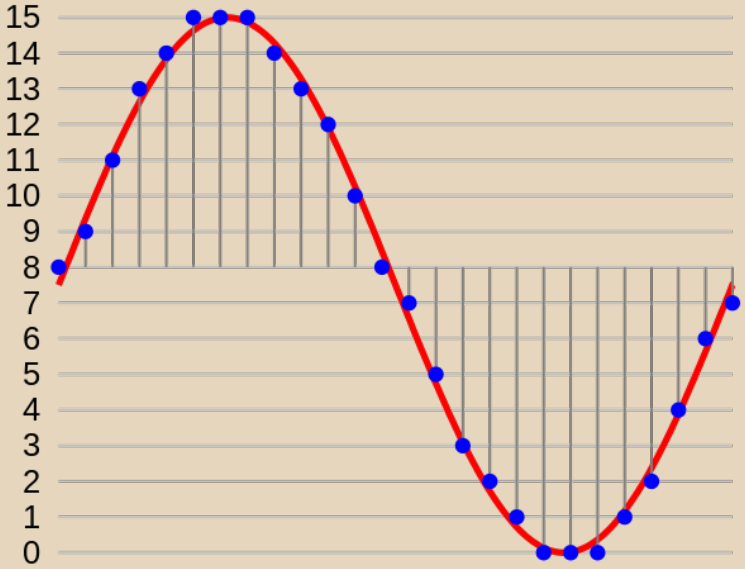
Today:
-How do we communicate?
-What is information?
-How do we measure it?
-Why does it matter?

How? - Digital vs. Analog

Discrete vs continuous (time and values)

Why?

- Dealing with noise
- Easier to do math on
- Easier to store



How? - Digital language

We speak with ‘0’ and ‘1’:

-We can represent any number (binary)

-Anything can be represented via numbers! QED

How do we know what ‘01101’ means? *Next lecture*

Information - What is it?

Which gives you the most information?

(outcome of a twenty sided-die)

- x is even?
- x is a perfect square?
- x is not 19?
- x is 16?

In a way, information $\Leftrightarrow$ surprise.

Information - Measuring it

How many bits would it take to write down?

Let’s start with probabilities:

- x is even?
- x is a perfect square?
- x is not 19?
- x is 16?

Information - Measuring it

How many bits would it take to write down?

Let's start with probabilities:

-*x* is even? 10/20

-*x* is a perfect square? 4/20

-*x* is not 19? 19/20

-*x* is 16? 1/20

Information: $I(x)=\log(1/prob(x))$

Information - Measuring it

How many bits would it take to write down?

Let's start with probabilities:

-*x* is even?	10/20 =>	1 bit
-*x* is a perfect square?	4/20 =>	2.32 bits
-*x* is not 19?	19/20 =>	0.07 bits
-*x* is 16?	1/20 =>	4.32 bits

Information: **I(x)=log(1/prob(x))**

Information - Bits

What does 2.32 bits mean?

Well, we can only transmit integer bits, so 3.

This tells us the *minimum* number of bits necessary to exchange the information.

Information - Entropy

How much information do you expect to get?

$$H=\sum p(x)I(x)$$

This is the average information we get for every message.