RUHR-UNIVERSITÄT BOCHUM

RUB

IGSN - SYMPOSIUM

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Principles of Brain Wiring

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Modelling the formation of neural circuits

Understanding the principles governing axonal and dendritic branching is essential to unravel the function of single neurons and the way in which they connect. I describe here a formalism that captures the general features of neuronal trees using locally optimised graphs. I then use this formalism to generate synthetic dendrites that replicate morphological features of all tested neurons. Dendrites of different cell types vary only in the shape of the volume that they span and in how they weigh their costs for wiring length and for conduction times. Using the model I derive equations that relate total dendrite length, number of branch points, spanning volume of a dendrite, the number of synapses, and space filling characteristics to each other. These equations hold true for all neurons measured so far and confine the possible computations a dendrite is capable of. Using live imaging of dendrite growth in flies I then describe how biology implements the branching rules that maintain the wiring constraints mentioned above. Finally, I give an outlook describing consequences from single cell wiring rules on the formation of larger neural circuits.

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