2017 CELSIUS-LINNÉ SYMPOSIUM  
February 10th 2017 in the The Svedberg Hall, the Biomedical Centre, Uppsala University

Behavior and pattern  
- complexity made simple

A Multi-Disciplinary Symposium

09:30  INTRODUCTION

09:35  PETER L. STRICK (Linné Lecturer)  
Evolution of the cortical control of movement: Why rodents can’t play the violin

10:25  JOHN GUCKENHEIMER (Celsius Lecturer)  
Mixed Mode Oscillations

11:15  ÅSA MACKENZIE UPPSALA UNIVERSITY  
Casting new light on the brain reward system: Identification of unique subpopulations enables physiological mapping of a multifunctional brain area

11:50  LUNCH BREAK

13:00  DAVID SUMPTER, UPPSALA UNIVERSITY  
The dynamics of animal groups, social segregation and association football

13:35  PER ENGSTRÖM, UPPSALA UNIVERSITY  
Humans or Econs – Using Register Data to Detect Misbehaving

14:10  RAAZESH SAINUNDIIN, UPPSALA UNIVERSITY  
Models of meme transmissions in the twitterverse

14:45  CONCLUDING DISCUSSION

15:10  COFFEE AND CAKE
DISTINGUISHED PROFESSOR PETER L. STRICK,  
SCHOOL OF MEDICINE, UNIVERSITY OF PITTSBURGH, USA

Evolution of the cortical control of movement: Why rodents can’t play the violin

Why are our motor skills so much more advanced than those of a rodent? What has changed in the human brain to allow us to perform complex motor tasks such as typing, playing a musical instrument, and performing gymnastics. This presentation will describe our recent evidence that new motor capabilities emerge not only because we have a larger brain, but also through the addition of new areas of the cerebral cortex. One new area contains output neurons that directly control the activity of motoneurons in the spinal cord. This cortical pathway enables humans to generate highly fractionated patterns of muscle activity such as those required for relatively independent movements of the fingers. The second addition is a set of cortical areas that are responsible for learning and performing complex motor sequences. Thus, rodents can’t play the violin because they lack areas of the cerebral cortex that are essential for learning and performing sophisticated motor skills.

PROFESSOR JOHN GUCKENHEIMER,  
MATHEMATICS DEPARTMENT, CORNELL UNIVERSITY, USA

Mixed Mode Oscillations

Mixed modes are oscillations that alternate between two distinct amplitude ranges. They were observed in chemical reactions thirty-five years ago and intensively studied at that time. Attempts to analyze differential equations models and fit these models to empirical data had mixed success. Recent work with Mathieu Desroches, Bernd Krauskopf, Christian Kuehn, Hinke Osinga, and Martin Wechselberger has produced new insight into how small amplitude oscillations of many MMOs arise from the interactions of different time scales. This lecture will present an overview of this work, including associated advances in the geometric theory of dynamical systems with multiple time scales and numerical methods for computing geometric objects that are significant for characterizing MMOs. One of the striking discoveries in this work are new types of bifurcations found on the boundaries of parameter regions where MMOs occur.

PROFESSOR ÅSA MACKENZIE  
DEPARTMENT OF ORGANISM BIOLOGY, MOLECULAR PHYSIOLOGY, UPPSALA UNIVERSITY

Casting new light on the brain reward system: Identification of unique subpopulations enables physiological mapping of a multifunctional brain area

The midbrain dopamine system is an essential part of the brain reward system and dopamine is also important for emotional memory formation, motivation and volitional movement. Parkinson’s disease is caused by neurodegeneration of the dopamine system and several neuropsychiatric disorders, including addictions and depression, can often be correlated with a dysfunctional dopamine system. While it has long been believed that the dopamine system is homogeneous, the multiple functional roles of the system suggest otherwise and today it is recognised that the dopamine system is heterogeneous both in terms of signalling and brain targets. In our lab, we have found that the dopamine system of both mice and humans consist of several subpopulations that can be identified by distinct gene expression patterns. We are currently exploring how these unique subpopulations contribute to behaviors associated with the brain reward system and also how these are associated with, and potentially can be of importance for, disorders of the dopamine system and their treatment.
Fish schools and ant trails are excellent illustrative examples of collective behaviour. Thousands or millions of individuals interact with each other and create a pattern, a fish school or an ant trail network, on a scale much larger than the individual animals. We have developed a systematic approach to studying these phenomena. We start with a relatively naive mathematical model, such as a self-propelled particle model, of how individuals interact and show how the patterns 'emerge' from individual interactions. We then work with experimental biologists to better understand the details of these interactions, typically using Bayesian methods to choose between competing models. By gradually refining our model we have gained insight into bird navigation, fish schools, ant trails and human crowds. We are currently applying the same methods to studying ethnic segregation, combining experiments in classrooms with longitudinal studies of segregation between Stockholm schools. Finally, I give a few remarks about how a similar approach can be used to solve the difficult (but to many people highly fascinating) problem of understanding team performance in football.

Humans or Econs – Using Register Data to Detect Misbehaving

Economics traditionally model humans as egoistic creatures with infinite deductive abilities – often called Econs. However, the last 40 years research has seen an explosion in the study of actual human behavior and how it, sometimes dramatically, deviates from the stylized behavior of Econs. Laboratory studies show that humans are less egoistic but more easily fooled (especially by randomness) than Econs. My research tries to take the study of human decision making out of the lab and into the field. Sweden has unique register data that may allow for the study of biases in human decision making (misbehaving) that otherwise only can be studied in the lab.

Models of meme transmissions in the twitverse

We explore twitter data around the US Presidential election to shed light on political echo-chambers. Transmissions of political and ideological memes are formalised as tweet transmission trees over a retweet-based ideological networks of individuals. Using various scalable distributed programs we discover community and network structures across left, right, alt-right and extremist groups classified by the US Southern Poverty Law Center. Our models can shed some light on the existence and stability of political echo-chambers in the current political landscape of “post-truth America”.

This is joint work with Akinwande Atanda, Kyle Nash, Ivan Sadikov, Rania Sahioun, Kumar Yogeeswaran, and Amandine Veber.