How do we get meaning from information?

Readings for today

- Dretske, F. I. (1983). Précis of Knowledge and the Flow of Information. Behavioral and Brain Sciences, 6(1), 55-63

Topics

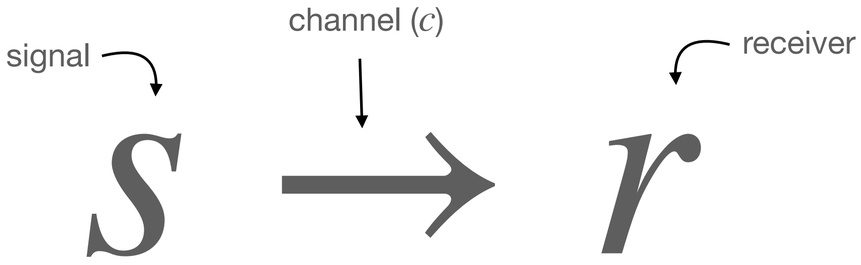
- Information
- Knowledge & Belief
- Perception

Information

Information theory

Goal: A formal theory for the transmission, processing, extraction, and utilization of information.

Approach: Quantify the *amount* of information a channel, c, can convey about a signal, s, to a receiver, r.



(Shannon & Weaver, 1949)

Amount of information in s

Question: How much information can be conveyed by the signal?

$$I(s) = \log_2(n)$$

- $I(s)$: information for signal s
- $\log_2$: base logic
- n: number of possible states s can take

Example:

$$n = 6$$

$$[0\ 0\ 1\ 0\ 0\ 0]$$

1 2 3 4 5 6

$$I(s) = \log_2(6) = 2.6 \text{ bits}$$

(Shannon & Weaver, 1949)

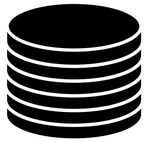
Amount of information in s

Question: What is the *average* amount of information conveyed by s?

$$I(s) = \sum p(s_i) \log_2 p(s_i)$$

- $I(s)$: information for signal s
- $p(s_i)$: probability that i^{th} state is observed
- $\log_2 p(s_i)$: information available from i^{th} state

Example:



$$I(s) = .5(1) + .5(1) = 1 \text{ bit}$$

(Shannon & Weaver, 1949)

Amount of information received by r

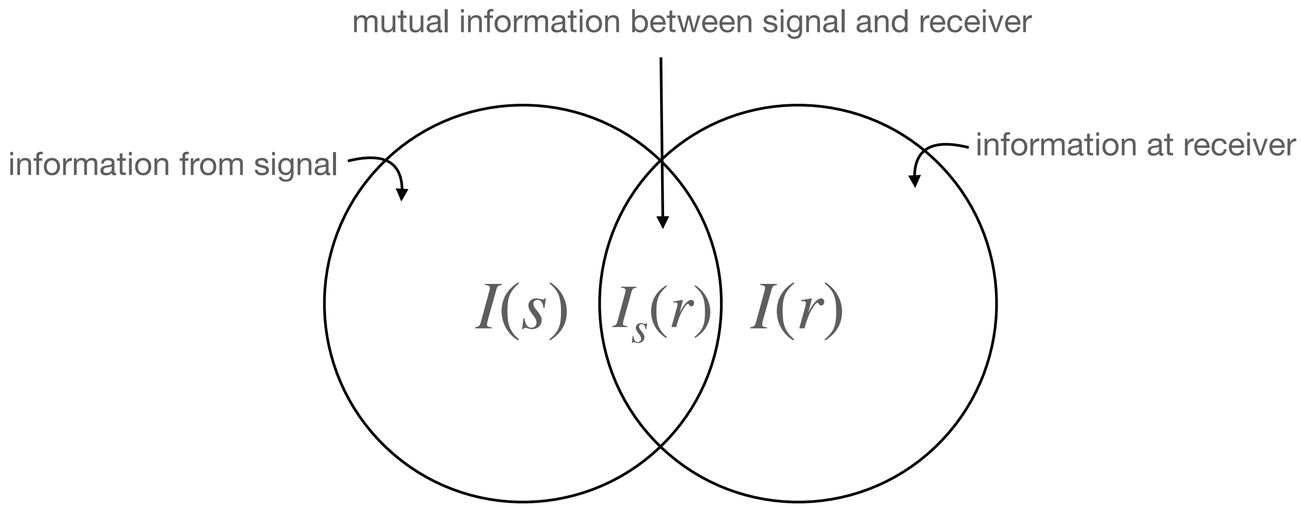
Question: What is the *average* amount of information received by r?

$$I(r) = \sum p(r_i) \log_2 p(r_i)$$

- $I(r)$: information for receiver r
- $p(r_i)$: probability that i^{th} state is observed
- $\log_2 p(r_i)$: information available from i^{th} state

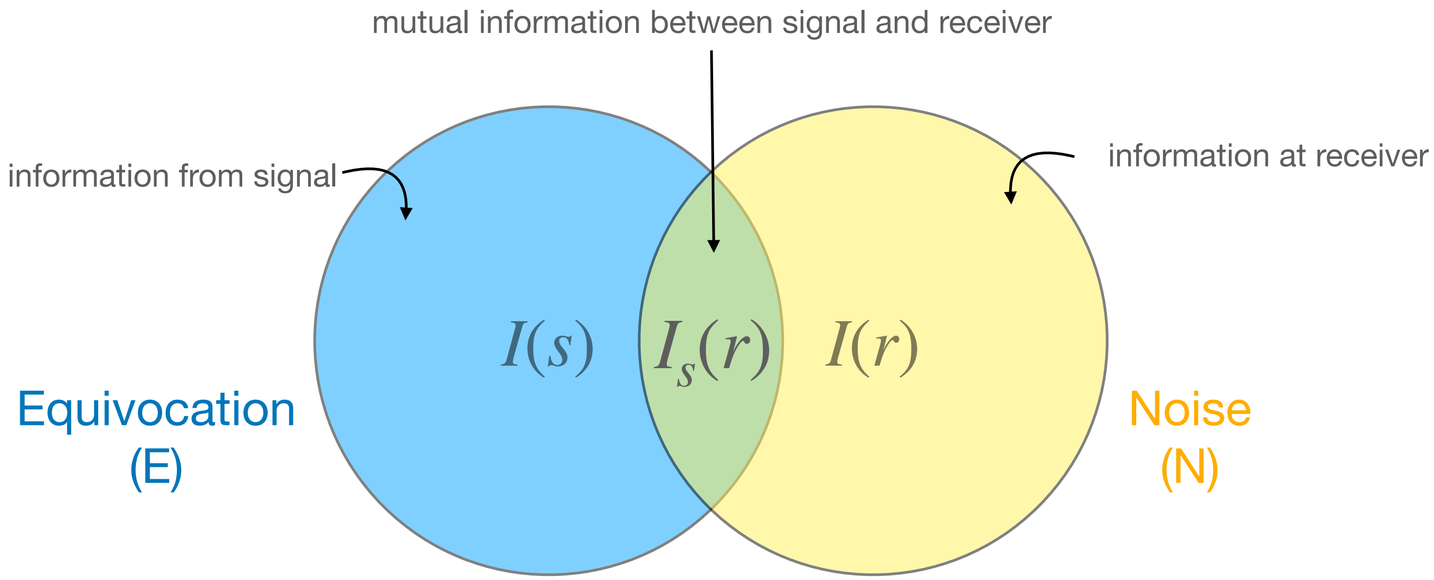
Note: Transmission can change information

$$I(s) \neq I(r)$$



(Shannon & Weaver, 1949)

$I_s(r)$: mutual information



$I_s(r)$: The information transmitted from s to r is the total amount of information available at r, $I(r)$, minus noise.

$$I_s(r) = I(r) - \text{noise}$$

$$I_s(r) = I(s) - \text{equivocation}$$

(Dretske 1981, 1983)

Information theory of meaning

Question: When does signal, s, indicated a specific state of the world, F?

Example:

$$[0\ 0\ 1\ 0\ 0\ 0] \rightarrow s_3 = \text{"3"}$$

1 2 3 4 5 6

The specific state of s has a meaning of “3”

Answer: A signal r (at the receiver) carries the information that s is F if the conditional probability of s’s being F, given r (and k), is 1 (but, given k alone, is less than 1)

prior knowledge

(Dretske 1981, 1983)

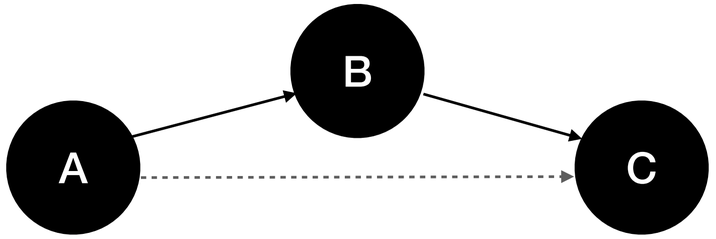
Information theory of meaning

A signal r (at the receiver) carries the information that s is F if the conditional probability of s's being F, given r (and k), is 1 (but, given k alone, is less than 1)

Question: Why require $p(s \text{ is } F \mid r) = 1$?

Answer:

- If $p(s \text{ is } F \mid r) < 1$, then there is a non-zero probability that s is G
- Xerox principle: "If C carries the information that B, and B's occurrence carries information that A, then C carries information that A."



information flow

- A threshold on setting the probability limit for certainty would be arbitrary and lead to ambiguity in meaning.

(Dretske 1981, 1983)

Information theory of meaning

A signal r (at the receiver) carries the information that s is F if the conditional probability of s's being F, given r (and k), is 1 (but, given k alone, is less than 1)

Question: What about mis/disinformation?

Answer: False information are not varieties of information any more than a decoy of a duck is a duck.

Question: What is the value of k?

Answer: Information only has meaning relative to what is already known.

Question: What about the intentional properties of s?

Answer:

- "The informational content of a signal or structure depends, not only on the reference (extension) of the terms used in its sentential expression, but on their meaning (intension)."
- "[O]ne can now that s is F, without knowing that s is G, despite the fact that all Fs are G, because knowledge requires information, and one can get the information that s is F, without getting the information that it is G."

(Dretske 1981, 1983)

Knowledge & Belief

Information view of knowledge & belief

Question: What is knowledge (k)?

Answer: An information-caused (or causally sustained) belief (b).

Question: What is a belief (b)?

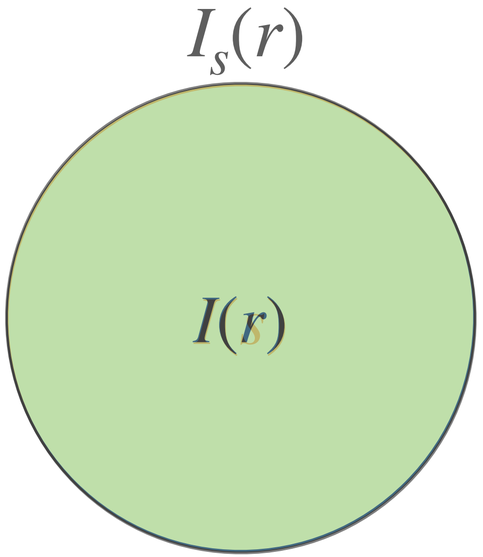
Answer:
- Internal state with content expressible as "s is F".
- A hypothesis about the state of the world conveyed in s.

New Answer: The belief that s is F is caused by the information that s is F (i.e., it is knowledge) if and only if the physical characteristics of s are causally driving the production o the belief that s is F.

Example: 3 quick knocks, pause, then 2 quick knocks as a prearranged signal indicating *who* is at the door (e.g., your friend Sam).

(Dretske 1981, 1983)

Knowledge and the flow of information



$I_s(r) = I(s) - \text{equivocation} = I(s) - 0 = I(s)$

$$s \xrightarrow{I_s(r)} k \longrightarrow a$$

action

(Dretske 1981, 1983)

The Lottery Paradox

Context:

- 1 in 1 million chance of winning the lottery.
- Before the drawing, one *should* know that 999,999 people will lose.
- One is justified in *believing* that if you buy a ticket you will lose.

Problem: A person *cannot* truly know that they will lose because $p(lose \mid ticket) < 1$.

Solution:

- Channel conditions = the framework of fixed, stable, enduring conditions within which one recons the flow of information.
- Equivocation remains small enough to be *effectively* zero.

(Dretske 1981, 1983)

Perception

Extensional vs. intensional definitions

Extensional: A concrete noun phrase that occurs as the object of a verb.

→ seeing a duck

The experience of perception

Intensional: A factive nominal as a compliment of a verb.

→ recognizing a duck

What we mostly think perception is

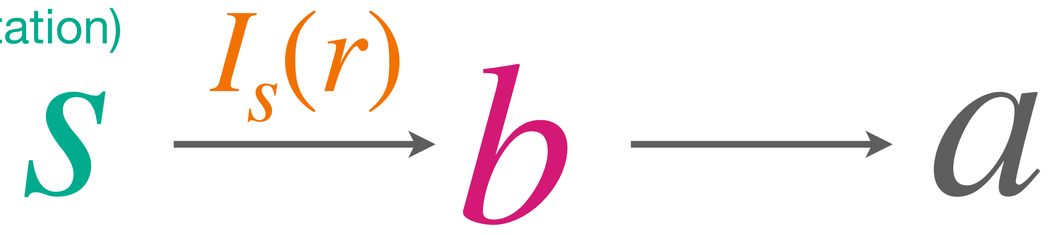
"You can see a duck, get information *about* a duck, without getting, let alone cognitively processing, the information that it is a duck."
-Dretske

(Dretske 1981, 1983)

From senses, to perception, to belief

Perception happens here

Senses encoded in *analogue* form (e.g., size, color, orientation)



Beliefs encoded in *digital* form (e.g., symbol, stripped of sensory representations)

(Dretske 1981, 1983)

Take home message

- Information theory gives us a useful foundation for understanding knowledge and meaning.
- The meaning of a signal is inferred by its specific state.
- Knowledge occurs when a belief that a state of the world *caused* the signal that carries its information.

Debate time!

Dretske: A signal r (at the receiver) carries the information that s is F if the conditional probability of s's being F, given r (and k), is 1 (but, given k alone, is less than 1)

Prompt: Does Dretske's definition provide a satisfactory answer to how knowledge arises from information?

Group A: Defend Dretske's position

Group B: Counter Dretske's position

Timeline: