

Analysis of Spatio-Temporal Spike Patterns in experimental parallel recordings with SPADE

Stella A. 1, Quaglio P. 1, Grün S. 1,2

a.stella@fz-juelich.de

1 INM-6, IAS-6 & INM-10, Juelich Research Centre, Juelich, Germany

2 Theoretical Systems Neurobiology, RWTH Aachen University, Aachen, Germany

Correlated neuronal activity is considered to be the signature of an active cell assembly, i.e. a group of neurons assumed to comprise the building blocks of information processing in the brain (Hebb, 1949). We suppose that activations of a particular cell assembly are expressed by the repetitive occurrences of precise spatio-temporal spike patterns (STP) composed of member neurons of the cell assembly. In order to detect these patterns, we employ a method called Spike PAttern Detection and Evaluation (SPADE; Quaglio et al. 2017). The method can cope with massively parallel spike data, by first counting repeating STPs using a frequent itemset approach (Torre et al, 2013), followed by a significance evaluation. To avoid massive multiple testing, patterns of the same signature, i.e. number of spikes involved, number of occurrences and pattern duration, are pooled. The significance of each signature is evaluated by comparing the number of patterns of that signature to surrogate data.

We aim to test if a particular assembly is activated in the motor cortex when a particular movement is performed. For doing so, we apply SPADE to simultaneous spike data recorded by a 10x10 Utah array from pre-/motor cortex of two macaque monkeys (Riehle et al. 2013). The animals performed a delayed reach to grasp task. After a preparatory period, they were instructed to pull and hold an object by two possible grips (side grip SG, or precision grip PG) and with two possible force levels (high force HF, or low force LF), giving thus four behavioural conditions. We analyze one session (of 15min) of each of the two monkeys (data publicly available, see Brochier et al, 2018). Each trial type (e.g. SG-HF) is segmented into six epochs of 500ms, each of which are analyzed separately. We find in both monkeys that a) most STPs are found during the movement period; b) all patterns found in this period are composed of different compositions of the same few neurons; c) the pattern compositions vary in the different movement behaviors; d) within one movement condition we find one neuron, that is involved in all the patterns, and e) that its individual spikes participate multiply in different patterns. The latter results suggests to consider these neurons as hub neurons.

Further analysis will include several sessions of the same experiment for each monkey, in order to see if these observations are of general nature.