Optimal cue integration with spiking neurons: time into the picture

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Recent evidence suggests that humans are able to take into account the reliability of multiple cues when they combine them in order to make perceptual decision or motor actions. This suggests that they are able to perform basic probabilistic computation and Bayesian inference. However, experimental tests have usually tackled extremely simplistic problems, i.e. static stimuli from different modalities to infer the state of a single variable, i.e. position. This is a very small subset of the statistical problem the brain has to solve, and in particular, inference have to be performed in time, for events that occur and change unpredictably, using sensory inputs compatible with several conflicting interpretations.

In this study we will consider a more general cue integration problem, i.e. the integration of cues that could have been caused by several time varying events. We model temporal dynamics of the cues by hidden Markov models. We show that this integration could be easily learned and performed by networks of integrate and fire neuron, and that, in turn, assumptions about the dynamics of the cause and the reliability of the cues and embedded in the biophysical properties of these neurons. These provide of very rich set of prediction, in particular, how partially conflicting cues interact over time, as a function of their temporal statistics in the natural world or the properties of the neural system that performs this integration.