Information Theory **DCC/ICEx/UFMG**
Prof. Mário S. Alvim **2024/1**

PROBLEM SET

Communication over a Noisy Channel

(MacKay - Chapter 9)

Necessary reading for this assignment:

- *Information Theory, Inference, and Learning Algorithms* (MacKay):
  - Chapter 9.1: *The big picture*
  - Chapter 9.2: *Review of probability and information*
  - Chapter 9.3: *Noisy channels*
  - Chapter 9.4: *Inferring the input given the output*
  - Chapter 9.5: *Information conveyed by a channel*
  - Chapter 9.6: *The noisy-channel coding theorem*
  - Chapter 9.7: *Intuitive preview of proof*

Note: The exercises are labeled according to their level of difficulty: `[Easy]`, `[Medium]` or `[Hard]`. This labeling, however, is subjective: different people may disagree on the perceived level of difficulty of any given exercise. Don't be discouraged when facing a hard exercise, you may find a solution that is simpler than the one the instructor had in mind!

Review questions.

1. Answer formally the following questions:
   (a) Define what is a discrete memoryless channel.
   (b) Describe the problem of reliable communication over a noisy channel.
   (c) Define the information conveyed by a channel in terms of mutual information. Explain what each term in the formula means.
   (d) What is the mathematical definition of the capacity of a channel? What is the operational definition of the capacity of a channel? What is the relation between both of them?

Exercises.

2. (MacKay 9.2) `[Easy]`
3. (MacKay 9.4) `[Easy]`
4. (MacKay 9.7) `[Easy]`
5. (MacKay 9.8) `[Easy]`
6. (MacKay 9.12) `[Medium]`
7. (MacKay 9.13) `[Medium]`