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Abstract: Hippocampal replay is characterized by the reactivation of population-wide neural sequences during non-exploratory states, such as sleep and rest. Replay is often correlated with firing sequences observed during preceding spatial navigation tasks. The generation of replay is crucial for memory consolidation and retention and is key to retrieving previous memories. Replay episodes contain information about the causality structure within a network of neurons, which helps to experimentally track how the memories are formed during learning. We investigate the relationship between replay and functional connectivity by simulating the activity of a network of CA3 place cells as seen in rats during spatial navigation. We use the NEURON simulation environment to implement a single-compartment multi-current pyramidal cell network connected with realistic AMPA and NMDA synapses and fitted with realistic in vivo-like excitatory and inhibitory uncorrelated background noise. The conductance of the synaptic currents is scaled by a connectivity matrix that we manipulate to introduce controlled causality structures in subgroups of neurons. We compare the results from three approaches designed to identify those subgroups of neurons and their firing order, if any. The first approach uses spike counts over some fixed synchrony window, the second approach leverages spectral analysis with Fourier transform, and the third approach extracts a directed acyclic graph that best describes the causality relationship between neurons by capturing the underlying generative model using the mathematical framework of Markov Decision Process. All three methods are tested against the ground-truth connectivity matrix to evaluate the robustness and degradation profiles of the algorithms. We discuss how extracting the neurons involved in replay, and the order in which the episodes propagate, highlights the role of place cells in spatial navigation, providing insights into learning and decision-making in complex environments. In future work, these algorithms will be used to assess hippocampal replay in datasets collected as the rats solve complex navigation problems in megaspace.