Quantifying information flow in single cells

Cells guide their decisions relying on the information that streams through the signalling pathways into the cellular interior. Signalling pathways are interconnected cascades of biochemical reactions which form complex networks. Given the variety of cellular behaviours which can result from stimulations of a single pathway, the ability to distinguish between a multitude of signals is expected. However, existing quantifications of cellular information flow reported low sensitivity for graded signals. Here, we study information flow in MAPK (ERK) pathway, one of key signalling pathways in eukaryotes. Combining optogenetic experiments and data analysis based on information theory, we quantify the input-output relationships between the receptor and ERK. Next, we discuss the role of intracellular and extracellular noise, stochastic activations of the pathway and the temporal aspects of information processing in the cell. We show that the signalling pathway can rely higher amounts of information than previously reported, as well as discuss the spatio-temporal aspects of information flow in a cellular population.