Technische Universität München

ENB Elite Master Program Neuroengineering (MSNE)
Invited Presentation

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Connecting the structure and function of neural circuits

Abstract: In this talk, I will describe how we developed deep learning based computational tools to solve two problems in neuroscience: inferring the activity of a neural network from measurements of its structural connectivity, and inferring the connectivity of a network of neurons from measurements and perturbation of neural activity. **1.** Can we infer neural connectivity from noisy measurement and perturbation of neural activity? Population neural activity measurement by calcium imaging can be combined with cellular resolution opto-genetic activity perturbations to enable the mapping of neural connectivity in vivo. This requires accurate inference of perturbed and unperturbed neural activity from calcium imaging measurements, which are noisy and indirect. We built on recent advances in variational auto-encoders to develop a new fully Bayesian approach to jointly inferring spiking activity and neural connectivity from in vivo all-optical perturbation experiments. Our model produces excellent spike inferences at 20K times real-time, and predicts connectivity for mouse primary visual cortex which is consistent with known measurements. **2.** Are measurements of the structural connectivity of a biological neural network sufficient to predict its function? We constructed a simplified model of the first two stages of the fruit fly visual system, the lamina and medulla. The result is a deep hexagonal lattice convolutional neural network which discovered well-known orientation and direction selectivity properties in T4 neurons and their inputs. Our work demonstrates how knowledge of precise neural connectivity, combined with knowledge of the function of the circuit, can enable in silico predictions of the functional properties of individual neurons in a circuit, leading to an understanding of circuit function from structure.

Biography: Srini Turaga is a group leader at the Janelia Research Campus of the Howard Hughes Medical Institute. He was previously a postdoctoral fellow at the Gatsby Unit at University College London, following a PhD from MIT in 2009. His research interests include machine learning and computational neuroscience, with a special focus on connectomics, variational auto-encoders, and deep learning.

The Talk is hosted by Prof. Dr. Jakob Macke (Computational Neuroengineering)

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(Neuroengineering Matinee starts 9:30 a.m.)

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All talks in the MSNE Invited Speaker Series are open to students, staff, and members of the public. Attendance is free.

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