INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

Project-Team Miaou

Mathématiques et Informatique de l'Automatique et de l'Optimisation pour l'Utilisateur

Sophia Antipolis — Futurs

THEME NUM

Activity Report

2003

Contents

1 Team

Head of project team

Laurent Baratchart [DR INRIA]

Vice-head of project team

Juliette Leblond [CR INRIA]

Administrative assistant

France Limouzis [AI INRIA, partial time in the project]

Staff member

José Grimm [CR INRIA]

Ph. D. Students

David Avanessoff [Fellow, INRIA]

Alex Bombrun [Since November, 1st]

Moncef Mahjoub [Co-advised, ENIT Tunis (in France in February, March, October, November)]

2 Overall Objectives

The project was terminated June the 30th, 2003. A proposal for a new project named APICS has been submitted to the steering comittee of Inria Sophia Antipolis.

The Team develops effective methods for modelling, identification and control of dynamical systems.

Research Themes

- Meromorphic and rational approximation in the complex domain, application to identification of transfer functions and matrices as well as singularity detection for 2-D Laplace operators. Development of software for frequency domain identification and synthesis of transfer matrices.

- Control and structure of non-linear systems: continuous stabilization, non-linear transformations (linearization, classification).

International and industrial partners

- Industrial collaborations with Alcatel-Space, etc
- Exchanges with CWI CNR (Italy), etc
- The project is involved in a NATO Collaborative Linkage Grant etc

3 Scientific Foundations

3.1 Identification and deconvolution

Let us first introduce the subject of Identification in some generality.

Abstracting in the form of mathematical equations the behavior of a phenomenon is a step called *modeling.* It typically serves two purposes: the first is to describe the phenomenon with minimal complexity for some specific purpose, the second is to *predict* its outcome. etc

3.1.1 Analytic approximation of incomplete boundary data

Participants: Laurent Baratchart, José Grimm, Birgit Jacob [University of Leeds (GB)], Juliette Leblond, Jean-Paul Marmorat [CMA, École des Mines], Jonathan Partington, Fabien Seyfert.

Key words: meromorphic approximation, frequency-domain identification, extremal problems.

etc, so that a prototypical Problem is:

(P) Let $p \geq 1$*,* $N \geq 0$*,* K *be an arc of the unit circle* T*,* $f \in L^p(K)$*,* $\psi \in L^p(T \setminus K)$ *and* $M > 0$*; find a function* $g \in H^p + R_N$ *such that* $\|g - \psi\|_{L^p(T\setminus K)} \leq M$ *and such that* $g - f$ *is of minimal norm in* $L^p(K)$ *under this constraint.*

Problem (P) is an extension to the meromorphic case, and to incomplete data, of classical analytic extremal problems (obtained by setting $K = T$ and $N = 0$), that generically go under the name *bounded extremal problems.* These have been introduced and intensively studied by the Team, [16] and [BL98].

3.1.2 Scalar rational approximation

Participants: Laurent Baratchart, Reinhold Küstner, Juliette Leblond, Martine Olivi, Edward Saff, Herbert Stahl, Franck Wielonsky.

Key words: rational approximation, critical point, orthogonal polynomials.

etc.

$$\left\|f - \frac{p_m}{q_n}\right\|_{L^2(d\mu)} \tag{1}$$

[BL98] L. Baratchart, J. Leblond, "Hardy approximation to L^p functions on subsets of the circle with $1 \leq p < \infty$", *Constructive Approximation 14*, 1998, p. 41–56.

where, by definition,

$$\|g\|^2_{L^2(d\mu)} = \frac{1}{2\pi}\int_{-\pi}^{\pi} |g(e^{i\theta})|^2 d\mu(\theta),$$

etc

If one introduces now as a new variable the rational matrix R defined by

$$R = \begin{pmatrix} L & H \\ 0 & I_m \end{pmatrix}^{-1}$$

and if T stands for the first block-row, normalizing the variance of the noise to be identity, the maximum likelihood estimator is asymptotically equivalent, when the sample size increases, to the minimization of

$$\|T\|^2_\Lambda = \mathbf{Tr}\left\{\frac{1}{2\pi}\int_0^{2\pi} T(e^{i\theta})\, d\Lambda(\theta)\, T^*(e^{i\theta})\right\}, \tag{2}$$

where Λ is the spectral measure of the process $(y\ u)^t$ (which positive and matrix-valued) and where $\mathbf{Tr}$ indicates the trace.

3.1.3 Continuous stabilization

Stabilization by continuous state feedback etc

Periodic stabilisation of non-linear systems. It is known that etc

Control Lyapunov functions. Lyapunov functions are etc

4 Application Domains

The activity of the team focuses on two bottom lines, namely etc

4.1 Geometric inverse problems for the Laplacian

Participants: Laurent Baratchart.

Key words: inverse problem, Laplace equation, non destructive control, tomography.

Localizing cracks, etc

4.2 Identification and design of resonant systems

Key words: telecommunications, multiplexing, filtering device, hyperfrequency, surface waves.

4.3 Spatial mechanics

etc

4.4 Non-linear Optics

etc

4.5 Transformations and equivalence of non-linear systems

Participants: Laurent Baratchart, Jean-Baptiste Pomet, David Avanessoff.

Key words: path planning, mobile cybernetics, identification, (max, plus) algebra.

etc

5 Software

5.1 The hyperion software

Participants: José Grimm [manager], Fabien Seyfert, Franck Wielonsky.

etc

5.2 The Tralics software

Participant: José Grimm [manager].

etc.

5.3 The RARL2 software

Participant: Jean-Paul Marmorat, Martine Olivi [manager].

RARL2 (Réalisation interne et Approximation Rationnelle L2) is a software for rational approximation (see module 3.1.1). Its web page is `http://www-sop.inria.fr/miaou/RARL2/rarl2.html`.

5.4 The RGC software

Participants: Fabien Seyfert, Jean-Paul Marmorat.

The RGC software etc

5.5 PRESTO-HF

Participant: Fabien Seyfert.

PRESTO-HF: a toolbox dedicated to lowpass parameter identification for hyperfrequency filters `http://www-sop.inria.fr/miaou/Fabien.Seyfert/Presto_web_page/presto_pres.html` etc

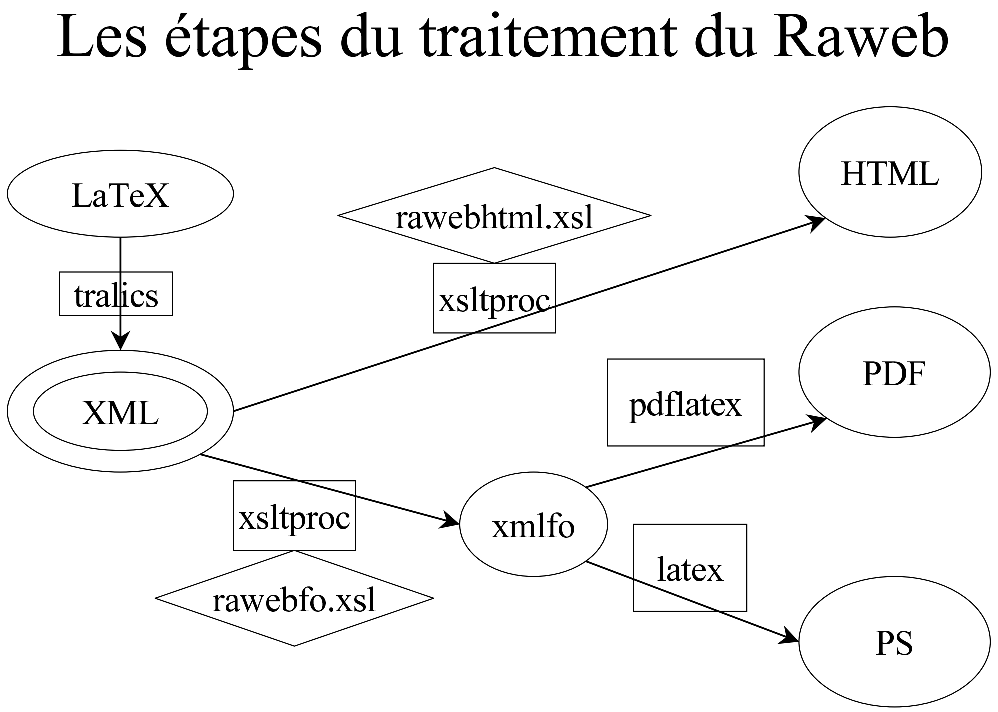

Figure 1: A slide that explains how the raweb operates. Rectangular boxes contain tools, diamond-shape boxes are style sheets, and ellipses contain language names; the name XML is in a double ellipse, it is the central object. The Perl script that handles the math formulas is not shown here; it uses tools borrowed from latex2html.

6 New Results

6.1 Tralics: a Latex to XML Translator

The main philosophy of Tralics is to have the same parser as TeX, but the same semantics as LaTeX. This means that commands like `\chardef`, `\catcode`, `\ifx`, `\expandafter`, `\csname`, etc., that are not described in the LaTeX book and not implemented in translators like latex2html, tth, hévéa, etc., are recognised by Tralics. This year we added constructions like `\endlinechar`, `\read`, `\uppercase`, `\endinput`, which are less used, and a bit tricky. Note that a construction like `\ifdim\wd0>0pt\fi` is recognised by the parser, but there is no way to change the size of the box number zero, so that the test is always false.

For more information, see the Tralics web page.

6.2 Parametrizations of matrix-valued lossless functions

etc

6.3 The mathematics of Surface Acoustic Wave filters

etc

6.4 Scientific Committees

L. Baratchart is member of the editorial board of *Computational Methods in Function Theory*.

7 Contracts and Grants with Industry

7.1 Contract ABCD-EFGH-INRIA

Contract n°1 03 E 2145

In the framework of a contract that links ABCD, EFGH and Inria, whose objective is etcthe work of Inria has been

- etcsee module 3.1.1,
- etc(see module 6.2),
- modeling and etc, see module 3.1.1.

In this contract, we promised version 1 of our software to both partners. This contract has been renewed in 2003.

7.2 Contract Company Somename (Cannes)

Contract n°1 01 E 0736.

This contract started in 2001, for three years. The objective is etc

7.3 Contract OtherName

Contract n°1 02 E 0327. This was a one year contract, that ended formally in February, 2003.

Subject. Objective was etc

Outcome. We have contributed to etc

8 Other Grants and Activities

8.1 National Actions

Together with project-teams Caiman and Odyssée (INRIA-Sophia Antipolis, ENPC), the University of Nice (J.A. Dieudonné lab.), CEA, CNRS-LENA (Paris), and a few French hospitals, we are part of the national action **ACI Masse de données « OBS-CERV »**, 2003-2006 (inverse problems, EEG).

The **region PACA** (Provence Alpes Côte d'Azur) is partially supporting the post-doctaral stay of Per Enquist until May, 2004. We also obtained a (modest) grant from the region for exchanges with SISSA Trieste (Italy), 2003-2004.

8.2 Actions Funded by the EC

The Team etcThe Team is member of the **TMR network** *European Research Network on System Identification* (ERNSI), see `http://www.cwi.nl/~schuppen/ernsi/ernsihp.html`. This formally ended in February. A new proposal of a Research Training Network (RTN) has been submitted to the EC.

The team obtained a **Marie Curie EIF** (Intra European Fellowship) FP6-2002-Mobility-5-502062, for 24 months (2003-2005). This finances Mario Sigalotti's post-doc.

The Team is a member of the **Marie Curie multi-partner training site** *Control Training Site*, number HPMT-CT-2001-00278, 2001-2005. See `http://www.supelec.fr/lss/CTS/`.

The project is member of Working Group Control and System Theory of the **ERCIM** consortium, see `http://www.ladseb.pd.cnr.it/control/ercim/control.html`.

8.3 Extra-european International Actions

NATO CLG (Collaborative Linkage Grant), PST.CLG.979703, « Constructive approximation and inverse diffusion problems », with Vanderbilt Univ. (Nashville, USA) et le LAMSIN-ENIT (Tunis, Tu.), 2003-2005.

8.4 Exterior research visitors

1=1, 2=6.1, 3=3 4=3.1 5=3.1.1

In addition to the "Scientific advisors" and to the "Visiting scientists" listed in section 1, the following scientists visited us in 2003.

- Mohamed Jaoua (Lamsin-ENIT, Tunis).
- Herbert Stahl (TU Berlin).
- etc

9 Dissemination

9.1 Teaching

Courses

- D. Avanessoff etc
- L. Baratchart, etc
- J. Leblond etc

Trainees

- Antoine Chaillet, etc

Ph.D. Students

- David Avanessoff, « Linéarisation etc » (dynamic linearization etc)
- Fehmi Ben Hassen, « Localisation etc »,
- Alex Bombrun, etc

Ph.D. thesis defended

- Reinhold Küstner, etc

L. Baratchart was (president|rapporteur|examinateur)[1] of the Thesis of X and Y and Z[2].

9.2 Community service

L. Baratchart is a member of the “bureau” of the CP (Comité des Projets) of INRIA-Sophia Antipolis.

9.3 Conferences and workshops

Glossary:

A B

C

A1 B1

C1

Talks, courses, sessions, software demonstrations at the CNRS-INRIA summer school “Harmonic analysis and rational approximation: their rôles in signals, control and dynamical systems theory”, Porquerolles, september. `http://www-sop.inria.fr/miaou/anap03/index.en.html`

J. Grimm gave a talk about Tralics at Eurotex 2003 (Brest)

[1] Rayer les mentions inutiles

[2] Remplacer les lettres par des noms

10 Bibliography

Major publications by the team in recent years

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[2] L. Baratchart, J. Grimm, J. Leblond, M. Olivi, F. Seyfert, F. Wielonsky, "Identification d'un filtre hyperfréquence par approximation dans le domaine complexe", *Rapport technique number RT-219*, Inria, 1998, `http://www.inria.fr/rrrt/rt-0219.html`.

[3] L. Baratchart, J. Leblond, F. Mandréa, E. Saff, "How can meromorphic approximation help to solve some 2D inverse problems for the Laplacian?", *Inverse Problems 15*, 1999, p. 79–90.

[4] L. Baratchart, M. Olivi, "Critical points and error rank in best H^2 matrix rational approximation of fixed McMillan degree", *Constructive Approximation 14*, 1998, p. 273–300.

[5] L. Baratchart, E. B. Saff, F. Wielonsky, "A criterion for uniqueness of a critical point in H^2 rational approximation", *Journal d'Analyse 70*, 1996, p. 225–266.

[6] L. Baratchart, F. Wielonsky, "Rational approximation in the real Hardy space H_2 and Stieltjes integrals: a uniqueness theorem", *Constructive Approximation 9*, 1993, p. 1–21.

[7] P. Fulcheri, M. Olivi, "Matrix rational H^2-approximation: a gradient algorithm based on Schur analysis", *SIAM J. on Control & Optim. 36*, 1998, p. 2103–2127.

[8] J. Leblond, M. Olivi, "Weighted H^2 approximation of transfer functions", *Math. of Control, Signals & Systems (MCSS) 11*, 1998, p. 28–39.

[9] J.-B. Pomet, "Explicit Design of Time-Varying Stabilizing Control Laws for a Class of Controllable Systems without Drift", *Syst. & Control Lett. 18*, 1992, p. 147–158.

[10] J.-B. Pomet, "On Dynamic Feedback Linearization of Four-dimensional Affine Control Systems with Two Inputs", *Control, Optimization, and the Calculus of Variations (COCV) 2*, June 1997, p. 151–230, `http://www.edpsciences.com/cocv/`.

Books and Monographs

[11] O. Author, "A work that is printed and bound, but without a named publisher or sponsoring institution", opt-howpublished, Address of Publisher, opt-month 2003, The note.

[12] O. Editor (editor), *Conference proceedings*, *optional series*, *opt-volume*, Optional Organization, Optional Address, Optional Publisher, opt-month 2003. The note.

[13] F. Mittelbach, M. Goossens, *A book with an explicit publisher*, edition opt-edition, *opt-series*, *opt-volume*, The Publisher, opt-address, opt-month 2003, The note.

Doctoral dissertations and "Habilitation" theses

[14] R. Küstner, *Asymptotic Zero Distribution of Orthogonal Polynomials with respect to Complex Measures having Argument of Bounded Variation*, PhD Thesis, Université de Nice, April 2003.

[15] F. Mittelbach, *A Ph.D. thesis*, optional type, School, Optional Address, opt-month 2003, The note.

Articles in referred journals and book chapters

[16] L. Baratchart, J. Grimm, J. Leblond, J. R. Partington, "Approximation and interpolation in H^2: Toeplitz operators, recovery problems and error bounds", *Integral Equations and Operator Theory 45*, 2003, p. 269–299.

[17] F. Mittelbach, M. Goossens, "An article from a journal or magazine", *Journal opt-volume*, opt-number, opt-month 2003, p. opt–pages, The note.

[18] F. Mittelbach, M. Goossens (editors), *A part of a book, e.g. a chapter, section, or whatever and/or a range of pages*, edition opt-edition, *opt-series*, *opt-volume*, A Publisher, opt-address, opt-month 2003, opt-type 4321, p. 123–125, The note.

[19] F. Mittelbach, M. Goossens, "A part of a book having its own title", *in: The title of the book*, O. Editor and H. Family (editors), edition opt-edition, *opt-series*, *opt-volume*, Publisher of the paper, Optional Address, opt-month 2003, opt-type opt-chapter, p. opt–pages, The note.

Publications in Conferences and Workshops

[20] J. Grimm, "Tralics, a LaTeX to XML Translator", *in: Proceedings of Eurotex*, 2003.

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[22] F. Seyfert, J.-P. Marmorat, L. Baratchart, S. Bila, J. Sombrin, "Extraction of Coupling Parameters For Microwave Filters: Determination of a Stable Rational Model from Scattering Data", 2003.

Internal Reports

[23] O. Author, *Technical documentation*, edition opt-edition, Optional Organization, Optional Address, opt-month 2003, The Note.

[24] D. Avanessoff, L. Baratchart, J.-B. Pomet, "Sur l'intégrabilité (très) formelle d'une partie des équations de la platitude des systèmes de contrôle", *Rapport de recherche number 5045*, INRIA, December 2003, `http://www.inria.fr/rrrt/rr-5045.html`.

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[28] European patent No. 03292257.7-, European patent office, September 2003, Title: "wavelength converter". Applicant/proprietor: Alcatel. Inventors: B. Lavigne, O. Leclerc, J.-P. Moncelet, A. Bombrun, F. Seyfert, J.-B. Pomet.

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