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Poster presentation

The representational capacity of cortical tissue

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The ability to make distinctions is one of the fundamental capacities underlying cognition, from perception through abstract (categorical) thought. The distinctions a cognitive system is capable of making, should be manifested in its neural activity. Given a set of distinctions, the natural question that arises is whether this imposes constraints on the activity spaces which could embed such a set. We hypothesize that an activity space can embed a given set of distinctions only if its structure corresponds in some sense to the set of distinctions (that is it does not cause collapse of distinctions or undue elaborations within domains or clusters). Thus, we reason that the homology of an activity space approximates the rough structure of the underlying set of distinctions that is realized by the system's activity. Therefore, we refer to the structure of a given activity space as its representational capacity.

Thus we hypothesize that there will be a disparity in representational capacity between different states of arousal (for example wakefulness as compared to sleep). In other words, that the structure of activity spaces becomes progressively more complex as arousal increases. To test this hypothesis we analyzed voltage sensitive dye imaging [1] data obtained from the primary visual cortex of behaving primates:

1) Instances of activity were registered at different states of vigilance (anesthesia/covered eyes/visual stimulation). We conjecture that what constitutes a state in terms of activity is similarity (invariance) in the structure of instances of activity. Thus, real (structure sensitive) functions could be utilized to classify activity according to state.

2) The level sets of the typical value corresponding to a state were calculated explicitly within a boundary of ε from the set of measurements

3) Finally, the persistent Betty numbers of such level sets, which give the rank of the corresponding homology groups, and the corresponding statistics were computed following [2-5].

Indeed, it was found that activity is an invariant of state – activity becomes less random, more regularly distributed in space and time, more correlated, and has typical distribution of spectral energy in specific spatial-temporal bands, as arousal increases. These phenomena are very robust and thus allow not only perfect classification of activity according to state, but also noticeable confidence margins. Moreover the representational capacity of the imaged cortical tissue increased with arousal – that is the structure of activity space tends to be more complex as arousal increases.

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