Advanced School on Modelling and Statistics for Biology, Biochemistry and Biosensing

11/09/2016 – 16/09/2016

Johannes Kepler University Linz, Altenbergerstraße 69, 4040 Linz, Austria Hörsaal (Lecture Hall) HS 8

Stochastic Processes and Stochastic Chains in Biology, Thermodynamics and Statistical Physics

Many processes occurring in nature and those being studied in engineering and economics can be realistically described only by time-dependent random variables. As an example we mention an urban electricity market: The electric consumption of a city at a certain time t has a random fluctuation that is dependent on the actual demand of the households and industry. The electric consumption can be considered as a continuous random variable X. When the observation time t changes, electric consumption is a continuous random variable at every moment, so it is a function of time. The stochastic analysis of time-dependent random variables leads to the concept of stochastic processes.

Stochastic processes arise in all scientific topics, in optics e.g. for describing fluctuations of light sources, detectors and lasers, represent turbulence in fluid mechanics, describe pattern formation in chemistry, morphogenesis in biology, brain function in neurology, behavior of stock exchange prices in economics, can model the formation and "locking-in" of public opinion in sociology. In addition, in biochemical processes stochastics and statistics play an important role. Gene expression, and transcription changes, for example, have a stochastic component through the molecular collisions — as during binding and unbinding of RNA and DNA.

The school will be focused on the following topics:

- modelling stochastic processes
- understanding statistic evaluations and data,
- big data mining and machine learning
- relation to physics / chemistry nomenclature: classical thermodynamic quantities
- statistical thermodynamics

Invited speakers come from Masaryk University, Brno. Besides the teaching schedule two poster sessions will enable students to present their work and discuss ideas in an relaxed atmosphere.

Stochastic Processes are universal and arise ubiquitous in nature: therefore MSc and PhD students from the following disciplines are invited to attend: (micro-) biology, genetics, mathematics, (bio-) chemistry, (bio-) physics, material science and engineering. The Sunday lectures will be used as a refresher in mathematics and physics.

Local Organisation and Registration:

The school is free, including daily lunch and a school excursion to "Salzkammergut". Housing has to be covered (~ 35€/night) by the participants.

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School Programme

TWINFUSYON

	Sunday 11.9.2016	Monday 12.9.2016	Tuesday 13.9.2016	Wednesday 14.9.2016	Thursday 15.9.2016	Friday 16.9.2016
8:30-9:45	Tutorial on and repetition of classical thermodynamics	Introduction to Probability Theory	Continuous time Markov models and the Gillespie algorithm for chemical reactions	Standard ODEs in Chemistry	Statistical Physics (Equilibrium)	Statistics in Neurosciences
9:45-10:45	Tutorial on and repetition of classical thermodynamics			Reaction rate equations		
10:45-11:15	**Coffee Break**	**Coffee Break**	**Coffee Break**	Social Event	**Coffee Break**	**Coffee Break**
11:15-12:30	**Break**	Introduction to Probability Theory	Wiener Process & Brownian Motion	Social Event	Statistical Physics (Equilibrium)	Statistics in Neurosciences
12:30-14:00	**Lunch Break**	**Lunch Break**	**Lunch Break**	Social Event	**Lunch Break**	**Lunch Break**
14:00-15:00	Tutorial on and repetition of classical thermodynamics	Introduction to stochastics	Stochastic differential equation (Langevin, Fokker Planck) models in Neuroscience	Social Event	Stochastic differential equations (Langevin, Fokker Planck) in physics	**Closing and Farewell**
15:15-16:15	Tutorial on and repetition of classical thermodynamics	Introduction to stochastic processes	Machine Learning and its applications in Life Sciences	Social Event		
16:15-16:45	**Coffee Break**	**Coffee Break**	**Coffee Break**	Social Event	**Coffee Break**	
16:45-18:00	Registration	Introduction to stochastic processes	Machine Learning and its applications in Life Sciences	Social Event	How microscopic Model lead to macroscopic PDEs	
18:00-20:00	Reception	Poster Session	Poster Session	Social Event	Conference /School Dinner	
Lecturers	***Kurt Hingerl***	***Evelyn Buckwar***	***Evelyn Buckwar, Ulrich Bodenhofer***	***Evelyn Buckwar, Massimiliano Tamborrino***	***Urbaan Titulaer, Josef Humlicek, Kurt Hingerl***	***Dmitry Efrosinin, Massimiliano Tamborrino***

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