Computational modelling is playing an increasing role in neuroscience research by providing not only theoretical frameworks for describing the activity of the brain and the nervous system, but also by providing a set of tools and techniques for better understanding data obtained using various recording techniques. The focus of this thesis was on the latter - using computational modelling to assist with analyzing measurement results and the underlying mechanisms behind them.

The first study described in this thesis is an example of the use of a computational model in the case of intracellular in vivo recordings. Intracellular recordings of neurons in vivo are becoming routine, yielding insights into the rich sub-threshold neural dynamics and the integration of information by neurons under realistic situations. In particular, these methods have been used to estimate the global excitatory and inhibitory synaptic conductances experienced by the soma. I first present a method to estimate the effective somatic excitatory and inhibitory conductances as well as their rate and event size from the intracellular in vivo recordings. The method was applied to intracellular recordings from primary motor cortex of awake behaving mice.

Next, I studied how dendritic filtering leads to missetimation of the global excitatory and inhibitory conductances. Using analytical treatment of a simplified model and numerical simulations of a detailed compartmental model, I show how much both the mean, as well as the variation of the synaptic conductances are underestimated by the methods based on recordings at the soma. The influence of the synaptic distance from the soma on the estimation for both excitatory as well as inhibitory inputs for different realistic neuronal morphologies is discussed.

The last study was an attempt to classify the synaptic location region based on the measurements of the excitatory postsynaptic potential at two different locations on the dendritic tree. The measurements were obtained from the in vitro intercellular recordings in slices of the somatosensory cortex of rats when exposed to glutamate uncaging stimulation. The models were used to train the classifier and to demonstrate the extent to which the automatic classification agrees with manual classification performed by the experimenter.