



Selected Questions

<http://www.isi.ee.ethz.ch/teaching/courses/it1.html>

Problem 1

Label all of the following statements with \leq or \geq such that the resulting inequality is valid. When does equality hold in each inequality?

$$H(X, Y|Z) \quad ? \quad H(X|Z) \quad (1)$$

$$I(X, Y; Z) \quad ? \quad I(X; Z) \quad (2)$$

$$H(X, Y, Z) - H(X, Y) \quad ? \quad H(X, Z) - H(X) \quad (3)$$

Problem 2

Consider a commander of an army besieged at a fort for whom the only means of communication to his allies is a set of carrier pigeons. Assume that each carrier pigeon can carry one letter (8 bits), and assume that a pigeon is released once every 5 minutes, and that it takes exactly 3 minutes to reach its destination.

- Assuming all the pigeons reach safely, what is the capacity of this link in bits/hour?
- Now assume that the enemies try to shoot down the pigeons, and that they manage to hit a fraction α of them. Since the pigeons are sent at a constant rate, the receiver knows when the pigeons are missing. What is the capacity of this link?
- Now assume that the enemy is even more cunning, and every time they shoot down a pigeon, they send out a dummy pigeon carrying a random letter (chosen uniformly from all 8-bit letters). What is the capacity of this link in bits/hour?

Set up an appropriate model for the channel in each of the above cases, and indicate how to go about finding the capacity.

Problem 3

Suppose that $\mathcal{X} = \hat{\mathcal{X}} = \{1, 2, 3, 4\}$. Consider an IID source emitting symbols uniformly over \mathcal{X} . The distortion measure $d(x, \hat{x})$ is given by

$d(x, \hat{x})$	$\hat{x} = 1$	$\hat{x} = 2$	$\hat{x} = 3$	$\hat{x} = 4$
$x = 1$	0	0	1	1
$x = 2$	0	0	1	1
$x = 3$	1	1	0	0
$x = 4$	1	1	0	0

Find $R(D)$.