Mathematical Neuroscience Edinburgh 2012
Tutorials, Sunday March 4th

13.00 – 13.15 Introduction by Steve Coombes and Mark van Rossum
13.15 – 14.15 Martin Wechselberger
14.15 - 15.15 Rachel Kuske
15.15 - 15.45 (break)
15.45 - 16.45 Claudia Clopath
16.45 - 17.45 Fred Wolf
17.45 Beer and pizza

Note that Tutorials are in a **different** place from the main meeting.
Location: Rm. G.07 Informatics Forum, Crichton Street, EH8 9AB (marked on map with circle).
It is a 15 min walk from the Edinburgh Waverley train station, which is also the last stop of the airport bus.

Sponsored by the EPSRC Doctoral Training Centre for Neuroinformatics and Computational Neuroscience

Martin Wechselberger
Multiple time-scale analysis of physiological models

Many models of physiological processes have the feature that one or more state variables evolve much faster than the other variables. Classic examples are neural activities such as bursting and spiking, and intracellular calcium signalling. In many of these models, the time scale separation becomes apparent in the form of a small dimensionless parameter (often denoted by ε) after non-dimensionalisation of the model that brings it into a standard slow-fast form. Geometric singular perturbation theory (GSPT) forms the mathematical foundation for the analysis of these multiple time scales problems. Perhaps the best-known instance of the use of GSPT in this way is the analysis of the famous Hodgkin-Huxley (HH) model of the (space-clamped) squid giant axon by FitzHugh.

In this tutorial, I will review GSPT, apply this theory to conductance based (Hodgkin-Huxley type) models and show that `canards' play an important role in understanding observed complex dynamics known as mixed-mode oscillations.

References:
There is a review paper (preprint) that can be found on
- M. Desroches, J. Guckenheimer, B. Krauskopf, C. Kuehn, H. Osinga, M. Wechselberger, Mixed-mode oscillatons with multiple time-scales, SIAM Review (to appear). See http://www.maths.usyd.edu.au/u/wm/wm-web/info.html

Another paper with some relevant material is:
- W. Zhang, V. Kirk, J. Sneyd and M. Wechselberger, Changes in the criticality of Hopf bifurcations due to certain model reduction techniques in systems with multiple timescales, J. of Mathematical Neuroscience 1 (2011), 9. A

Fred Wolf
TBA

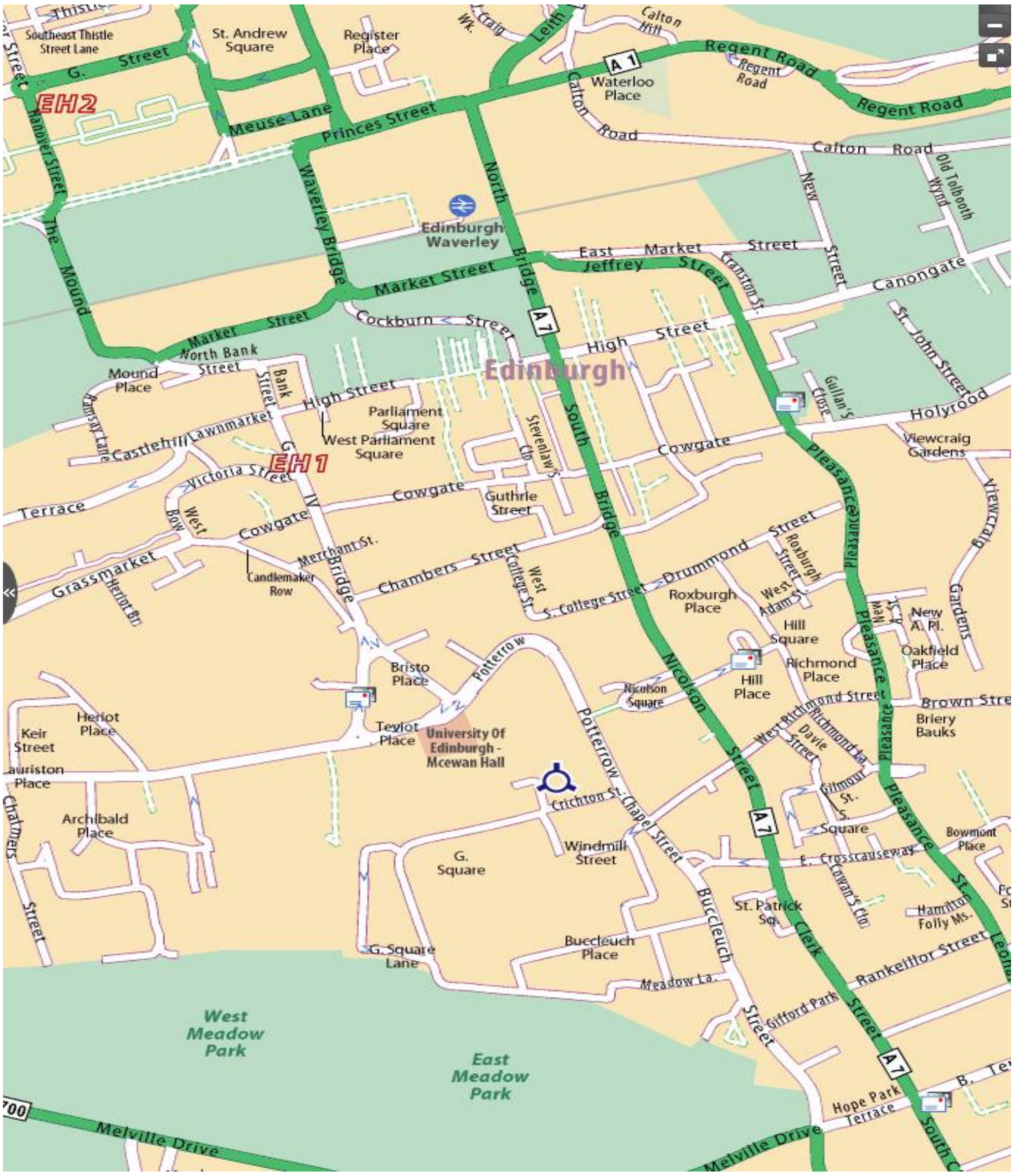
Rachel Kuske
Noise-induced phenomena in neuro models

The tutorial will review some basic mechanisms that lead to noise-induced phenomena. We will review some simple models that exhibit qualitative changes in neural dynamics due to stochastic effects. We will especially focus on some cases where the noise-induced behaviour may be difficult to distinguish from deterministic phenomenon, and show some basic measures that can be used to identify and quantify the effects of the noise.

References:
- C.B. Muratov and E. Vanden-Eijnden, Noise-induced mixed-mode oscillations in a relaxation oscillator near the onset of a limit cycle, Chaos, 18 (2008), 015111.
- A.S. Pikovsky and J. Kurths, Coherence resonance in a noise-driven excitable system, Phys. Rev. Lett., 78 (1997), 775–778.
- Noise-induced coherence and network oscillations in a reduced bursting model, S. Reinker, Y.X. Li, and R. Kuske, Bull. Math. Bio, 68, 2006, 1401-1427.
- R. Kuske, ``Competition of noise sources in systems with delay: the role of multiple time scales", J. Vibration and Control, 7, 2010.
- G. B. Ermentrout, R. F. Galán and N. N. Urban (2008). Reliability, synchrony and noise. Trends in Neurosciences, 31(8):428-434.
- P. Borowksi and R. Kuske, Characterizing Noisy Mixed Mode Oscillations in Neuron al Models, Chaos, 20, 2010, 043117. Bull. Math Bio.

Claudia Clopath
Modeling Synaptic Plasticity

This tutorial will cover different aspects of learning in the brain, in particular synaptic plasticity. I will talk about the difference between supervised, unsupervised and reinforcement learning. Various plasticity experiments will be explained as well as the zoo of plasticity models.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Meuse Lane
Princes Street
Calton Road
Calton Road
New Street
Old Tolbooth Wynd
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North Bridge
Edinburgh Waverley
East Market Street
Jeffrey Street
Cranston St.
Canongate
The Mound
Market Street
Market Street
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Pleasance
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Candlemaker Row
Grassmarket
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West Adam St.
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