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Automatic Control and Systems Engineering

The Department of Automatic Control & Systems Engineering
is pleased to announce the following seminar:

Reconstruction, identification and implementation methods for spiking neural circuits

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The University of Sheffield

Wednesday, 7 December 2016 at 14:00
LT02, Sir Henry Stephenson Building

Abstract
One of the 14 grand challenges for engineering in the 21st century, as proposed by the National Academy of Engineering in the US, is the "reverse engineering" of the brain. Understanding how the brain works will enable researchers to simulate its activities, leading to more accessible and flexible testing solutions for biotechnology products tackling brain disorders, such as Alzheimer's and Parkinson's disease. The neurons in the brain respond to analog inputs with action potentials, or spikes, which are generated when the neuron membrane potential exceeds a threshold value. In this talk, I will address three important information processing and modelling problems, detailed as follows. The encoding performed by the integrate-and-fire (IF) neuron model has been studied using the nonuniform sampling theory. I will present a new framework which reformulates the IF time encoding problem as a uniform sampling problem. This framework forms the basis for new algorithms for reconstructing signals from spike time sequences, shown numerically to be faster, and thus better suited for real-time processing, while providing a similar level of accuracy, compared to the standard reconstruction algorithms. Furthermore, this presentation will also include two new recent approaches, with fewer assumptions than the approaches in the literature, for the identification of neural circuits comprising filters in series with spiking neurons. The first step for both of the new approaches involves the estimation of the spiking neuron parameters. In the second step, the structure and the parameters of the filter are inferred using the NARMAX identification methodology. The third problem that I will address in this talk is the lack of a general theory to characterize the processing of information by circuits that operate with spike trains. I will present a recent result that develops a direct relationship between the input and output of an arbitrary linear filter, both encoded into spike times sequences by an IF neuron model. Based on this relationship, I will present a new algorithm for computing the output spike times sequence directly from the input spike time sequence.

Biography
Dr Dorian Florescu is a Postdoctoral Research Fellow in the Department of Automatic Control and Systems Engineering at the University of Sheffield, working on the 'Digital Fruit Fly Brain' project, funded jointly by BBSRC and the National Science Foundation. He was awarded the PhD degree in Automatic Control & Systems Engineering from the University of Sheffield in 2016. Prior to joining the University of Sheffield in 2011, he was awarded the BEng degree in Systems Engineering from the Technical University of Iasi, Romania, in 2011. His research concerns the identification of neural circuits, as well as information processing in neuroscience.

Light refreshments will be served in the
foyer of the Sir Henry Stephenson Building following the seminar