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MITx: 6.008.1x Computational Probability and Inference

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Homework Problem: Ainsley Works on Problem Sets

(10/10 points)

Ainsley sits down on Sunday night to finish S problem sets, where S is a random variable that is equally likely to be 1, 2, 3, or 4. She learns C concepts from the problem sets and drinks D energy drinks to stay awake, where C and D are random and depend on how many problem sets she does. You know that $p_{C|S}(c|s) = 1/(2s+1)$ for $c \in \{0, 1, \dots, 2s\}$. For each problem set she completes, regardless of concepts learned, she independently decides to have an energy drink with probability q. That is, the number of energy drinks she has is binomial with parameters q and S:

$$p_{D|S}(d|s) = \begin{cases} \binom{s}{d} q^d (1-q)^{s-d} & d \in \{0, \dots, s\} \\ 0 & \text{otherwise} \end{cases}$$

where $\binom{n}{k} = \frac{n!}{k!\,(n-k)!}$.

- **(a)** Does the conditional entropy $H(C|S = s)$ decrease, stay the same, or increase as s increases from 1 to 4?

  ○   It decreases.

  ○   It stays the same

◉   It increases. ✔

- **(b)** The next morning, her roommate notices that Ainsley drank d energy drinks. What is the expected number of concepts that she learned?

  You should derive a general expression for this although in the answer boxes below we only ask you to evaluate the expression for specific choices of d and q. If you're general expression is correct, your answers to these should also be correct.

  (Please be precise with at least 3 decimal places, unless of course the answer doesn't need that many decimal places. You could also put a fraction.)

  When $q = .2$, $\mathbb{E}[C|D = 1] =$ | 2.76370280146 | ✔

  When $q = .5$, $\mathbb{E}[C|D = 2] =$ | 3.125 | ✔

  When $q = .7$, $\mathbb{E}[C|D = 3] =$ | 3.54545454545 | ✔

- **(c)** Is the mutual information $I(C; D)$ greater than, less than, or equal to zero? You should assume that q lies in the range $0 < q < 1$.

  ◉   Greater than 0 ✔

  ○   Less than 0

Exercises due Oct 13, 2016 at 02:30 IST

Week 4: Homework 3

Homework due Oct 13, 2016 at 02:30 IST

▸ Part 2: Inference in Graphical Models

    ○   Equal to 0

You have used 2 of 5 submissions

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