MPIDS Colloquium

Indications for optimality of motor cortex

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The brain processes time-varying input, but it is not known how it achieves its high computational performance. Indeed, neuronal networks can show a rich set of dynamical states. Such states can differ in the measureable spatio-temporal patterns of activity [1]. But they may also differ internally, in terms of their degree to which they produce chaotic activity [2].
We here show that recordings from motor cortex support an operation close to a transition to chaos [3]. We identify this computationally beneficial regime by combining finite-size mean-field theory with massively parallel spike recordings. The theoretical predictions resolve the puzzle how a balanced state can be compatible with widely distributed correlations and long-time dynamics.
We then investigate how such networks process input by quantifying how time-varying input suppresses chaos so that a novel dynamical regime emerges [2]: memory capacity in this regime is optimal.
Together these findings provide hints towards the operation principles of cortical networks.

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[1] Johanna Senk, Karolína Korvasová, Jannis Schuecker, Espen Hagen, Tom Tetzlaff, Markus Diesmann, Moritz Helias (2018), “Conditions for traveling waves in spiking neural networks”, arXiv:1801.06046 [q-bio.NC]
[2] Jannis Schuecker, Sven Goedeke, Moritz Helias (2016), “Optimal sequence memory in driven random networks”, arXiv:1603.01880 [q-bio.NC]
[3] David Dahmen, Markus Diesmann, Moritz Helias (2016), “Distributions of covariances as a window into the operational regime of neuronal networks”, arXiv:1605.04153 [cond-mat.dis-nn]

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