STATISTICAL SIGNIFICANCE

The way our brains respond to environmental information is rapid change in neuronal electrical activities, and the rapid impulse response is called the neural spike. When the surrounding stimulus change, the spiking pattern will also change. In reverse, if we can extract information from this pattern efficiently, we may become a great "mind reader".

LIE TO ME…

Read Mind From Neural Spikes

As living human beings, we receive information from environment every minute and second. Our brains "choose" to respond and process these 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 change, 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".

Powerful Decoder: Mean and Variance

Currently, most elder 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, no wonder we will be a more powerful decoder. Some decoders have tried to allow variance be larger than mean. The final piece is when the variance is less than mean. Our decoder achieve 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 mind from neural spikes, we fundamentally assume our brains' reactions to the same stimulus stay the same from one moment to the next. However, this is not true even within a short time range. In the 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.■