Information Theory	DCC/ICEx/UFMG
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HOMEWORK
Symbol Codes
(MacKay - Chapter 5)

Necessary reading for this assignment:

- *Information Theory, Inference, and Learning Algorithms* (MacKay):

  - Chapter 5.1: *Symbol codes*
  - Chapter 5.2: *What limit is imposed by unique decodeability?*
  - Chapter 5.3: *What's the most compression we can hope for?*
  - Chapter 5.4: *How much can we compress?*
  - Chapter 5.5: *Optimal source coding with symbol codes: Huffman coding*
  - Chapter 5.6: *Disadvantages of the Huffman code*
  - Chapter 5.7: *Summary*

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) What is a symbol code for an ensemble? What is an extended code for an ensemble?

   (b) When is a symbol code uniquely decodable? When is a symbol code prefix-free?

   (c) State Kraft's inequality and explain in what sense it is related to the notion of which prefix-free codes are actually possible.

   (d) Explain what the Source coding theorem for symbol codes means in terms of the limits of compression of an ensemble.

Exercises.

2. (MacKay 5.19) `[Easy]`

3. (MacKay 5.20) `[Easy]`

4. (MacKay 5.21) `[Medium]` You only need to do:

   (a) X^2 and X^3 when $\mathcal{P}_X = \{0.9, 0.1\}$; and

   (b) X^2 when $\mathcal{P}_X = \{0.6, 0.4\}$.

5. (MacKay 5.22) `[Medium]`

6. (MacKay 5.24) `[Easy]`