University of Zurich[UZH]

Department of Economics – Neuroeconomics Seminar

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Unified theoretical explanations of puzzling error characteristics in human perception and memory

Measuring and interpreting errors in behavioral tasks play a critical role in understanding cognition. This talk will discuss two lines of investigations for understanding the characteristics of errors observed in perception and memory tasks.

The first part of the talk will focus on the biases in perception. To understand these biases, previous work has proposed a number of conceptually different and even seemingly contradicting ingredients, including attraction to a Bayesian prior, repulsion from the prior due to efficient coding, and central tendency effects on a bounded range. I will present a unifying Bayesian theory of biases in perceptual estimation. We theoretically demonstrate an additive decomposition of perceptual biases into attraction to a prior, repulsion away from regions with high encoding precision, and regression away from the boundary. The results reveal a simple and universal rule for predicting the direction of perceptual biases. Our theory accounts for, and leads to new understandings of biases in the perception of a variety of stimulus attributes, including orientation, color, and magnitude.

The second part concerns the global shape of error distributions in estimation tasks. I will present a new theory for explaining the heavy-tail error distribution observed in various visual short-term memory tasks. We find that the shape of error distribution in Bayesian estimation is determined by the geometrical structure of the neural representation via a simple rule. In the case of high-dimensional geometry, the error distributions should naturally exhibit flat tails. This simple theory can account for a large array of visual short-term memory data with only two free parameters: one represents the magnitude of the noise; the other captures the geometry. These results demonstrate that the geometry of the representation represents a critically important, yet under-appreciated factor in determining error characteristics of human behavior.