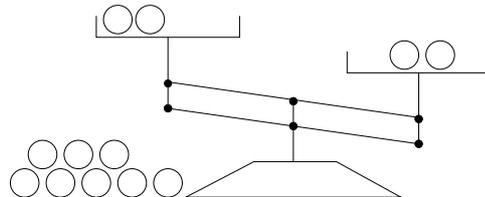


Information Theory, Pattern Recognition and Neural Networks

Part III Physics, January 2005

Please work on the following exercise before lecture 2.

The weighing problem



You are given 12 balls, all equal in weight except for one that is either heavier or lighter. You are also given a two-pan balance to use. In each use of the balance you may put any number of the 12 balls on the left pan, and the same number on the right pan, and push a button to initiate the weighing; there are three possible outcomes: either the weights are equal, or the balls on the left are heavier, or the balls on the left are lighter. Your task is to design a strategy to determine which is the odd ball *and* whether it is heavier or lighter than the others *in as few uses of the balance as possible*.

The course textbook is *Information theory, inference, and learning algorithms*, by David J.C. MacKay. Cambridge University Press (2003). (Rayleigh library: 39 M 20.) This 640-page textbook covers the whole course, and a whole lot more. I encourage all students to buy this textbook. The book's cover price is £35; if you buy it at the CUP bookshop with University ID, it costs £28. But if you don't want to buy it, there are alternative options:

1. The book is also available for **free on-screen viewing** at

<http://www.inference.phy.cam.ac.uk/itprnn/>.

2. You can **borrow the book** from me: I have copies available for a cash deposit of £21.
3. **Money-back Guarantee:** *If you buy the book, then decide that you don't want to keep it, I will buy it from you for a good price and sell it on to a future student.*

Note-taking: During lectures, I encourage you to take notes, rather than just follow along in the textbook. Learning is an active process, not a passive one. I aim to lecture at the right pace so that you can take notes and understand. If the pace is wrong, please let me know.

Exercises: The book contains numerous exercises, complete with worked solutions. A subset of these exercises will be designated as the exercises you should work on before supervisions. [Generally, these exercises are the ones marked 'highly recommended' by a marginal rat.] *I encourage you not to look at the worked solutions for these exercises before you have attempted them yourself.*

The first bunch of exercises are: 1.3 (p. 8), 1.5–7 (p. 13), 1.9, & 1.11 (p. 14). The first supervision will focus on exercise **1.9** (p. 14).

Supervisions: Officially, you are meant to get three supervisions in small groups. However, feedback from students indicates a preference for *six* supervisions in larger groups. Assuming that you would like this, the supervisions will be on Thursdays at 2pm or 5.30pm starting **Thursday 2nd February**. Location: HEP seminar room, Rutherford building (Room 980); later in the term the location will move to Ryle seminar room (Room 930). Please attend one supervision per week, and sign the attendance register each time.

