Maximum entropy models reveal the correlation structure in cortical neural activity during wakefulness and deep sleep
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The macroscopic brain states of wakefulness and sleep emerge from rich interactions within networks of neurons at the microscopic scale. Recent experimental advances, through the recording of spikes of up to 10^2 neurons throughout several hours, have permitted the exploration of these dynamics *in vivo*.

To analyse such complest system, one is interested in searching for the simplest model, able to explain the most of the data statistics. This can be achieved by maximisation of entropy in the system, with constraints imposed by the empirical statistics (Jaynes 1982).

Maximum entropy modelling has been applied to the spiking activity of neuronal networks. While the approach had been demonstrated to accurately predict certain patterns of empirical neural activity, we show that existing models (Schneidman 2006, Okun 2015, Gardella 2016) fail to reproduce the strongly synchronous behaviour of inhibitory neurons during sleep (Nghiem 2017).

By accounting for the interactions between each neuron and the excitatory and inhibitory populations separately, we introduce a model able to overcome this pitfall. We investigate this on multi-electrode array recordings in the cortex of a human and a non-human primate (Peyrache 2012, Dehghani 2016).

Our results suggest that neural dynamics during wakefulness are dominated by pairwise interactions, while neural activity during sleep may be governed by longer-range population- wide interactions. Overall, they highlight inhibitory neurons play a fundamental role in organising coherent dynamics in the cerebral cortex during sleep (Nghiem 2018).

This approach provides a powerful framework to take full advantage of neuron type classification, which is becoming increasingly available in empirical data. More generally, our model may prove useful to constrain bio-physically realistic models of wakefulness and sleep.

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