PS530 STUDENTS: GUIDELINES FOR A FINAL PROJECT USING CATACOMB.

This final project will explore the role of theta modulation of different parameters in the functional properties of the model. The theta modulation comes from circuit elements in the "normalized theta" icon (the cyan population to the lower LEFT of the "EC-STM" population and to the right of the "PFC-STM"population – you can see the names of individual icons or local circuits by either left clicking on them, and looking at the label at the top of the menu on the right, or by clicking with your righthand mouse button on the icon to bring up the label, which will sometimes end with "skt" for socket). This circuit provides the theta rhythm for the entire network, and the specific phases of this theta modulation going to different locations is set by changing the phase of theta coming out of the normalized theta circuit . You can see that this population has multiple blue output lines coming from the right hand side of that population. You can trace these and find that many of them go to icons that look like gray boxes with four dots on them. If you right click on one of these you'll see in the menu area on the right that it is labelled "delayBuffer", and then . (One of the outputs from the normalized theta skt goes first to a logic:VectorRenormalizer (a gray icon box with three lines which spread out toward the right) and then gets split before being sent to a number of different delayBuffers.

CHANGE THE VALUES IN THE DELAYBUFFERS (delayBuffers). You can arbitrarily choose one of the delay buffers (the boxes with the four dots on them). A left click on these boxes will open up a menu on the right that has just a delay value. This delay determines the phase of theta modulation for whatever structure comes in the chain after the delayBuffer (sometimes the output goes through a vector broadener and then goes to various components of different regions, so that one delay buffer can still influence a number of parameters). You should arbitrarily choose a delay buffer (preferably toward the lower end of the window) and you should test it as described below. Because the theta frequency is 8 Hz, the full theta cycle is 125 msec. Changing the delay by a certain amount x will change the phase by (x/125) * 360. Thus, if you change it by 125 msec, you are changing by 360 degrees and will probably have no effect on the network, because 360 degrees should be equivalent to a zero degree phase shift. I would recommend first try changing the delay with a shift of 62.5 msec (e.g. if it starts at 30 msec, change it to 92.5 msec. NOTICE that I'm talking about a CHANGE in the delay, not the absolute value of the delay). This is a 180 degree phase shift and should give the biggest change in behavior. You can analyze the behavior of the simulation by clicking on the camera and seeing what the rat does. NOTE that his ENCODING behavior will NOT be affected, because that is a precoded trajectory. His RETRIEVAL behavior SHOULD be affected (at the end of the encoding period). Also, you can analyze the activity of the network, by looking at the three populations (ECIII, CA3 and CA1) that you looked at in assignment #2. Obviously, you'll want to initially focus on the population for which you have changed the phase of modulation. For example, if you change the delay buffer for modulation of the synaptic population in ECIII-skt getting input from PFC-STM, then you'll want to try to figure out what changed within ECIII (particularly the timing of the goal input). The effects will be complex, particularly since these delay buffers still influence a number of connections, but try to get some understanding of what was affected by comparing the various changed values with the fully functioning network. Also, try splitting the values progressively (start with 62.5 msec change, then 31 msec, then 15 msec, then 7 msec) to get a sense of the sensitivity of the overall simulation to the change in values of this particular phase. For your write-up, you should provide the following information:

1. What parameter did you change and what did it affect (e.g. the number of the delayBuffer and the specific connections influenced by its output – you will need to trace which post-synaptic population is contacted by the blue line, and what connection is providing input to that synaptic connection). There will often be MULTIPLE connections affected by an individual delayBuffer.
2. What changes in delay affected behavior. That is, when does the rat continue to perform correct retrieval? You should choose a delayBuffer that causes a break in behavior with 180 degree change (62.5 msec change), and you should characterize what range of phases allow correct behavior.
3. At changes in delay that JUST affected behavior, what is changed in the network. You don't want to just look at the 180 degree phase shift. If behavior starts to break down with a shift of 15 msec (about a 45 degree phase shift), then you should focus on activity at that phase shift. Look at the spiking of population ECIII, CA3 and CA1 and try to see what is messed up during encoding or retrieval that might prevent the correct behavior. The changes may be complex, but I'd like you provide as good an analysis of the effect as you can.
4. Provide a list of potential bugs with the catacomb program, or changes that would make the program easier to work with.
5. IMPORTANT: Describe in about three paragraphs, what you think is happening in the model when the function breaks down. Remember that I discussed the role of the phases in separating encoding and retrieval when I lectured about the Neural Computation article (Hasselmo, Bodelon and Wyble, 2002). You can use your knowledge about that lecture and about the example in the mid-term on encoding versus retrieval. In fact, you can use this knowledge to help you find the delayBuffers that will affect the behavior most strongly (specifically those modulating synaptic transmission and LTP). However, I am willing to have you focus on any specific delayBuffer that will affect behavior – I just want you to try to understand this in terms of what happens in the network.

The whole write up should be about 2-3 pages. You do NOT need to provide figures of what happens. I am most interested in you providing a detailed explanation of which parameters were changed, how this affected the patterns of activity in different regions, and most importantly – HOW the phase change caused the breakdown in function. Last year, too many people just told me what the phases of function breakdown were without describing how it caused this breakdown.