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Talk Title: Towards a unified computational model of spatial and semantic representations in medial temporal lobe

Abstract:
In medial temporal lobe (MTL), place cells in the hippocampus and grid cells in the entorhinal cortex encode spatial information, enabling spatial computation such as estimation of self-position (path integration) and efficient goal-directed navigation. In the same brain regions, neurons that respond to non-spatial semantic concepts (a specific person, a landmark, or a semantic group like “food” and “clothes”), named as concept cells, have been found. There can be shared computational mechanisms for these two types of representations in MTL, however, theoretical relationships have not been fully understood. Here I introduce a unified neural representation model for spatial and semantic computations, which is called as disentangled successor information (DSI). DSI was derived from a mathematical correspondence between reinforcement learning for spatial navigation and word embedding models in natural language processing, which suggests a theoretical connection between spatial and semantic computations. In 2-D spaces, DSI representations become similar to place cells and grid cells which support path integration and spatial navigation. On the other hand, the same DSI model also generates semantic representations like concept cells when linguistic inputs (text data) are given, suggesting that there are related mechanisms for spatial and semantic representations found in MTL. Furthermore, as in word embedding models, we can perform the inference of words based on simple arithmetic operations, and the same computation also enables the inference of spatial structures. DSI model suggests shared computational mechanisms between spatial and semantic representations in MTL.

Biographical information:
April 2023 - present: Tenure-track researcher at Center for Information and Neural Networks (CiNet)

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