

1. The mutual information between X and Y is defined as

$$\begin{aligned} I(X; Y) &= E \log \frac{f(Y|X)}{f(Y)} \\ &= \int_{\mathcal{S}_X} \int_{\mathcal{S}_Y(x)} f(y|x) \log \frac{f(y|x)}{f(y)} dy dF(x). \end{aligned}$$

2. When both X and Y are continuous and $f(x, y)$ exists,

$$I(X; Y) = E \log \frac{f(Y|X)}{f(Y)} = E \log \frac{f(X, Y)}{f(X)f(Y)}.$$