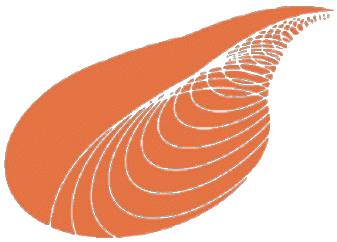
Friday May 16, 2014

IAP DYSCO Study Day:

Dynamical systems, control and optimization

University of Namur

Amphithéâtre Pedro Arrupe PA02, rue de Bruxelles, 5000 Namur



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Program

8:30 Registration and Welcome of participants

9:05 Welcome by Philippe Toint, Vice-rector for Research and IT Policy of the University of Namur

9:10 Welcome by the IAP network coordinator Vincent Blondel

9:15 Plenary Lecture 1: *Hyperbolic geometry of complex networks* by **Prof. Marián Boguñá** (Department of Fundamental Physics, University of Barcelona, Spain)

10:15 Poster session 1 and coffee break

11:30 Short Plenary Lecture 1: *Local and global dynamics of complex systems* by **Jean-Charles Delvenne** (UCL)

12:00 Short Plenary Lecture 2: *Understanding active network management in 20 minutes* by **Damien Ernst** (ULg)

13:00 Lunch at Arsenal (and meeting of the IAP promoters)

14:00 Plenary Lecture 2: *Can cascades be predicted?* by **Prof. Jure Leskovec** (Computer Science Department, Stanford University, USA)

15:00 Poster session 2 and coffee break

16:15 Short Plenary Lecture 3: *Engineering controlled quantum systems* by **Alain Sarlette** (UGent)

16:45 Short Plenary Lecture 4: *Noise reduction in coarse bifurcation analysis of stochastic agent-based models: an example of consumer lock-in* by **Giovanni Samaey** (KULeuven)

17:15 End

9:15 Plenary Lecture 1: *Hyperbolic geometry of complex networks*

by Prof. Marián Boguñá (http://complex.ffn.ub.es/~mbogunya/)
(Department of Fundamental Physics, University of Barcelona)

The existence of underlying metric spaces shaping the topology of complex networks is one of the most appealing explanations of the widespread presence of strong clustering in real networks. From this perspective, clustering is the outcome of the triangle inequality that holds in any metric space --involving triads of elements-- while interactions among nodes are still pairwise. This fact has fundamental implications and practical applications as it allows us to treat networks embedded in metric spaces with analytical tools. Once we accept the hypothesis of the existence of hidden metric spaces, the relevant question is: What geometry is the most congruent with the topology of real complex networks? Quite unexpectedly, the answer is hyperbolic geometry, the simplest geometry able to generate simultaneously scale-free, small-world, and clustered networks. While hyperbolic geometry may appear as a very exotic one, we shall show that it may arise out of very simple and intuitive mechanisms, both in static and growing models. In this talk, we will review the progress made in this field during the last years and we will present empirical evidence of the existence of metric spaces. We will also discuss interesting connections between our models and cosmology.

BIO: M. Boguñá (Barcelona, 1967) is an associate professor at the **Departament de Física Fonamental of the Universitat de Barcelona**. He graduated in Physics in 1994 and obtained his PhD also in Physics in 1998. In 1999, he moved to the USA to do a postdoctoral stay with Professor George H. Weiss at the **National Institutes of Health**, Washington DC. After this period, he moved back to Barcelona where, in 2003, he was awarded a **Ramón y Cajal fellowship**. He got the tenure position at the end of 2008. During this period, he has also spent several months in the USA as invited guest scientist at Indiana University. M. Boguñá has written over 60 publications in major peer reviewed international scientific journals, book chapters, and conference proceedings. Among those, *Nature*, *Nature Physics, Nature Communications, Proceedings of the National Academy of Sciences US, and Physical Review Letters*. He was the chair of the international conference *BCNeWORKSHOP 2008 Trends and Perspectives in Complex Networks* and has served as a program committee member in many international conferences. In January 2008, he obtained the *Outstanding Referee* award of the **American Physical Society**. In December 2010, he was awarded as **ICREA Academia Professor 2010.** Since January 2013 he serves as an editorial board member for ***Scientific Reports***.

11:30 Short Plenary Lecture 1: ***Local and global dynamics of complex systems***
by Jean-Charles Delvenne (UCL) (http://perso.uclouvain.be/jean-charles.delvenne/)

Complex systems, or networked systems, arising from the composition of many small systems or agents, are naturally found in statistical physics, biology, chemistry, social sciences, power networks and control theory, among others. A fundamental question is to characterize the dynamics of the global complex system arising from two fundamental ingredients: the interconnection network, and the individual agents' dynamics. In this talk we review some related results and focus on an unusual example in control theory: random walks, epidemics and other stochastic diffusion processes on networks.

We look at the interesting behaviours induced by the irrational transfer functions, which lead to a neat separation between those networks where the individual dynamics dictate the global dynamics, and those networks where the network does. We deduce the implications for the decomposition of natural complex systems into intermediate-size dynamically coherent modules, intimately related to time-scale separations in the global dynamics, which allows to better understand and represent those systems. Various illustrations on real-life data will be given.

12:00 Short Plenary Lecture 2: ***Understanding active network management in 20 minutes***
by Damien Ernst (ULg) (http://www.montefiore.ulg.ac.be/~ernst/)

In Europe, concern on the environmental impact of the electricity industry is currently driving the growth of renewable electricity generation through a class of financial support mechanisms. Such incentives have resulted in the ongoing installation of wind and solar generation resources at the distribution level of the electricity network. This development calls for the evolution of the distribution network planning and operational strategies in order to accommodate the energy inflow from such DG resources. The dominant doctrine for the distribution network planning and operation has been the fit and forget approach. Under this approach, enough investments in network components (i.e., lines, cables, transformers, etc.) must be made in order to always avoid congestion and voltage problems. To that end, network planning is made with respect to a set of critical scenarios consisting of DG production and demand levels. In this manner, sufficient operational margins are always ensured. Nevertheless, with the rapid growth of DG resources, the preservation of such conservative margins comes at continuously increasing network reinforcement costs.
In order to avoid prohibitively high network reinforcement costs, active network management (ANM) strategies have recently been proposed as alternatives to the fit and forget approach. The principle of ANM is to address congestion and voltage issues via short-term decision making policies, developed on the basis of the optimal power flow (OPF) problem formulation.

In this talk, I will describe in a detailed way active management solutions. More specifically:
1. I will show through examples how to state mathematically active network management problems.
2. I will discuss computational and technical challenges for implementing solutions to these problems.
3. I will (briefly) discuss the models of interaction between the different actors of the electrical industry that need to be implemented to accommodate the ANM solutions proposed for these examples.

14:00 Plenary Lecture 2: ***Can cascades be predicted?***
by Prof. Jure Leskovec (http://cs.stanford.edu/~jure)
(Computer Science Department, Stanford University)

Social networks play a central role in spreading of information, ideas, behaviors, and products. As such "contagions" diffuse from a person to person they may go "viral," and large cascades can form. However, a growing body of research has argued that virality and cascades may be inherently unpredictable. Thus, one of the central questions is whether information cascades can be predicted and possibly even engineered. In this talk, I will discuss a framework for predicting cascades and making them go viral. We study large sample of cascades on Facebook and find strong performance in predicting whether a cascade will continue to grow in the future. The models we develop help us understand how to create viral social media content: by using the right title, for the right community, at the right time.

BIO: Jure Leskovec <http://cs.stanford.edu/~jure> is assistant professor of Computer Science at Stanford University. His research focuses on mining large social and information networks. Problems he investigates are motivated by large scale data, the Web and on-line media. This research has won several awards including a Microsoft Research Faculty Fellowship, the Alfred P. Sloan Fellowship and numerous best paper awards. Leskovec received his bachelor's degree in computer science from University of Ljubljana, Slovenia, and his PhD in machine learning from the Carnegie Mellon University and postdoctoral training at Cornell University. You can follow him on Twitter @jure <http://www.twitter.com/jure>

16:15 Short Plenary Lecture 3: ***Engineering controlled quantum systems***
by Alain Sarlette (UGent) (http://users.ugent.be/~asarlet/)

We give a short introduction to the emerging field of engineering quantum physical devices from a systems & control point of view. Besides a brief summary of the general challenges of quantum technology, we present the basic models involved and two feedback stabilization strategies: one equivalent to classical measurement-based control, and the other working as control by interconnection. We illustrate these strategies on a quantum microwave cavity experiment from the Laboratoire Kastler Brossel at ENS Paris.

16:45 Short Plenary Lecture 4: ***Noise reduction in coarse bifurcation analysis of stochastic agent-based models: an example of consumer lock-in***
by Giovanni Samaey (KULeuven) (http://people.cs.kuleuven.be/~giovanni.samaey/Site/Home.html)

We investigate the occurrence of coarse macroscopic states in an agent-based model of consumer lock-in. The system studied here is a prototypical Ising-type sociological system with binary state variables and spatially-dependent agent parameters. In the regime of globally-coupled agents with independent identically-distributed parameters, we derive an analytic approximate coarse evolution-map for the expectation of the average purchase. We interpret metastable locked-in states as fixed points of this one-dimensional first moment map. We then study the emergence of coarse fronts in the regime of heterogeneous agents with strongly discordant preferences. When agent polarization becomes less pronounced, the front destabilizes and one of the two products prevails, giving rise to inhomogeneous profiles featuring pockets of resistance. Stochastic continuation of the spatially-extended case poses a numerical challenge, as Jacobian-vector products are severely affected by noise. We exploit the non-uniqueness of the lifting step introducing weighted lifting/restriction operators, which result in variance-reduced Jacobian-vector products. We test our numerical strategy and show that weighted operators induce good convergence properties of the Newton-GMRES solver. We then show that macroscopic fronts destabilise at a coarse symmetry-breaking bifurcation

10:15 Poster session 1 - Abstracts

BARREA Allan et CORDOVA BULENS David (UCL)
Title: A simple and reliable method to measure the fingertip coefficient of friction at different levels of grip force
Authors: A. Barrea, D. Córdova Bulens, P. Lefèvre and J-L. Thonnard
Abstract: The static coefficient of friction (CF) plays an important role in dexterous object manipulation. Indeed, the minimal grip force needed to hold an object is dictated by the object weight through CF. Here, we propose a new method allowing a simple and reliable measure of CF at different grip force levels. This method is based on active fingertip movement on a fixed six-axis force and torque sensor. The measured forces and torques are processed to compute the position of the finger center of pressure (COP) on the sensor during measure. This COP position combined with the measured forces allows determining slip onset and therefore CF. Using this method, we were able to reproduce the results of André et al. (2009) who highlighted the dependence of CF on both grip force and fingertip moisture.

CLOQUET Christophe (UCL)
Title: Forecasting event attendance with mobile phone data
Authors: Christophe Cloquet & Vincent D. Blondel
Abstract: No reliable tool exists to forecast the attendance to large events. In this paper, we propose two methods using mobile phone data to forecast the time at which the maximum attendance will be reached, for exceptional events known in advance. Our contributions are:
- a comparison between the time evolution of the number of text messages, voice calls, Foursquare check-ins, Twitter messages and headcounts, for three different events ;
- two forecast method of the time at which people do not flow anymore to the event ;
- an insight into a forecast of the number of attendants.

DERAVET Nicolas (UCL)
Title: Prior experience biases visually-guided smooth pursuit response
Authors: Nicolas Deravet, Jean-Jacques Orban de Xivry, Gunnar Blohm and Philippe Lefèvre
Abstract: In a recent model, Orban de Xivry, Coppe et al. (2013) suggested that the impact of visual and prior information on smooth pursuit eye movements is weighted by their reliability. After building prior experience through repetitive presentation of an identical target movement, we tested the influence of this prior on visually guided pursuit by changing target velocity. Results confirmed predictions of the model and showed that the eye velocity during catch trials was influenced by prior information about target velocity during training trials.

LANGONE Rocco (KUL)
Title: Clustering data over time using kernel spectral clustering with memory
Authors: Rocco Langone, Raghvendra Mall and Johan Suykens
Abstract: This work discusses the problem of clustering data changing over time using the kernel spectral clustering with memory (MKSC) algorithm. The latter is developed in a constrained optimization setting and its objective function is designed to explicitly incorporate temporal smoothness. Experiments over a number of real and synthetic datasets provide very interesting insights in the dynamics of the clusters evolution. Moreover, a simple and compact visualization of the cluster dynamics in a 3D embedding is proposed.

YANG Yuning (KUL)
Title: Redescending M-Estimator based Approaches for Robust Matrix and Tensor Completion
Authors: Yuning Yang en Johan Suykens
Abstract: Arising from real-world applications such as online recommendation systems, image processing, pattern recognition as well as intelligent transportation system, the problem of recovering data with certain low rank structure from incomplete observations can naturally be formulated as low rank matrix and tensor completion problems. Since real-world data might be contaminated by sparse gross errors, robust techniques are demanded. However, existing

approaches may not be very robust to outliers. To address this problem, we employ redescending M-estimators, which has been introduced in robust statistics, into matrix and tensor completion problems. Redescending M-estimators bring us robustness, whereas they also lead to nonconvexity. Nevertheless, by verifying the Lipschitz continuity, we solve our approaches by simple gradient descent based algorithms, which produce high quality recovery results, as demonstrated by experiments on synthetic as well as real data sets.

NORIEGA Estefania (KUL)
Title: Microbiological safety of dairy products enriched with stevia and tagatose
Authors: M. M. Lobete, E. Noriega Fernandez, J. F. Van Impe
Abstract: Consumer trend towards healthier nutritional habits is challenging food industry to develop novel product formulations characterized by, for instance, the substitution of added-sugars with no-caloric sweeteners. Stevia and tagatose are potential alternatives with adequate organoleptic properties, weight loss promotion, no glycemic effect, etc. However, little is known of their effect on food concerning bacteria. For instance, dairy products are a target for sugar-replacement formulations that may easily get contaminated with undesired microorganisms (Salmonella spp.). In this work, the effect of novel sweeteners on the growth dynamics of Salmonella Typhimurium in Tryptone Soya Broth-dextrose-free (TSB-df) and milk was assessed. Both media were enriched with stevia, tagatose, sugar and laboratory sucrose, and inoculated with Salmonella Typhimurium. Based on these media, a full factorial design was implemented with different concentration of sweeteners (3, 9 and 15% (w/v)) and temperatures (8 and 20ºC). At regular intervals, cell concentration was determined by plate counting. The Baranyi model was applied to estimate the growth parameters. Experimental results show that the growth dynamics of S. Typhimurium are affected i) when comparing synthetic media with real food, since lower microbial growth in milk is recorded for all the conditions; and ii) when sucrose is substituted by the studied sweeteners. For TSB-df, similar growth curves are obtained between sweeteners at 20ºC, although stevia and tagatose show respectively the highest and lowest values of the maximum growth rate, at any concentration. At 8ºC, TSB-df with 3% tagatose, microbial growth is reduced, and even inhibited when increasing its concentration. The opposite effect is observed with stevia. Results obtained in this work will contribute to select the most suitable sweeteners for novel product formulations. The potential effect of tagatose as antimicrobial, and stevia as growth enhancer, should be considered for future an optimal design of food safety assurance systems.

TACK Ignace (KUL)
Title: Individual-based modelling of microbial colonies
Authors: I. Tack, F. Logist, E. Noriega, J. Van Impe
Abstract: OBJECTIVE(S): Mathematical models in predictive microbiology are traditionally set up as low-complexity systems of coupled differential and/or algebraic equations expressing the dynamics of macroscopic characteristics of the integral microbial population. These models are accurate to describe and predict planktonic dynamics of pure cultures with a relatively high cell number in homogeneous liquids. Nevertheless, most food products have a semi-solid structure restricting microbial mobility, leading to local microbial growth as colonies. High cell numbers in these colonies result in nutrient overconsumption and overproduction of acid cell products. As a result, nutrient depletion and acidification occur in the colony center. Consequently, cells exhibit strongly different individual behaviors according to their position along the colony radius.
METHOD(S): In order to take into account different individual behaviors and interactions of microorganisms in a colony, colony dynamics are simulated by means of an individual-based model, in which the individual cell is the basic modeling unit. This implies that global colony dynamics are not modeled explicitly, but emerge from processes at the cell level.
RESULTS: Typical colony behaviors emerge from the simulations with the individual-based model. Varying the diffusion coefficient or initial concentration of the nutrient influences colony morphology, which is in accordance to previously obtained experimental data1 and simulations2.
CONCLUSIONS AND IMPACT OF THE STUDY: Classical models in predictive microbiology describe macroscopic characteristics of an integral microbial population with similarly behaving microorganisms in homogeneous liquid media. To relieve the inaccuracies of these models in predicting microbial dynamics in semi-solid food products, an individual-based model has been implemented. On the long term, the information that will be generated with the individual-based model can be incorporated in the mathematical structure of the traditional macroscopic predictive models. In this way, a low-complexity but more accurate model suitable for industry purposes can be created to describe microbial population dynamics in structured food media.
REFERENCES:
1 Fujikawa et al. 1991. Journal of the Physical Society of Japan, 60, 88.
2 Ginovart et al. 2002. Physica A, 305, 604-618.

ZHANG Zhifei (UGent)
Title: Synchronization of Kuramoto oscillators with non-identical natural frequencies: a quantum dynamical decoupling approach
Authors: Zhifei Zhang, Alain Sarlette and Zhihao Ling
Abstract: We propose a method to counter the drift associated to unknown non-identical natural frequencies in the Kuramoto model of coupled oscillators. Inspired by the quantum dynamical decoupling approach, it builds on a time-varying variant of the dynamics in order to effectively bring the oscillator phases closer to the same value. For two agents admitting instantaneous position exchanges, we exactly compute how the relative phase converges to a stable periodic fixed point. This stable point tends to zero if the dynamics switches fast enough, even in a situation with a large gap in natural frequencies with respect to the coupling strength. Moreover, we show how the same results can be obtained with continuous state evolutions, using a dynamic controller: exact phase synchronization despite differing natural frequencies is proved by construction of a Lyapunov function. We explicitly generalize the method to multiple oscillators with instantaneous state exchanges, that can be implemented by cycling through a predefined sequence or randomly. Simulation results validate the effectiveness of the algorithms.

EVDOKIMOVA Ekaterina (UGent)
Title: Performance analysis of channel- and buffer-aware schedulers in wireless communications
Authors: Ekaterina Evdokimova, Koen De Turck, Sabine Wittevrongel, Dieter Fiems
Abstract: We consider scheduling at a wireless access point serving multiple mobile nodes. Transmission to the different mobile nodes depends on exogenous channel conditions that may vary over time. Therefore, the access point can optimize performance by channel-aware bandwidth allocation, that is, by opportunistic scheduling. To assess performance of buffer aware schedulers at the access point, we consider a finite-capacity Markovian queueing model. The model includes a buffer for every mobile node served by the access point, and a Markovian channel which models the changes in channel capacity of all mobile nodes. To cope with the inherent size of the state space of the Markov model at hand, we rely on numerical Taylor series expansion techniques. This approach yields accurate approximations, both in light-traffic situations as well as in overload.

DE COCK Alexander (VUB)
A preliminary study on D-Optimal Input Design for Nonlinear Systems,
Authors: Alexander De Cock, Johan Schoukens
Abstract: Optimal input design is an important step of the identification process in order to reduce the model variance. In this work a D-optimal input design method for FIR-type nonlinear systems is presented. The optimization of the determinant of the Fisher matrix is expressed as a convex optimization problem. The optimization is performed using an equivalent dispersion-based criterion. This method is easy to implement and converges monotonically to the optimal solution. Without constraints, the optimal design cannot be realized as a time sequence. By imposing that the design should lie in the subspace described by a symmetric and non-overlapping basis, a realizable design is found. Next, a graph-based method is implemented in order to find a time sequence that realizes this optimal constrained design.

GEERARDYN Egon (VUB)
The Local Rational Method for H-infinity Norm Estimation,
Authors: Egon Geerardyn, Johan Schoukens
Abstract: Accurate uncertainty modeling is of key importance in high performance robust control design. This poster shows a new uncertainty modeling procedure that enhances the accuracy of the H-infinity norm. A frequency response based approach is adopted. The key novelty is a method to address the intergrid error using local parametric modeling methods by means of the Local Rational Method (LRM). These local rational models enhance the estimates at the discrete frequency grid. Moreover, the presented methods are shown to enhance the intergrid error estimate. Compared to the local polynomial models, local rational models are able to handle lightly-damped resonances using far fewer data points and a far shorter measurement time. This is illustrated using experiments on an industrial active vibration isolation system.

GEMINE Quentin (ULg)
Title: Active network management for electric distribution systems: problem formulation and benchmark
Authors: Quentin Gemine, Damien Ernst, Bertrand Cornélusse
Abstract: In order to operate an electric distribution network in a secure and efficient way, that is to respect physical constraints while avoiding prohibitive network reinforcement costs, it becomes necessary to rely on active network

management strategies. These strategies, induced to a large extent by the rise of distributed generation, rely on short-term policies that control the power level of generators and loads connected to the network. While a simple solution would be to curtail the production of generators, a more interesting one could be to move the consumption of loads to relevant time periods in order to better exploit the renewable energy sources on which generally rely these generators. However, such a control scheme introduces a time-coupling nature to the problem which leads to the formulation of a mixed-integer non-linear problem of optimal sequential decision-making under uncertainty. In order to promote research in this very complex field, we propose a generic formulation of the problem of active network management of a medium-voltage distribution system which relies on a Markov decision process formulation. In this work, we also introduce a specification of this decisional model to a 75-buses network with a given set of modulation services. The resulting test instance is available at http://www.montefiore.ulg.ac.be/~anm/ and aims at assessing and comparing the performances of resolution techniques that will be developed.
Keywords: Active network management, electric distribution network, flexibility services, renewable energy, optimal sequential decision-making under uncertainty, large system.

CASTRONOVO Michael (ULg)
Title: Bayes Adaptive Reinforcement Learning versus Off-line Prior-based Policy Search: an Empirical Comparison.
Author: Michael Castronovo
Abstract: This paper addresses the problem of decision making in unknown finite Markov decision processes (MDPs). The uncertainty about the MDPs is modeled using a prior distribution over a set of candidate MDPs. The performance criterion is the expected sum of discounted rewards collected over an infinite length trajectory. Time constraints are defined as follows: (i) an off-line phase with a given time budget can be used to exploit the prior distribution and (ii) at every time step of the on-line phase, decisions have to be computed within a given time budget. In this setting, we compare two decision-making strategies: OPPS, a recently proposed meta-learning scheme which mainly exploits the off-line phase to perform policy search and BAMCP, a state-of-the-art model-based Bayesian reinforcement learning algorithm, which mainly exploits the on-line time budget.
We empirically compare these approaches in a real Bayesian setting by computing their performances over a large set of problems. To the best of our knowledge, it is the first time that this is done in the reinforcement learning literature. Several settings are considered by varying the prior distribution and the distribution from which test problems are drawn. The main finding of these experiments is that there may be a significant benefit of having an off-line prior-based optimization phase in the case of informative and accurate priors, especially when on-line time constraints are tight.

FERNANDES Sofia (UMons)
Title: Extended and Unscented Kalman Filter design for hybridoma cell cultures
Authors: Afonso Fernandes, S.; Dewasme, L., Amribt, Z. (ULB), Bogaerts, B. (ULB), Vande Wouwer, A.
Abstract: The production of monoclonal antibodies by means of cultures of hybridoma cells in bioreactors operated in fed-batch or perfusion mode is increasingly applied in the pharmaceutical sector. Recently, a macroscopic model has been proposed [Z. Amribt *et al*, 2013], which accounts for overflow metabolism within glycolysis and glutaminolysis. The overflow metabolism phenomenon is induced when the concentration of substrate exceeds a critical value, leading to a by-product formation which inhibits the oxidative capacity and the cell growth. To avoid this phenomenon, on-line measurements of glutamine and glucose concentrations are required, implying the availability of probes, which are expensive and with poor durability (about 1-3 months). Therefore, the design of software sensors for glucose and glutamine estimation is a useful alternative strategy widely recognized in bioprocess monitoring and control. In this study, two different software sensors, including an Extended Kalman Filter (EKF) and Unscented Kalman Filter (UKF), were developed for glucose and glutamine estimation in hybridoma cell fed-batch cultures based on the available measurements (biomass, lactate and ammonia). Both EKF and UKF are able to estimate the unmeasured glucose concentration satisfactorily, but UKF appears to have better performance for the estimation of glutamine, which is very poorly estimated by EKF.

PETIT Alexis (UNamur)
Title: The modeling of atmospheric drag on space debris
Authors: Alexis Petit
Abstract: Earth gravity and atmospheric drag are the two major forces that will affect the dynamics of artificial satellites or space debris in a low Earth orbit. Our aim is to integrate a simplified but realistic expression of the atmospheric drag in numerical integration software as NIMASTEP which have been developed in the University of Namur to study the dynamics of an object in orbit. Different drag models will be compared and presented and a discussion on modeling environmental variables used by these models as the solar radio flux or geomagnetic activity will be conducted. This is a preliminary step in the study of the evolution of a synthetic population of space debris evolving on a long time scale, because the atmospheric drag is a natural mitigation mechanism.

GARGIULO Floriana (UNamur)
Title: Driving forces of researchers mobility
Authors: Floriana Gargiulo and Timoteo Carletti
Abstract: Starting from the dataset of the publication corpus of the APS during the period 1955–2009, we reconstruct the individual researchers' trajectories, namely the list of the consecutive affiliations for each scholar. Crossing this information with different geographic datasets we embed these trajectories in a spatial framework. Using methods from network theory and complex systems analysis we characterise these patterns in terms of topological network properties and we analyse the dependence of an academic path across different dimensions: the distance between two subsequent positions, the relative importance of the institutions (in terms of number of publications) and some socio–cultural traits. We show that distance is not always a good predictor for the next affiliation while other factors like ''the previous steps'' of the career of the researchers (in particular the first position) or the linguistic and historical similarity between two countries can have an important impact. Finally we show that the dataset exhibit a memory effect, hence the fate of a career strongly depends from the first two affiliations.

15:00 Poster session 2 - Abstracts

HUDON Nicolas (UCL)
Title: Development of a Control Framework for Open Irreversible Macroscopic Systems
Authors: N. Hudon, N. H. Hoang, D. Dochain
Abstract: The objective of this project is to develop a framework for the modeling, analysis, and nonlinear control design of open macroscopic nonlinear systems subjected to irreversible evolution constraints. Such class of systems appears, for example, in the context of chemical reacting systems. This contribution focuses on the representation of nonlinear balance systems as potential-driven systems via a geometric decomposition approach and on the stability and passivity properties using the obtained representation.

KUMAR Alok (UCL)
Title: Route Discovery in the Internet
Authors: Alok Kumar, Jean-Charles Delvenne
Abstract: In this work, we present a new route discovery scheme for the Internet. It exploits the connectivity with neighboring ASs (Autonomous Systems) and country code [ISO 3166] of ASs to search for routes between the source and destination ASs. Consideration of the country code gives rise to a navigation algorithm that passes messages to the neighbor that is the most similar to the target node, whereas consideration of the degree gives rise to an algorithm that favours the neighbor with the highest degree. The simulation results show that the scheme can successfully discover paths, which are near-optimal.

TAYLOR Adrien (UCL)
Title: Assessing the Performance of First-order Algorithms: a Convex Optimization Approach
Authors: F. Glineur, J. Hendrickx, A. Taylor
Abstract: We formulate the problem of estimating the worst-case performance of (unconstrained) first-order methods (for smooth convex optimization) as a convex program. Our approach relies on the idea proposed by Drori and Teboulle that the worst-case performance of an algorithm can itself be formulated as an optimization problem. Our new formulation turns out to be convex and to provide exact worst-case for the problem. We use it to compute the performance of several methods in terms of different measures, such as the objective distance to optimality or the residual gradient norm.

GILLIS Joris (KUL)
Title: Efficient numerical methods for robust periodic optimal control with Lyapunov differential equations
Authors: Joris Gillis and Moritz Diehl
Abstract: This work compares various numerical methods to robustify periodic optimal control problems using the paradigm of Lyapunov differential equations. In this paradigm, estimates for state-covariance are obtained by solving the periodic Lyapunov equations for the a system linearized along a to-be-optimized trajectory, and are added to objective or constraints of the original optimal control problem. For non-trivial dynamical systems, method details were found to be critical to obtain algorithms with reasonable time complexity. An application for time-optimal quadcopter flight is worked out numerically with the optimal-control tool CasADi, which was extended by the author to solve discrete periodic Lyapunov equations using the SLICOT library.

MELIS Ward (KUL)
Title: A Relaxation Method with Projective Integration for Solving Nonlinear Systems of Hyperbolic Conservation Laws.
Authors: Pauline Lafitte, Ward Melis, Giovanni Samaey.
Abstract: Hyperbolic conservation laws are present in numerous physical applications as a basis for the modeling of a system or process of interest. Many examples can be found in several domains such as fluid dynamics, plasma physics, traffic modeling and electromagnetism. The goal of our work is to construct a high-order solution strategy for solving generically a system of nonlinear hyperbolic conservation laws. Instead of focusing on the given hyperbolic problem a kinetic equation from kinetic theory is put forward. The purpose of this relaxation-based approach is to convert the initial possibly nonlinear flux function into a linear one by introducing a relevant consistent source term. Next, the design and analysis of a numerical method - a so-called projective integration method - is treated. These methods consist of two embedded integrators which employ a different time step. They guarantee that on the one hand the fast modes are sufficiently damped by using a small time step and that on the other hand the slow modes of interest are adequately perceived by using a large time step. Projective integration methods offer very appealing properties in practice such as their explicit nature and the ability of attaining an arbitrary order in time. In addition, they are surprisingly simple to implement even if the given problem is drastically altered. The proposed technique was applied

to the linear advection equation, Burgers' equation and the Euler equations in compressible fluid dynamics both in one and two dimensional domains. For future work we foresee to look at kinetic equations on traffic networks and the implementation of a coarse-graining (i.e. clustering) technique of both the network itself and the dynamics on the network.

LAWRENCE Piers (KUL)
Title: Linearizations for interpolation bases
Authors: Piers Lawrence, Marc Van Barel, Paul Van Dooren
Abstract: In his work we investigate certain arrowhead linearizations for polynomials expressed in the Lagrange basis. We will show that the computed eigenvalues of these linearizations often give roots with small backward errors under mild conditions on the input polynomials. We will also describe two procedures to reduce the linearizations to Hessenberg form in O(n^2) cost.

NORIEGA Estefania (KUL)
Title: Bio-preservative ability of Lactic Acid Bacteria against Listeria monocytogenes on vacuum packed Frankfurter sausages.
Authors: M. Baka, E. Noriega, L. Mertens, E. Van Derlinden, J.F. Van Impe
Abstract: Novel preservation technologies are continuously being investigated, in order to ensure the absence of foodborne pathogens in food products. For instance, lactic acid bacteria (LAB) tend to be used as bio-preservatives. The competitive and frequently bacteriostatic effect of this species group has been reported against foodborne pathogens, such as L. monocytogenes. This pathogen is one of the major threats in the food industry, due to its virulence and ability to thrive under harsh conditions.
In this study, Frankfurter sausages were bought in the Belgian market, vacuum packed and incubated at four static temperatures (4, 8, 12 and 25°C), with different inoculum levels of LAB (102, 103 and 104 CFU/g), isolated from the sausages themselves, and 102 cfu/g of L. monocytogenes kindly provided by BCCM-LMG (Gent). At specific time intervals, the pH value and the concentration of both species were measured. The enumeration was made in MRS agar and Palcam agar respectively for the two species. LAB were identified as Leuconostoc carnosum by the 16S-RNA sequence analysis.
Results illustrated that the lower the temperature and the higher the initial inoculum level of LAB, the earlier L. monocytogenes stops growing and the lower maximum population is reached. This observation supports the hurdle theory, if temperature and LAB addition are considered as two distinctive hurdles. Furthermore, it is observed that L. monocytogenes stops growing while pH is still at the initial value, proving that it is not the pH decrease having a bacteriostatic effect against L. monocytogenes. Additionally, temperature appears to play a decisive role in the interactions of the two co-cultured species. Jameson (1961) observed that, for two species co-cultured in liquid media, when the 'predator' enters the stationary phase then the 'pray' subsequently follows. The lower the temperature, the earlier L. monocytogenes enters stationary phase in comparison to LAB.

LOPATATZIDIS Stavros (UGent)
Title: First steps towards Little's Law with imprecise probabilities
Authors: Stavros Lopatatzidis, Jasper De Bock, Gert de Cooman
Abstract: We examine the (distributional version of) Little's Law from an imprecise-probabilistic point of view. We study the law for a discrete-time, single-server queue where at each time point arrivals and departures occur according to probability intervals. We assume that arrivals and departures are (stochastically) independent. We make two additional assumptions regarding the properties of the queue as well. The first one is that upon arriving, an item needs to remain in the queue till served. And secondly, departure is characterised by the FIFO (first in first out) property. We present our results using the framework of coherent lower and upper previsions. Our main result is a relation between the lower (and upper) prevision of the waiting time of the last item in the queue and the lower (and upper) prevision of the number of items in the queue at any given time point. We find that this result holds for different independence assumptions on the departure process.

MARCONATO Anna (VUB)
Study of the effective number of parameters in nonlinear identification benchmarks,
Authors: Anna Marconato, Maarten Schoukens, Yves Rolain and Johan Schoukens
Abstract: This poster discusses the importance of the notion of effective number of parameters as a measure of model complexity. Exploiting this concept allows a fair comparison of models obtained from different model classes. Several illustrative examples of linear and nonlinear models are presented to provide more insight in the problem. A number of possibilities to reduce the model complexity are also discussed, including regularization techniques and an alternative approach based on rank reduced estimation. These ideas are then applied to two nonlinear real world problems: the Wiener-Hammerstein and the Silverbox benchmarks.

UGRYUMOVA Diana (VUB)
Nonparametric FRF estimation from data with partially missing output,
Authors: Diana Ugryumova, Rik Pintelon, Gerd Vandersteen
Abstract: Nonparametric frequency response function (FRF) estimation is a quick and relatively easy way of getting information about a system from input-output measurements. Samples are sometimes missing due to imperfect measurement devices or communication links. If redoing the measurement is not possible, we need to find a way to accurately estimate the FRF while some measurement samples are missing. Here we extend the existing Local Polynomial Method (LPM, Pintelon *et al*) by putting the missing samples as additional (global) unknowns. LPM estimates a nonparametric frequency response of the system in the frequency-domain from time-domain input-output data, taking into account the difference between the initial and final conditions of the experiment (the transient effect). The only assumptions we make are that the input has a "rough" frequency spectrum and that the frequency response can be approximated locally by a polynomial. We show that the method can handle different missing patterns, random or one block, and that even with 50% of output missing we get very good results: an accurate estimate of the FRF, the output noise variance and the noiseless values of the missing samples with their uncertainty.

FRANÇOIS Vincent (ULg)
Title: Estimating the revenues of a hydrogen-based high-capacity storage device: methodology and results.
Author: Vincent François
Abstract: The poster proposes a methodology to estimate the maximum revenue that can be generated by a company that operates a high-capacity storage device to buy or sell electricity on the day-ahead electricity market. The methodology exploits the Dynamic Programming (DP) principle and is specified for hydrogen-based storage devices that use electrolysis to produce hydrogen and fuel cells to generate electricity from hydrogen. Experimental results are generated using historical data of energy prices on the Belgian market. They show how the storage capacity and other parameters of the storage device influence the optimal revenue. The main conclusion drawn from the experiments is that it may be interesting to invest in large storage tanks to exploit the inter-seasonal price fluctuations of electricity.

MAUROY Alexandre (ULg)
Title: Spectral operator-theoretic description of nonlinear systems: a systematic approach to global stability analysis.
Author: Alexandre Mauroy
Abstract: The description of a nonlinear system through a linear (but infinite-dimensional) operator provides a powerful insight into the global properties of the system. In particular, the spectral properties of the so-called Koopman operator are closely related to the geometric properties of the dynamics. Using this framework, we show that specific eigenfunctions of the Koopman operator capture the global stability properties of the attractor. We also develop numerical techniques that lead to systematic methods for global stability analysis and estimation of the basin of attraction.

MISHRA Bamdev (ULg)
Title: Riemannian preconditioning
Authors: Bamdev Mishra and Rodolphe Sepulchre
Abstract: We exploit a basic connection between sequential quadratic programming and Riemannian gradient optimization to address the general question of selecting a metric in Riemannian optimization in a way that not it only exploits the constraints but also the cost function. The proposed method is shown to be particularly insightful and efficient in quadratic optimization with orthogonality and rank constraints, which covers most current applications of Riemannian optimization in matrix manifolds.

GRIMARD Jonathan (UMons)
Title: Mathematical modeling of a twin-screw extruder using the residence time distribution
Authors: Jonathan Grimard, Laurent Dewasme, Alain Vande Wouwer
Abstract: Hot melt extrusion is a complex process involving several physical phenomena. Mathematical models have to take account of mass, momentum, and energy balances, and are distributed parameter systems, accounting for temporal and spatial variation. One possible approach is the representation of the twin-screw extruder by a series of interconnected ideal reactors, with forward and backward flow of material. The number of these reactors (level of discretization of the system) can be selected experimentally according on the concept of residence time distribution (RTD). In practice the RTD can be determined using tracer tests on the real process. In this study, we demonstrate the applicability of this approach, and show several numerical results. An alternative modeling approach is the description by partial differential equations, which is also considered.

PIMENTEL Araujo (UMons)
Title: Lab-scale aquaculture plant fitted with sMBR: design, data collection and sMBR modeling
Authors: Araujo Pimentel, G. ; Hantson, A.-L.; Rapaport, A. (INRA, Montpellier); Vande Wouwer, A.
Abstract: An aquaculture Lab-scale plant with submerged membrane bioreactor for nitrogen removal has been designed. This plant is equipped with flowmeters, pressure sensors and a PLC that controls the process. The measurements are gathered using an OPC-server that connects the PLC and a LabView software recording data every second. The poster presents the pilot plant configuration, the experimental data collection and the calibration of a simple dynamic model of the filtration mechanisms. The results show the feasibility of the approach to mimic the sMBR filtration dynamics.

SANLI Ceyda (UNamur)
Title: Fluctuations drive viral memes in online social media: Integrating criticality into network science
Authors: Ceyda Sanlı, Vsevolod Salnikov, Lionel Tabourier, and Renaud Lambiotte
Abstract: Online social media allows users to publish material and make it freely available for everyone. Research on Twitter has shown that an activity of different users is not independent. Moreover, if certain memes and #hashtags are heavily propagated through retweets and mentions, a majority of them attracts no attention. This heterogenous virality could be explained by the fairly small fraction of "active" Twitter users. In analogy with disordered dense systems, e.g. jammed cars in traffic or glassy state of colloids, when the number of elements in a system increases beyond a critical value, a competition emerges for a restricted amount of sources. In this poster, we will present recent work where we analyze Twitter data available with recent statistical techniques developed for granular flows and argue that nature of fluctuations leading to criticality have a similar behavior.
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