Exercise: A measure of correlation (normalized mutual information)

(Source: (**?**, Q2.20).)

Let X and Y be discrete random variables which are identically distributed (so $H(X) = H(Y)$) but not necessarily independent. Define

$$r = 1 - \frac{H(Y|X)}{H(X)} \tag{1}$$

1. Show $r = \frac{I(X,Y)}{H(X)}$
2. Show $0 \leq r \leq 1$
3. When is $r = 0$?
4. When is $r = 1$?