

Mathematical Neuroscience

Homework Set 2 - due 3/1/04

Problems that are marked with a (*) are required only for graduate students in the class. Problems marked with (**) are required only for undergraduates (although graduate students should consider doing these as exercises anyway). Unmarked problems are required for everybody.

The numbered problems refer to exercises that can be found on Abbott's website. You will find a link to the .pdf files containing these problems on my website. I have posted the pages containing the equations that are referred to in these problems on my website, although I recommend strongly that you buy this book.

1. There are two papers to read for next week. The first one is on receptive fields, and you can start reading it as soon as you received this assignment. The second one should not be very difficult. We will discuss the topics of this chapter in class, but, since it is somewhat long, you may want to start on it early as well (give yourself a few hours on that one).

DeAngelis, et al. provides an overview of a number of experiments that lead to the results about receptive fields that we have discussed in class. What do you see as the main point of this paper? What are the limitations of the approach that they advocate, and where do they become apparent. In particular, think about how they distinguish simple and complex cells, and cells with separable and nonseparable receptive fields, and whether the description they use shows everything there is to know about how these cells process inputs.

The part of chapter 3 from "Spikes" provides an introduction to ideas from information theory, and their application in neuroscience. This something we will discuss in class in some detail. Think about whether there are limitations to these ideas keeping in mind where they originated. Also, do you think that there are biases in the methods that are discussed.

2. Chapter 2, problem 1. You can do this one using Matlab, or you can use the XPP programs on Bard Ermentrout website at
3. (*) Chapter 2, problem 5.
4. Chapter 2, problem 6. You should use Mathematica or Matlab to help you along on this one.
5. Chapter 2, problem 8.
6. (*) Chapter 2, problem 12.
7. (**) Chapter 3, problem 1.
8. (*) Use Lagrange multipliers to show that among all stimuli with constant energy

the stimulus that gives the largest response is proportional to the kernel $D(\tau)$. If you get stuck on this, use the appendices in Dayan and Abbott.