Interuniversity Attraction Poles

Phase VI/4

2007 – 2011

"Dynamical systems, control and optimization"
DYSCO

Study Day

Monday 31 May 2010
09:30 – 16:45

Het Pand, Onderbergen 1 ,9000 Gent

Program

9:30 Registration at the “Welcome Desk”

10:00 Plenary Lecture 1:
“Consensus, Social Learning and Distributed Estimation in Complex Networks”,
Prof. Ali Jadbabaie, University of Pennsylvania, Philadelphia, USA

11:00 Poster session 1

12:15 Lunch

13:45 Plenary Lecture 2:
“Coordinated Estimation and Control for Traffic Networks”,
Prof. René Boel, University of Ghent, Ghent, Belgium

14:45 Poster Session 2

15:45 Plenary Lecture 3:
“Active and passive control: from thought experiment to Formula One racing”,
Prof. Malcolm C. Smith, University of Cambridge, Cambridge, UK

16:45 End

List of participants

(First authors of contributed posters are highlighted)

Guest Speakers

Prof. Ali Jadbabaie, University of Pennsylvania, Philadelphia, USA
Prof. René Boel, University of Ghent, Ghent, Belgium
Prof. Malcolm C. Smith, University of Cambridge, Cambridge, UK

UGent

Aeyels Dirk
Andrei Raluca
Bhojwani Lokesh
Boel René
Chavarro Adrian
Dutta Abhishek
De Cooman Gert
De Smet Filip
Fabregas Ernesto
Hermans Filip
Hernandez Andres
Hodrea Ramona
Loccufier Mia
Marc Robert
Marinica Nicolae
Moradzadeh Mohammad
Neamtu Daniel
Orban Istvan
Petit Frits
Rogge Jonathan
Shariatmadar Keivan
Sutarto Herman
Zhong Yu

UCL

Abouzaïd Bouchra
Badler Jeremy
Bastin Georges
Blondel Vincent
Borckmans Pierre
Browet Arnaud
Cason Thomas
Chang Chia-Tche
Coppe Sébastien
Crevecoeur Frédéric
Dasnoy Thibault
David Bob
Dehaye Jérémy
Dehez Bruno
Delhaye Benoît
Delvenne Jean-Charles
Devolder Olivier
Dochain Denis
De Montjoye Yves-Alexandre
Ego Caroline
Gevers Michel
Glineur François
Hautphenne Sophie
Ishteva Mariya
Ivanov Tzvetan
Krings Gautier
Labbe Thibaut
Leclercq Guillaume
Maclean Heather
Melchior Samuel
Nesterov Yuri
Orban de Xivry François-Xavier
Rentmeesters Quentin
Simon Emile
Traag Vincent
Van Dooren Paul
Winkin Joseph

Ulg

Bullinger Eric
Collard Anne
Defourny Boris
Drion Guillaume
Fabozzi Davide
Fey Dirk
Fonteneau Raphaël
Mauroy Alexandre
Meyer Gilles
Rachelson Emmanuel
Sacré Pierre
Sarlette Alain
Sepulchre Rodolphe
Trotta Laura

KUL1

Bernaerts Kristel
Bonilla Julian
D'Huys Pieter-Jan
Gins Geert
Logist Filip
Smets Ilse
Vanlaer Jef
Velliou Eirini
Van den Kerkhof Pieter
Van Erdeghem Peter

Agudelo Mauricio
Alzate Carlos
Anderssen Joel
Batselier Kim
Bertrand Alexander
Breckpot Maarten
Clerinx Peter
De Brabanter Jos
De Brabanter Kris
Defraene Bruno
Diehl Moritz
Dinh Tran Quoc
Domanov Ignat
Dreesen Philippe
Ferreau Joachim
Falck Tillmann
Forouzan Amir
Gil-Cacho Pepe
Huyck Bart
Installé Arnaud
Kozma Attila
Langone Rocco
Liu Xinhai
Luts Jan
Moraes Rodrigo
Ojeda Fabian
Schuddinck Pieter
Serizel Romain
Signoretto Marco
Sima Diana
Stamati Ioanna
Suykens Johan
Tsiaflakis Paschalis
Van Huffel Sabine
van Waterschoot Toon

KUL2

Abbeloos Dirk
Bultheel Adhemar
Chesnokov Andrey
Corveleyn Sam
Debrabant Kristian
Delaere Koen
De Vlieger Jeroen
Frederix Yves
Gumussoy Suat
Jarlebring Elias
Meerbergen Karl
Michiels Wim
Roose Dirk
Rosseel Eveline
Saadvandi Maryam
Vanbiervliet Joris
Vandebril Raf
Wu Zhen
Yue Yao

VUB-ELEC

Barbé Kurt
Lataire John
Louarroudi Ebrahim
Marconato Anna
Monteyne Griet
Pintelon Rik
Sjöberg Jonas
Vanbeylen Laurent
Van Moer Wendy
Van Mulders Anne

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Albert Jaroslav
Amribt Zakaria
Bogaerts Philippe
Boulkroune Boulaid
Buttafuoco Angelo
Coutinho Daniel
Galvez Manuel
Grosfils Valérie
Kajdan Rudy
Kinnaert Michel
Konopka Tomasz
Mukepe Kahilu Moise
Niu Hongxing
Richelle Anne
Rooman Marianne
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Almeida Pedro
Dewasme Laurent
Donoso Andres
Mailier Johan
Retamal Cristina
Saraiva Ines
Sbarciog Mihaela
Stancu Alexandru
Suvarov Paul
Zamorano Francisca

Plenary Lecture 1
(10.00-11.00)

Consensus, Social learning, and Distributed Estimation in Complex Networks

Prof. Ali Jadbabaie, University of Pennsylvania, Philadelphia, USA. Joint work with Usman Khan, Victor Preciado, Alireza Tahbaz Salehi, and Pooya Molavi

Over the past few years there has been a rapidly growing interest in analysis, design and optimization of various types of collective behaviors in networked dynamic systems. Collective phenomena (such as flocking, schooling, rendezvous, synchronization, agreement, and information aggregation) have been studied in a diverse set of disciplines, ranging from computer graphics and statistical physics to distributed computation, and from robotics and control theory to social sciences and economics. A common underlying goal in such studies is to understand the emergence of some global aggregation of information from local rules and interactions.

In this talk, I will expand on such developments and present and analyze new models of consensus in random networks as well as information aggregation tailored to social networks that go beyond existing "consensus-based" models. Specifically I will present a model of social learning in which each agent acts as a rational Bayesian agent with respect to her own observations, but exhibits a bias towards the average belief of her neighbors. I will show that when each agent's observed signal is independent from others, agents will "learn" like a Bayesian with access to all information. The second part of the talk will deal with a naïve learning model in which the underlying state of the world follows a potentially unstable linear dynamics and no individual agents' observation is rich enough to recover the state. For this model I will present a single time-scale distributed estimator where the observation fusion and innovation steps happen at the same time scale and will result in bounded mean square error. Finally I will introduce the notion of Network Tracking Capacity, which quantifies the interplay between (in)stability of the dynamics, network structure, and observability.

Plenary Lecture 2
(13:45-14:45)

Coordinated Estimation and Control for Road Traffic Networks

Prof. René Boel,Ghent University, Belgium.

Urban traffic is a typical example of a network of interacting hybrid dynamical systems (in the traffic example the components are intersections controlled by traffic lights, and links connecting these intersections). We consider the problem of coordinating the control agents, selecting the switching times of traffic lights in the traffic example, so as to find a good compromise between locally reducing queueing delays and maximizing throughput through the network as a whole. Coordination of traffic lights must for example avoid starvation where during some time interval a given direction at an intersection has a green light, but there are no inflowing vehicles in this direction because of red lights upstream.
The presentation assumes that there are local control agents that receive measurements from some local sensors detecting passing vehicles, that generate estimators for queue lengths at the local interesection, and that select locally optimal switching times for the local traffic light. Coordination cna be achieved by a supervisor adjusting the local cost functions. The requirements on the communication between neighboring agents and between agents and the supervisor will be discussed. It will be shown that the solution depends heavily on the traffic load.

Plenary Lecture 3
(15:45-16:45)

Active and passive control: from thought experiment to Formula One racing

Prof. Malcolm C. Smith, University of Cambridge, UK.

The talk will discuss the contrasting possibilities of active and passive control both abstractly and in the context of automotive suspensions. It will be shown how systems and control thinking can highlight design trade-offs and suggest new approaches which otherwise can remain hidden. The expanded possibilities for passive_ control using the "inerter" mechanical device will be discussed.
Classical results and future directions in passive network synthesis will be highlighted. The talk will be illustrated by examples of practice in Formula One racing.

Poster Session 1
(11:00-12:15)

Positive Stabilization of Infinite-dimensional Linear Systems

ABOUZAÏD Bouchra, WERTZ Vincent, WINKIN Joseph

Abstract: this presentation deals with the positivity and the positive stabilization of nfinite dimensional linear systems with some new points of view and perspectives. Algebraic conditions of positivity for dynamical systems defined on an ordered Banach space whose positive cone has an empty interior are derived. The positive stabilization problem for linear infinite-dimensional systems is also addressed. Sufficient conditions are established to stabilize positively a class of distributed parameter systems, such that the closed loop system is stable and positive. The concepts and results are illustrated by a diffusion model with Neumann boundary conditions.

Dynamic modeling of *Streptomyces lividans* growth on semi-defined media: integration of mechanistic knowledge

Kristel Bernaerts, Pieter-Jan D'Huys, Ivan Lule, Sven Van Hove, Dominique Vercammen, Jozef Anné, Kristel Bernaerts, Jan Van Impe

Abstract: *Streptomyces lividans* exhibits, alongside being one of the most important producers of antibiotics, useful properties for expression of heterologous proteins. Unlike *E. coli*, which is the most common host for heterologous protein production, *S. lividans* excretes these proteins into the extracellular medium which facilitates downstream processing.

To optimize large-scale production of heterologous protein production with *Streptomyces lividans*, more knowledge is needed about the internal mechanisms of its metabolism, and robust, predictive models need to be build, preferably based on such mechanistic knowledge. In this work, the first steps are taken to exploit *dynamic flux balance analysis* (dFBA) to build a dynamic model for the wild-type strain based on the recently elucidated metabolic network of another member of the *Streptomyces* family, i.e., *S. coelicolor A3(2)*. The dFBA framework combines kinetics of extracellular compounds with intracellular steady-state behavior (flux balance analysis) and relies on the metabolic reprogramming of a cell as a function of the changing environment. Current results apply the *dynamic flux balance analysis* model for *S. lividans* grown on a complex medium (~ 15 substrates).

Design of a teleoperated palpation device for minimally invasive thoracic surgery

Angelo Buttafuoco, Amaury Dambour, Thomas Delwiche and Michel Kinnaert

Abstract: Minimally invasive surgery (MIS) consists in operating through small incisions in which a camera and adapted instruments are inserted. It allows to perform many interventions with reduced trauma for the patient. One of these is the ablation of peripheral pulmonary nodules.

Nevertheless, the means for detecting nodules during MIS are limited. In fact, be- cause of the lack of direct contact, the surgeon cannot palpate the lung to find invisible lesions, as he would do in classical open surgery. As a result, only clearly visible nodules can be treated by MIS presently.

Our work aims at designing, building and the controlling a teleoperated palpation instrument, in order to extend the possibilities of MIS in the thoracic field. Such an instrument is made of a master device, manipulated by an operator, and a slave device which is in contact with the patient and reproduces the task imposed by the master. Adequate control laws between these two parts allow to restore the operator's haptic sensation.

A pantograph has been designed to be used as the master of the palpation device, since this kind of architecture provides good ergonomics and low inertia. The length of each link has been optimized in order to maximize the manipulability of the device within its workspace. A 2 dof force sensor has also been designed and integrated to the pantograph so that the force applied by the operator can be measured.

At present time, the pantograph is under construction, and the slave device is still under development. Future work will see experiments with the surgeons to validate the design of the palpation device and the development of control laws that best suit the needs of palpation.

Similarity Measures in Graphs

CASON Thomas, ABSIL P-A, VAN DOOREN Paul, BLONDEL Vincent

Abstract: many social, biological, and information systems can be properly described as networks with nodes representing individuals or organizations and edges representing the interactions among them. Many efforts have been made to analyze the structure of these networks and reveal their underlying properties. E.g., in the complex networks, nodes play very specific roles basically determined by the characteristics of their neighborhood. Therefore one can try to classify the nodes and possibly quantify how similar or dissimilar two nodes are with respect to their role in the network. Measures of node similarity in graphs have a broad array of applications, including comparing chemical structures, navigating in complex networks like the World Wide Web, and analyzing different kinds of biological data.

In this work, we generalize several existing similarity measures and further propose novel definitions of similarity that possess certain desirable properties.

Cross-impact of the material distribution formalism and the optimization algorithm on the efficiency of topology optimization methods

DENIES Jonathan, GLINEUR François, DEHEZ Bruno

Abstract : Topology optimization methods are based on a subdivision of a design space into cells. Their goal consists then in finding the best way to distribute some predefined materials in the cells according to one or several objective functions. These methods therefore involve a material distribution formalism and an optimization algorithm. The first defines the way the design space is subdivided, the design parameters, and consequently, the link between the design parameters and the solution. The second modifies the solution trough the design parameters in order to minimize the objective function(s). Both elements can have a significant impact on the optimization tool performances. This study aims to compare two material distribution formalisms (static and dynamic) and two heuristic optimization algorithms (genetic and simulated annealing) through a theoretical study case (search for a hidden reference shape).

Coexistence of stationary and synchronous solutions in a spiking neural network

Filip De Smet and Dirk Aeyels

Abstract: We consider an all-to-all coupled neural network with an infinite number of leaky integrate-and-fire neurons. For small values of the coupling strength, the solution is stationary and incoherent. In a bounded range for the coupling strength, both the stationary and the synchronous solution seem to be stable. When the coupling strength is further increased, the stationary solution becomes unstable, and all solutions exhibit (partial) synchronization.

Acetate monitoring in *E. coli* fed-batch cultures

L. Dewasme, C. Retamal, A.-L. Hantson, A. Vande Wouwer

Abstract: Escherichia coli is one of the most common host microorganisms in biotechnology for the production of recombinant proteins. Growth of *E. coli* is generally performed in fed-batch operating mode. However, an excessive feeding (i.e., an excess of the main carbon source) can lead to acetate production inhibiting cell growth, in a phenomenon called "overflow metabolism".
In this work, an in-house experimental setup designed to measure on-line the acetate concentration is presented. The underlying technique is based on a gas diffusion cell and a conductivity measurement. This on-line probe can be used to monitor the fed-batch culture and optimize the feeding policy.
Batch and fed batch experiments are carried out in order to collect experimental data with a view to the development of a mechanistic model of *E. coli* B strain using the measurements of biomass, substrate, acetate and molar fraction of oxygen. This model takes the respiro-fermentative pathway (i.e. oxidation and fermentation of glucose) into

account and considers that oxygen conditions are not limiting the cell growth. This latter model could be used for the design of software sensors, as an alternative to the use of sophisticated hardware sensors.

From polynomial optimization to eigenvalue problems: applications in systems theory and identification

Dreesen P., Batselier K., De Moor B.

Abstract: Polynomial optimization problems (problems where a multivariate polynomial objective function is optimized with respect to polynomial (in-)equality constraints), are ubiquitous in science and engineering.
The related problem of solving systems of polynomial equations, i.e., finding their roots, is a fundamental research topic in mathematics. Both tasks play an important role in system identification and modelling. When tackling such problems using traditional methods, most of the underlying algebraic and geometric structure remains unattended. It turns out that linear algebra and realization theory play an important role in understanding and solving this problem.

Model-free Monte Carlo-like Policy Evaluation

Raphael FONTENEAU

Abstract: We propose an algorithm for estimating the finite-horizon expected return of a closed loop control policy from an a priori given (off-policy) sample of one-step transitions. It averages cumulated rewards along a set of ``broken trajectories'' made of one-step transitions selected from the sample on the basis of the control policy. Under some Lipschitz continuity assumptions on the system dynamics, reward function and control policy, we provide bounds on the bias and variance of the estimator that depend only on the Lipschitz constants, on the number of broken trajectories used in the estimator, and on the sparsity of the sample of one-step transitions.

Sensitivity analysis in epidemic models

HAUTPHENNE Sophie, KRINGS Gautier, DELVENNE Jean-Charles

Abstract : We model the spread of a contagious disease through a set of cities in the United States connected by air routes. The early stages of the epidemic are approximated by a multitype branching process, which has the advantage of being more tractable than a stochastic epidemic process. We analytically compute the sensitivity of quantities of interest, such as the mean number of infected people at a given time, with respect to the parameters of the model (contamination rates and travel rates). The

sensitivity analysis notably informs us about the impact of small errors in the data on pertinent measures obtained from the model.

Multi-view spectral clustering via tensor methods.

Liu X., De Moor B.

Abstract: We present a tensor based multi-view spectral clustering framework, which can be regarded as an extension of the spectral clustering method. Our framework includes two novel algorithms:the average multi-view spectral clustering algorithms based on higher-order singular value decomposition (AMSC-HOSVD) and the weighted multi-view spectral clustering algorithms based on higher-order orthogonal iteration (MSC-HOOI). Clustering experiments conducted on both synthetic data and on a large journal set retrieved from the Web of Science (WoS) database demonstrate the effectiveness of the proposed algorithms.Furthermore, we provide a cognitive analysis of the clustering results as well as the visualization as a mapping of the journal set.

Remote Laboratory for Leader-Follower Formation Control

Daniel Neamtu, Ernesto Fabregas and Robin De Keyser

Abstract: This poster presents the work done so far at the EESA department for the development of a remote laboratory. The remote laboratory consists of a server, a router, a network camera and a group of mobile robots. The remote user is able to connect to the remote lab using an Internet connection and perform the actions enabled by the GUI (Graphical User Interface). The software consists of a server and a client application, Matlab, C code running on the robot platforms. In the formation, one robot acts as leader and the others have to follow each other by controlling the distance between them. The robot position is detected using an on-board camera. The images are processed and based on this information, commands are sent to the motors. The structure of this formation is very similar to what happens with cars on a high-way, where a certain distance between cars has to be maintained.

Spectral stochastic simulation of a ferromagnetic cylinder rotating at high speed

Eveline Rosseel, Herbert De Gersem and Stefan Vandewalle

Abstract: Ferromagnetic cylinders rotating at high speed can be found as part of solid-rotor induction machines in various machining tools and in magnetic brakes. Designing solid-rotor devices with high-speed conductive parts requires to take ferromagnetic saturation effects into account, which typically cannot be quantified exactly. This uncertainty is expressed by introducing random variables into the mathematical model, which takes the form of a nonlinear stochastic partial differential equation (PDE). We

apply two state-of-the-art high-order stochastic solution approaches, the stochastic Galerkin and stochastic collocation method, to determine the influence of uncertainty on the machine properties. The stochastic Galerkin
method requires less stochastic unknowns than the stochastic collocation approach to reach a certain level of accuracy, however at a higher computational cost. Numerical experiments show that a small input variability can have a large influence on the variation of the torque.

Active noise control in hearing aids

Serizel R. Moonen M.

Abstract: The usage of hearing aids with an open fitting has become more common over the past years mainly owing to the availability of more efficient feedback control schemes and fast signal processing units. Whereas removing the earmold reduces the occlusion effect and improves the physical comfort, one major drawback is that the noise leakage through the fitting cannot be neglected anymore. Conventional Noise Reduction (NR) systems do not take this contribution into account. Combined with the attenuation in the acoustic path between the loudspeaker and the tympanic membrane (the so-called secondary path), the noise leaking through the fitting can override the action of the processing done in the hearing aid. One efficient way to cancel this undesired noise leakage is to use Active Noise Control (ANC). The principle of ANC is to generate a zone of quiet, in this case at the tympanic membrane, cancelling the effect of noise leakage. In the hearing-aid framework, ANC then has to be performed together with a NR algorithm.
This presentation introduces a scheme integrating ANC and NR in a single set of filters. Its performance are analyzed and different evolutions of the primary scheme are presented.

Dealing with uncertain constraints in optimisation using decision theory

Keivan Shariatmadar, Erik Quaeghebeur and Gert de Cooman

Abstract: We consider constrained optimisation problems with a real-valued, bounded objective function on an arbitrary space. The constraints are expressed as a relation between the optimisation variable and the problem parameters. We assume that there is uncertainty about these parameters. The aim is to reduce such problems to (constrained) optimisation problems without uncertainty. We investigate what results can be obtained for different types of parameter uncertainty models: linear expectations, vacuous expectations, possibility distributions, and p-boxes. Our approach is based on a reformulation as a decision problem under uncertainty of the original problem. For the reformulation, we investigate two different optimality criteria: maximinity and maximality. We present some general results and simple illustrations.

Kernel-based Learning from Infinite Dimensional 2-way Tensors

Signoretto M., De Lathauwer L., Suykens J.A.K.

Abstract: In this work we elaborate on a kernel extension to tensor-based data analysis. The proposed ideas find applications in supervised learning problems where input data have a natural 2-way representation, such as images or multivariate time series. Our approach aims at relaxing linearity of standard tensor-based analysis while still exploiting the structural information embodied in the input data.

Fixed-order output-feedback control design: A new algorithm to reduce conservatism

SIMON E., RODRIGUEZ-AYERBE P., STOICA C., DUMUR D., WERTZ V.

Abstract : This work proposes an algorithm to reduce the conservatism of fixed-order output-feedback control design for Linear Time Invariant (LTI) systems with Linear Matrix Inequalities (LMIs)-representable objectives. Using Lyapunov theory and the Schur complement many objectives can be written as Bilinear Matrix Inequalities (BMIs), which in general are hard to solve and have a non-convex space of solutions.
The classical response to this is to use LMIs reformulation of BMIs, therefore using convex subspaces of the non-convex space of all solutions and thus introducing conservatism in general.
Here a new use of a change of variables is proposed, so that consecutive convex subspaces are considered iteratively. This algorithm explores further the non-convex space of solutions, leading to improved objectives with reduced conservatism.

Reduction of polynomial nonlinear state-space models

Anne Van Mulders, Laurent Vanbeylen and Johan Schoukens

Abstract: Nowadays, there is a need for good quality nonlinear models. However, Polynomial Nonlinear State-Space models (PNLSS), which have quite good approximation capabilities, contain typically several hundreds of parameters. After identification of a PNLSS model, in general all parameters will be nonzero, while it is known that a very simple, sparse representation exists for Wiener-Hammerstein and nonlinear feedback systems. In this approach, we focus on reducing the number of parameters in the model, by using a property valid for such block-structured nonlinear systems: the nonlinear parameter matrix has a low rank. We impose this property by means of a re-parameterisation via singular value decomposition. A standard optimisation method can then be used to get a new parameter fit with fewer parameters.

Computing all characteristic roots of delay differential equations in a given right half plane using a spectral method

Zhen Wu and Wim Michiels

Abstract: We aim at the efficient computation of the right most characteristic roots of delay differential equations (DDEs) by using spectral methods. Since an appropriate choice of the number of discretization points N is crucial in reducing computational time, we will present a procedure that can automatically select N to compute all roots in a given right half plane accurately. Our proposed approach is based on connections between the spectral discretization and a rational approximation of exponential functions. Firstly, we estimate a region that contains all the desired characteristic roots; secondly, we select the smallest N such that inside this region the rational approximation of the exponential function is accurate. The numerical results show that this procedure is very efficient and has the potential to be used for decreasing computational time.

Poster Session 2
(14:45-15:45)

A multigrid method of the second kind for the optimal control of time-periodic parabolic PDEs

Dirk Abbeloos, Stefan Vandewalle and Moritz Diehl

Abstract: We present a multigrid method of the second kind to optimize time-periodic, parabolic, partial differential equations (PDE). We consider a quadratic tracking objective with a linear PDE constraint. The first order optimality conditions are given by a coupled system of boundary value problems. These conditions can be rewritten as an integral equation of the second kind, which is solved by multigrid of the second kind. The evaluation of the integral operator consists of solving sequentially a boundary value problem for respectively the state and the adjoints. Both are solved effciently by a space-time multigrid method.

Linearizing oscillometric blood pressure measurements: (non)sense?

Kurt Barbé and Wendy Van Moer

Abstract: The oscillometric waveform measured by automatic non-invasive blood pressure meters (NIBP) is analyzed by transforming the data from the time domain to the frequency domain. This Fourier analysis reveals that the measured blood pressure signals are heavily disturbed by nonlinear contributions. Classical blood pressure algorithms are based on the envelope of the measured blood pressure waveform. Due to the nonlinear contributions, calculating this envelope is not a self-evident task. The following question is answered: Are nonlinear contributions a significant source of information to compute the systolic and diastolic blood pressure?

Robust sensor fault detection and isolation for doubly-fed induction generators

B. Boulkroune, M. Gálvez-Carrillo, M. Kinnaert

Abstract: Doubly-fed induction generators (DFIG) are a class of induction machines widely used in wind energy conversion systems (WECS). They use a partial-scale power converter which traduces in lower cost and power losses than other concepts, while allowing a wide range of generator speed. The latter is necessary for controlling the power produced by a wind turbine.
Nevertheless, the generator can be subject to internal faults, external faults (coming from the power grid), and to faults affecting their sensors and their actuators. In order to prevent that faults can turn into failures, fault detection and isolation (FDI) systems are designed. A FDI system consists of a residual generator that produces signals

intended to react in the presence of a given fault, and of a decision system that performs the detection and isolation of the fault.
The problem of fault detection and isolation (FDI) in the current sensors of a DFIG in the presence of model uncertainty is presented here. The uncertainty comes from the fact that electrical parameters, namely the stator and rotor resistances, can vary due to temperature changes.
The proposed FDI systems consist of a multi-observer strategy for residual generation, namely the generalized observer scheme (GOS). Each observer is a robust H_- /H_∞ fault detection filter (FDF) followed by a Kalman-like observer. The latter filters a specific frequency in the output generated by the H_- /H_∞ FDF. A statistical-change detection algorithm performs the detection and isolation at one, processing the entire residual vector.

Multivariable orthogonal polynomials and structured matrix computations

Andrey Chesnokov and Marc Van Barel

Abstract: The recurrence coefficients of orthogonal polynomials in one variable with respect to a discrete inner product can be computed by solving a structured inverse eigenvalue problem. The poster will show how this inverse eigenvalue problem is modified and can be solved in case of multivariable orthogonal polynomials.

Filtering state estimation for optimal control of stochastic processes subject to multiplicative noise

CREVECOEUR Frédéric, SEPULCHRE Rodolphe, THONNARD Jean-Louis, LEFEVRE Philippe

Abstract : Computational models for the neural control of movement must take into account the properties of sensorimotor systems, including the signal-dependent intensity of the noise and the transmission delay affecting the signal conduction. For this purpose, this poster presents an algorithm for model-based control and estimation of a class of linear stochastic systems subject to multiplicative noise affecting the control and feedback signals. The state estimator based on Kalman filtering is allowed to take into account the current feedback to compute the current state estimate. The optimal feedback control process is adapted accordingly. The resulting estimation error is smaller than the estimation error obtained when the current state must be predicted based on the last feedback signal, which reduces variability of the simulated trajectories. In particular, the performance of the present algorithm is good in a range of feedback delay that is compatible with the delay induced by the neural transmission of the sensory inflow.

Dynamical modeling of alcoholic fermentation and its flavour markers

DAVID Robert

Abstract : The objective in this work is the description of the main phenomenological aspects of wine fermentation, including the main flavour markers. This will provide relevant information so as to improve the aromatic profile of the considered wine.

Multilevel Monte Carlo path simulation using the Milstein discretisation for option prizing

Kristian Debrabant

Abstract: In computational finance, Monte Carlo methods are used to estimate the expected value **E**[P] of a discounted payoff function which depends on the solution of an SDE of the generic form

$$d S = a(S,t) \, d t + b(S,t) \, d W, \qquad 0 \leq t \leq T.$$

Compared to simple Monte Carlo simulation, the computational complexity of approximating **E**[P] can be considerably reduced by the new multilevel Monte Carlo approach recently introduced by Giles. In this work we analyse its efficiency for different types of options when using the Milstein discretisation.
This is joined work with Mike Giles [Oxford] and Andreas Röβler [Freiburg]

Flux balance analysis and flux spectrum analysis for *Streptomyces lividans* batch fermentations

Pieter-Jan D'Huys, Ivan Lule, Sven Van Hove, Dominique Vercammen, Jozef Anné, Kristel Bernaerts, Jan Van Impe

Abstract: *Streptomycetes* are worldwide used for the commercial production of antibiotics and industrial enzymes. Recently, several species of this Gram-positive bacterium are being tested as host for the production of heterologous proteins given their ability to efficiently secrete proteins in the culture medium. Among them, *Streptomyces lividans* is considered an interesting host for the secretory production of heterologous protein. Up till now, the primary metabolism of this strain is poorly investigated, while this part of the metabolism is responsible for the production of biosynthetic precursors, energy and reductive power for biomass and heterologous protein synthesis. To gain insight into the cell metabolism, particularly the primary metabolism, the present work aims to determine metabolic flux distributions for *Streptomyces lividans* growing on a complex medium. An experimental and mathematical framework is setup to perform stoichiometric modeling of the primary metabolism of *S. lividans* during batch fermentations, by means of flux balance analysis (FBA) and flux spectrum analysis (FSA). Different stages involved are: (i) data

generation, (ii) estimation of specific conversion rates from concentration profiles, (iii) FBA and FSA using a genome-scale metabolic network model.

Identification of Hammerstein Systems using Overparametrization and Nuclear Norms

Falck T., Suykens J.A.K., Schoukens J., De Moor B.

Abstract: The overparametrization scheme for Hammerstein systems is studied in the presence of regularization. Different convex approximations for the implicit rank one constraint are analysed. We porose the use of nuclear norms inplace of frequently used ridge regression. Simple examples illustrate that this yields a solution close to the best possible convex approximation.
Furthermore the experiments suggest that ridge regression in combination with a projection step yield a generalization performance close to the one obtained by nuclear norms.

On the best low multilinear rank approximation of tensors

ISHTEVA Mariya, ABSIL P-A, VAN HUFFEL Sabine, DE LATHAUWER Lieven

Abstract : higher-order tensors are generalizations of vectors and matrices, i.e., arrays indexed with more than two indices. As in matrix algebra, the concept of rank plays an essential role in tensor algebra. We consider a generalization of column and row rank of a matrix to tensors, called multilinear rank. Given a higher-order tensor, we are looking for another tensor, as close as possible to the original one and with multilinear rank bounded by prespecified numbers. We briefly discuss several algorithms for this purpose and present some numerical experiments. We also point out that the associated cost function can have a number of local minima, which could cause problems in real applications.

Generating robust time delays using cascades of genetic switches.

Jaroslav ALBERT

Abstract: Many biological processes require some genes to be activated for a specific time lapse and in a particular temporal sequence. We propose a gene regulatory network consisting of genetic switches with positive auto-regulation capable of generating a robust cascade of gene activation. We present an approximate analytic expression for the activation times in terms of physical parameters and show they are robust against high levels of noise. The posibility of controlling the timing of the gene activations makes this network architecture ideal for use in synthetic biology. Similar types of networks which become active during the developmental stages can also be found in real biological systems.

Dealing with convexity issues in topology optimization of electromagnetic devices

LABBE Thibaut, GLINEUR François, DEHEZ Bruno

Abstract : Topology optimization methods aim at distributing predefined materials inside a design space in order to maximize a given objective function. Thanks to this approach, the optimization can be performed without any knowledge of the final design since these methods can produce any topology starting from an empty design space. When applied to the design of electromagnetic devices, these methods may suffer from a lack of convexity. Gradient-based algorithms, although effective, can therefore be trapped in local minimizers and produce different solutions depending on the initial conditions.
In this context, we study methods designed to cancel as much as possible the influence of the initial conditions and to best approach the global minimizer. They are based on specific convexity-oriented constraints and mapping functions. Their effectiveness is illustrated through a practical case, the design of a switched reluctance motor.

Estimating nonlinear dynamics in nonlinear state-space models

Anna Marconato, Jonas Sjoberg, Johan Schoukens, Johan Suykens

Abstract: Based on a combination of ideas from the statistical learning community used to solve nonlinear regression problems on one hand, and methods to handle dynamics from the system identification community on the other hand.
The proposed approach consists of the following steps: (1) model the dynamics of the system based on the concept of best linear approximation; (2) estimate the nonlinear states by solving a least squares problem; (3) model the nonlinearities by using regression methods such as Neural Networks and Support Vector Machines.

Multimesh H_2-optimal model reduction

MELCHIOR Samuel, VAN DOOREN Paul, LEGAT Vincent

Abstract: we describe a multimesh approach for model reduction of large scale dynamical systems, modelled via generalized state-space systems { M, A, B, C } of the type

$$\begin{cases} M\dot{x}(t) = Ax(t) + Bu(t) \\ y(t) = Cx(t) \end{cases}$$

(with input $u(t) \in R^m$, state $x(t) \in R^N$ and output $y(t) \in R^p$), obtained from a finite element discretization constructed on a fine mesh. The basic step of the algorithm is a fixed point iteration used to solve the H_2 model reduction problem.

This iteration requires the solution of a pair of Sylvester equations defined in terms of the state space equations and a current low order approximation $\{\hat{M}, \hat{A}, \hat{B}, \hat{C}\}$ of the dynamical system.
We show how this fixed point can be efficiently obtained using a multilevel approach where the fixed point iteration is applied only a few steps on each grid level. We illustrate these ideas on the construction of low order models for a particular example of advection-diffusion equations.

Learning to Replan: a Contribution of Supervised Learning to Mixed Integer Programming

Emmanuel RACHELSON

Abstract : In some Mixed Integer Programming problems, constraints on boolean variables have a predominant influence on the solution. Based on the illustrative case of the daily recourse plan computations in the French electrical network, cast as a MIP problem, we introduce a new method for simplifying the problem's resolution, by exploiting these structuring constraints. Our method learns offline a predictor on the values of the boolean variables, which allows to considerably shorten the online optimization time. We illustrate empirically that this method allows to find quasi-optimal solutions (less than 0.1% optimality loss on the example presented) with an order of magnitude gain in time complexity, while being more robust to the various hazards that trigger the re-planning procedure than the standard continuous relaxation or heuristic approaches.

Sophisticated humanoid robot control

Róbert Marc, Abhishek Dutta and Robin De Keyser

Abstract: In the legged robotics control literature feedback linearization is mostly used till date, along with computer torque control, variable structure control, optimal and adaptive control. The biped robot control locomotion in general addresses the following three problems. Firstly, the reference trajectory is planned based on the stability analysis of the robot (ZMP/FRI). Then it is also desirable to obtain a minimum jerk humanistic movement. Moreover the robot actuators have obvious physical limitations. It is interesting to note that the above pattern of problem formulation naturally fits into the MPC framework. This work explores the existing void in this direction. One of the advantages of MPC is also that robust control ideas can be easily incorporated. A non-linear MIMO dynamical system of a three link biped robot with rigid, point feet would be considered for simulation purposes.

Consensus with Nearest-Neighbor Interaction as a Quadratic Optimal Control Problem

Jonathan Rogge, Johan Suykens and Dirk Aeyels

Abstract: We present the consensus problem in the framework of optimal control. Our aim is to synchronize a set of identical linear systems. We propose a cost which penalizes mutual differences between the states of these systems. The feedback matrix resulting from this linear quadratic control problem represents the interconnection network which synchronizes the systems. In general the interconnection structure is of the all-to-all type. We show that it is possible to devise an LQR problem in which the cost results in an interconnection structure representing nearest neighbor coupling. Care has to be taken that the effect of the feedback control is restricted to synchronizing the systems, i.e. when the systems are synchronized, the feedback control signal is required to be equal to zero.

Nonlinear model predictive control of fed-batch cultures of E. coli

L. O. Santos, L. Dewasme, A. Vande Wouwer

Abstract: This work addresses the control of a lab-scale fed-batch culture of Escherichia coli with a nonlinear model predictive controller (NMPC) to determine the optimal feed flow rate of substrate. The objective function is formulated in terms of the kinetics of the main metabolic pathways, and aims at maximizing glucose oxidation, while minimizing glucose fermentation. As bioprocess models are usually uncertain, a robust formulation of the NMPC scheme is proposed using monotonicity arguments and a min-max optimization problem. The potentials of this approach are demonstrated in simulation using a Monte-Carlo analysis.

Regularization of ill-posed errors-in-variables linear models by Bayesian model averaging.

D. M. Sima, J.-E. Geay, S. Van Huffel

Abstract: We present an application of Bayesian model averaging (Raftery (1993), Burnham and Anderson (2004)) in the setting of truncated singular value decomposition and truncated total least squares for ill-posed linear approximation problems Ax=b. For each truncation level k, the corresponding truncated solution is multiplied by a weighting factor that is computed according to (approximate) Bayesian posterior model probabilities; then, the final estimate for x is the sum of the weighted truncated solutions. For estimating the Bayes factors, Akaike Information Criterion or Bayesian Information Criterion can be employed. An essential ingredient is the effective number of model parameters, which is simply equal to the truncation level k for truncated singular value decomposition, but must be computed as the sum of filter factors for other regularization schemes.