Definition 2.17 For random variables X and Y, the mutual information between X and Y is defined as

$$I(X;Y) = \sum_{x,y} p(x,y) \log \frac{p(x,y)}{p(x)p(y)} = E \log \frac{p(X,Y)}{p(X)p(Y)}.$$

Remark $I(X;Y)$ is symmetrical in X and Y.

Remark Alternatively, we can write

$$I(X;Y) = \sum_{x,y} p(x,y) \log \frac{p(x,y)}{p(x)p(y)} = \sum_{x,y} p(x,y) \log \frac{p(x|y)}{p(x)} = E \log \frac{p(X|Y)}{p(X)}.$$

However, it is not apparent from this form that $I(X;Y)$ is symmetrical in X and Y.