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Task 8: Estimating discrete entropy

Due date: Monday, June 20, 11:59 AM

Task

Make sure you understand the code framework. We only treat discrete entropy, i.e. your random variable can take a finite number of discrete states. You are meant to evaluate the methods on two types of distributions, the uniform and a Zipf-law-like distribution.

- In a uniform distribution, the probability of all states is identical: $p(X = x) = \frac{1}{\#states}$
- In a Zipf-law-like distribution, the probability of a state is inversely proportional to its rank: $p(X = x) = \frac{1}{x}$

The first part is replicating the graphs shown in the lecture, the second is new. Think about possible reasons for differences between the two distributions. Modify the plotting function to show errorbars were appropriate.

1. **ML estimator and Miller-Maddow correction**. Implement the maximum-likelihood estimator for discrete entropy as discussed in the lecture as well as the bias-corrected version with Miller-Maddow correction.
   We take $0 \log 0 = 0$, such that symbols that were never observed ($f_i = 0$) are simply not taken into account in the sum over symbols.
2. **Jackknife estimator.** Implement the jackknife estimator for entropy, which essentially uses a leave-one-out estimate of the entropy bias to correct the bias.
3. **Coverage-adjusted entropy estimator.** Implement the coverage-adjusted entropy estimator. For reference, see Vu et al. 2007, Statistics in Medicine[1].
4. **Get an advanced entropy estimator to run.** Download and use either the Best Upper Bound estimator by Paninski[2] or the Pitman-Yor estimator by Archer et al.[3] or any other advanced entropy estimator you find suitable. Modify the plotting function to show this estimator as well.

Figure: Use the provided function to plot the estimated entropies for all estimators and both uniform and Zipf distributions in comparison to the true entropy.

[1] http://www.vince.vu/papers/cae.pdf
[2] http://www.stat.columbia.edu/~liam/research/info_est.html
[3] https://github.com/pillowlab/PYMentropy