



Exercise 9 of April 27, 2017

<http://www.isi.ee.ethz.ch/teaching/courses/it2.html>

Problem 1

Feedback Capacity of a Channel with Causal State Information at the Transmitter

Show that for a discrete memoryless channel whose state is causally known to the transmitter but not to the receiver, noiseless feedback from the channel output to the transmitter does not increase the channel capacity.

Hint: In this case, the encoder can be described as $X_k = f_k(M, S_1^k, Y_1^{k-1})$.

Problem 2

A DMC Where the Transmitter Knows Only the Previous States

Consider a discrete memoryless channel whose previous states but not the present state are known to the transmitter (none of the states are known to the receiver). The information known to the transmitter at time k is thus the message M and the states S_1^{k-1} . What is the capacity of this channel?

Problem 3

A BSC With a State

Consider the DMC defined by the input-output relation

$$Y = x \oplus Z \oplus S,$$

where x is the binary input, Z is Bernoulli- ϵ distributed noise, and S is a Bernoulli- δ distributed state independent of Z . Compute the capacity of this channel when the state S is known causally at the transmitter. Does the capacity increase when the state is also revealed to the receiver?

Problem 4

Causal State Information Does Not Always Help

Consider a binary-input binary-output DMC with states “stuck” and “good”. When the channel is “stuck”, then the output is always 0, and when the channel is “good”, then the output is equal to the input of the channel. Assuming that the states are IID with $\Pr[\text{“stuck”}] = \rho$, find the capacity of this channel when the states are not known at the transmitter and the receiver. Show that causal knowledge of the states at the transmitter does not increase the capacity of the channel.

Problem 5

Receiver State Information Can Help

Find a DMC governed by an IID state that is known causally at the transmitter for which the capacity is increased by revealing the state also to the receiver.