Order These in Terms of Entropy
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Mutual Information and Entropy

Theorem: Relationship between mutual information and entropy.

\[ I(X;Y) = H(X) - H(X|Y) \]
\[ I(X;Y) = H(Y) - H(Y|X) \]
\[ I(X;Y) = H(X) + H(Y) - H(X,Y) \]
\[ I(X;Y) = I(Y;X) \text{ (symmetry)} \]
\[ I(X;X) = H(X) \text{ (“self-information”)} \]
Chain Rule for Entropy

Theorem: (Chain rule for entropy): \((X_1, X_2, \ldots, X_n) \sim p(x_1, x_2, \ldots, x_n)\)

\[
H(X_1, X_2, \ldots, X_n) = \sum_{i=1}^{n} H(X_i | X_{i-1}, \ldots, X_1)
\]
Chain Rule for Mutual Information

**Theorem:** (Chain rule for mutual information)

\[ I(X_1, X_2, \ldots, X_n; Y) = \sum_{i=1}^{n} I(X_i; Y | X_{i-1}, X_{i-2}, \ldots, X_1) \]
What are the Grey Regions?

\[ H(X), H(Y), H(Z) \]