Information Theory — Tutorial 1

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MacKay's textbook can be downloaded as a PDF at:
`http://www.inference.phy.cam.ac.uk/mackay/itila/book.html`

Remember to put any questions and comments on any of the lecture materials hosted on NB. Email `i.murray@ed.ac.uk` if you haven't got an invite to NB.

1. **Expectations:** MacKay's book Exercises 2.21 and 2.22, p37.

2. **Numerical experiment:** Sample 12 uniform random numbers between zero and one (using your favourite programing language's random number library routine) add them up and subtract 6. Do this many times (10^3 to 10^6 times) and plot a histogram of the numbers you get.

   Also plot what the Central Limit Theorem predicts. (The lecture slides contained plots for the sums of 3 and 20 uniform random numbers.) Is your Central Limit Prediction the same shape as your histogram? Does your prediction match the overall height of the histogram? If not, what went wrong with your prediction?

   If you don't have time to write code: write down the formula(s) you would use to make the Central Limit Theorem prediction, and sketch what you would expect to see.

3. **Repetition codes:** MacKay's book Exercise 1.3, p8 (p7 in early printings).

   It's easy for your mathematics to get very messy. Hint: Stirling's approximation only guarantees a small *relative* error. Therefore, further neglecting the small relative difference between N and $N+1$ is ok, and can be abused to make your maths a lot simpler.

   Warning: you should always have a thorough attempt at questions *before* looking at any answers. In this case, parts of MacKay's answer is more complicated than I expect from you.

   Why do you think R2, R4, etc. were omitted from Figure 1.12?
   If you have time, try to reproduce this figure.

BONUS, OPTIONAL QUESTION:

4. **Central Limit Theorem:** MacKay's book Exercise 2.16, p36.

   Read the marginal note by this question (not present in early printings of the book). If you generalize your answer to (d) you can sum up any number of dice and get a uniform distribution. Why does the central limit theorem not apply?