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NE360/HS361
Lab 7: Due 10/30/13

Abstract:

In this lab we explored how multiple features (dimensions) of an auditory stimulus can be represented on a cortical map. To represent the cortical map we used Self-Organizing-Maps (SOM). SOM are data structures that use unsupervised learning algorithms to produce lower dimension topographical representations of high dimensional data set. Unsupervised learning is a machine learning problem that involves finding structures in unlabeled data, where there is no error or reward signal.

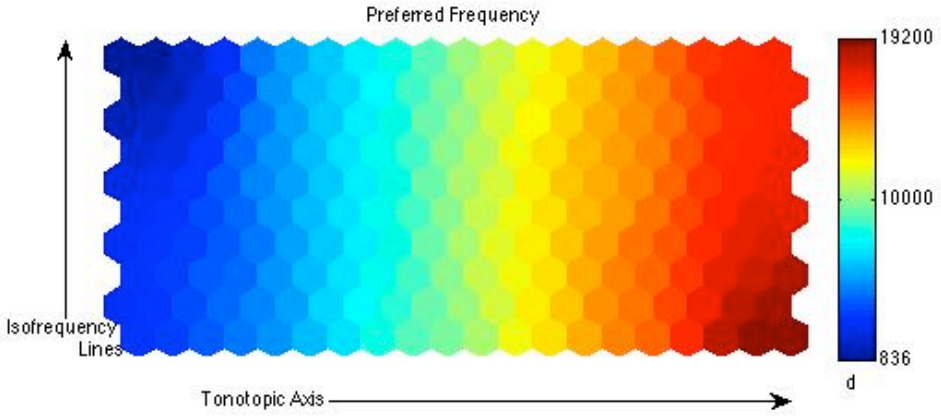
Results:

Part 1 of the lab is a basic overview of SOMs. The algorithm works as such

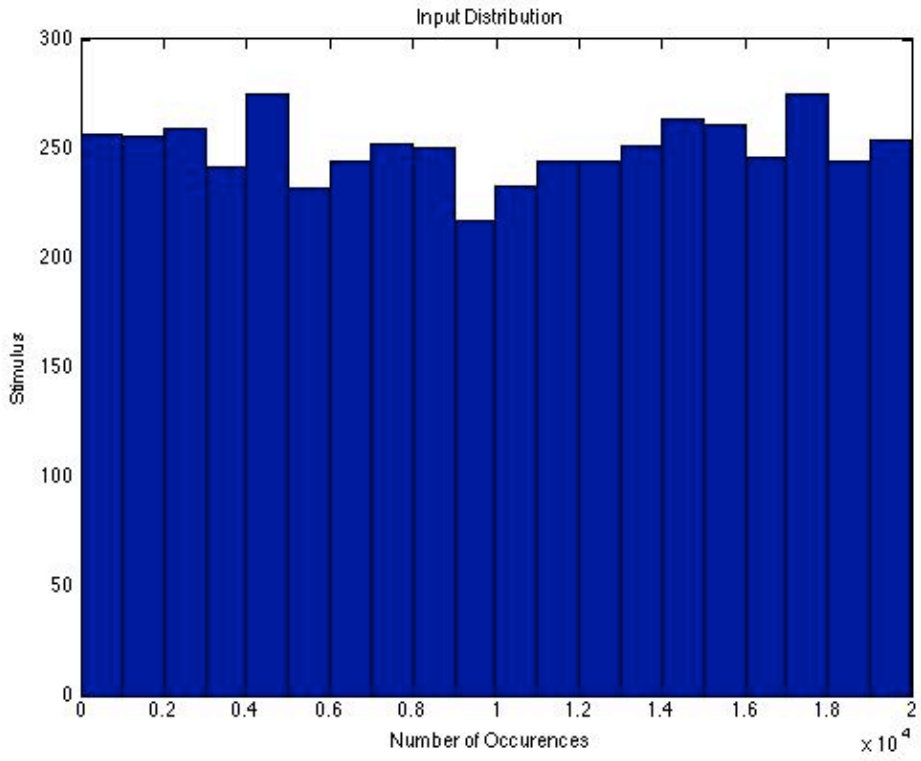
- Assign a random preferred input for each cell
- Provide a training stimulus to the model
- Find the cell who's preferred stimulus best matches the training signal
- Assign a new preferred stimulus to the neighboring cells so that it is closer to the preferred stimulus of the selected cell
- Repeat from step 2

In part 2 of the lab, 1D to 2D mapping is explored. A 5000 tone simulation, with tones randomly distributed between 0 and 20,000Hz, is run with a 200 cell output.

- The map moves from dark gray in the top left to white in the bottom right (low intensity to high intensity).



1D to 2D Mapping

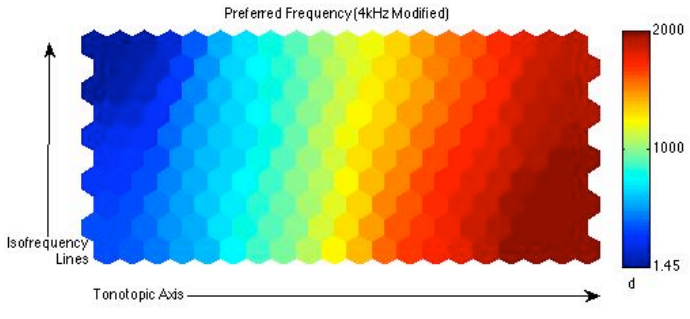


- They are all relatively evenly distributed, as are the iso-frequency bands

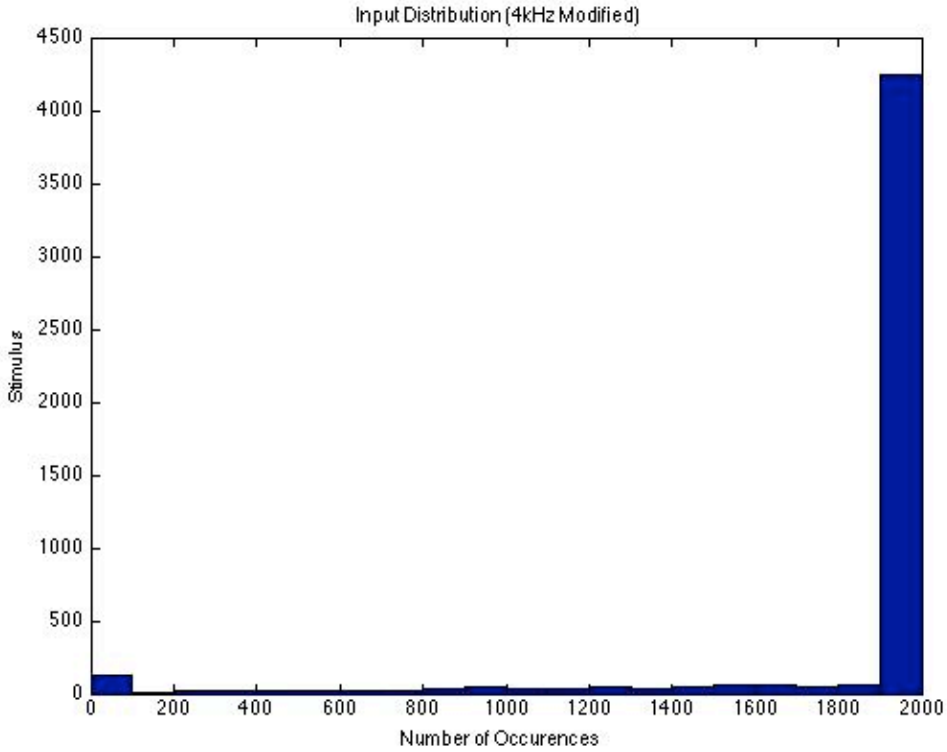
In part 3 of the lab, we looked at what happens when the distribution of the inputs is altered from normal.

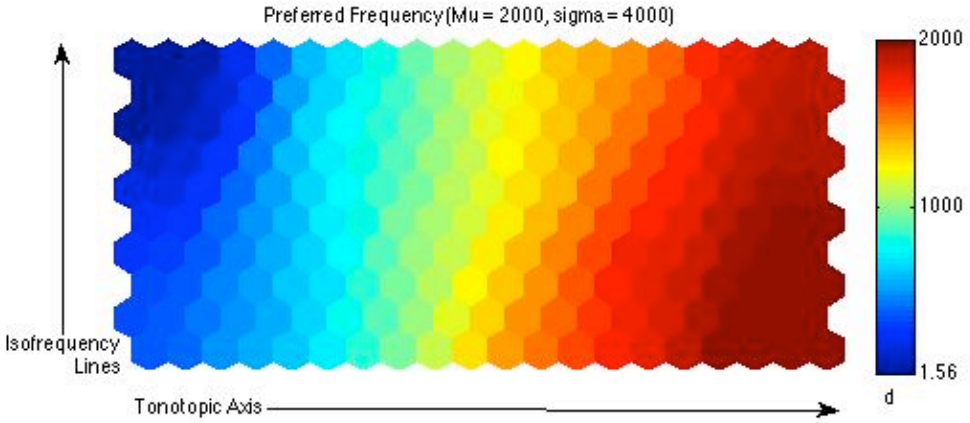
In 3.1 we checked the effects of introducing a cluster of inputs at 4kHz.

- The effect is a higher concentration of red cells in the lower right corner. This corresponds to a higher concentration around 2000. This would be beneficial for a species if they base their vocal range around a specific frequency.

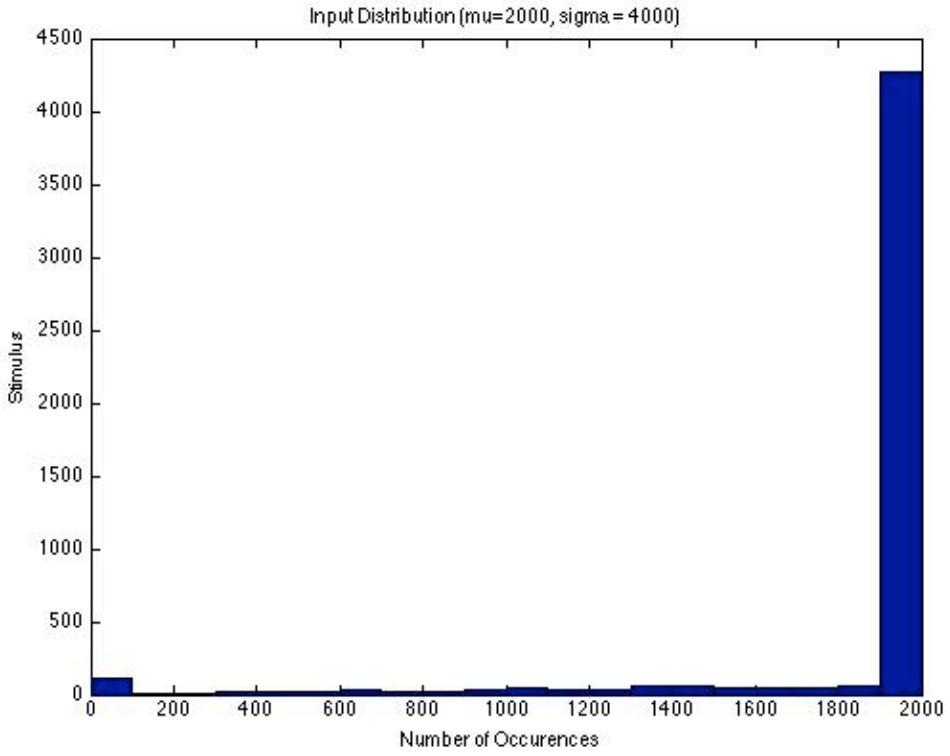


1D to 2D Mapping



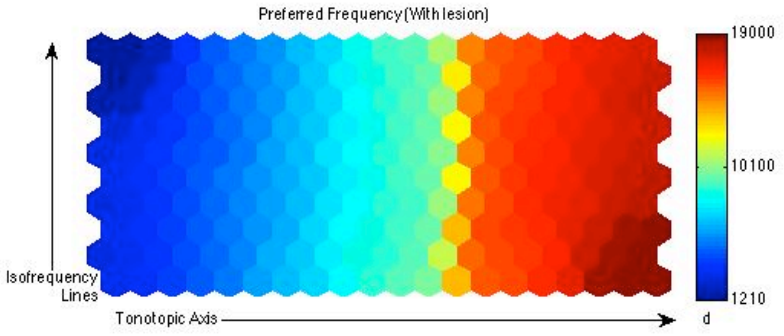


1D to 2D Mapping

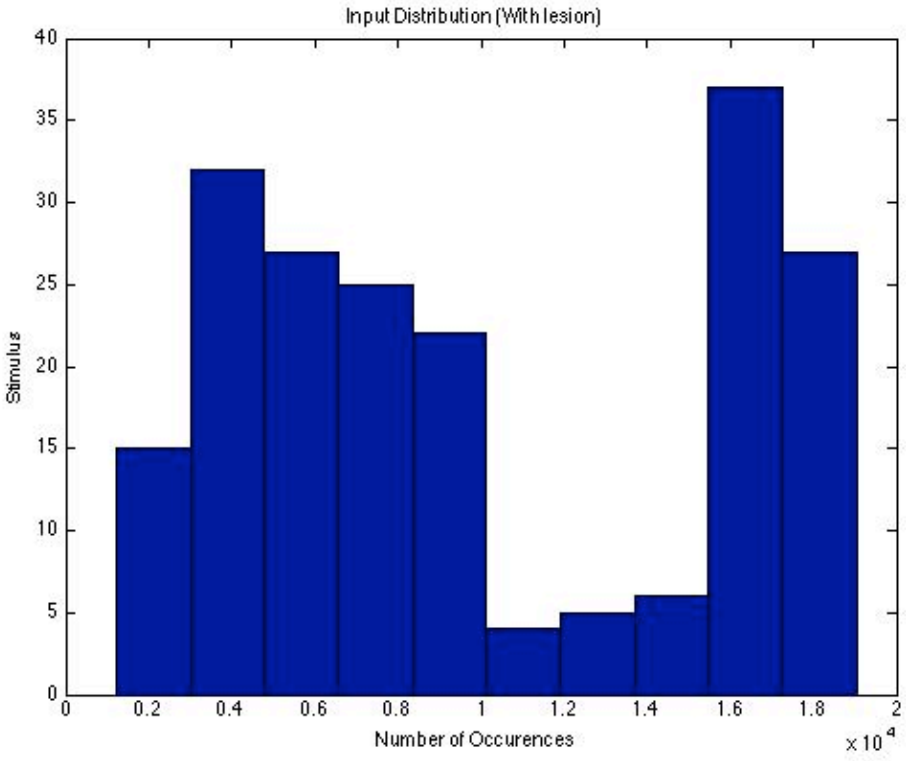


In 3.2 we simulater the effects of a cochlear lesion.

- In the corticle map and the distribution there is a falloff at the region corralated to the prefered frequency of the cochlea at the lesion site. In the cortical map the regions neighboring the nonreponsive areas take over the nonresponsive areas, as described in the lecture notes.



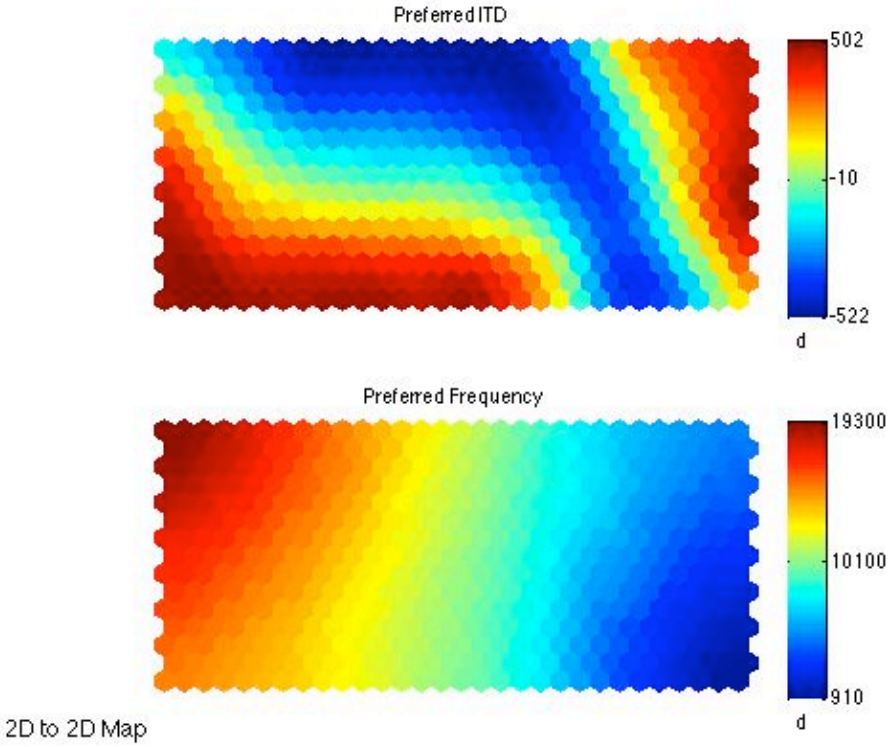
1D to 2D Mapping



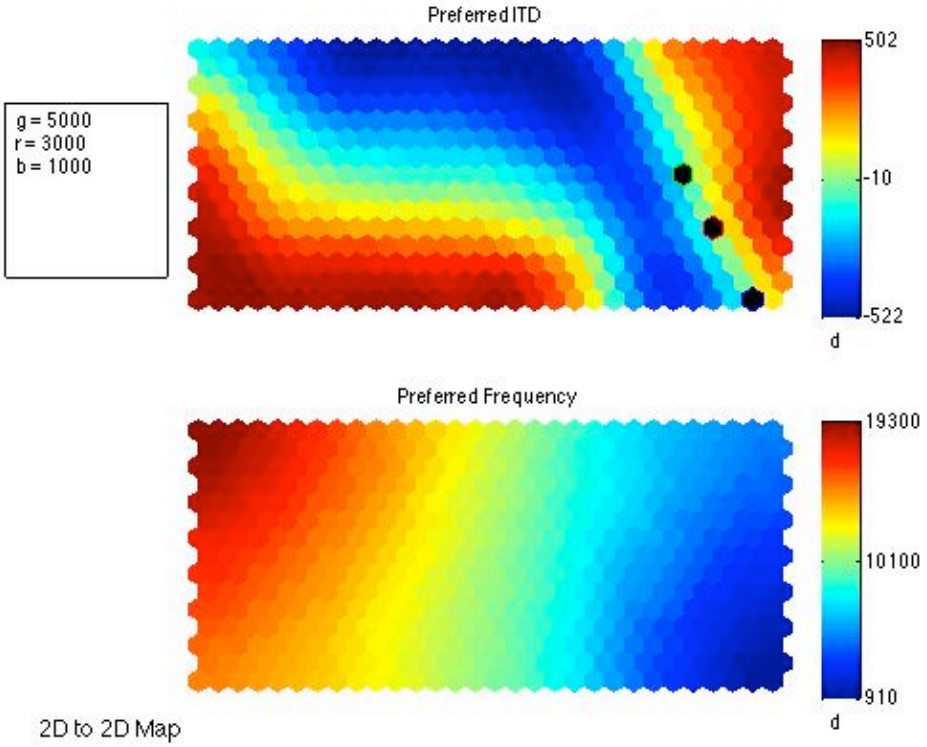
- Cells along the same isofequency lines all react ruffly the same, regarless of the other forms of input (ex. time or amplitude). This model therefore does not take into account these importatnt aspects of audio analysis.

In part 4 of the lab we looked at a more complex model, maping 2D data onto a 2D space. These two demensions are frequency and ITD (interaural time difference).

- Though the lerning process changes trial to trail, the resulting graph is relativly consistatnt: a somewhat regular graph. The resulting cortical map shows that along the isofrequency lines several different prefered ITDs exist. This alongs for a dynamic maping between the two demensions, where specific cells will respond to a given frequency at a givien ITD.

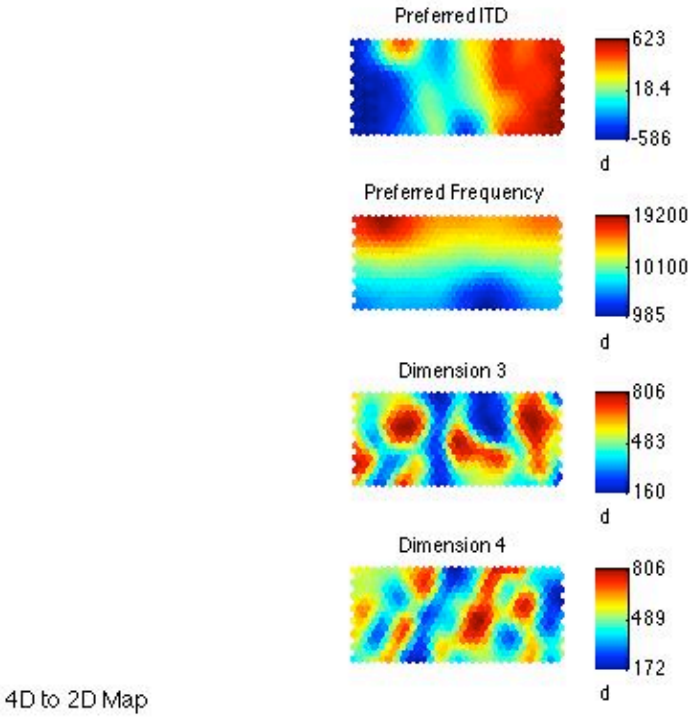


- The labeled cells all have an ITD of 0. The selected cells are those that overlap the preferred ITD and frequency of a given input. They therefor would be the cortical cells that respond to a given frequency at a given ITD.



In part 5 of the lab we looked at maping four different inputs onto a 2D map.

- When multiple new dimmensions are added, the result is that the SOMs still will display cells that map to a single given value for each of the given dimensions. The shapes in the graphs are not regular, since they are formed by readjusting the maps iterativly based on new stimuluses, and each are dependant on previous graphs. This last aspect is what causes the iragular shapes.



4D to 2D Map

- The other demensions could be amplitude of the waveform or its phase.

Conclusion:

The purpose of SOMs is to model the way the AI processes sound. It uses the aproach that all processing is learned, and is not inate. This process creates maps that make either way can model the cortex in later life, but not nesicarily early. For some parameters, frequency or amplitude, that are nesicary for auditory processing this does not make sence, where as parameters like ITD's, that are used for localization, this could be acurate.