Psy 5018H: Math Models Human Behavior
Spring 2004
Prof. Paul Schrater
Homework #2, Due Mar. 30th, midnight.

Problem Set

Submit homework as an electronic file via email. You may submit any common file format.

1) Bayesian perception of motion (35%)

Read Weiss,Simoncelli, and Adelson "Motion Illusions as Optimal Percepts". We will simulate their theory on a simple stimulus. I have written a series of utility files in Matlab for this purpose Download the following files: MakePlaidMovie.m, ComputePrior.m, ComputeVelLikeli.m, ComputeImageDerivs.m, ShowPdistandMovieFrames.m, and BayesianMotPerExample.m. The function MakePlaidMovie will make an image sequence for a simple "plaid" stimulus. The other files will analyze and display the motion Do the following steps for several different plaid stimuli

1) Make a movie sequence and view it
2) Compute the velocity likelihood for some image patch and view it
3) Combine the likelihood and the prior
4) Find the maximum a posteriori velocity

Examples of these steps are given in BayesianMotPerExample.m (except finding the maximum

The assignment:

a) Write a function to return maximum a posteriori velocity estimates.

b) Make a plot of "perceived" velocity (maximum a posteriori estimates) for some image patch location against 1) the contrast of the second component, and 2) size of the averaging window. Fix all other parameters at some reasonable values.

c) For some parameter combinations, the plaid components are not combined but appear to move separately. Find a parameter set for which this is true for you and report it in your writeup. Can you explain this phenomena using the theory outlined in the paper? Briefly explain why, or if not what can be done to fix it.

2) Modeling forgetting (30%)

This problem is very similar to the first, but is designed to help you understand what a simple modeling project looks like. There is a Matlab script that will allow you to collect data on your word recognition performance in a simple memory task. You will then complete some code to build a simple model to simulate forgetting. Please download: fastsample.m, MemorySimulation.m,SampleWords.m,basic_english.m, and

RunMemoryExperiment.m. Three of the scripts are just supporting files (fastsample.m, SampleWords.m,basic_english.m). Executing RunMemoryExperiment.m runs an experiment. You will see a series of word pairs that flash up at the end of every delay period (default delay is 1 sec). After 10 word pairs you will be asked if you have previously seen the current word pair. Every other pair changes slightly in color to help you notice the changes. Disregard the order of the pair in your answer (i.e. **collar coin** is the same as **coin collar).** To answer click your mouse on the words YES or NO in the figure window. At the end of each trial you will be told if you were correct and if correct, will be given points using a formula that rewards longer word length pairs more heavily. The points are an attempt to change the value you place on successful recognition. The key point in the experiment is that we are sampling word pairs from a distribution that makes recently occurring things more probable, like Anderson and Lael Schooler's work on relating forgetting to environmental frequencies. Running yourself in the experiment will help you understand what this kind of event model 'feels like'. Please read the comments and code in the file to see how it works.

RunMemorySimulation.m is an INCOMPLETE file - your task is to complete the code and make the simulation work. The idea for the simulation is as follows. There is an internal memory buffer that stores information as a push-down stack (essentially an 'In Box' where the most recent things are on top and older things are buried underneath). When you have to retrieve a memory it costs to search this stack. I have set the search cost as a multiple (called gamma) of the number of steps into the stack (equivalently trials back in the task). The system looks for a memory by taking a series of steps back in its memory stack. When the search becomes more costly than the expected payoff (the predicted probability of the word pair times the point reward for the word pair) the search terminates and a failure to recall (forgetting) results.

The assignment:

a) Run yourself in the memory experiment. If you can handle the time pressure, you can shorten the delay parameter is 0.5sec or less to decrease time spent in data collection. Try to get 100 or more judgments. The data structure returned can be saved, and manipulated as illustrated in the comments in the RunMemoryExperiment.m. Submit your data as a .mat file. You can use:

```
>> save 'MyFilename.mat' data
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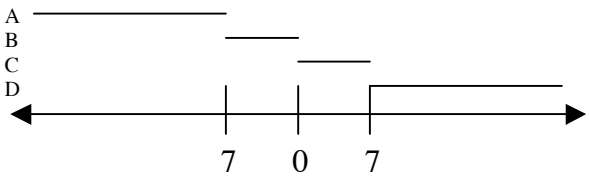
b) Complete the code in RunMemorySimulation.m. The comments in the file should guide you in what to do. Change gamma from 5 to 1 and then to 10 and generate two more sets of simulated data. At the end of the file there is code to plot results. Modify the plot command to superimpose the results of the three levels of gamma (there should be 3 curves on the plot).

c) Determine a way to compare your data to the model data. What aspects of the model can you test?

d) **5 points Extra Credit:** I have given an experimental procedure (even if ineffective) for manipulating the subject's gain for correct recall. Propose an experimental method to vary the costs associated with memory retrieval. A good method will allow multiple graded steps of additional cost.

3) Use Prospect Theory to analyze the following decision scenario (35%):



Minnesota wins **Iowa wins**

You can make bets involving 4 different football outcomes based on a match-up between Minnesota and Iowa. A=Minnesota wins by more than 7. B=Minnesota wins by no more than 7 points. C=Iowa wins by no more than 7 points. D=Iowa wins by more than 7 points. Bookies have assigned the following payoffs for the different outcomes: A) 10 to 1 B) 3 to 1 C)1.5 to 1 D) 3 to 1. You have been given as an endowment 16 dollars and decide to hedge your bets by splitting the money two ways and betting on two outcomes. You must bet all the money or else you have to give it all back. Due to bookie rules, all bets come in $4 increments with a minimum of $4. The best expert opinion assigns the following probabilities for the four outcomes: p(A) = 0.3; p(B) = 0.1; p(C)=0.2; p(D)=0.4. Thus you form prospects of the form Prospect(j)=($(X),p(X); $(Y),p(Y)). For example, bet $4 on A and $8 on C=> Prospect = ($40,0.3; $12, 0.2). What is the best betting strategy someone for someone basing their decisions on cumulative prospect theory? Assume that the value of an amount of money x goes as $v^{+}(x) = x^{\alpha}$ if $x>0$ and $v^{-}(x) = -\lambda(-x)^{\alpha}$ if $x<0$, and assume that $\alpha=0.88$ and $\lambda=2.25$. Also assume that decision weights obey:

$w(p) = a\ p^{d}/(\ a\ p^{d}+(1-p)^{d}\ )$, where a= 0.76, and d = 0.72 for gains and d = 0.66 for losses.

Think about the game, and try to decide what you would you. Try to find the best prospect. How do they compare?