SCORING SEQUENCES OF HIPPOCAMPAL ACTIVITY USING HIDDEN MARKOV MODELS

Etienne Ackermann and Caleb Kemere

Problem statement

Neuronal firing patterns are often preserved and repeated in a time compressed manner (replay or neural reactivation).

It remains challenging to:
1. Identify and
2. Quantitatively assess these events.

In particular we want to determine if a candidate sequence represents spatially consistent movement through an environment, as well as how good that representation is.

Introduction

Encoding position—place cells

Populations of neurons in the rodent hippocampus (H) have been shown to accurately encode information about the animal's location in its environment: so-called 'place cells'.

Replay

Place cells fire sequentially as animals move around, and these sequences sometimes repeat during sharp wave ripples (SWRs).

So what is replay? The replay process, time-compressed neural activity which the firing order is preserved.

Quality of replay

Which putative replay event is the 'best?' Why are some candidate sequences better than others?

Multiple models for different contexts

Many events are simply classified as 'noise'—need models that "sense" environment.

Context classification

Log probability can effectively discriminate between sequences from different environments.

Length normalization

Sequences were not length normalized.

Experimental data

Data set description

He: 3 data sets from (HC) 2446 animal days run on two linear tracks per day (66-67 shown here): each session lasted about 40 minutes with N = 91 cells (66-67).

Experiment

Animals ran back and forth on a familiar track for rewards.

Simulation

Simulated results show that HMMs capture both structural and sequential structure from the data.

Conclusion

Scoring sequences score effectively discriminates true sequences from shuffled sequences.

Conclusions

We have shown that HMMs score sequences higher if:
1. Those sequences are more sequentially consistent.
2. Firing events agree with the assumed firing events.

Future work include the analysis of replay and other SWR-scale sequences, and a refinement of the proposed sequences score.

References