Association des Doctorants du campus STIC

Séminaires doctorants 14

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From 2nd to 4th Order Diffusion Tensor MRI

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Abstract. Diffusion Magnetic Resonance Imaging (D-MRI), introduced in the mid 1980s by LeBihan and Breton, is a relatively new modality of MRI. It has proved its effectiveness by its success in clinical neuro-diagnostics, and by its unique and powerful capacities to infer the geometric structure of the anatomical fibers in the underlying biological tissue, and at a resolution well beyond that of the original image. Currently, it is also the only approach capable of achieving these results non-invasively and in-vivo.
In 1994, LeBihan et al. introduced the formalism of Diffusion Tensor Imaging (DTI), to model the anisotropic diffusion of water molecules, which used 2nd order positive definite tensors, to reconstruct the diffusivity in the biological tissue from diffusion weighted MR images. This model, unfortunately, is inherently limited in its capacity to discern complex fiber crossings in a single voxel, which proves to be an important shortcoming in tractrography. High Angular Resolution Diffusion Imaging (HARDI) and Q-Ball imaging (QBI), a non-tensorial and model-free scheme, was successfully introduced by Tuch et al. over 2002 to 2004 to tackle this same problem. We, however, return to the tensorial model and explore 4th order tensor models in an attempt to improve on the 2nd order DTI.

* Joint work with Rachid Deriche.

Efficient and Flexible OO SPMD for Numerical Applications

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Abstract. High Performance Computing (HPC) usually refers to intensive numerical applications such as weather forecasting, physical simulations (like computational fluids dynamics), cryptanalysis, ... High Performance Computers can be divided into two sub-categories: the shared memory systems (SMP) and the massively parallel systems (MPP). Different programming models were developed for each systems such as OpenMP for SMP and MPI for MPP. However, since several years the amount of transistors in a chip does not scale up anymore, announcing the overcome of the Moore's law. By the way, new processors are frequently designed with two or four cores which are sharing some memory, and some founders are announcing the construction of processors with hundreds of cores. In such a context, Grids are changing from a set of uniprocessors computers to a set of multi-cores computers.
The Asynchronous Sequential Process (ASP) model is well designed for HPC with clusters of uniprocessors systems, but will no longer be adapted with new multi-cores systems. The point of this study is to take advantage of these new processors by adding parallelism while preserving the properties offered by ASP.

Formal Verification of Kantorovitch's Theorem

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Abstract. Formal methods have at present applications in various domains. Their main purpose is to guarantee that the software used corresponds to its formal specifications. We are interested in applying such techniques to numerical methods. In particular, we want to provide a formal verification of Kantorovitch's theorem, which gives sufficient conditions for the convergence of Newton's process.
The work accomplished during this internship can be divided in three main parts: proving the theorem in the unidimensional case, formalizing the necessary concepts from multivariate calculus and providing a formal proof for the theorem in the multidimensional case.

Types, Logic and Implicit Coercions

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Abstract. Coercive subtyping within typed lambda calculus has attracted attention during the last decade, partly because of it's importance in the applications of these systems, including formalization of mathematical concepts.
We restrict ourselves to the non-trivial case of simply typed lambda calculus in which we describe a powerful mechanism of coercive subtyping and give a type inference algorithm.

Study of the Competition Between Species in a Multivariable Environment: an Inverse Approach

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Abstract. Nowadays, people at large are trying to understand the biodiversity mechanisms and the coexistence of different species in the natural environment. The object of the research session is the study of the competition of species eating the same substrate in an open environment (chemostat), with a cyclic command: the environmental conditions (such as light or food supply). The study is carried out on the Droop model (Smith, 1995; Bernard and Gouze, *Math. Biosc.* 1999).
My specified work within the COMORE team is

1. to predict, for constant environmental conditions, the result of the competition between N species;
2. to find a selection criterium for some specified time-varying command (the environmental conditions);
3. to envisage the reverse approach: to find conditions that cause species to survive or die;
4. to select among the species the one of interest.

Search by Metaheuristics for a Rule that Solves a Synchronization Problem

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Abstract. The synchronization of processes is one of the most wide spread dynamical behaviors in nature. A classical problem is the firing squad synchronization problem (FSSP). The goal is to construct a one dimensional cellular automaton that will make all the cells enter in a special state at the same time. The evolution of the automaton is only based on local information exchanged between the cells within a radius equal to 3. So, the synchronization problem is not a trivial one because it asks for a meaningful propagation of the information in order to reach a configuration in which all the cells are in the same new state. Our approach to solving FSSP with 5 states is expressed in the context of the stochastic optimization. Following the previous work made in the same context, two optimization problems were defined: MAXFn et MAXF2, n. The optimization of the corresponding objective functions is made by metaheuristics, which are algorithms adequate for difficult problems with a large search space.
The best metaheuristic is a hybrid algorithm that combines the advantages of an evolutionary algorithm with a local search. This was successfully used to solve the MAXF2, 15 problem: the algorithm finds a transition function that solves FSSP for a cellular automaton with any size between 2 and 15. The problem with 4 states has no solution that synchronizes the cellular automaton with a size between 2 and 9. So, for FSSP with 5 states, a future search must be made for greater sizes of the cellular automaton.

Object Detection for the Guidance of an Autonomous Underwater Vehicle

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Abstract. The team Têtard design a robot in the framework of the Student Autonomous Underwater Challenge - Europe (SAUC-E). The rules are to perform a few missions like to hit or avoid some objects and to draw a map of them. To achieve this, we need to analyze data from embedded video cameras and detect whether these objects are present on the images recorded.
Our program is based on a computer vision library, OpenCV, and some basic image segmentation algorithms, such as color filters (thresholding). Since our processor is not very powerful, we have to make the code as fast as we can. Optimization is one of our priorities. Another one is the accuracy : we know what objects look like, we expect to find them while searching, and must be sure when it happens.

* Joint work with Angelica Lim and Nelly Pustelnik. Supervised by Maria-João Rendas and Sébastien Verel.

Detection of Man-made Objects in Video Sequences

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Abstract. In order to detect objects in natural images, we use a parametric approach. We focused on the work of Figueiredo who employs a coding theoretic approach for image segmentation. His method is based on the Minimum Description Length principle of Rissanen to estimate homogeneous regions in image.
The Figueiredo's MDL uses the Two-Part Coding approach, which can be refined by Normalized Maximum Likelihood proposed by Shtarkov. This second model, which is considered as an optimal one, needs Parametric Complexity computation. Frequently this Complexity is computed with asymptotic approximation. However, if the parameters used to compute Complexity are bounded, it is possible to have a finite Complexity.
In this presentation we will present our Complexity approach and the performance of our solution in comparison of Figueiredo's study.

* Joint work with Maria-João Rendas.

Modeling Motion Processing in the Primate Visual Cortex

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Abstract. At first we describe the properties of the macaque visual cortex starting from global brain area connectivity to neurons features. In particular we study the V1 and MT ares, the main ones involved in motion processing and their feedforward/feedback links. At a finer scale neuronal tuning and connections will be described.
We then go to modeling theses areas and their connections, emphasizing on a recent model proposed by Bayerl and Neuman (2005). This model solves classical motion processing problems such as the aperture ambiguity but some gaps remain. Proposed extensions include a better form integration and faster dynamics.

Dynamics in Spiking Neuronal Networks

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Abstract. We have studied and simulated the dynamics of spiking neuronal networks on the specific framework of the model called BMS-model. We have chosen particular types of synapses and network structures, i.e., the so called BMS-Laplacian NN on a $\mathbb{T}^2$ tori. We took special attention to understand the behavior of dynamical characteristics in presence of constant external input. We have found a great influence of stimuli in this type of model and network. Moreover we have characterized the creation of a more sensible region in the parameter space when an input is applied that we have called High-Input region. This region is richer in dynamical modes and the characteristic values of system may variate strongly there. We propose some specific theoretical results we have found and understood during the work and finally we discuss some future lines of research in the subject.

Notes

Les séminaires doctorants

Les séminaires des doctorants STIC permettent aux futurs docteurs d'échanger leurs expériences dans leur travail de thèse, tant sur le plan scientifique que sur le plan professionnel et éducatif. Ces rencontres ont lieu mensuellement dans l'un des laboratoires STIC de Sophia Antipolis.

Un séminaire est l'occasion de trois à quatre interventions, dont une effectuée par un jeune permanent. Chaque intervention comporte un exposé technique d'une vingtaine de minutes et une période d'échanges et de retours d'expérience d'une dizaine de minutes.

Ces actes compilent les résumés en anglais des exposés techniques du séminaire doctorant du 18 juin 2007.

L'ADSTIC

L'ADSTIC est l'association des doctorants du campus sciences et techniques de l'information et de la communication de l'université de Nice Sophia Antipolis. Créée en 2004, l'ADSTIC est une association loi 1901.

Notre but essentiel est de faciliter les contacts entre les doctorants des différentes disciplines présentes sur le campus STIC, de les informer et de valoriser leur formation doctorale. L'ADSTIC se veut aussi un lien entre les doctorants passés, actuels et futurs...

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