General information

The conference will take place in the People's Palace (building 33 on the map that can be found here) on the Mile End campus of Queen Mary, University of London. The lecture room "Skeel" is located on the top floor of this building, while the lecture rooms People's Palace 1 (PP1) and People's Palace 2 (PP2) are located in the basement of the building. All lecture rooms can be reached via the stairwell in the Lobby of the People's Palace.

Social programme

Welcome reception

A welcome reception will take place on Monday 22nd June from 19.00-20.30, on or near the campus. Further information on the venue will be announced during the conference. Drinks tickets will be provided at registration.

Conference banquet

The conference banquet will take place on Tuesday 23rd June at 20.00 in the Trafalgar Pub in Greenwich. Further information about travel arrangements to the venue will be provided during the conference. Extra banquet tickets can be purchased for £60 at the conference desk on Monday 22nd June.

Internet access

Wireless internet access will be available around the conference area.

Acknowledgment

The CHAOS09 logo: the City of London along the Mile End Road – a view from the Mathematical Sciences building, by courtesy of Carl Murray.

Monday 22nd June

10.00-13.30	Registration	
11.00-12.00	IPC Meeting	
12.00-13.30	Lunch	
13.30-13.50	Opening	
14.00-15.00	MA1 Plenary Lecture E. Mosekilde	
15.00-15.30	Tea	
15.30-17.50	MB1 Mathematical modelling of neural systems (inv.)	MB2 Synchronization
19.00-20.30	Reception	

Tuesday 23rd June

9.00-10.00	TA1 Plenary Lecture W. Michiels	
10.00-10.30	Coffee	
10.30-12.30	TB1 Dynamics of piecewise smooth systems (inv.)	TB2 Communication
12.30-14.00	Lunch	
14.00-15.00	TC1 Chaos theory	TC2 Discontinuous systems
15.00-15.30	Tea	
15.30-17.30	TD1 Current challenges in chaos from biosystems to signal transmission (inv.)	TD2 Applications and experiments
20.00	Conference banquet	

Wednesday 24th June

9.00-10.00	WA1 Plenary Lecture M. di Bernardo	
10.00-10.30	Coffee	
10.30-12.30	WB1 Time delay systems (inv.)	WB2 Bifurcations
12.30-14.00	Lunch	
14.00-16.00	WC1 Computation and artificial intelligence	WC2 Control design
16.00-16.10	Closing ceremony	

13.30-13.50 Opening

Skeel

13.30-13.35

Opening remarks by the General Chair of CHAOS09, H.J.C.Huijberts

13.35-13.50

Opening by the Acting Principal of Queen Mary, University of London, Prof P.E. Ogden

15.30-17.50 MB1 Mathematical modelling of neural systems (inv.)

People's Palace 1

Organizers: H. Nijmeijer, I. Tyukin
Chairs: H. Nijmeijer, I. Tyukin

15.30-15.50
Coupled maps as tool for modeling human information processing: issues of readout (inv.)
D. Archer, M. van Someren, C. van Leeuwen

15.50-16.10
Emergence of spiking activity in a network of synaptically coupled neurons with axonal delays (inv.)
V.B. Kazantsev, I.V. Mukhina, Y.V. Zaytsev, M.O. Galkina

16.10-16.30
Delayed feedback in an excitable stochastic neuron model: renewal theory approach (inv.)
A. Pototsky, N. Janson

16.30-16.50
Model of the tadpole spinal cord: The interplay of deterministic and stochastic processes in development of specialised neural circuit (inv.)
R. Borisyuk

16.50-17.10
Semi-passivity and synchronization of neuronal oscillators (inv.)
E. Steur, I. Tyukin, H. Nijmeijer

17.10-17.30
Complete stability in networks with counter-clockwise neural dynamics (inv.)
D. Angeli

17.30-17.50
Modelling and estimation of chaotic biological neurons
R. Vepa

15.30-17.50 MB2 Synchronization

People's Palace 2

Chairs: M. di Bernardo, C. Cruz-Hernández (TBC)

15.30-15.50 *Delay-dependent adaptive synchronization of master-slave systems with mixed time-delays and nonlinear perturbations*
H.R. Karimi, M. Zapateiro, N. Luo

15.50-16.10 *Synchronization of a modified Chua's circuit and its application to communication*
O.R. Acosta del Campo, C. Cruz-Hernández, R.M. López-Gutiérrez, E.E. García-Guerrero

16.10-16.30 *Synchronization of two non-identical hyperchaotic circuits*
A. Buscarino, L. Fortuna, M. Frasca

16.30-16.50 *Synchronization of complex networks via hybrid adaptive coupling and evolving topologies*
P. de Lellis, M. di Bernardo

16.50-17.10 *Controlling ideal turbulence: Stabilization and synchronization of time-delayed Chua's circuits*
M. Susuki, N. Sakamoto, K. Naito

17.10-17.30 *Dynamic behaviour of two coupled Lorenz systems*
M. Camplani, B. Cannas, P. Carboni

17.30-17.50 *Experimental synchronization of non-identical chaotic circuits*
A. Buscarino, L. Fortuna, M. Frasca, G. Sciuto

10.30-12.30 TB1 Dynamics of piecewise smooth systems (inv.)

People's Palace 1

Organizers: P. Kowalczyk, J. Sieber
Chairs: P. Kowalczyk, J. Sieber

10.30-10.50 *Robustness of grazing-sliding bifurcations in hybrid systems (inv.)*
P. Kowalczyk, J. Sieber

10.50-10.10 *Dynamics of the archetypal piecewise linear oscillator close to grazing (inv.)*
J. Ing, E. Pavlovskaia, M. Wiercigroch

11.10-11.30 *Two-folds in nonsmooth dynamical systems (inv.)*
M.R. Jeffrey

11.30-11.50 *Hybrid modelling of a discontinuous dynamical system including switching control (inv.)*
E.M. Navarro-López

11.50-12.10 *Smooth and nonsmooth tangencies in a gear model with impacts (inv.)*
P.T. Piiroinen, J.F. Mason

12.10-12.30 *Border collision of non-hyperbolic fixed points (inv.)*
A. Colombo, F. Dercole

10.30-12.30 TB2 Communication

People's Palace 2

Chairs: S. Čelikovský, X. Xia

10.30-10.50 *A novel chaotic encryption technique for secure communication*
R. Kharel, K. Busawon, Z. Ghassemlooy

10.50-10.10 *A chaos-based CDMA scheme with a chaos-based encryption algorithm*
X. Liang, J. Zhang, X. Xia

11.10-11.30 *Estimation of nonuniform invariant density chaotic signals with applications in communications*
M. Eisencraft, M. Almeida do Amaral

11.30-11.50 *Efficient cascaded 1-D and 2-D chaotic generators*
H. Noura, S. Henaff, I. Taralova, S. El Assad

11.50-12.10 *Anti-synchronization chaos shift keying method: error derivative detection improvement*
S. Celikovský, V. Lynnyk

12.10-12.30 *Synchronizing a chaotic coder in the presence of noise: evolution of a set-membership algorithm toward a genetic algorithm*
J.-P. Mangeot, F. Launay, P. Coirault

14.00-15.00 TC1 Chaos theory

People's Palace 1

Chairs: N. Corron, G. Csernák

14.00-14.20
Chaotic properties of elementary cellular automata rule 110
F. Chen, G. Wang, L. Chen, G. Chen

14.20-14.40
Continuous-time limit of a shift map yielding an exactly solvable chaotic differential equation
N.J. Corron

14.40-15.00
Micro-chaotic behaviour in PD-controlled systems
G. Csernák, G. Stépán

14.00-15.00 TC2 Discontinuous systems

People's Palace 2

Chairs: S. Banerjee, J.-P. Barbot

14.00-14.20
Chaotification of piecewise smooth systems
D. Benmerzouk, J.-P. Barbot

14.20-14.40
Two dimensional chaos in a random commutable pendulum
V.R. Nosov, H. Dominguez, J.A. Ortega Herrera

14.40-15.00
Periodic increment cascades in a discontinuous map with square-root singularity
P. Sharathi Dutta, S. Banerjee

15.30-17.30 TD1 Current challenges in chaos from biosystems to signal transmission (inv.)

People's Palace 1

Organizer: R. Femat
Chairs: R. Femat, H. Nijmeijer

15.30-15.50 *Secure multiple signal transmission using chaos synchronization (inv.)*
G. Solís-Perales, R. Femat

15.50-16.10 *Some hints for the design of digital chaos-based cryptosystems: lessons learned from cryptanalysis (inv.)*
D. Arroyo, G. Alvarez, S. Li

16.10-16.30 *Conditions for synchronization and chaos in networks of β-cells (inv.)*
J.M.W. van de Weem, J.G. Barajas-Ramírez, R. Femat, H. Nijmeijer

16.30-16.50 *Is the catecholamine secretion chaotic? (inv.)*
G. Quiroz, I. Bonifas, J.G Barajas-Ramírez, R. Femat

16.50-17.10 *Preserving synchronization under characteristic polynomial modifications (inv.)*
D. Becker-Bessudo, G. Fernandez-Anaya, J.J. Flores-Godoy

17.10-17.30 *Bounding the domain of some three species food systems*
K.E. Starkov, L.N. Coria

15.30-17.30 TD2 Applications and experiments

People's Palace 2

Chairs: D. Giaouris, J. Sieber

15.30-15.50 *Nonlinear dynamics in experimental two-phase microfluidics timeseries*
F. Sapuppo, F. Schembri, M. Bucolo

15.50-16.10 *Correlation between spatial and temporal chaotic behaviour in two-phase microfluidics*
F. Sapuppo, F. Schembri, M. Bucolo

16.10-16.30 *Using feedback control and Newton iterations to track dynamically unstable phenomena in experiments*
J. Sieber, B. Krauskopf

16.30-16.50 *Interactive bubble robots for art: movement sequences learning through mirror neurons*
A. Buscarino, C. Camerano, L. Fortuna, M. Frasca

16.50-17.10 *Modeling and stability analysis of closed loop current-mode controlled Čuk converter using Takagi-Sugeno fuzzy approach*
K. Mehran, D. Giaouris, B. Zahawi

17.10-17.30 *A new optimization algorithm for multi-user transmission using chaotic carriers*
J.-P. Mangeot, F. Launay, P. Coirault

10.30-12.30 WB1 Time Delay Systems (inv.)

People's Palace 1

Organizer: T. Oguchi
Chairs: T. Oguchi, P. Hövel

10.30-10.50 *Time-delayed feedback control of delay-coupled neurosystems and lasers (inv.)*
P. Hövel, M. Dahlem, T. Dahms, G. Hiller, E. Schöll

10.50-10.10 *Design of multiple delay connections in a pair of oscillators for amplitude death (inv.)*
K. Konishi, H. Kokame, N. Hara

11.10-11.30 *Analogue private communication based on hybrid chaotic systems with delays (inv.)*
G. Zheng, W. Aggoune, J.-P. Barbot

11.30-11.50 *Chaos synchronization with time-delayed couplings: Three conjectures (inv.)*
W. Kinzel, A. Englert, I. Kanter

11.50-12.10 *A synchronization condition for coupled nonlinear systems with time-delay - A Circle Criterion Approach (inv.)*
T. Oguchi, H. Nijmeijer, N. Tanaka

12.10-12.30 *Observer Based Synchronization for a Class of Chaotic Time-Delay Systems*
A. Zemouche

10.30-12.30 WB2 Bifurcations

People's Palace 2

Chairs: C. Piccardi, E. Ponce

10.30-10.50 *Influence of network heterogeneity on chaotic dynamics of infectious diseases*
C. Piccardi, R. Casagrandi

10.50-10.10 *Fast-slow scale bifurcation in higher order open loop current-mode controlled DC-DC converters*
I. Daho, D. Giaouris, S. Banerjee, B. Zahawi, V. Pickert

11.10-11.30 *Chaos through sliding bifurcations in a boost converter under a SMC strategy*
E. Ponce, D.J. Pagano

11.30-11.50 *A complete bifurcation analysis of planar conewise affine systems*
J.J.B. Biemond, N. van de Wouw, H. Nijmeijer

11.50-12.10 *Discontinuity induced bifurcations in a piecewise-smooth satellite power subsystem model*
L.F.R. Turci, M. di Bernardo, E.E.N. Macau, T. Yoneyama

12.10-12.30 *Unfolding the dynamics of a nonsmooth model of gear rattle*
J. Mason, P. Piiroinen

14.00-15.40 WC1 Computation and artificial intelligence

People's Palace 1

Chairs: E.I. Scarlat, I. Zelinka

14.00-14.20 *Reconfigurable Logic blocks based on a discrete chaotic circuit: Implementation of all fundamental two input, one output logic functions*
H.R. Pourshaghaghi, R. Ahmadi, M.R. Jahed-Motlagh

14.20-14.40 *Evolutionary synthesis and control of chaotic systems*
R. Senkerik, I. Zelinka, Z. Oplatkova, D. Davendra

14.40-15.00 *Evolutionary identification of chaotic system*
I. Zelinka, R. Senkerik, Z. Oplatkova, D. Davendra

15.00-15.20 *The role of the embedding dimension and time delay in time series forecasting*
M. Camplani, B. Cannas

15.20-15.40 *A Generalized Devil Staircase-based generator for the JPY-USD exchange rate?*
E.I. Scarlat, L. Preda, M. Mihailescu

14.00-15.40 WC2 Control design

People's Palace 2

Chairs: J. Biggs, S. Santini

14.00-14.20 *Active chaos control of a cam-follower impacting system using FPIC technique*
J.A. Taborda, S. Santini, M. di Bernardo, F. Angulo

14.20-14.40 *A new delayed feedback control scheme for discrete time chaotic systems*
Ö. Morgül

14.40-15.00 *An optimal gains matrix for time-delay feedback control*
J. Biggs, C.R. McInnes

15.00-15.20 *Adaptive robust control of hyperchaotic Rössler system in the presence of matching disturbance*
M.M. Arefi, M.R. Jahed-Motlagh

15.20-15.40 *Anti-control of chaos in rigid body motion using an internal torque source*
H. Zargarzadeh, M.R. Jahed-Motlagh

15.40-16.00 *Bifurcation control of aeroelastic oscillations*
M. Demenkov, M. Goman

14.00-15.40 WC2 Control design

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15.40-16.00 *Bifurcation control of aeroelastic oscillations*
M. Demenkov, M. Goman

MA1 Plenary Lecture

Synchronization and chaos in living systems
E. Mosekilde
Department of Physics
The Technical University of Denmark

Everything changes all the time – that's what life is.

Contrary to the classical concept of homeostasis, regulatory mechanisms in living systems tend to be unstable and produce oscillatory dynamics of significance to the normal physiological functioning of the systems. This is true, for instance, of the release of growth hormone and insulin, which, besides a variety of faster rhythms associated with regulations at the cellular level, displays both a circadian (24 hr) and a clearly pronounced ultradian (2-4 hr) rhythm. Sometimes the hormonal secretion can become so erratic that one wonders how the release patterns are related to the observed response. It is well documented, however, that a fluctuating hormonal concentration can be more effective in eliciting a particular response than a constant concentration of the same average value.

Rhythmic signals are also essential to coordinate the processes that take place in the individual cell and enable communication between neighbouring cells. Besides neurons and muscle cells, which are known to sustain travelling electrical signals, many other cells exhibit spiking and bursting dynamics in their membrane potential, and the insulin producing β-cells in the pancreas, for instance, are known to control their hormonal release via the inflow of calcium ions that take place during the bursting phases.

Interaction among rhythmic processes produces a great variety of complex nonlinear phenomena, including frequency and amplitude modulation of one mode due to the presence of another, synchronization between different rhythms, as well as various forms of chaotic dynamics. Living systems, therefore, offer one of the most obvious realms of application for the ideas and techniques of nonlinear science.

The kidneys play an important role in regulating blood pressure and maintaining a proper environment for cells in the body. To protect their own function and secure a relatively constant blood supply, the kidneys utilise two different feedback mechanisms that both operate at the level of the individual functional unit (the nephron). The two regulations are both unstable, and they produce self-sustained oscillations in nephron pressures and flows with typical periods of 5-8 and of 30-40 sec, respectively. The two mechanisms involve the same cellular processes, and this coupling gives rise to chaotic dynamics as well as to different forms of internal synchronization between the oscillatory processes.

Neighbouring nephrons interact via their shared blood supply. This interaction again involves two different mechanisms: a hemodynamic coupling that arises from the displacement of blood from one nephron to its closest neighbours as they each try to adjust their own blood supplies, and a vascular propagated coupling in the form of waves of muscular contraction that travel along the arteriolar walls. The two coupling mechanisms tend to cause neighbouring nephrons to synchronize their flow regulation to be either in phase or in anti-phase.

The presentation will illustrate how nonlinear dynamic phenomena are involved in many types of normal physiological regulation and how the dynamics changes during the development of diabetes, hypertension, Parkinsons disease and other progressive disorders. We explain how mechanism-based models of pulsatile insulin secretion and nephron blood flow regulation can be constructed and validated by combining information from many different experiments and present a relatively detailed analysis of the dynamics of each of these models. We finally show how synchronization between neighbouring nephrons is affected by administration of a drug that influences blood pressure.

References:
E. Mosekilde: Topics in Nonlinear Dynamics – Applications to Physics, Biology and Economic Systems, World Scientific (1998),
E. Mosekilde, Yu. Maistrenko and D. Postnov: Chaotic Synchronization – Applications to Living Systems, World Scientific (2002),
Zh. Zhusubaliyev and E. Mosekilde: Bifurcations and Chaos in Piecewise-Smooth Dynamical Systems, World Scientific (2003),
M. Bertau, E. Mosekilde and H.V. Westerhoff: Biosimulation in Drug Development, Wiley-VCH (2008).

TA1 Plenary Lecture

Delay effects in dynamical systems and networks: analysis and control interpretations

W. Michiels
Department of Computer Science
Katholieke Universiteit Leuven
Belgium

Time-delays are important components of many systems from engineering, economics and the life sciences, due to the fact that the transfer of material, energy and information is mostly not instantaneous. They appear for instance as computation and communication lags, they model transport phenomena and hereditary and they arise as feedback delays in control loops.

From a qualitative point of view the presence of time-delays in dynamical systems may induce complex behavior, and this behavior is not always intuitive. Even if the system's equation is scalar, oscillations and chaotic behavior may occur. But on the other hand time-delayed feedback is typically used for stabilizing chaotic systems. Time-delays in control loops are usually associated with degradation of performance and robustness, but there are situation where time-delays are beneficial and even used as controller parameters. They may also interact with different scales of the system: sometimes very large delays can be tolerated, but there are situations where an arbitrarily small delay may destabilize a stable system.

While one may argue that the research on stand-alone systems with relatively small dimensions has reached some maturity, the dynamical systems and control communities face severe challenges due to the emergence of important new application fields, mainly in the area of large-scale interconnected systems and networks (interacting neurons, control of communication networks, networked controlled systems, distributed decision making and control, tele-operation,...). These new applications are described by highly complex models exhibiting multiple time-varying delays, several types of nonlinearities, as well as different time-scales. They require new controller structures (e.g. suitable for a distributed implementation) that are not only expected to meet the nominal specifications, but also to scale well with respect to the system's and network size. At several levels it becomes necessary to exploit structure and sparsity, in the development of analysis techniques and numerical algorithms as well as in the control design.

The aim of the talk is to present a guided tour on stand-alone and interconnected systems with delays, thereby explaining some important qualitative properties. The focus rather lies on the main ideas as technical details are avoided. The presentation starts with a selection of motivating examples from different application areas. Next, mathematical models described by delay differential equations are introduced. Some basic properties of time-delay systems are briefly discussed, by pointing out the similarities and differences between the solutions of ordinary differential equations and delay differential equations.

This will make clear that time-delay systems exhibit some ambiguity in the sense that, depending on the viewpoint, they behave as finite or infinite-dimensional systems. This ambiguity plays an important role in explaining the qualitative properties and it sheds a light on the available analysis and control design tools.

In the second part of the talk, different mechanisms in which delays can interact with the system are outlined, with the emphasis on the effects of delays on stability. It is clarified how these mechanisms affect control design problems. Not only limitations induced by delays in control loops are discussed, including fundamental limitations, but also opportunities to use delays in the construction of controllers. The latter include the use of delays to generate predictions and to stabilize predictors (with application to prediction based control and anticipative synchronization), time-delayed feedback, stabilizing oscillatory systems by means of phase synchronization, and the use of delays to approximate missing derivatives or in state reconstruction.

In the last part some extensions of these results toward networks of interconnected dynamical systems are discussed, with the focus on relative stability problems, in particular consensus and synchronization problems.

WA1 Plenary Lecture

From one to many: Synchronization, control and applications of complex systems
M. di Bernardo
Bristol Centre for Applied Nonlinear Mathematics
University of Bristol

Nonlinear dynamics has traditionally focussed on the analysis, control and synchronization of low-dimensional nonlinear systems. Much research effort was spent in the past to find novel methods to control and synchronize chaotic systems and to study chaotic systems of different types and nature that were found in a large number of application areas. The limitations of the traditional analytical and numerical (e.g. continuation) tools available seemed to be that they coped well with certain classes of systems but failed in more general cases; for instance for systems with discontinuous vector fields or in the case of large, extended systems. Over the past few years, interest has shifted from the analysis of single nonlinear systems to the study of ensembles of interconnected dynamical systems. The motivation is the large number of complex networked systems that occur in nature and technology. Examples of these systems include communication networks and power grids, biological and physiological networks, swarming and flocking behaviour in animals and robots, sensor networks and neural networks. The common thread in all of these examples is that they consist of many interacting agents communicating over a web of interconnections characterized by a complex topology. Three key essential ingredients are then needed to describe this type of systems: (i) a model of the dynamics of each agent in the system; (ii) a communication protocol (or interaction model) describing how agents communicate with each other and (iii) a graph (network) describing the topology of the interconnections between agents. The resulting model is a complex network of dynamical systems.

A fundamental problem in this context is that of studying the emergence of coordinated behaviour in complex networks. Recently much attention has been focussed on the problem of synchronizing or controlling a network of dynamical agents onto some common evolution. It has been shown that, not only the dynamics of each individual system in the network, but also the network topology itself can have a dramatic effect on the synchronization and control performance.

The aim of this talk is to discuss the problem of synchronizing and controlling complex networks. In particular, novel adaptive evolving strategies will be introduced to solve the synchronization and control problems. Firstly, a strategy will be considered where the network topology is fixed while neighboring nodes can decide the strength of their mutual coupling on the basis of purely local information. Then, the network topology itself will be evolved on the basis of the agent dynamics. A possible hybrid approach to generate the network topology will be discussed and shown to effectively solve the control and synchronization problem. The resulting topologies will be analyzed and shown to guarantee certain performance criteria in the presence of different constraints. A key implementation issue will be for the adaptive strategies to be simple while relying on a minimal amount of local information on the network nodes and topology. Applications of these techniques will be discussed to some representative case studies from control theory, robotics and biology.