Memory and navigation: How does our brain learn remember and navigate in space?

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One of the striking features of natural intelligence is its ability to acquire, store and retrieve information that it receives from the surroundings. Memories once acquired modulate our perception of the surroundings as novel, related to what we know and same as what we know. Interestingly the very brain regions that are responsible for encoding and storing this information initially, are also the regions which represent external space surrounding us. The mammalian brain having evolved through natural selection exhibits plasticity at multiple scales through diverse mechanisms. These natural neural networks encode memories of events across multiple regions depending on the time elapsed since the event. Such an organisation of information spanning multiple regions is thought to imbibe several unique characteristics to retrieval of these memories. Understanding and emulating some of these features using artificial neural networks (ANN's) resulted in the Complimentary Memory System model. However, such a model still falls short when it comes to understanding generalisation (the act of abstracting commonalities across multiple related memories). Core to understanding such an abstraction is being able to identify, characterize and follow molecular, neuronal and network level changes as the animal acquires and consolidates these memories. Students who participate in this project would pursue research to identify and elucidate these mechanisms utilising a multitude of optical, electrophysiological, behavioral, and computational approaches (including ANN's). Specifically, we will be investigating the relationship between the changes in local field potentials as the animals acquire memory following behavioral training across different brain regions. We will be developing novel optical and electrophysiological tools that utilise ANN's to collect, analyse and model the experimental data.