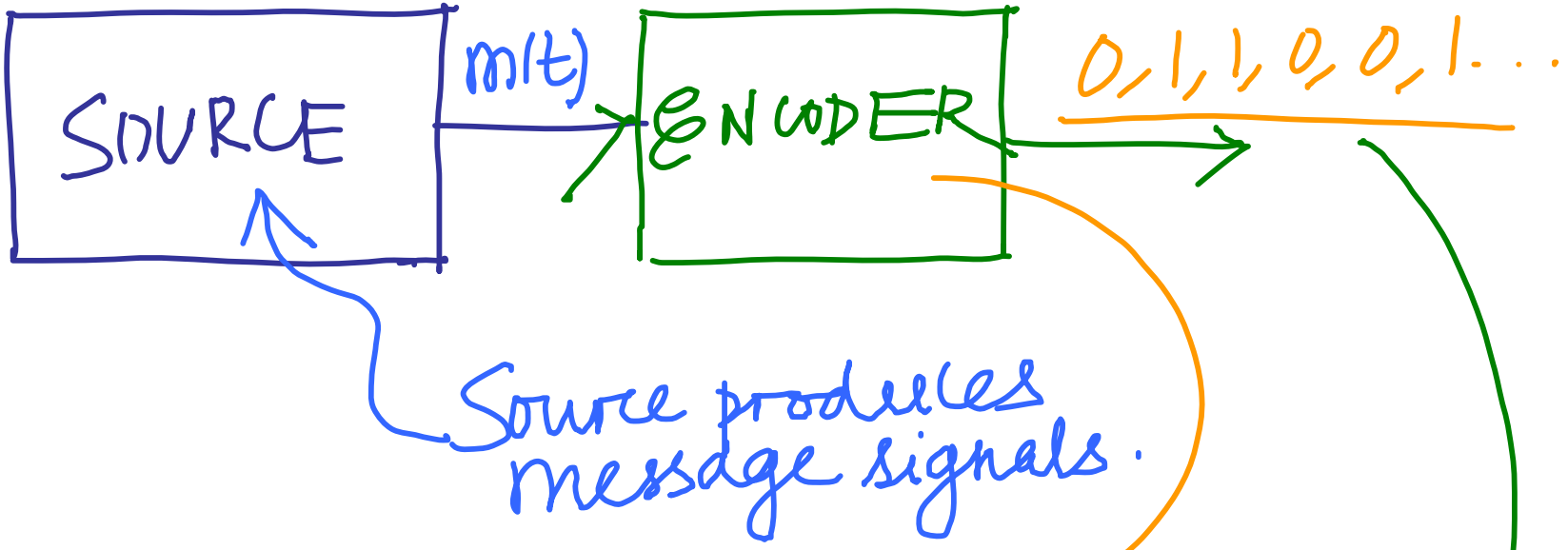
INFORMATION THEORY

Fundamental to understanding and characterizing the performance of communication systems.



Typically, we would like to convey maximum possible information using minimum resources —

such as time or Bandwidth.

We would like to encode or represent each message using the fewest possible number of bits.

Information Theory enables us to precisely do this!

i.e. represent maximum information using very few bits — maximize information per bit.

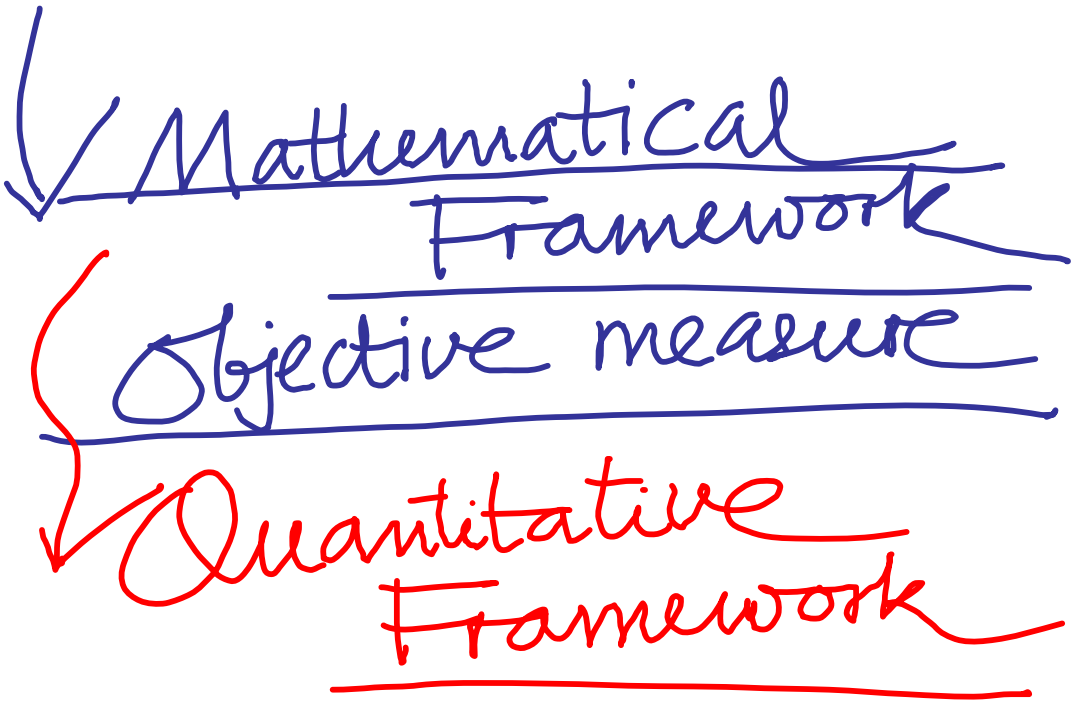
Familiar with

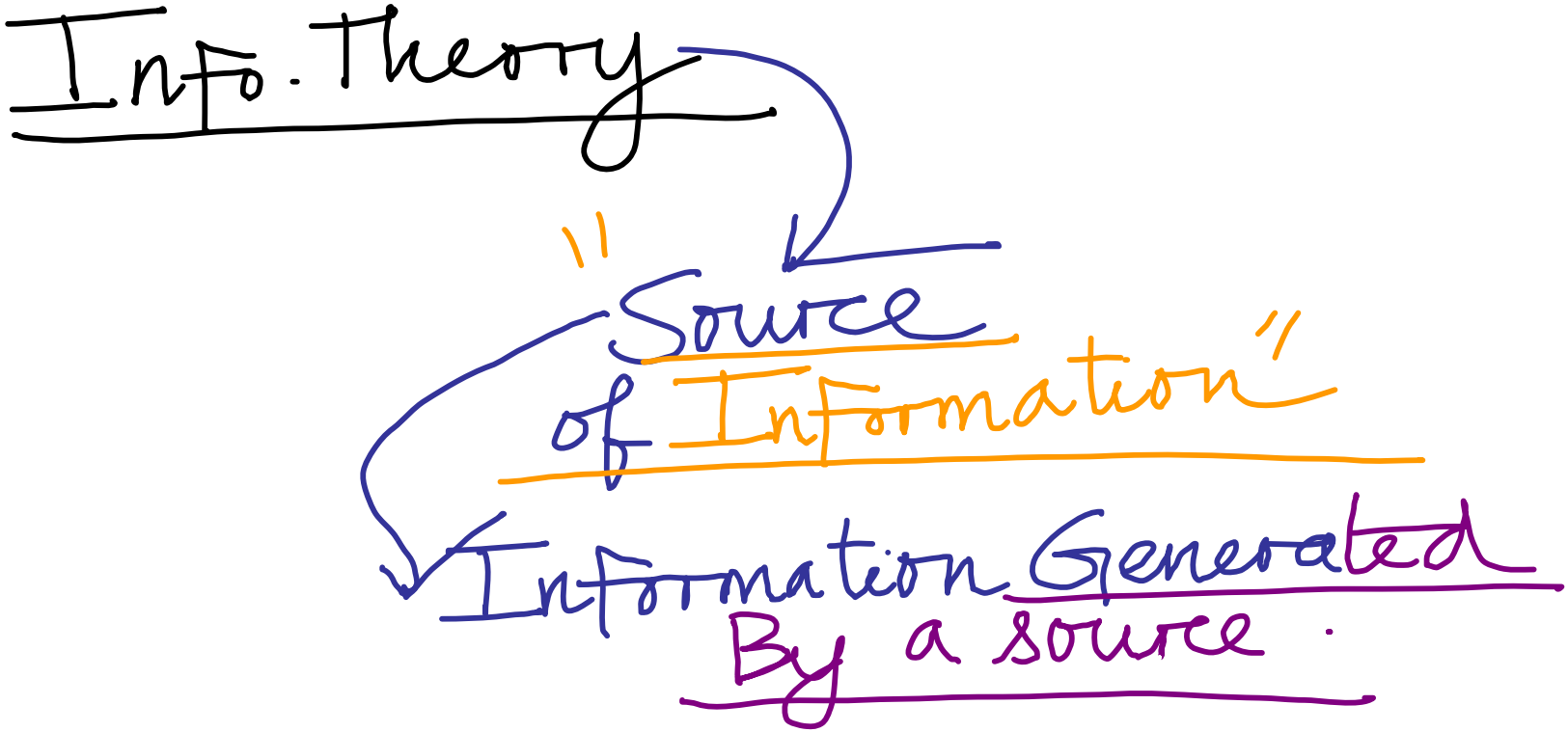
Characterize physical attributes such as Weight, Height, Volume etc.

But how does one characterize something abstract such as the information content?

Information Theory

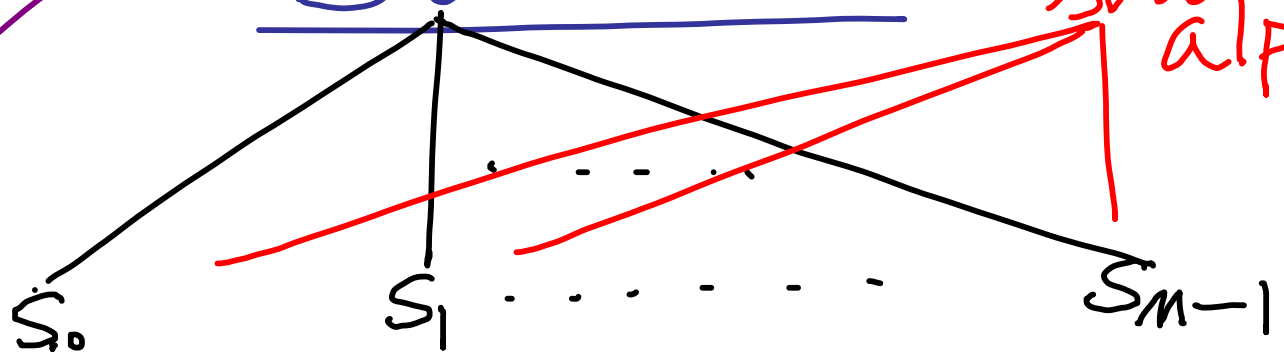
Tangible measure of Information content of a source.


Mathematical Framework
Objective measure
Quantitative Framework


Info. Theory
Source of Information"
Information Generated By a source.

Continuous Sources also Exist

DISCRETE SOURCE



symbol set

Generates a Discrete set of symbols.

$$S = \{S_0, S_1, \ldots, S_{M-1}\}$$

Source Alphabet

Symbols are generated according to a probability Distribution

$$Pr(S_0) = P_0$$
$$Pr(S_1) = P_1$$
$$\vdots$$
$$Pr(S_{M-1}) = P_{M-1}$$

Axioms of Probability

$$P_i \geq 0$$
$$\sum_{i=0}^{M-1} P_i = 1$$

Information Content:

How to characterize information content of symbol?

$$I(s_i) = \log_2 \frac{1}{P(s_i)} = \log_2 \frac{1}{P_i} \text{ bits}$$

information of symbol s_i

Definition of information content.

$I(s_i)$ —— Depends on probability of occurence of symbol.

Further $I(s_i) \propto \frac{1}{P_i}$

$\log_2 \frac{1}{P_i}$

If $P_i \to 1 \Rightarrow I(s_i) \to \log_2 1 = 0$.

If $P_i \to 0 \Rightarrow I(s_i) \to \infty$

symbols or events with

very low probability of occurrence, have higher information content.

$\propto \frac{1}{P_i}$ = Relative infrequency

Ex: Rare events $\Rightarrow$ Higher Information

News: ← News coverage Focused on rare events

$\frac{1}{P_i}$ = large

$\Rightarrow$ such events are infrequent

Sensational Events!

- Against Practice.
- Unconventional
- Unorthodox

Carry more information

Attract Attention.