

Decoding and information theory

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Abstract - don't include this header in actual essay

Introduction

Neuron decoding is trying to calculate the stimulus that caused a certain measured response. The complexity of this issues varies widely with both the method used to decode and the response that is being decoded. In an effort to keep things simple this paper attempts to decode head direction(HD) cells in mice. HD cells in mice are neurons where the firing rate is directly related to the compass heading of the mouse, forming a clear tuning curve. This paper applies and analyzes the nearest neighbour method on a population of neurons in areas of the mouse brain known to contain HD cells.

Methods

The cell population recordings were found from *Paper here* and consists of measurements from the thalamus and post subiculum. Due to time and computing power constraints the data was constrained to recordings from mouse 28 in session 14038 consisting of 80 cells. The continuous head angle data, which can be viewed as the stimulus, was discretized into 40 non-overlapping 9 degree bins. The session was then split into two unshuffled halves, with the first half as the training set and the other half as the test set.

Reference vectors for each of the 40 angle bins was calculated by calculating the average firing rate of each neuron at each angle bin using only the training set. The population vector was then calculated on the test set by using a sliding 100 ms smoothing window. Finally population vectors for timestamps that had no angle data were removed before performing predictions. This left 89000 population vectors to perform predictions on.

The predictions were calculated using the nearest neighbour algorithm between a single population vector and the 40 reference vectors. Pairwise Pearson correlation was used as the distance measure.

Results

Model Output

Figure 1 shows examples of the decoders output.

Model performance

Running the described method on the test set resulted in a root mean square error(RMSE) of 20 and an accuracy of 50%.

The RMSE is relatively high. In figure 2a the distribution shows that this is in general due to a lot of predictions 1-3 bins off the target value rather than a few extreme errors. The confusion matrix in 2b shows that there are cases where the model frequently predicts a very wrong angle.

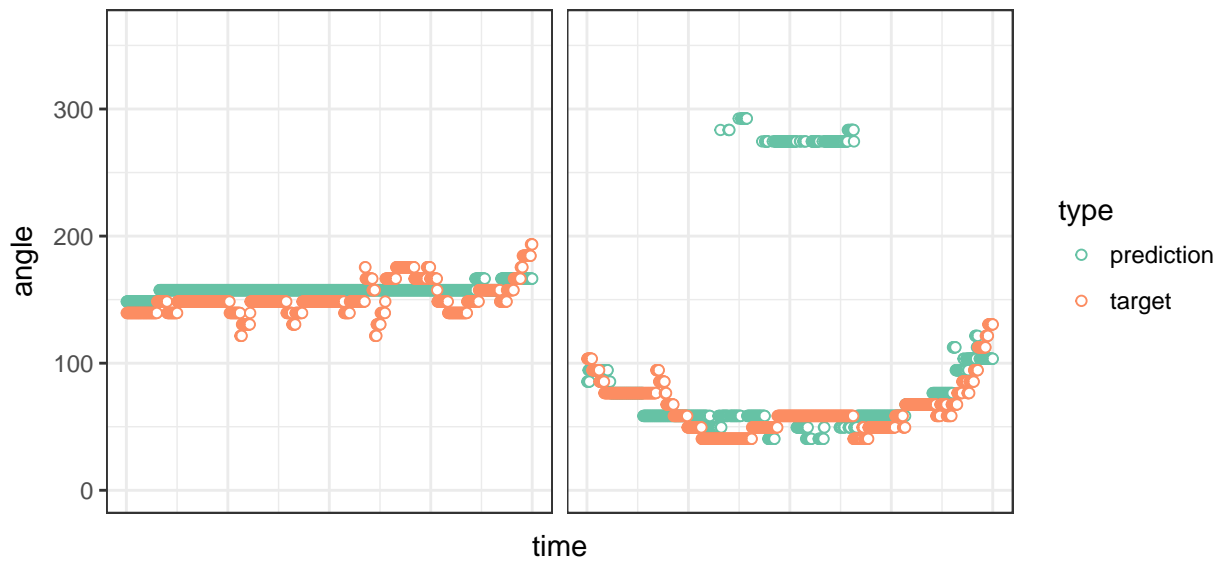


Figure 1: WIP

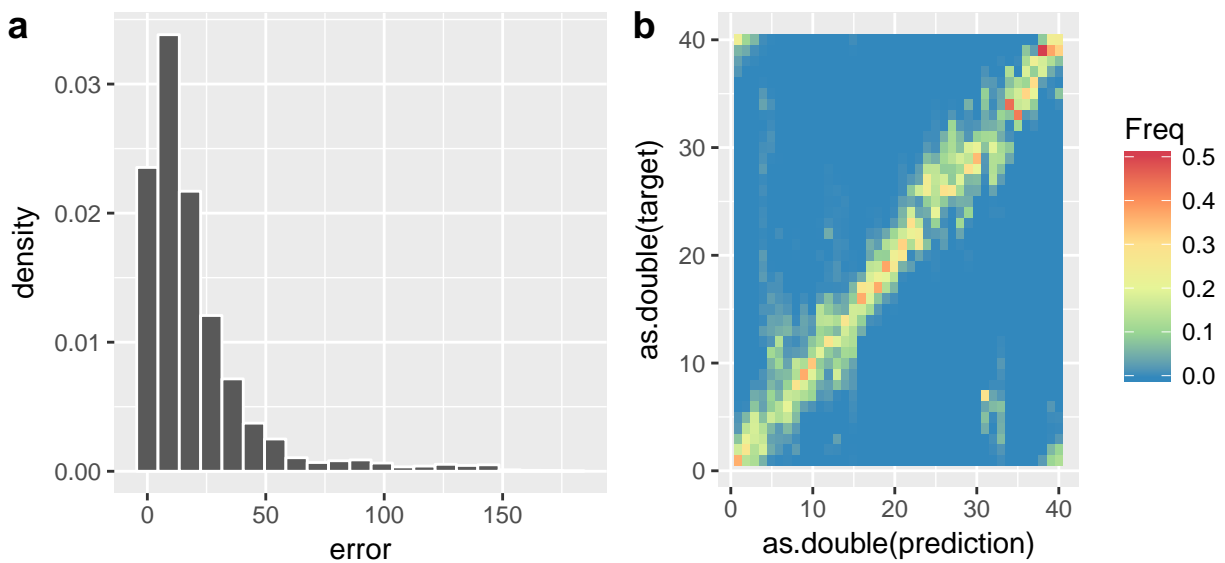


Figure 2: Visualization of model performance on test set. Figure A: The distribution of prediction error.
Figure B: Confusion matrix

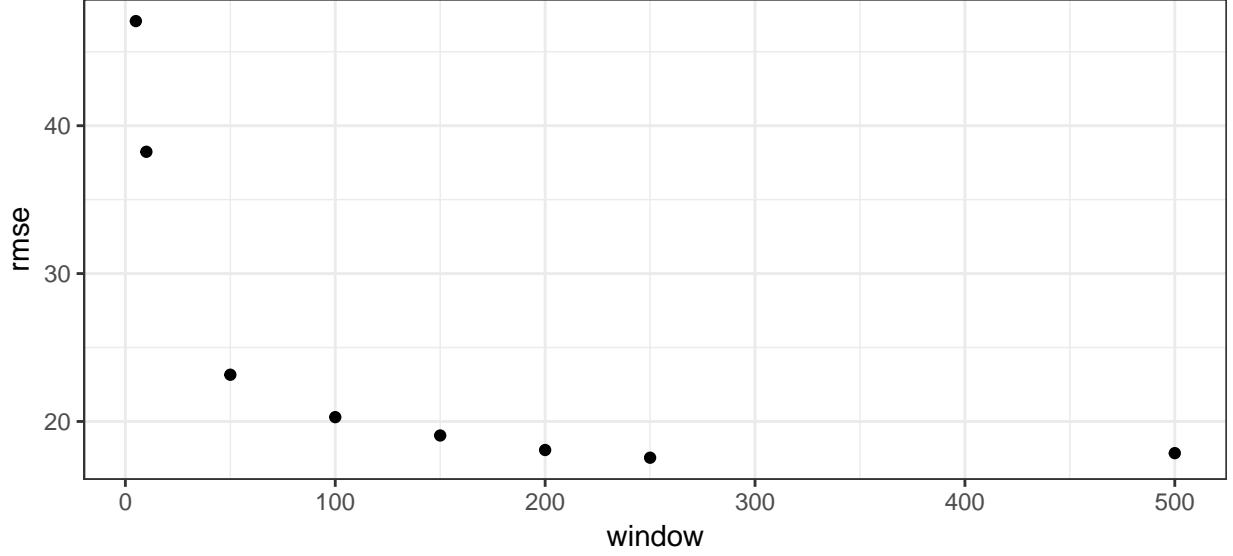


Figure 3: Visualization of model performance on test set.

Smoothing window size

The choice of smoothing window effects the model as it removes the temporal information of when the timespikes occurred but decreases the noise of the firing rate. The effect of changing this window can give insight into if head angle information is coded in the spike timing. Figure 3A shows the change in the RMSE of the model using different sized smoothing windows. As the smoothing window increases, the RMSE decreases. This suggests that the temporal relation between spikes is not important for encoding as losing this information when increasing window size should increase error. However, this plot alone is not enough to rule out that the decrease in noise outweighs the information lost. Figure 3B shows the change in information rate with bin size. Here

Discussion