Context separation of spatiotemporal haptic signals by second-order somatosensory neurons

During haptic exploration a wealth of stimuli targets the human fingertips, and the forces applied to the skin produce complex non-linear deformations that must be interpreted by the nervous system through the signals sent by the mechanoreceptors innervating the epidermis. In this talk we will focus on optimal feed-forward encoding/decoding of tactile signals at the early stages of the somatosensory pathway. In particular, we will investigate the role played in this process by the cuneate nucleus (CN), which constitutes the first synaptic relay between the periphery and the central nervous system.

We will present a theoretical analysis stressing the importance of the relative spike timing of the signals processed by the CN. On the one hand, a novel information-theoretical measure, which has been derived analytically to assess haptic discrimination downstream the CN, will be described. On the other hand, the context separation of spatiotemporal signals at the CN level will be addressed with the aid of a computational model that allows us to simulate a large network of CN cells by a population of probabilistic spiking neurons.

The theoretical framework presented is studied in the presence of two data sets. First, we employ as inputs to our putative CN network the spatiotemporal responses of real mechanoreceptors recorded via microneurography experiments in humans (data by R. Johansson) and then we use a set of spike trains generated by transducing the analogue readouts of an artificial touch sensor into spiking activity.