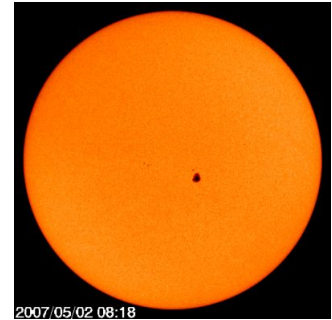# BELGIAN MATHEMATICAL SOCIETY

Comité National de Mathématique   CNM

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NCW   Nationaal Comite voor Wiskunde

BMS-NCM NEWS: the Newsletter of the Belgian Mathematical Society and the National Committee for Mathematics

BMS-NCM NEWS
—
No 63, May 15, 2007

Letter from the editor

Welcome

to this May 15, 2007- Issue of our Newsletter!
Our next issue is scheduled for September 15, 2007
BUT
there will be a <u>special issue</u>
dedicated to the second PhD-Day (see below), at the beginning of September

Regards, Françoise

Contents

1   News from the BMS

2007 PhD-Day

Monday 10 September 2007 at the ULB

On September 10, the Belgian Mathematical Society organizes its second

PhD-Day

The aim is to bring together the Belgian Mathematicians preparing their PhD or having obtained their PhD diploma during the academic year 2006–2007.

The PhD students will have the opportunity to present their research projects via oral presentations and poster sessions. An award will be offered for the best poster. They will also have time to get to know each other and become friends.

In this way we can also present our Society to colleagues just starting their career in Mathematics and show them what we can offer. It is therefore *very important* that all members participate to this activity and encourage their students to come to Brussels on September 10th. For this purpose we include a leaflet at the end of this newsletter. You can use this (and make copies if necessary) to announce the event in your department or neighbourhood. Remember that young colleagues who are not (yet) member of the BMS do not receive this newsletter and can only be aware of this event *through YOU!*

There is no participation fee and a lunch will be offered to BMS members. For organizational reasons we ask **to register via**

                    http://bms.ulb.ac.be/phdday

before July 1st, 2007.
The preliminary programme is as follows.

   10h00 Welcome from the president of the Society
   10h15 "Godeaux Lecture", by G. Vanden Berghe

"Simon Stevin (1548-1620) Mathematician, physicist, ..., Uomo universale"

11h15 Coffee
11h45 Poster presentations
12h45 Lunch (free for BMS members)
14h15 Oral presentations
16h15 Poster presentations
17h15 Drink and award for best poster

We scheduled 2 hours ($= 6 \times 20$ min) of oral presentations and have room for many posters.

On that day the first *Godeaux Lecture* will be delivered by Prof. Guido Vanden Berghe (Universiteit Gent).

The Godeaux Lecture will be organized at least once every two years during a BMS event. These lectures honoring the memory of Lucien Godeaux are organized with the assets of the Belgian Center for Mathematical Studies which were transferred to the BMS after the dissolution of this Center. Lucien Godeaux (1887-1975) was one of the world's most prolific mathematicians (with 644 papers published) and took many initiatives to encourage young mathematicians to communicate their research. He was the founder of the Belgian Center for Mathematical Studies in 1949.

Any suggestion about this activity is welcome !

The organizing committee consists of

F. Bastin (`f.bastin@ulg.ac.be`)   A. Bultheel (`adhemar.bultheel@cs.kuleuven.be`)
S. Caenepeel (`scaenepe@vub.ac.be`)   E. Colebunders (`evacoleb@vub.ac.be`)
Ph. Cara (`pcara@vub.ac.be`)   C. Finet (`catherine.finet@umh.ac.be`)
P. Godin (`pgodin@ulb.ac.be`)   H. Van Maldeghem (`hvm@cage.ugent.be`)

See also the leaflet at the end of the Newsletter.

2   Meetings, Conferences, Lectures

2.1   May 2007

DEPARTMENTAL COLLOQUIUM IN MATHEMATICS at K.U.Leuven

Thursday May 24th, Celestijnenlaan 200, Heverlee, in room 200N 00.04

Inaugural Lectures

- 14:00 Sören Krausshar (K.U.Leuven)

  Applications of hypercomplex analysis to the Navier-Stokes equations

- 15:00 Giovanni Lapenta (K.U.Leuven)

  The challenge in the mathematics of space weather: Bridging the micro-macro gap.

Afterwards there's a reception in the meeting room of the Department of Mathematics (B 02.05)
For further information check the website http://wis.kuleuven.be/colloq2007.htm

2.2   June 2007

Groupe de Contact FNRS
Analyse Fonctionnelle

FNRS Group– Functional Analysis–June 7-8, 2007

Following the tradition,

the FNRS group "Functional Analysis" will meet next June (Thursday 7, Friday 8).

The meeting will take place in the small town of

Esneux, in the "Domaine du Rond-Chêne"

Program:

- 15:00-15:50, Thursday, 07-06-07, **Jean-Marie AUBRY (U. Paris12-Créteil)**
  Ultrarapidly decreasing ultradifferentiable functions, Wigner distributions and density matrices

- 16:00-16:30, Thursday, 07-06-07, Coffee break

- 16:30-17:20, Thursday, 07-06-07, **Samuel NICOLAY (U. Liège)**
  Pointwise smoothness of space-filling functions

- 17:30-18:20, Thursday, 07-06-07, **Thomas KALMES (U. Trier)**
  Hypercylcic semigroups generated by first order differential operators

- 09:30-10:20, Friday, 08-06-07, **Aaron ZERHUSEN (U. Oldenburg)**
  Local Banach space theory and solvability of the $\bar{\partial}$ equation

- 10:30-11:00, Friday, 08-06-07, Coffee break

- 11:00-11:50, Friday, 08-06-07, **David JORNET (U. Pol. Valencia)**
  ω-micro-hypoelliptic differential operators of constant strength

- 12:00-12:50, Friday, 08-06-07, **Catherine FINET (U. Mons)**
  Vector valued pertubed variational principles

Organizers: F. Bastin and J. Wengenroth (both ULg)
For further information, please contact Françoise Bastin ULg (F.Bastin@ulg.ac.be)

2.3   July 2007

The EMS is a member society of ICIAM (=International Congress on Industrial and Applied Mathematics); please note the

Congress ICIAM 2007, 16-20 July 2007 in Zurich

See information on the web pages at the address http://www.iciam07.ch/registration

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POB 68 (Gustaf Hällströmink. 2b), FI-00014 University Helsinki, Finland
fax: +358-9-1915 1400

2.4   September 2007

The second PhD- day

organized by the BMS is scheduled on

Monday September 10, 2007.

It will take place at the ULB.
See announcement (and informations) at the beginning of this Newsletter and the leaflet at the end.

Non commutative rings and geometry
A conference in honour of Freddy Van Oystaeyen on the occasion of his 60th birthday
Almería, September 18-22, 2007
First announcement

Organizing Commitee: Stefaan Caenepeel (Brussels), Claudia Menini (Ferrara), Blas Torrecillas (Almería) and Alain Verschoren (Antwerp)

Local Commitee: Maria Jesús Asensio, Justo Peralta and Luis Oyonarte

Invited speakers (tentative list): E. Enochs, I. Reiten, A. Joseph, J.L. Gomez Pardo, M. Van den Bergh, H. Schneider, S. Majid, A. Bondal, C. Năstăsescu, J. Alev, A. del Río, E. Jespers, D. Stefan, A. Melnikov, P. Jara, A. Szenes

The conference will take place in Almería, Spain, from September 18 until September 22, 2007. The arrival day is Monday, September 17. On Saturday afternoon there will be no lectures and we plan to organize a visit to the Natural Park of Cabo de Gata or some other nice countryside place and a conference dinner.

A very limited number of talks will be accepted.

A special issue of "Algebras and Representation Theory" will be dedicated to this meeting. Authors should submit their contributions in LaTex to A. Verschoren, alain.verschoren@ua.ac.be. Submitted papers will be treated as ordinary submissions to the journal (see http://www.springer.com); authors will be notified about acceptance immediately after the refereeing process. Authors are invited to include a dedication like "Dedicated to Fred Van Oystaeyen, on the occasion of his sixtieth birthday".

Registration for this event may be done through the web page www.ual.es/Congresos/fred/, where information about the city of Almería, the lodging offered by the organization and other related questions can be found.

2.5   2008

8th German Open Conference on Probability and Statistics:
4-7 March 2008

The conference will be held in Aachen, Germany, 4-7 March 2008.

Continuing the series of Conferences in Marburg 1993, Freiberg 1996, München 1998, Hamburg 2000, Magdeburg 2002, Karlsruhe 2004, and Frankfurt 2006, which have become the major events in probability and statistics in Germany, the DMV-Fachgruppe Stochastik jointly with the RWTH Aachen University organizes the 8th German Open Conference on Probability and Statistics ("Aachener Stochastik-Tage 2008").

In the tradition of the previous conferences, it provides an international forum for presentation and discussion of new results in the area of probability and statistics. Participants from universities, business, administration, and industry are welcome.

Sections:

Stochastic Analysis; Limit Theorems and Large Deviations; Stochastic Geometry, Spatial Statistics, and Image Analysis; Random Discrete Structures and Analysis of Algorithms; Stochastic Processes: Theory and Applications; Time Series and Statistics of Stochastic Processes; Curve Estimation; Asymptotic Statistics; Stochastic Optimization and Operations Research; Data Analysis and Multivariate Statistics; Stochastic Models in Finance and Insurance; Statistical Methods in Finance and Insurance; Econometrics and Risk Analysis; Stochastic Models in the Natural Sciences; Statistics in Medicine and Biosciences; Stochastic Methods in Engineering

Plenary speakers will be:

N. Balakrishnan (McMaster University, Canada), Steven N. Evans (University of California at Berkeley, USA), Frank den Hollander (Universiteit Leiden, The Netherlands), Eva Riccomagno (Politecnico di Torino, Italy), and Aad van der Vaart (Vrije Universiteit Amsterdam, The Netherlands)

For a first announcement of the conference including more detailed information please visit the conference website http://gocps2008.rwth-aachen.de.

Contact information:

Email: gocps2008@stochastik.rwth-aachen.de

Programme committee:

Christine Müller (chair), Department of Mathematics, University of Kassel, D-34132 Kassel, Germany

Local organizing committee: Udo Kamps (chair), Institute of Statistics, RWTH Aachen University, D-52056 Aachen, Germany

5ECM, July 14-18, 2008
5th EUROPEAN CONGRESS of MATHEMATICS

Informations can be found at the address **http://www.5ecm.nl**

3 Summary of PhD theses

Joost VERCRUYSSE
Galois theory for corings and comodules
VUB March 9, 2007

Promotor: Stefaan Caenepeel

Abstract

Corings can be understood as coalgebras over a possibly non-commutative base ring. More precizely, corings are coalgebras (or co-monoids) in the monoidal category of bicomodules over a (non-commutative) ring. In this way they are, from the categorical point of view, the dual notion of a ring(extension). One of the most interesting and beautiful applications of corings is an elegant formulation of descent theory. In this thesis, we develop a more general version of this theory.

We construct a new type of corings, being comatrix corings associated to firmly projective modules. This construction generalizes the previously known 'finite' comatrix corings and the canonical Sweedler coring. Our new comatrix corings lead to a theory of Galois comodules over firm rings. We can formulate several structure theorems, which characterize equivalences between categories of comodules over a coring and categories modules over a (firm) ring. In the one-dimensional case we recover the faithfully flat descent theorem.

In the next chapters we study the relation between Galois theory and Morita theory. We investigate as well a special type of Galois comodules satisfying an additional normal basis property. These comodules are called cleft bicomodules and lead to a unification of all previously known theories of cleft extensions.

In the last part of the thesis we study some special properties of functors, such as separability and the Frobenius property. We are especially interested in the forgetful functor from a category of comodules to the category of modules over the basering. We give a characterization of these functors and investigate the impact of these properties on the Galois theory of the associated corings.

Jan POTEMANS
Mathematical modelling of aggregated traffic streams on the Internet
KU Leuven, April 4, 2007

Promotors: A. Van de Capelle and E. Van Lil

Abstract

The Internet is a packet switched network. When a station wants to transmit data to another station, the information is split into packets that travel independently through a network of routers and switches. These network nodes will forward the packets to other nodes based on a destination address that is included for each packet. Just like with traditional postal services, it is possible that packets can not be handled right away and have to be buffered. This will induce packet delay or even packet loss when the buffer size is too small to accommodate all the waiting packets. With the advent of interactive multimedia applications on the Internet, like telephony or television, it has become more and more important to keep the packet delay and loss under control. During our research, we developed a new mathematical model that is able to represent real packet streams in a very accurate way. The model makes it possible to precisely predict the packet delay and packet loss.

Ares LAGAE
Tile-based methods in computer graphics
KU Leuven, April 17, 2007

Promotor: Ph. Dutré

Abstract

Many complex signals, such as point distributions and textures, cannot efficiently be synthesized and stored. In this dissertation we present tile-based methods to solve this problem. Instead of synthesizing a complex

signal when needed, the signal is synthesized on forehand over a small set of tiles. Arbitrary large amounts of that signal can then efficiently be generated when needed by generating a stochastic tiling.

Tile-based methods are traditionally based on Wang tiles. The colored edges of Wang tiles only constrain the four direct neighboring tiles, but not the four diagonally neighboring tiles. This problem introduces unwanted artifacts in the tiled signals, and complicates methods for synthesizing signals over a set of Wang tiles. To solve this problem we present corner tiles. Corner tiles are unit square tiles with colored corners rather than colored edges. The colored corners of corner tiles constrain all neighboring tiles. We revisit the most important applications of Wang tiles, and we show that corner tiles have substantial advantages for each of these applications.

Stochastic tilings are traditionally generated using scanline stochastic tiling algorithms. However, these algorithms store the complete tiling and are therefore not efficient. To solve this problem, we present direct stochastic tiling algorithms for Wang tiles and corner tiles. These algorithms are capable of evaluating a stochastic tiling locally, without explicitly constructing and storing the tiling up to that point. We also introduce long-period hash functions to generate very large tilings. Poisson disk distributions and textures are two examples of complex signals. We present tile-based methods for generating Poisson disk distributions and for synthesizing textures. Tile-based methods not only allow to efficiently generate Poisson disk distributions and synthesize textures, but also enable new applications such as tile-based texture synthesis and a procedural object distribution function. This new texture basis function allows to distribute procedural objects over a procedural background, using intuitive parameters such as the scale, size and orientation of the objects. We also present an overview of applications of tiled Poisson disk distributions, and a detailed comparison of methods for generating Poisson disk distributions. We study corner tiles in the context of the tiling problem and aperiodic tile sets, and we construct several new aperiodic sets of Wang tiles and corner tiles.

The tile-based methods we present in this dissertation are a valuable tool for computer graphics, and help to keep up with the continuously increasing demand for more complexity and realism in digitally synthesized images.

Dirk NUYENS
Fast construction of good lattice rules
KU Leuven, April 20, 2007

<u>Promotor:</u> R. Cools

<u>Abstract</u>

We develop a fast algorithm for the construction of good rank-1 lattice rules which are a quasi-Monte Carlo method for the approximation of multivariate integrals. A popular method to construct such rules is the component-by-component algorithm which is able to construct good lattice rules that achieve the optimal theoretical rate of convergence. The construction time of this algorithm is $O(s^2 n^2)$, or $O(sn^2)$ when using $O(n)$ memory, for an s-dimensional lattice rule with n points.

We show how to construct good lattice rules in time $O(sn \log(n))$, using $O(n)$ memory, by means of a new algorithm, called the fast component-by-component algorithm. First this is shown for the base case when n is a prime number and the underlying function space is a weighted, shift-invariant and tensor-product reproducing kernel Hilbert space. Then we show that, by a minor increase in construction cost, also more generally weighted function spaces can be handled by the fast algorithm. In particular we show this for order-dependent weights.

When n is not a prime number it turns out that fast construction is also possible, although the construction is more involved for numbers n which have a large number of unique prime factors. An additional advantage is obtained when choosing n to be a prime power, since then the rules are embedded for increasing powers of the prime. Using this embedding, we propose a new fast algorithm to construct lattice sequences which can be used point by point.

Two natural extensions of the algorithm are the construction of polynomial lattice rules and so called copy rules. We show that also here the fast component-by-component algorithm can be applied. The quality of the constructed point sets is finally demonstrated on some finance and statistics examples.

David MAGIS
Influence, information and item response theory in discrete data analysis
ULg, May 4, 2007

Promotors: Gentiane Haesbroeck

Abstract

The main purpose of this thesis is to consider usual statistical tests for discrete data and to present some recent developments around them. Contents can be divided into three parts.

In the first part we consider the general issue of misclassification and its impact on usual test results. A suggested diagnostic examination of the misclassification process leads to simple and direct investigation tools to determine whether conclusions are very sensitive to classification errors. An additional probabilistic approach is presented, in order to refine the discussion in terms of the risk of getting contradictory conclusions whenever misclassified data occur.

In the second part we propose a general approach to deal with the issue of multiple sub-testing procedures. In particular, when the null hypothesis is rejected, we show that usual re-applications of the test to selected parts of the data can provide non-consistency problems. The method we discuss is based on the concept of decisive subsets, set as the smallest number of categories being sufficient to reject the null hypothesis, whatever the counts of the remaining categories. In this framework, we present an iterative step-by-step detection process based on successive interval building and category count comparison. Several examples highlight the gain our method can bring with respect to classical approaches.

The third and last part is consecrated to the framework of item response theory, a field of psychometrics. After a short introduction to that topic, we propose first two enhanced iterative estimators of proficiency. Several theoretical properties and simulation results indicate that these methods ameliorate the usual Bayesian estimators in terms of bias, among others. Furthermore, we propose to study the link between response pattern misfit and subject's variability (the latter as individual latent trait). More precisely, we present "maximum likelihood"-based joint estimators of subject's parameters (ability and variability); several simulations suggest that enhanced estimators also have major gain (with respect to classical ones), mainly in terms of estimator's bias.

Yves SCHOLS
A combined surface/volume integral equation approach to model quasi-3D structures in a multilayered environment
KU Leuven, May 9, 2007

Promotors: Guy Vandenbosch

Abstract

Een integraalvergelijkingsmodel voor quasi-3D structuren in een meerlagige omgeving Het ontwerp van antennes en circuit componenten gebeurt tegenwoordig met behulp van elektromagnetische veld simulatoren, die snelle numerieke oplossingen bieden voor de wetten van Maxwell. Om steeds complexere problemen te kunnen analyseren, wordt er fundamenteel onderzoek verricht naar mogelijke uitbreidingen of verbeteringen van de oplossingsmethodes. De theoretische ontwikkelingen in dit werk moeten in deze context geplaatst worden. Er wordt een nieuw en efficiënt integraalvergelijkingsmodel voorgesteld voor heterogene diëlektrische volumes in een meerlagige omgeving. Om de efficiëntie van de oplossing te kunnen garanderen, wordt de analyse beperkt tot quasi-3D volumes. De integratie van dit model in de veld simulator MAGMAS 3D rondt een jarenlange evolutie af, van een specifieke simulator voor vlakke antennes tot een algemeen simulatie instrument met sterk uitgebreide toepassingsmogelijkheden in het ganse domein van elektronica ontwerp. Deze opwaardering maakt het mogelijk om nauwkeurig en efficiënt structuren te analyseren, die zowel eindige als oneindige stukken diëlektricum bevatten, hetgeen op dit moment een ware uitdaging vormt voor om het even welke oplossingsmethode of commercieel pakket.

Pieter VAN LEEPUT
Multiscale and Equation-Fee Computing for Lattice-Boltzmann Models
KU Leuven, May 10, 2007

Promotors: D. Roose, K. Lust, W. Vanroose

Abstract

Many physical and chemical systems can be described at different levels of abstraction due to a separation of time and space scales in their dynamics. We consider two multiscale modeling techniques that take advantage of

this scale separation: the equation-free framework developed by Kevrekidis et al., which enables a time simulation for an unknown macroscopic model using only microscopic or mesoscopic simulations, and spatially hybrid models, which couple a microscopic/mesoscopic particle-based model to a macroscopic continuum model in space. At the microscopic/mesoscopic level, we consider lattice Boltzmann models (LBMs) for one-dimensional reaction-diffusion systems.

First, we show that time stepper based numerical bifurcation analysis techniques developed for partial differential equations (PDEs) can be used for LBMs as well. We use the LBM or the "coarse" equation-free time stepper wrapped around the LBM as the time stepper.

Second, we focus on the multiscale interfacing problem. During initialization and spatial coupling, one has to solve a one-to-many problem. A few macroscopic quantities have to be mapped to meaningful values for a larger set of microscopic/mesoscopic variables. We perform an extensive study of the influence of the initialization process (called lifting or reconstruction) on the minimal time step of the coarse time stepper and the accuracy of the results. Furthermore, we analyze the behavior of the so-called constrained runs initialization scheme for the LBMs considered. We prove that the scheme is unconditionally stable and that it converges to a first order correct approximation of the Chapman-Enskog relations. We also implement constrained runs schemes that use interpolation techniques to obtain a higher order accuracy.

Finally, we analyze the spatial discretization error of the hybrid model obtained by spatially coupling a LBM to a finite difference discretization of a PDE and show that the global error of the hybrid model is one order less accurate than the local error made at the interface. At the interface, the Chapman-Enskog relations or the constrained runs scheme can be used.

Filip COOLS
Grassmann secant varieties and plane curves with total inflection points
KU Leuven, May 16, 2007

<u>Promotor:</u> Wim Veys

<u>Abstract</u>

The thesis consists of two parts, both situated in algebraic geometry.

Part I. Grassmann secant varieties

If X is an irreducible projective variety in a projective space P and if h and k are integers with $h < k$, we consider the (h, k)-Grassmann secant variety $G_{h,k}(X)$ of X, i.e. the Zariski closure of the set of h-dimensional linear subspaces of P contained in the span of $k + 1$ independent points of X. The variety $G_{h,k}(X)$ has an expected dimension (by a parameter count). We say that X is (h, k)-defective if and only if the dimension of $G_{h,k}(X)$ is less than its expected one. We prove a lower bound on the dimension of $G_{h,k}(X)$ and classify the varieties attaining this bound. In the case where $h = k - 1$, we prove a rough characterization and a fine classification.

Part II. Plane curves with total inflection points

A couple (L, P) is called a total inflection point of a plane curve C (in a projective plane over an algebraically closed field k) if and only if L is a line and the set-theoretical intersection of C with L is the singleton $\{P\}$.

Given integers d and e, we study plane curves of degree d having at least e total inflection points. In particular, we look at the configurations of the total inflection points and we examine the image of the smooth curves under the moduli map. After giving some general results, we focus on the case where e is 3, 4 or 5.

Hendrik HUBRECHTS
Elliptic and hyperelliptic curve point counting through deformation
KU Leuven, May 25, 2007

<u>Promotor:</u> Jan Denef

<u>Abstract</u>

Punten tellen op elliptische en hyperelliptische krommen via deformatie. Het is bijzonder moeilijk om elektronische communicatie weg te denken uit onze moderne samenleving. De wetenschap die dit mogelijk maakt op een (min of meer) veilige manier is de cryptografie. Een groot deel van de cryptografische schema's is gebaseerd op de veronderstelde moeilijkheid van het berekenen van discrete logaritmes in eindige groepen: in goed gekozen groepen is het mogelijk heel snel een groot veelvoud $n.P$ van een element P te bepalen, maar is het heel moeilijk deze operatie om te keren: uit $P4$ en $n.P$ moet je dan n kunnen vinden. Om te bepalen of een groep

bruikbaar is voor cryptografie, is het zeer belangrijk de grootte ervan te kennen. In deze thesis ontwikkelen we een *p*-adische cohomologie die toelaat algoritmes te ontwerpen die in staat zijn het aantal elementen in bepaalde soorten groepen te berekenen, namelijk elliptische krommen en jacobianen van hyperelliptische krommen over eindige velden. Beide soorten groepen worden intensief bestudeerd door cryptografen en wiskundigen en er bestaan reeds commercieel verkrijgbare producten die gebruik maken van elliptische krommen.

De twee centrale begrippen in dit werk zijn de Monsky-Washnitzer cohomologie – deze laat toe de grootte van de kromme uit te drukken m.b.v. de matrix van een bepaalde afbeelding op een *p*-adische vectorruimte – en deformatie. Deformatie is een techniek waarbij een ganse familie krommen tegelijk bekeken wordt: één kromme uit de familie is van bijzonder eenvoudige vorm en de verandering doorheen de familie kan worden weergegeven d.m.v. een *p*-adische differentiaalvergelijking. De idee is dan de 'moeilijke' kromme te deformeren tot een 'gemakkelijke' en via de differentiaalvergelijking resultaten terug te brengen tot de moeilijke.

Door deze twee ideeën te combineren voor hyperelliptische krommen heb ik een *p*-adische relatieve cohomologie uitgewerkt die aanleiding geeft tot algoritmes die veel efficiënter zijn dan oudere bestaande, in het bijzonder wat betreft de hoeveelheid geheugen die gebruikt wordt. Voor elliptische krommen kunnen we dit aanpassen tot een uitzonderlijk snel algoritme dat de grootte van een kromme die mogelijkerwijze bruikbaar is voor cryptografie kan berekenen in een halve seconde.

<div align="center">

Steven DELVAUX
Rank structured matrices
KU Leuven, June 11, 2007

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<u>Promotor:</u> M. Van Barel

<u>Abstract</u>

In this thesis we study rank structured matrices from both a theoretical and practical point of view. The thesis consists of three parts.

In the first part we study the preservation of structure under several standard linear algebra operations: the QR-algorithm, matrix inversion and Schur complementation.

In the second part we describe some practical algorithms for rank structured matrices. To this end, we introduce the Givens-weight representation. The algorithms we develop for this representation involve both the solution of a linear system of equations, and the computation of all the eigenvalues of the given rank structured matrix by means of the QR-algorithm or the Hessenberg reduction algorithm.

Finally, in the third part of this thesis we study Fourier matrices and Kronecker products. We show that such matrices have generally a lot of low rank submatrices. We show that these low rank submatrices are related to the Fast Fourier transform (FFT), and to an uncertainty principle for Fourier transforms over finite Abelian groups.

4 Miscellaneous

<div align="center">

2007 is
THE YEAR OF EULER (Leonhard Euler 1707 - 1783) - EULER TERCENTENARY . . .

</div>

In this edition, see Adhemar Butheel's article on the next pages.
Visit the the Euler Shop at http://www.mathematicianspictures.com/EULER/Euler300.htm
and more. . .

The Leonhard Euler Tercentenary 2007

Leonard Euler was born in Basel on the 15th of April 1707. Therefore 2007 is declared to be an Euler year. There are several events organized at several places on this occasion. For example at the site `euler-2007.ch` you can find several activities, some of them have already passed, others are planned later this year. There are too many to list them all here. I just mention that there are exhibitions, symposiums, films, concerts (Euler has tried hard to incorporate music theory as a part of mathematics), etc. Several conferences are organized. For example in Basel in September, in St. Petersburg in June (Euler died in St. Petersburg on 18 September 1783) and the US based Euler Society organizes one in August in San Jose. The Math. Assoc. of America is even organizing a tour to Basel, St. Petersburg and Berlin (another place where Euler spent about 25 years of his life).

Birkhäuser published a comic strip *Leonhard Euler A Man to Be Reckoned with* by Andreas and Alice Heyne, (2007, 45 p., Hardcover ISBN: 978-3-7643-8332-9), or in German *Leonhard Euler: Ein Mann, mit dem man rechnen kann* ISBN: 978-3-7643-7779-3.
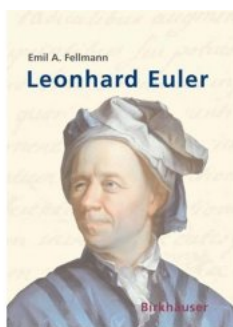
Also the biography *Leonhard Euler* by E.A. Fellmann, which appeared originally in German in 1995, was just published in an English version (translation by Erika and Walter Gautschi) by Birkhäuser in 2007, (179 p., 58 illus., Hardcover, ISBN: 978-3-7643-7538-6)

A special stamp has been brought out in Switzerland.

The influence of Euler on mathematics and physics has of course been enormous. The very long list of topics named after Euler on wikipedia `en.wikipedia.org/wiki/List_of_topics_named_after_Leonhard_Euler` is a proof already. There are of course many mathematical Euler-terms, but did you know that the following things were named after Euler: The Euler latex font (in which this text is typeset), the Euler craters on the moon, the 2002 Euler astroid, the Euler programming language, and of course there is an Euler street in Paris, and an Euler hotel in Basel, and I am sure there will be many restaurants and bistros in Basel, St. Petersburg or Berlin called after Euler, and I should probably mention all the computers having Euler as their pet name.

Leonhard Euler comic strip

Euler was one of the most prolific mathematicians of all time. The publication of his *Opera Omnia* was started in 1911 and has not been finished yet. you must certainly have a look at `www.eulerarchive.org` where you can find (and read) most of Euler's work in the original form (mostly in Latin).

Does Euler belong to your scientific genealogy? Now is an appropriate time to look it up. I did, and low and behold, I am an intellectual descendant from Euler indeed, as probably many of you are too.

To find that out, you should check out the web site `genealogy.math.ndsu.nodak.edu` of the Mathematical Genealogy Project (MGP) and look up who your advisor's advisor's ... advisor is. You may, as I did, eventually end up hitting upon Euler's name. Being linked to Euler in this way is probably much more frequent than having a low Erdös number. I am certainly not the only one having Euler among his scientific ancestors. According to the MGP, Euler had only Lagrange as a student, but there are 41194 descendants who are students of students of students ... and the MGP is far from complete. Thus, because of many missing links, this number is most probably considerably larger.

Eulers biography published by Birkhäuser
New Swiss stamp dedicated to Euler

The following table shows how, according to the MGP, I am linked to Leonhard Euler. The rule is that my advisor was P. Dewilde, whose advisor was R. Newcomb etc. I also mention in what year and where the PhD was obtained.

I am not a historian and I never did a thorough search but I wonder if somebody can fill in the gaps.

The thesis of Ernst Guillemin is not given on the MGP pages, nor on the many web pages sketching his life. Paul Levrie did find a title mentioned in a slide of a presentation by R. Seising, but since it also happens to be the title of a paper from 1926, correctness is not guaranteed.

	A. Bultheel	1979 K.U.Leuven Recursive Rational Approximation
	P. Dewilde	1970 Stanford Univiversity Cascade Scattering Matrix Synthesis
	R. Newcomb	1960 University California, Berkeley Synthesis of Non-Reciprocal and Reciprocal Finite Passive 2n-Poles
	C. Desoer	1958 Massachusetts Institute of Technology Communication Through Channels in Cascade
	R. Fano	1947 Massachusetts Institute of Technology Theoretical Limitations on the Broadband Matching of Arbitrary Impedances
	E. Guillemin	1926 Ludwig-Maximilians Universität München Zur Theorie der Frequenzvervielfachung durch Eisenkernkopplung
	A. Sommerfeld	1891 Universität Köningsberg Die willkürlichen Functionen in der mathematischen Physik
	C.L.F. Lindermann	1873 Friedrich-Alexander Universität Erlangen-Nürnberg Über unendlich kleine Bewegungen und über Kraftsysteme bei allgemeiner projektivischer Maßbestimmung
	C.F. Klein	1868 Rheinische Friedrich-Wilhelms-Universität Bonn Über die Transformation der allgemeinen Gleichung des zweiten Grades zwischen Linien-Koordinaten auf eine kanonische Form
	R. Lipschitz	1853 Universität Berlin Determinatio status magnetici viribus inducentibus commoti in ellipsoide
	G. Dirichlet	1827 Rheinische Friedrich-Wilhelms-Universität Bonn Partial Results on Fermat's Last Theorem, Exponent 5
	J.B. Fourier	
	J.L. Lagrange	no degree
	L. Euler	1726 Universität Basel

The bottom part is a bit tricky, and it raises further questions. Gustav Peter Lejeune Dirichlet got his PhD in Germany, but he studied with Poisson and Fourier before he returned to Bonn. So he can be considered to be a student of these. Jean-Baptiste Joseph Fourier was taught by Lagrange, but the St.-Andrews history pages do not mention a PhD. I guess he never produced one. Joseph Louis Lagrange never got a degree, but he certainly studied the work of Leonhard Euler.

Plücker was another advisor of Klein, and that would lead me to his advisor who was Carl Friedrich Gauss.

Adhemar Bultheel

THE BELGIAN MATHEMATICAL SOCIETY
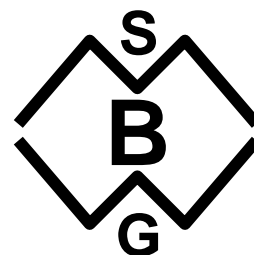
Young mathematicians,

TELL US WHAT YOU ARE DOING !

The Belgian Mathematical Society invites you to its second

PhD-Day

on **Monday, 10 September 2007**

at the **Université Libre de Bruxelles**
(Room **Forum E**, Campus Plaine, Boulevard du Triomphe, 1050 Bruxelles)

On this day we give the opportunity to all Belgian PhD students to present their research and to get to know their colleagues from all over the country.

PROGRAMME OF THE DAY

10h00 Welcome from the president of the Society
10h15 Godeaux Lecture "Simon Stevin (1548-1620) Mathematician, physicist, ..., Uomo universale" by G. Vanden Berghe
11h15 Coffee
11h45 Poster presentations
12h45 Lunch (free for BMS members)
14h15 Oral presentations
16h15 Poster presentations
17h15 Drink and award for best poster

For more information and registration (deadline is July 1):

`http://bms.ulb.ac.be/phdday`