Tutorial : Quantifying Information

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Quantifying Information

1/1 point (ungraded)

I make up a random 4-bit two's complement number by flipping a fair coin to determine each bit. You're trying to guess the number. If I tell you that the number is positive (> 0), how many bits of information have I given you? Provide the answer in the form log2(X/Y).

Information in my message: log2(16/7) ✔ bits

$\log_2\left(\frac{16}{7}\right)$

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✔ Correct (1/1 point)

Quantifying Information

1/1 point (ungraded)

X is an unknown 8-bit binary number. You are given another 8-bit binary number, Y, and told that the Hamming distance between X and Y is 7. How many bits of information about X have you been given?

- (●) 5.00 bits
- ( ) $log_2\,(8/256)$ bits
- ( ) 1 bit
- ( ) 7 bits
- ( ) None of the above

✔

Explanation

There are 8 numbers with Hamming distance of 7 from Y. Information is given by: $log_2\left(\frac{1}{P(E)}\right)$ where P(E) is the probability of the event. There are 2^8 total 8-bit numbers so $P\,(E) = \frac{8}{256}$ and therefore info = $log_2\left(\frac{256}{8}\right)$ = 5.00 bits.

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Answers are displayed within the problem

Quantifying Information and Error Correction

2/3 points (ungraded)

We wish to transmit messages comprised of the four letters shown below with their associated probabilities and 5-bit fixed length encoding.

symbol	p $(sy$	encoding

Calculator

symbol	(p(symbol)	encoding
A	0.25	00000
B	0.5	11100
C	0.125	11011
D	0.125	10111

An unknown letter is received and you are told it's not D. How much information have you received?

- $log_2\,(1 - 0.125)$ bits
- $log_2\,(0.125)$ bits
- $-log_2\,(1 - 0.125)$ bits ✔
- (selected) $-log_2\,(0.125)$ bits
- None of the above

✖

Explanation
The information received is given by the log base 2 of 1 over the probability of the message: $log_2\,(\frac{1}{P_{message}})$. The probability of the message in this case is 1 - p(D) = 1 - 0.125. So the answer is $log_2\,(\frac{1}{1-0.125}) = -log_2\,(1 - 0.125)$.

When transmitting a message comprised of these four symbols with the probabilities as given above, the expected amount of information received when learning of a symbol is

- (selected) 1.75 bits
- 1.25 bits
- 2 bits
- 1.5 bits
- None of the above

✔

Explanation
The expected amount of information received is given by the probability-weighted sum of the information received from learning each symbol: $\sum p_i * log_2\,(\frac{1}{p_i})$. The expected information in this case is then $0.25 * log_2\,(4.0) + 0.5 * log_2\,(2.0) + 0.125 * log_2\,(8.0) + 0.125 * log_2\,(8.0) = 1.75$ bits.

If we transmit messages using the 5-bit fixed-length encoding shown above, will it be possible to perform single-bit error detection and correction at the receiver?

- (selected) no
- yes
- not enough information to tell

✔

Calculator

Explanation
Comparing each of the encodings to all others, we find that the minimum number of bits that change from one encoding to another is 2 bits. This means that the Hamming distance for this encoding is 2. In order to detect a single-bit (E = 1) error, one needs a Hamming distance greater than or equal to E + 1 = 2. To correct a single-bit (E = 1) error, one needs a Hamming distance greater than or equal to 2E + 1 = 3, so single-bit errors can be detected but not corrected using this encoding.

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Answers are displayed within the problem

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- Grammatical error — It should say "comprising" or "composed of" not "comprised of". This is a common grammatical mistake — 1
- isn't the Hamming distance in the last question is 3 ? — How is it that the Hamming distance is just 2 ? — 5
- confusion in entropy and expected value of information — Is the expected amount of information received and entropy are same things?? — 2
- 2's complement of8 in 4bit — 2's complement of (1000) is same as (1000). how 8 would be distinguished from -8? — 2
- What is the different between Entropy and the expected length of a encoding? — I am confused on the difference of the entropy and the expected length of a encoding which is calculated by sum of the products o... — 3
- 2nd Q : hamming distance of 7 — In this question : X is an unknown 8-bit binary number. You are given another 8-bit binary number, Y, and told that the Hamming dis... — 2
- How is the second last question solved? — The expected amount of an information when learning of a symbol. How is it calculated? — 4
- Hamming Distance and Information — I still don't understand how to solve this question: X is an unknown 6-bit binary number. You are given another 6-bit binary number, ... — 7

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