

UniReps Workshop

Unifying Representations in Neural Models

Testing Assumptions Underlying a Unified Theory for the Origin of Grid Cells

Rylan Schaeffer

2023/11/18



Mikail
Khona



Prof. Sanmi
Koyejo

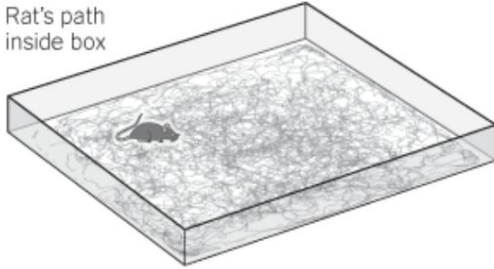


Prof. Ila
Fiete

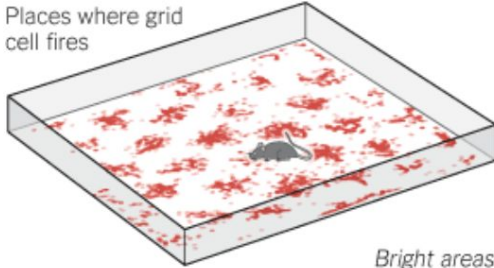


What are grid cells?

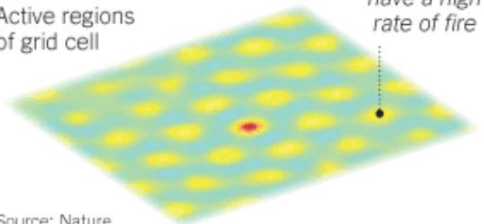
Rat's path inside box



Places where grid cell fires

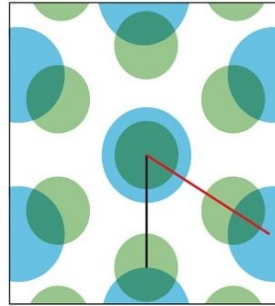


Active regions of grid cell

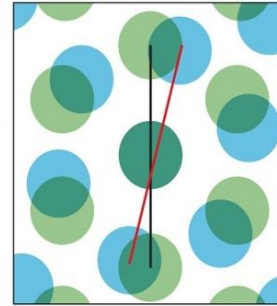


Source: Nature

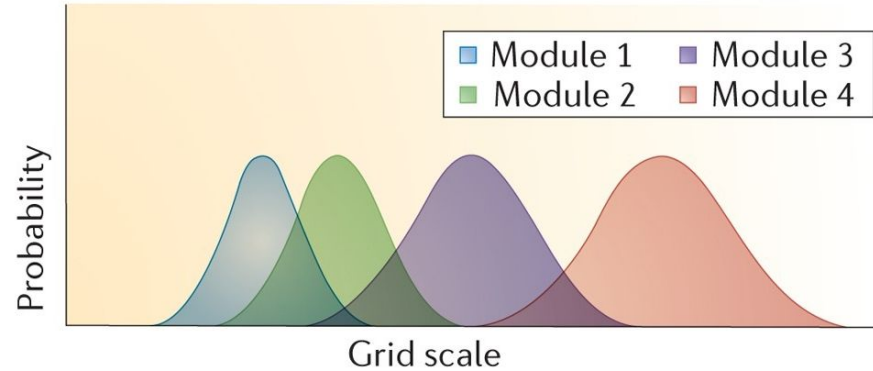
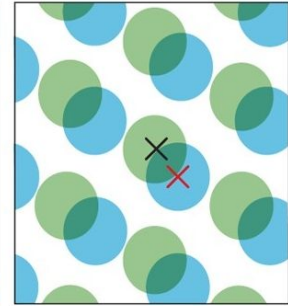
Grid scale



Grid orientation



Grid phase



The Nobel Prize in Physiology or Medicine 2014

A Unified Theory for the Origin of Grid Cells

A unified theory for the origin of grid cells through the lens of pattern formation

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A unified theory for the computational and mechanistic origins of grid cells

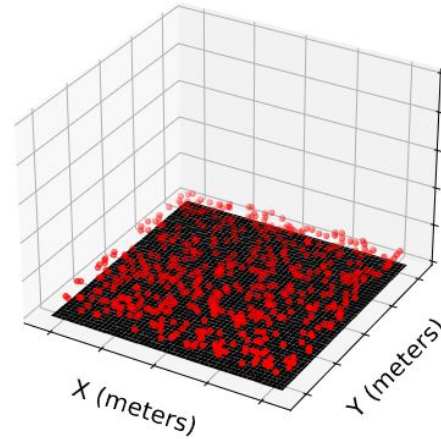
[Ben Sorscher](#) ⁴ • [Gabriel C. Mel](#) ^{4, 5} [✉](#) • [Samuel A. Ocko](#) • [Lisa M. Giocomo](#) • [Surya Ganguli](#) • [Show footnotes](#)

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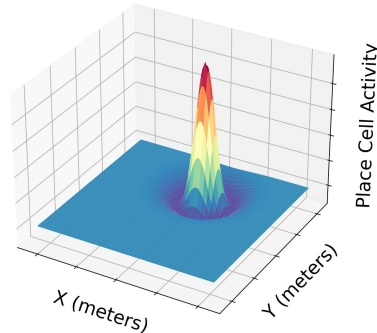
Two Key Mathematical Assumptions

1. Place cells, as a population, are translationally invariant
2. Place cells, individually, have center-surround tuning curves

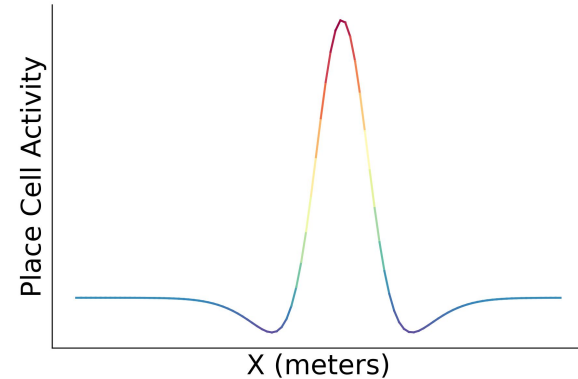
Place Cell Centers



Place Cell 1

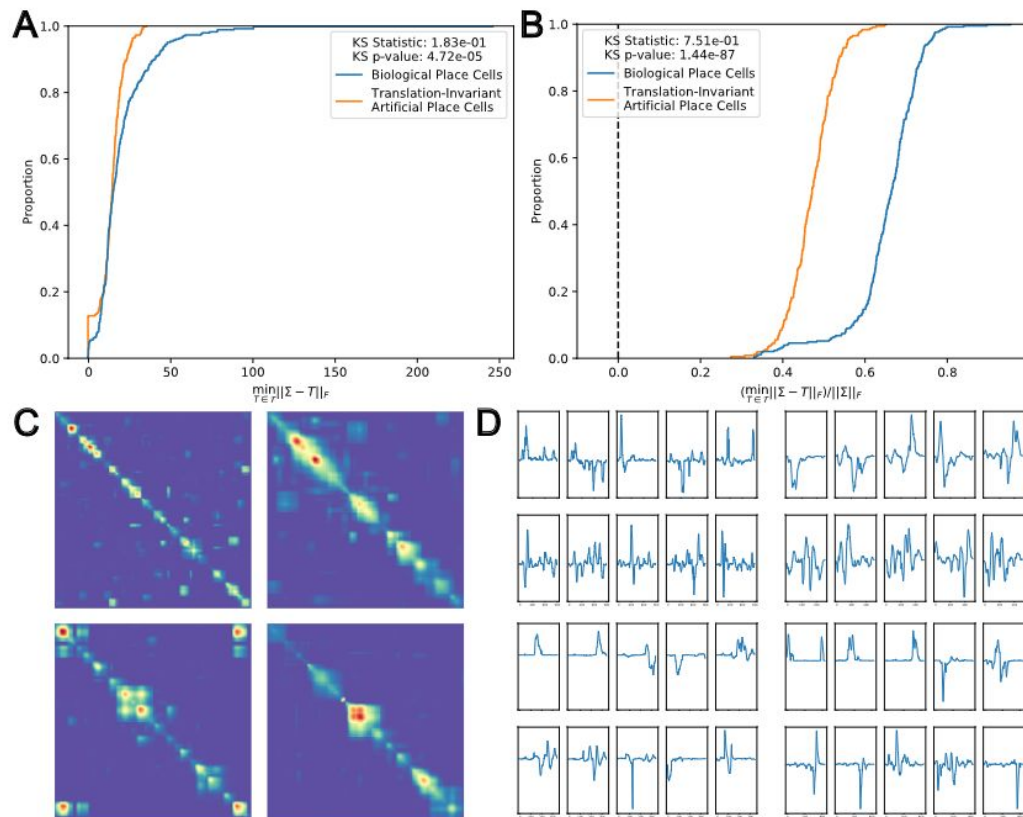


Place Cell 1



Translation Invariance: Biologically Unlikely

$$\Pi_{\mathcal{T}}(\Sigma_i) \stackrel{\text{def}}{=} \arg \min_{T \in \mathcal{T}} \|T - \Sigma_i\|_F^2.$$



Center Surround Tuning: Biologically Unlikely

Figure S2
place field sequence

