

Network Dynamics M4A38 Advanced Dynamical Systems

Here are notes on the course content. More details (assessment etc) will be provided shortly. Any questions to mikefield@gmail.com. Provisional schedule is at the end.

The course will be about *dynamics on networks*. We consider various approaches: from physics, engineering, and mathematics and their range (and lack) of applicability to real problems in the physical sciences, and technology. The basic question is that of understanding the *function* of a complex network — how it works and figuring out why it works well.

This is a hard problem.

Topics covered will include:

1. The concept of a network and basic examples (mainly without dynamics). *Invariants* (adjacency matrices, degrees, network graph, etc) and some key definitions (all-to-all coupled, scale free network, hubs, etc).
2. Dynamics (continuous, discrete, hybrid, random). Mainly a review.
3. Reduction to phase oscillator dynamics. Kuramoto systems. Mean field approach. (**Physics** viewpoint.) Some mathematics but concentration on the ideas.
4. Synchronization and Synchrony in networks. Chimeras.
(What can and cannot — yet — be proved.) What is hard.
5. Coupled cell systems. Heterogeneous systems, heteroclinic cycles and networks, bifurcation.
(**Mathematics** viewpoint.) Relevance?
6. Control and delay.
(Surprises.)
7. Spike timing dependent plasticity: relative timings.
(Biology problems: applicability of physics & mathematics viewpoints. Local time.) Unravelling the complexity.
8. Asynchronous networks and event driven dynamics I: motivation and examples.
(**Engineering** viewpoint.)
9. Asynchronous networks and event driven dynamics II: Functional networks; theory and reductionism revisited. Results.

Extensive notes will be provided.

Provisional schedule and rooms

October 14	13:00–15:00 Room 139
October 21	13:00–15:00 Room 139
October 28	13:00–15:00 Room 139
November 4	13:00–15:00 Room 642 [<i>Note room change</i>]
November 11	13:00–14:00 Room 139 [<i>Note time</i>]
November 18	13:00–15:00 Room 642
November 25	13:00–15:00 Room 642
December 2	13:00–15:00 Room 130 [<i>Note room change</i>]
December 9	13:00–15:00 Room 130
December 16	13:00–15:00 Room 642

Prof Michael Field, October 7, 2015.