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Homework Assignment #4

1. Define the following:
   1. Shannon’s measure of information:
   2. Joint entropy

This is the measure of how much uncertainty you can reduce if the two random variables x and y are given together.

* 1. Mutual information: The reduction in uncertainty due to another random variable, also I(X;Y) is a measure of correlation between the two random
  2. Marginal information: The information entropy of a single random variable
  3. Conditional entropy: Measures the uncertainty is reduced for a random when the value of another random variable is known.
  4. Algorithmic entropy: also known as Kolmogorov, indicates the shortest code that produces the desired output
  5. Johnson noise: Johnson Noise is created when the electrons within a conductor are thermally agitated, regardless of any applied voltage
  6. A Brownian ratchet is a ratchet connect to a set of vanes, the vanes will rotate as random collisions of air particles collide with it therefore rotating the ratchet, which can only turn in one direction. Over time the ratchet will do work, however this will not work in a single temperature environment.
  7. Differential entropy: when f(x) is the probability density function of X and s is the supporting se.
  8. Probability density function is a function f(x) for random variable x such that
  9. Uncertainty principle: You cannot determine the position and momentum of a molecule at the same time, with the same accuracy because molecules/particles can also behave like a wave
  10. Shannon’s coding theorem:

This is the 2nd law of thermodynamics applied to bits.

* 1. Microstate and Macrostate: Macrostates refer to the Configuration of the numbers of particle 1 and particle 2. Each macrostate is made up of a multiplicity of microstates which is the number of positions the macrostate’s particles can be in. The probability for each microstates are the same, however the probability is different for each macrostate.

1. Consider the probability that parrots are grey is 0.3, and the probability that they are male or female is equal. However, male parrots are 1.5 times more likely than female parrots to be grey

|  |  |  |  |
| --- | --- | --- | --- |
|  | Male | Female | Sum |
| Grey | 0.18 | 0.12 | 0.3 |
| Colorful | 0.32 | 0.38 | 0.7 |
| Sum | 0.5 | 0.5 |  |

X is the probability of a female parrot being grey: 0.3 = x +1.5x =2.5x therefore x =0.12

* 1. You learn that non-grey parrots are male, how much information do you gain from this knowledge?

Shannon’s Measure of Information

bits

* 1. Rank the Uncertainties in descending order

The proper ranking is ii, iv,iii,i

* + 1. Uncertainty about color
    2. Uncertainty about gender
    3. Uncertainty abut color, provided that a parrot is male

Since we know the parrot is male the probabilities must be doubled

* + 1. Uncertainty about gender, provided that a parrot is non-grey

1. The average temperatures in Paris, France in the year 2017 are in the attached spreadsheet

The calculations were done in Python, the equations used to get the answers are shown below.

* 1. What is the uncertainty of the temperature?

H(T) =4.63

* 1. What is the joint entropy of temperatures and months

H(M,T) = 6.73

* 1. How much information is shared between temps and months

I(M,T)=1.48

* 1. What is the uncertainty given that month is May?

H(T|May)= 3.54