

Spike-train patterns in the Primary Visual Cortex

By

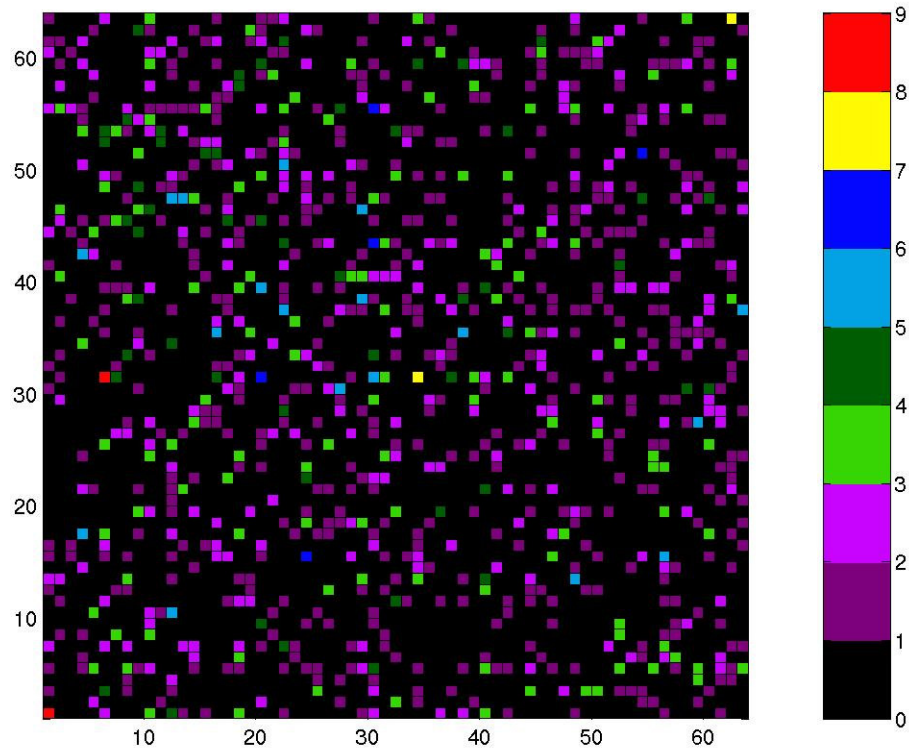
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THE MOVIE



The movie is a simulation of the spiking of the neurons within a 6 second time span. The movie runs for 24 seconds and runs at 10 frames per second. Every second represents 4 cycles of the visual stimulus causing the neurons to fire. The grid itself represents a model cortex in which the data used is from. When a certain square within the grid is colored, the coloring represents that the specific neuron that is in that location has fired. The different colors represent the amount of times that specific neuron fires within an interval.

Spikes-Trains & Interspike Intervals (ISI)

The focus of the research lies within studying the spike-trains in the visual cortex using a model cortex. The spike-trains can be analyzed by two different methods. One is looking at the spiking due to the firing rate of the stimulus which the model cortex used in this project cycles at 4 Hz. This is known as Input Spiking, since it is dependent firing rate and not on time itself. The other, known as Output Spiking, is dependent on time. Output Spiking is the spiking of the neurons onto the model cortex, tracking each indexed neuron and recording the time it spikes. These different types of spiking are what constitutes for the calculations taken and the graphs made.

The graphs shown are the Interspike Intervals of the spike-train from the model cortex. The Interspike Intervals (ISI) is the time differences between two different neuron spikes. The ISI can tell us certain things about the visual cortex. Since we have two different types of spiking occurring, we take two different types of ISI, Input and Output. By taking the two different types of ISI (explained in detail below) it can be seen visually and mathematically that neurons firing in both types of spiking fit into a Poisson curve. The visual representation is done by methods of graphing the ISI, both Input and Output and the mathematics is shown by the calculation of the coefficient of variance (CV). All the calculations and graphs were done on the programming language of Matlab.

Input ISI

The Input ISI is taken from a certain bin of spike times. In the pictures shown on page (x) the first set of graphs (left) are Input ISI's taken from spike times in a 6 ms bin that is centered where the firing rate is highest. The second set of graphs' (right) data is taken from a 5 ms bin to the left of where the firing rate is lowest. All the spots for both sets of graphs are taken from areas where the firing rate is positive. In both sets of graphs, 1 bin is taken first and then it is superimposed on the second graph which represents the entire time span of the data set used. As it can be seen the slope of the curve drops at the same time the CV comes closer to 1 as 1 small sample is expanded to a larger sample, showing that the data set is Poisson could be Poisson.

Output ISI

The Output ISI is taken based on the index of each neuron that is part of the model. Each neuron is singled out and has its personal ISI taken, then it is added together with the rest of the neurons taken in each of the calculations. The neurons selected for each calculation are dependant on type and location. All the neurons fit into a 64x64 grid, each 1x1 square representing a neuron, as seen in the movie. The top 2 graphs refer represent the center 32x32 grid and the bottom two are the entire set or neurons. The way that the graphs split up left and right is dependant on the type of synapses that the neurons fire from. There are two types of these synapses, excitatory and inhibitory. The excitatory neurons fire based on stimulus and the inhibitory firing is not influenced by the stimulus. Each picture has two lines, representing exponential fittings of the Output ISI, to better show the curvature of the ISI. When the CV calculations are made, it can be seen just the same as in the Input ISI, that the CV gradually comes closer to 1. It is not as rapid for the excitatory neurons, possible because there could be outside factors that influence the excitatory spiking, but still with the larger sample, the CV comes closer to 1, showing again that the model could be Poisson.

Resources

Abbott, L.F. & Dayan, Peter; Theoretical Neuroscience; The MIT Press; Cambridge, Massachusetts 2001.

Hanselman, Duane & Littlefield, Bruce; Mastering MATLAB 6; Prentice Hall; Upper Saddle River, New Jersey 2001

Hubel, David H.; Eye, Brain, and Vision; Scientific American Library; New York, New York 1988.