Place Field Grid Pattern Analysis

*Introduction*

This analysis was conducted to test the hypothesis that the hexagonal grid pattern observed in entorhinal cortex grid cells can be faintly detected in hippocampal CA1 place cells. The script analyses firing data from place cells that was collected as a subject rat moved around a testing area. A simpler prior analysis which directly overlapped place cells did not yield observations of the hypothesized grid pattern; this script extended previous efforts by introducing a variety of features maximizing the overlap of the annulus surrounding the centre of the place cells and smoothing to prevent interpolation errors and anomalies.

*Methods*

The script loads timestamped data regarding the position of the rat and the spiking of cells. Using timestamps, the cell spiking is matched with positional data and transformed into a map of cell spiking over the testing area. The map is corrected for the amount of time that the rat spent occupying regions of the testing area.

The script presents images of each cell to user. If the cell has an apparent place field, the user identifies the centre of the field with a mouse click. If the cell has no place field, the user can skip the cell (by pressing ‘Enter’), which eliminates the cell from further consideration. Each cell is remapped to move its place field centre into the middle of the image. Missing pixels from outside the recording area are set to NaN. A buffer of NaN values is placed around the map to prevent data loss during image rotation.

A summation map is created by iteratively adding the map of each cell to the summation. The cell map that is selected for addition on each iteration is the rotated version of the original cell map which correlates the most with the existing summation map, according to the following algorithm:

A modified version of the place field map is made in which the centre of the place field is removed so that only the annulus is considered, and the map is smoothed. The modified map is rotated in 1° increments, each time recording the correlation between the existing summation map and the modified map. The correlation curve is smoothed, and the maximum correlation is selected from the curve. The unmodified place field is rotated to the corresponding angle and added to the summation map.

When the iteration is completed, a total summation map for the session is formed. The process is repeated for each recording session being considered. The session maps are rotated for maximum overlap and summed to create a grand average map.

*Results*

A hexagonal grid pattern was not observed in the session maps or grand average map. Rather, each map displays a plume of high activation toward one side of the place field centre.