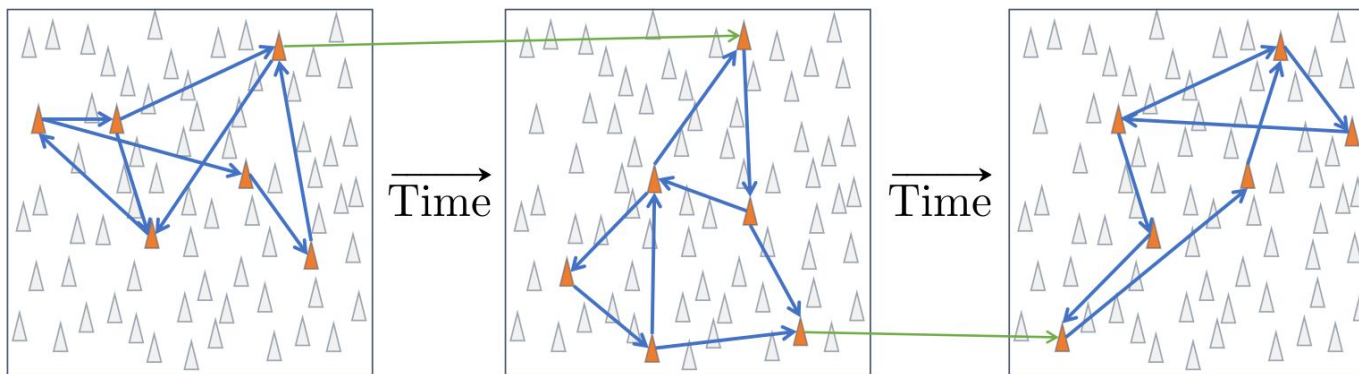# Detection of Spatio-Temporal Patterns in Electrophysiological Recordings of Behaving Monkey

Alessandra Stella[1,2]

1. Institute of Neuroscience and Medicine (INM-6, INM-10), Institute for Advanced Simulation (IAS-6) and Jara Brain Institute I (INM-10), Jülich Research Centre
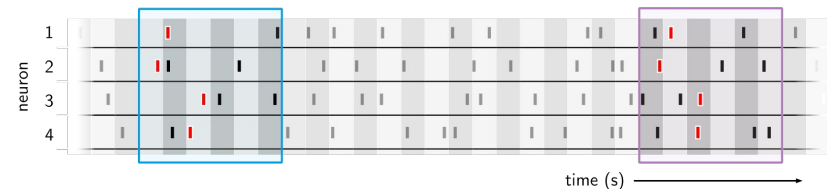2. Theoretical Systems Neurobiology, RWTH Aachen University, Germany

Hebbian assemblies activated over time. Adapted from Bouss, 2019 (Master thesis)
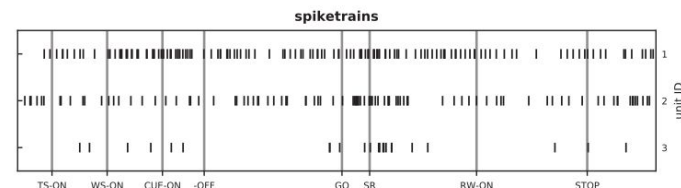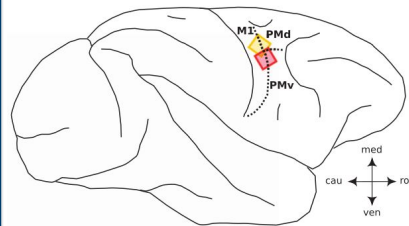
Detection of Spatio-Temporal patterns

Electrophysiological recordings of behaving monkey

Spike trains

neuron

bin size b   window size w

time (s)
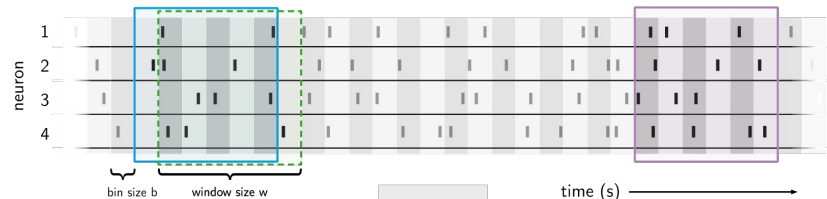
Spike trains with detected pattern

neuron

time (s)

STP detection on parallel spike trains. Adapted from Stella et al. 2019

spiketrains

unit ID

TS-ON WS-ON CUE-ON -OFF   GO SR   RW-ON   STOP

home position   SG   PG

Instructed delay reaching and grasping experiment. One 10x10 Utah electrode array is inserted in pre-/motor cortex of two macaque monkeys. Figures adapted from Brochier et al. 2018. Data from the lab of Thomas Brochier, INT Marseille.

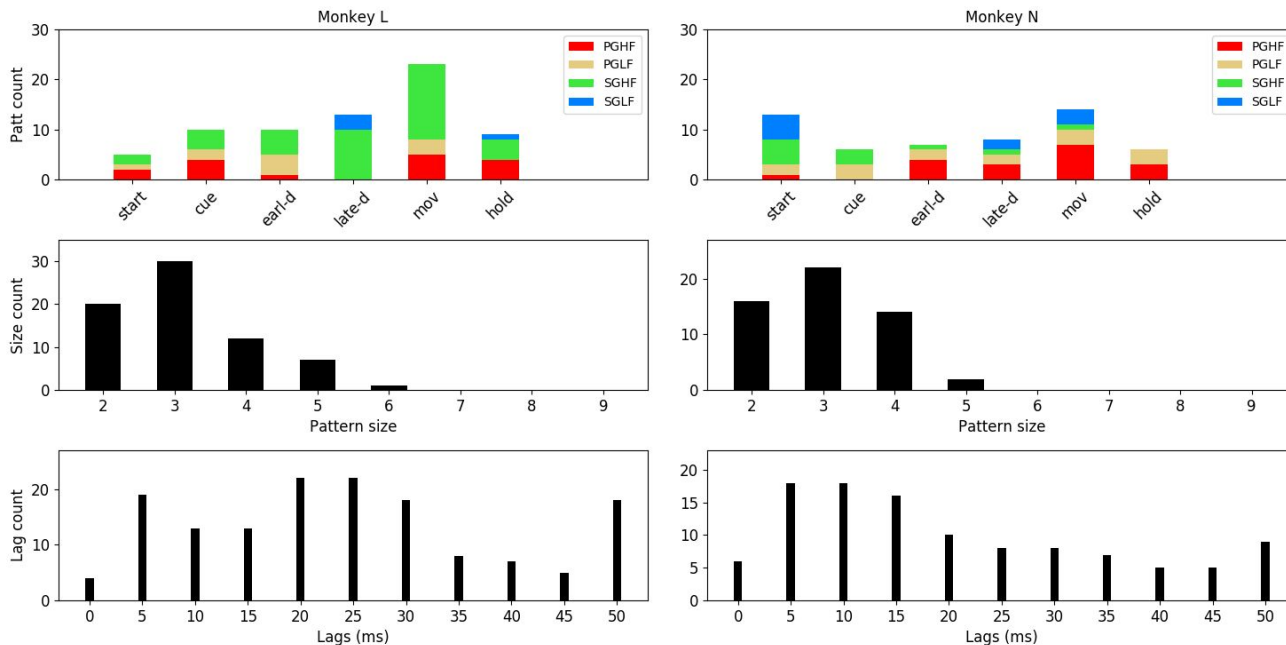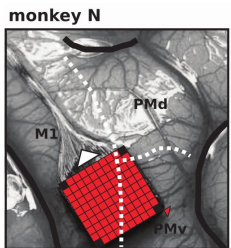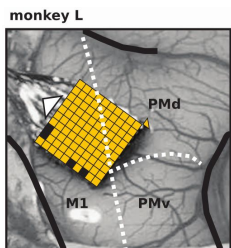a.stella@fz-juelich.de

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SPADE

Spatio-temporal PAttern Detection and Evaluation
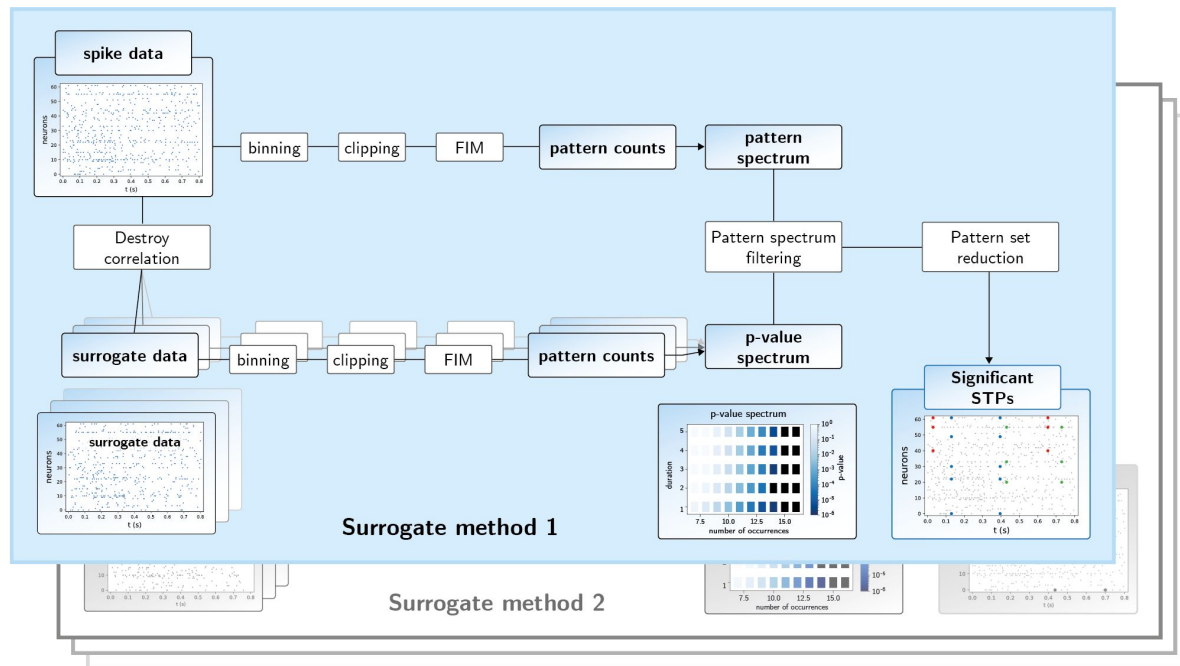
- SPADE **detects Spatio-temporal Spike Patterns** in massively parallel spike trains. (Quaglio et al. 2017)

- Combines
  - an **optimized pattern mining algorithm** (Porrmann et al., in preparation)
  together with
  - **robust statistical testing** (Stella et al. 2019; Stella et al., in preparation)

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Spatio-temporal spike patterns in the macaque motor cortex

We analyzed with SPADE over 20 sessions of the reach-to-grasp experiment (2 monkeys) and found numerous patterns.

Utah electrode arrays implanted in Monkey L and N. Figure adapted from Brochier et al. 2018

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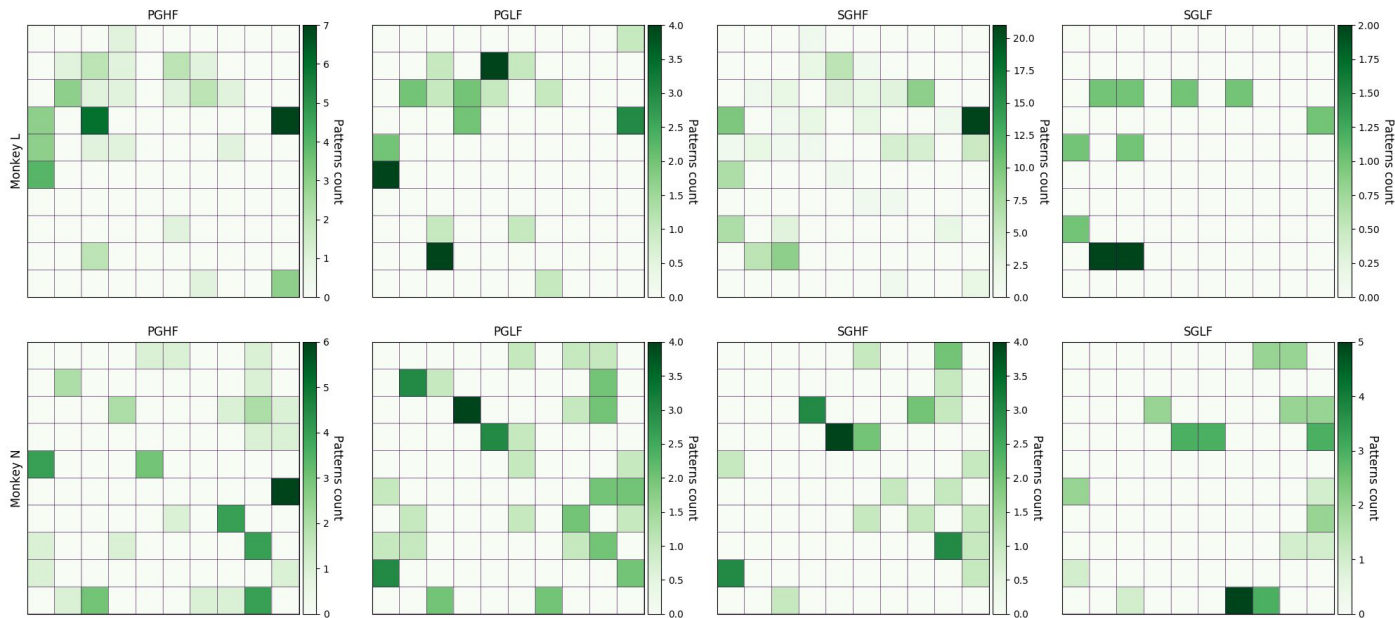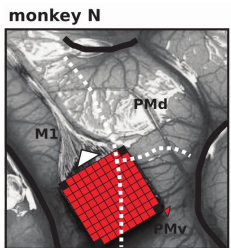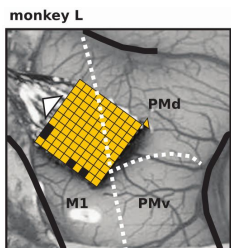# Spatio-temporal spike patterns in the macaque motor cortex

We analyzed with SPADE over 20 sessions of the reach-to-grasp experiment (2 monkeys) and found numerous patterns.
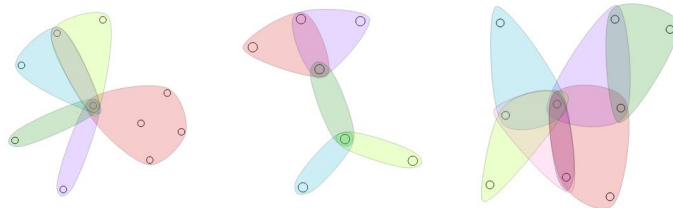

Utah electrode arrays implanted in Monkey L and N. Figure adapted from Brochier et al. 2018

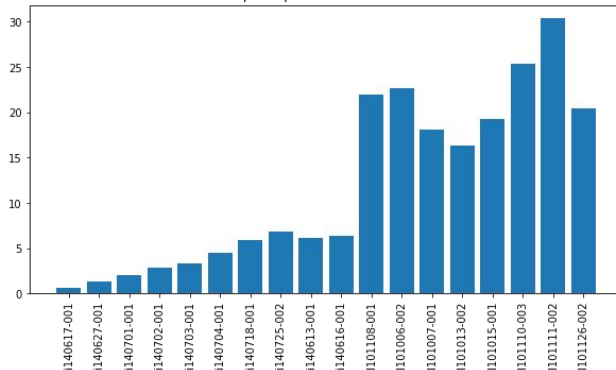a.stella@fz-juelich.de

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Spatio-temporal spike patterns in the macaque motor cortex
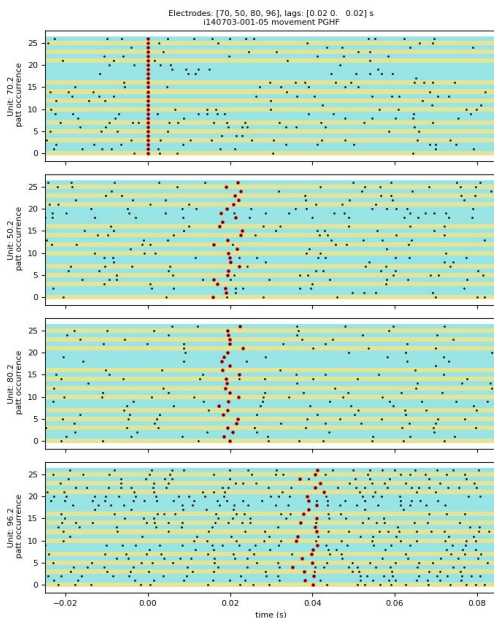
Repeated occurrence over trials of a STP of size 4 aligned on the first spike.

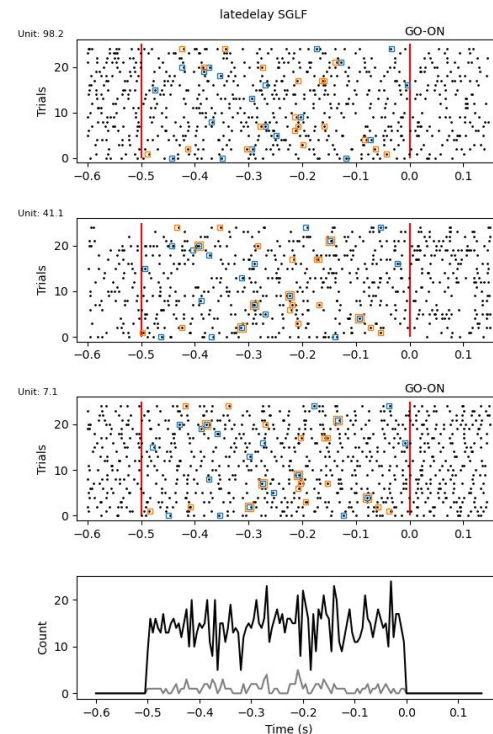Clustering of STPs detected in three experimental sessions. Each dot is a neuron, each color represents a pattern. The hypergraphs show that numerous neurons are involved in multiple STPs.

Percentage involvement of neurons in patterns per session. Percentages are drastically different depending on the monkey.

Two STPs detected within the late waiting segment across trials..

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Conclusions

- We hypothesize that assembly activity is expressed by the occurrence of **precise spatio-temporal patterns of spikes** emitted by neurons that presumably are members of an assembly

- We **developed a method, called SPADE, detecting significant spatio temporal patterns** in massively parallel spike trains

- We **analyzed N=20 experimental sessions** with SPADE consisting of about 100 parallel spike trains recorded by a 10x10-electrode Utah array in the pre-/motor cortex of two macaque monkeys performing a reach-to-grasp task

- Our results show that **spatio temporal patterns occur in all phases of the behavior**

- Patterns are specific to a behavioral condition, suggesting that **different assemblies are activated for each specific behavioral context**

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Thanks for listening

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Special thanks to:

- Prof. Dr. Sonja Grün
- Prof. Dr. Günther Palm
- Peter Bouss
- Dr. Pietro Quaglio
- Dr. Emiliano Torre
- Dr. Alexa Rlehle
- Dr. Thomas Brochier

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