Solutions for Tutorial 1: Basic Model Building

1 A Memory Experiment

Your tutor will do a short memory experiment with you. This will hopefully help you understand how such experiments work, and what type of data they generate.

2 Getting Started with Matlab

Log on to your Dice account. Type `matlab` on the command prompt. This will bring up the Matlab desktop, which consists of three panels:

- current folder;
- command window;
- workspace;
- command history.

Download the following file, which contains the model that you will work with in this tutorial (it is linked from the Assignments page):

http://www.inf.ed.ac.uk/teaching/courses/ccs/tutorials/ccs_t01.tar.gz

Unpack this file, which will result in two Matlab source files, `SLPhonologicalLoop1.m` and `SLPhonologicalLoop2.m`.

The code is taken from Chapter 2 of L&F and explained there in more detail. Please read this chapter if you need help understanding the code.

To run the Matlab code for the first phonological loop model, type:

`SLPhonologicalLoop1`

This assumes that the file `SLPhonologicalLoop1.m` is in Matlab's current working directory. If that's not the case, use `cd` in the Matlab command window to change the current directory.

3 Exploring the Phonological Loop Model

If you have managed to run `SLPhonologicalLoop1.m` correctly, it will have produced a plot in a separate Matlab window.

**Question 1:** Inspect the plot. Is it the same one as the one presented in the lecture (and in the textbook)?

**Solution 1:** The code is taken from the textbook, so it should reproduce the graph exactly.
Doubleclick on SLPhonologicalLoop1.m in the Current Folder window. This opens the source code for this model. If you inspect the code, you will notice that the model is run not once to produce the plot, but multiple times. This is controlled by the variable nReps.

**Question 2:** What happens if you vary nReps? Generate plots for 5, 10, and 100 repetitions. Explain your result.

**Solution 2:** The number of repetitions makes no difference. The model is completely deterministic.

Two other important parameters are the decay rate dRate and the rRange, the range of speech rates covered.

**Question 3:** Modify rRange so that a larger range of speech rates is covered. Does the shape of the curve change? Increase or decrease dRate. Again, does the shape of the curve change?

**Solution 3:** In both cases the shape of the curve doesn’t change. If more speech rates are tested, the curve becomes more dense. If dRate is increased or decreased, the curve moves up or down but retains its shape.

4 The Phonological Loop Model with Variable Decay

Now type run SLPhonologicalLoop2 to run the second version of the phonological loop model discussed in the lecture, which includes variable decay.

**Question 4:** Again inspect the plot. How does it differ from the one generated by SLPhonologicalLoop1? Explain which aspect of the model causes this difference.

**Solution 4:** The answer can be found in Chapter 2 of L&F and in lecture 2.

**Question 5:** Generate plots for 5, 10, 100, and 1000 repetitions. Explain your result.

**Solution 5:** Now there is randomness in the system. The graph stabilizes at around 100 repetition. More than 1000 repetitions don’t result in a change any more.

Again, the decay plays an important role in this model. The decay parameters in SLPhonologicalLoop2 are called decRate and decSD (standard deviation of the decay rate).

**Question 6:** Run the model with decRate values of 0.2, 0.4, 0.6, 0.8. How does the behavior of the model change? Which decRate values result in a plot that matches the experimental data?

**Solution 6:** For small values of decRate, the model doesn’t forget, i.e., produces a flat line. For medium values, it produces an exponential curve; for values $\geq 0.8$ it produces the linear function that corresponds to the experimental data.

Look at line 22 in the Matlab code for SLPhonologicalLoop2. It controls the decay of the model and represents the crucial difference with the SLPhonologicalLoop1. You can get help on Matlab commands by highlighting them and the pressing F1.

**Question 7:** Explain what line 22 does, and how it introduces randomness in the model. What’s the role of the decSD?

**Solution 7:** This model generates a decay value which is randomly distributed around the mean decRate with standard deviation decSD. This relies on the Matlab function rand, which generates a random number in the range $[0, 1]$. 

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5  Cognitive Modeling Concepts

The aim of this part of the tutorial is to discuss key concepts in cognitive modeling with your tutor and your colleagues, in order to make sure you have understood them and to clarify any things that are unclear.

**Question 8:** Reflect on the issue of *parameter estimation* for cognitive models. In Sections 1 and 2, you have explored the parameter space of the phonological loop model by hand. Discuss if this a good approach or not.

**Solution 8:** Manual exploration of the parameter space is useful to confirm that the model is behaving as expected and to get an intuition for what the parameters do. In this case, it’s helpful. However, it is infeasible for large parameter spaces where it’s necessary to use automated methods to systematically find the best parameter settings.

**Question 9:** Explain the concept of *goodness of fit* of a model. How does it relate to parameter estimation? What role does *discrepancy function* play in this context?

**Solution 9:** Goodness of fit refers to how well a model fits the data. We have talked about root mean squared deviance (RMSD) as way of quantifying goodness of fit. Discrepancy functions such as RMSD be used to guide the search for optimal parameters.

**Question 10:** Lewandowsky and Farrell, 2011 describe three levels of modeling: data description, process characterization, and process explanations. How does a data description differ from the other two? Which category does the phonological loop model fall into?

**Solution 10:** The answer can be found in Chapter 1 of L&F and in lecture 1. The phonological loop model is an example for a process explanation.

References