STATISTICAL SIGNIFICANCE

Our brains respond to environmental information with rapid changes in neural activity called action potentials or "spikes". When stimuli in the environment change, the spiking pattern will also change. By accurately modeling the relationship between the stimulus and spiking, we may be able to decode the mind.

LIE TO ME…

Reading Minds From Neural Spikes

As living human beings, we receive information from environment every minute and second. Neurons respond and process this information by electrical activities. When there's a stimulus, there will be a rapid impulse change in the membrane voltage of the neuron, which is called as an action potential or a "spike". When the stimulus changes, the neural spiking pattern will also change.

What if we make use of this in a reverse way? By tracking the spikes from an area of someone's brain, we can magically become a "mind reader" to some degree. This reverse process is technically called "decoding". Usually, there are consistent relationships between spiking and stimuli in the environment, but the number of spikes that occur may vary each time the same stimulus is presented.

Powerful Decoder: Mean and Variance

Currently, most traditional decoders tries to "read mind" by tracking the mean of spike counts purely, which may loose too much information. There is growing experimental evidence suggesting that the variability of neural activity changes over time and may also provide information about the external world. Moreover, most of these elder decoders assume equal variance and mean spike counts, i.e. the neural variability is Poisson distributed. This is far from real situation, even in the controlled settings.

If we can flexibly track both mean and variance, we may be able to develop a more powerful decoder. Our decoder achieves this by assuming the spiking counts are Conway-Maxwell-Poisson (CMP) distributed, which is a flexible distribution that can handle different mean-variance relationships.

Beyond Mind Reading: Strange Brains

To read the mind from neural spikes, we fundamentally assume our brains' reactions to the same stimulus stay the same from one moment to the next. In controlled experiment, the spiking patterns of neuron may sometimes change from trial to trial!

Although in this case, tracking spiking activities in terms of mean and variance no longer makes us become a great "mind reader", it is more meaningful for scientific development— it helps us detect unexpected side of brains and push the boundary of knowledge to our own mind.■