

INSTITUTE FOR MATHEMATICS AND ITS APPLICATIONS

University of Minnesota

400 Lind Hall

207 Church Street S.E.

Minneapolis, Minnesota 55455

FAX (612) 626-7370

telephone (612) 624-6066

e-mail: ima-staff@ima.umn.edu

IMA Schedules via finger: finger_seminar@ima.umn.edu

Newsletters, Updates and preprints are available via

anonymous ftp: [ftp.ima.umn.edu](ftp://ftp.ima.umn.edu), www: <http://www.ima.umn.edu/>

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IMA NEWSLETTER # 317

1–28 February 2003

2002–2003 Program

OPTIMIZATION

See <http://www.ima.umn.edu/optimization/> for a full description of the 2002–2003 program on Optimization.

IMA schedules are subject to revision, particularly during workshops. See <http://www.ima.umn.edu/~seminar/sched> and <http://www.ima.umn.edu/newsletters/> for the latest scheduling information.

PART I: NEWS AND NOTES

Arriving IMA Long-Term Visitors

The IMA is pleased to host John Dennis and Michael Powell during the winter quarter. Well-known experts in the field of Optimization and Numerical Analysis, they are also Ordway Visiting Professors in the School of Mathematics at the University of Minnesota.

Also visiting the IMA this month are Mauritz Diehl (University of Heidelberg) and Luis N. Vicente (University of Coimbra, Portugal).

New Directions Program

The IMA is delighted to announce New Directions Visiting Professorships for 2003-2004 and the New Directions Short Course in summer 2003. Applications are due 15 March 2003 and 1 April 2003, respectively. These programs offer extraordinary opportunities for the established mathematicians to branch into new directions and increase the impact of their research. For more information, please point to

<http://www.ima.umn.edu/new-directions/>

PARTICIPATING INSTITUTIONS: Centrum voor Wiskunde en Informatica (CWI), Consiglio Nazionale delle Ricerche, Georgia Institute of Technology, Indiana University, Iowa State University, Kent State University, Los Alamos National Laboratory, Michigan State University, Mississippi State University, Northern Illinois University, Ohio State University, Pennsylvania State University, Purdue University, Sandia National Laboratories, Seoul National University (BK21 Math-SNU), Seoul National University (SRCCS), Texas A&M University, University of Chicago, University of Cincinnati, University of Delaware, University of Houston, University of Illinois (Urbana), University of Iowa, University of Kentucky, University of Maryland, University of Michigan, University of Minnesota, University of Notre Dame, University of Pittsburgh, University of Wisconsin, University of Wyoming, Wayne State University.

PARTICIPATING CORPORATIONS: Boeing, Ford, General Motors, Honeywell, IBM, Lockheed Martin, Lucent, Motorola, Schlumberger, Siemens, Telcordia Technologies, 3M.

Version of March 5, 2003

IMA Website

Comments or suggestions concerning the IMA website may be addressed to

webmaster@ima.umn.edu.

In particular, we appreciate any information about World-Wide Web links appropriate to current and upcoming IMA programs.

PART II: SCHEDULE FOR 1–28 FEBRUARY 2003

Monday, February 3

The 10:30 IMA break will be in Lind Hall 400.

Tuesday, February 4

The 10:30 IMA break will be in Lind Hall 400.

IMA POSTDOC SEMINAR, Lind Hall 409:

11:15-12:15 **Michael J. D. Powell** Radial Basis Function Methods for Global Optimization
University of Cambridge

Abstract: Let the least value of a function $F(\underline{x})$, $\underline{x} \in \mathcal{D}$, be required, where \mathcal{D} is a bounded subset of \mathcal{R}^n and where the objective function is defined by a computer program that calculates $F(\underline{x})$ for any \underline{x} in \mathcal{D} . An algorithm is proposed for this problem that depends on the fact that there is a natural measure of “smoothness” of a radial basis function interpolant to function values at general positions in \mathcal{D} . The main task of the k -th iteration of the algorithm is to pick a new trial vector of variables, $\underline{x}_{k+1} \in \mathcal{D}$ say, using the values of F that have been calculated by previous iterations. We try to achieve the property that, if the method is applied for many iterations, then the least of the numbers $\{F(\underline{x}_j) : j = 1, 2, \dots, k+1\}$ becomes close to the required minimum value of the objective function. Therefore some iterations should take advantage of any small function values that are available, and others should choose vectors of variables in parts of \mathcal{D} that are relatively unexplored. The position of \underline{x}_{k+1} depends on a low target value, F_k^* say, of the required minimum. For each $\underline{y} \in \mathcal{D}$, we let $\sigma(\underline{y})$ be the “smoothness” of the radial function s that is defined by the interpolation equations $s(\underline{x}_j) = F(\underline{x}_j)$, $j = 1, 2, \dots, k$, and $s(\underline{y}) = F_k^*$. Then \underline{x}_{k+1} is chosen to be the \underline{y} that optimizes $\sigma(\underline{y})$, $\underline{y} \in \mathcal{D}$. A mix of low and high values of F_k^* is employed by the sequence of iterations, because a low value of F_k^* helps to spread out the trial vectors of variables, while a higher value provides local minimization by giving attention to the calculated function values. These features will be explained. Numerical experiments by H.M. Gutmann have shown that the method is successful on a range of small test problems.

The IMA Postdoc Seminar is organized by M. Yvonne Ou and Olga Brezhneva.

SPECIAL APPL MATH AND NUM ANALYSIS SEMINAR, Vincent Hall 570:

11:15-12:15 **Barbara Niethammer** On Models of Ostwald Ripening
University of Bonn

10:10 **Lawrence Cowsar** Raman Amplified Optical Transport Systems
Bell Laboratories, Lucent Technologies

Abstract: Optical transport system capacity has outpaced Moore's law over the past two decades. The pace continues unabated as a new generation of commercial products based on Raman amplification are being introduced. This talk will focus on some of the simulation challenges that arise in the design, control and testing of this next generation of optical transport.

Monday, February 10

The 10:30 IMA break will be in Lind Hall 400.

OPTIMIZATION SEMINAR, Lind Hall 409:

11:00-12:00 **Dr. John Dennis** Optimization tech transfer is a two-way street
Rice University and IMA

Abstract: This talk will present arguments, backed by examples from my industrial experience, that optimization is a particularly valuable tool for providing more robust solutions to industrial problems. My three main points will be:

- (*) Optimization can only solve the problem you give it. Involving optimization expertise early in the problem formulation process will help users/clients refine their thinking by exploiting any weakness in their problem formulation.
- (*) Academic Optimization technology provides a toolbox, but tools do not build a product. Inhouse optimization expertise is a key to success.
- (*) Industrial optimization problems are becoming more difficult as the need for more reliable solutions in engineering design increases. Collaboration between academic and industrial optimization researchers is critical in developing robust and fit-for-purpose solutions to industrial problems.

Tuesday, February 11

The 10:30 IMA break will be in Lind Hall 400.

IMA POSTDOC SEMINAR, Lind Hall 409:

11:15-12:15 **Peh Ng** A commodity family extended formulation approach to
U of Minnesota, Morris & IMA solving uncapacitated fixed charge network flow problems

Abstract: In general, uncapacitated fixed charge network flow problem, (UF), is NP-Hard. However, previous research on a few NP-Hard problems has shown that improved linear programming relaxations can be obtained by using extended reformulations. In this research, we develop a theory of extended formulations for (UF) by reformulating these problems in terms of an extended variable set corresponding to flow commodities defined by arbitrary demand subsets. In particular, we show how to produce an extended formulation for any suitable commodity family and isolate simple axioms characterizing the families that yield the most useful reformulations.

The IMA Postdoc Seminar is organized by M. Yvonne Ou and Olga Brezhneva.

JUNIOR COLLOQUIUM, Vincent Hall 570:

3:35pm **John Dennis** Two lectures on nonlinear optimization, II
Rice University

Abstract: For more than 10 years, I have been working with ExxonMobil, United Technologies, and Boeing on methods for optimal design using virtual prototyping. We have had some fine successes, but I feel we are just getting to the real

problem. In these two lectures, I will try to give you a feel for what these problems are like and how mathematicians can help.

Lecture 2: Formulations of multidisciplinary design optimization. In this lecture, I will use aeroelastic design of an airfoil to motivate a difficult class of multidisciplinary design optimization problems. In such problems, it is often crucial which of several mathematically equivalent formulations one tries to optimize.

Wednesday, February 12

The 10:30 IMA break will be in Lind Hall 400.

BROWN BAG SEMINAR, Lind Hall 409:

12:00	Montaz Ali Witerwatersrand U and IMA	Burning Issues of the Simulated Annealing Algorithm
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Thursday, February 13

The 10:30 IMA break will be in Lind Hall 400.

APPL. MATH. AND NUM. ANALYSIS SEMINAR, Vincent Hall 570:

11:15-12:15	Dominik Schoetzau University of Base	Title TBA
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MATHEMATICS DEPARTMENT COLLOQUIUM, Vincent Hall 16:

3:30	Michael J. D. Powell University of Cambridge	A new algorithm for minimization without derivatives
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Abstract: Let the least value of a given function $F(x)$, $x \in \mathcal{R}^n$, be required. Many iterative algorithms for this calculation employ quadratic polynomial approximations to F , and, if derivatives are not available, each approximation may be defined by $\frac{1}{2}(n+1)(n+2)$ interpolation conditions. Another approach, taken from gradient methods, is to employ fewer conditions, and to take up the freedom in a new quadratic approximation by minimizing a measure of the change from the previous approximation. A technique of this kind will be presented and discussed. It provides some excellent numerical results when the number of interpolation equations is only $2n+1$.

Friday, February 14

The 10:30 IMA break will be in Lind Hall 400.

Monday, February 17

The 10:30 IMA break will be in Lind Hall 400.

Tuesday, February 18

The 10:30 IMA break will be in Lind Hall 400.

IMA POSTDOC SEMINAR, Lind Hall 409:

11:15-12:15 **Moritz Diehl**
University Heidelberg & IMA

Nominal Stability for Nonlinear Model Predictive Control

Abstract: Nonlinear Model Predictive Control(NMPC) is a technique for the design of feedback controllers that works by online minimization of an objective depending on the predicted system behaviour. Typically, the system shall be kept in some desired steady state, and the objective penalizes deviations from it. A basic requirement for the resulting feedback controller is that it stabilizes the system at the given operating point at least in the case that the model is perfect - this property is called nominal stability.

In the talk, I will introduce the basic ideas underlying the standard stability proofs for NMPC. I will shortly discuss how the stability problem changes if numerical optimization errors are taken into account, and give a sketch of recent results to address this problem.

The IMA Postdoc Seminar is organized by M. Yvonne Ou and Olga Brezhneva.

Wednesday, February 19

The 10:30 IMA break will be in Lind Hall 400.

BROWN BAG SEMINAR, Lind Hall 409:

12:00 **Lisa Evans**
IMA

Master Cyclic Group Problems with Applications to Cutting Planes for Integer Programming

Thursday, February 20

The 10:30 IMA break will be in Lind Hall 400.

APPL. MATH. AND NUM. ANALYSIS SEMINAR, Vincent Hall 570:

11:15-12:15 **Marshall Slemrod**
U of Wisconsin-Madison

Title TBA

Friday, February 21

The 10:00 IMA break will be in Vincent Hall 502.

IMA/MCIM INDUSTRIAL PROBLEM SEMINAR, 570 Vincent Hall:

10:10 **Lili Ju**
IMA

Cortical Surface Flattening Using Discrete Conformal Mapping with Minimal Metric Distortion

Abstract: Although flattening a cortical surface necessarily introduces metric distortion due to the non-constant Gaussian curvature of the surface, the Riemann Mapping Theorem states that continuously differentiable surfaces can be mapped without angular distortion. Several techniques have been proposed for flattening polygonal representations of surfaces while substantially minimizing metric distortion, and methods for conformal flattening of polygonal surfaces have also been proposed. We describe an efficient method for generating conformal flat maps of triangulated surfaces while minimizing metric distortion within the class of conformal maps. Our method, which controls both angular and metric distortion, involves the solution of a linear system and a small scale nonlinear minimization. It can be applied to user-defined “patches” or to an entire cortical surface.

Monday, February 24

The 10:30 IMA break will be in Lind Hall 400.

Tuesday, February 25

The 10:30 IMA break will be in Lind Hall 400.

IMA POSTDOC SEMINAR, Lind Hall 409:

11:15-12:15 **Luis N. Vicente** Space mapping: models, algorithms and applications
University of Coimbra, Portugal and
Watson Research Center

Abstract: A number of new techniques have been developed to deal with optimization problems which involve expensive function evaluations from simulation or experimentation.

One of the techniques that has been recently considered in the engineering community is the so-called space-mapping approach. Space mapping assumes the existence of two models for the same physical phenomenon: a fine model, accurate and expensive, and a coarse model, significantly cheaper and considerably less accurate. The idea behind space mapping is to "construct" a mapping between the fine-model space of parameters or variables and the coarse-model space that allows to defer the optimization process to the coarse model, where most function evaluations should take place. Space-mapping techniques are typically iterative as the mapping is unknown a priori and it is calculated for a sequence of points in the fine space.

One of the goals of this talk is to organize some of the model and algorithmic aspects of space mapping in a mathematical framework which allows us to look at the properties of the space mapping and to fit the convergence analysis of the algorithms into the existence convergence theory of nonlinear optimization. We will also introduce new ways of building the space mapping and deriving the algorithms.

We will report recent numerical testing with the application of the space-mapping methodology to optimal control problems governed by partial differential equations. We will show how the space mapping technique can be used in the context of this class of problems.

This is joint work with Michael Hintermuller.

The IMA Postdoc Seminar is organized by M. Yvonne Ou and Olga Brezhneva.

Wednesday, February 26

The 10:30 IMA break will be in Lind Hall 400.

BROWN BAG SEMINAR, Lind Hall 409:

12:00 **John Dennis** Early Career Issues for Mathematicians
Rice Univ and IMA

Thursday, February 27

The 10:30 IMA break will be in Lind Hall 400.

APPL. MATH. AND NUM. ANALYSIS SEMINAR, Vincent Hall 570:

11:15-12:15 **John Dennis** An Algorithm for Nonlinear Programming with Mixed
Rice Univ and IMA Variables

Friday, February 28

The 10:30 IMA break will be in Lind Hall 400.

PART III: CURRENT IMA PARTICIPANTS

FIRST YEAR POSTDOCTORAL MEMBERS

NAME	PREVIOUS INSTITUTION
Olga Brezhneva	Russian Academy of Sci.
Lisa Evans	Georgia Tech
Balaji Gopalakrishnan	Georgia Tech
Herve Kerivin	University Blaise Pascal-France
Tamon Stephen	University of Michigan
Jing Wang	University of Minnesota

SECOND YEAR POSTDOCTORAL MEMBERS

NAME	PREVIOUS INSTITUTION
Dacian Daescu	University of Iowa
Gregory S. Duane	University of Colorado
Daniel Kern	University of Illinois-Chicago
M. Yvonne Ou	University of Delaware
Toshio Yoshikawa	University of Utah

POSTDOCTORAL MEMBERS IN INDUSTRIAL MATHEMATICS

NAME	PREVIOUS INSTITUTION	INDUSTRIAL AFFILIATION
Yusuf Altundas	University of Pittsburgh	Schlumberger
Lili Ju	Iowa State University	VA Hospital
Aurelia Minut	Michigan State University	3M
Haewon Nam	Texas A & M University	GE
Jun Zhao	Texas A & M University	Schlumberger

LONG TERM VISITORS

NAME	HOME INSTITUTION
John Dennis	Rice University
Peh Ng	University of Minnesota
Collette Coullard	Northwestern University
Michael Powell	University of Cambridge
Montaz Ali	Witwatersrand University
Moritz Diehl	University of Heidelberg
Luis Nunes Vicente	Universidade de Coimbra

VISITORS IN RESIDENCE (as of 29 Jan 2003)

ADAMS, SCOT	U of Minn	SEP 1 2002 – JUN 30 2003
ALI, MONTAZ	Witwatersrand U	NOV 1 2002 – OCT 31 2003
ALTUNDAS, YUSUF BILGIN	IMA	SEP 3 2002 – SEP 2 2004
ARNOLD, DOUGLAS N.	U of Minn	SEP 1 2002 – JUN 30 2003
ARONSON, DONALD	U of Minn	SEP 1 2002 – JUN 30 2003
BREZHNEVA, OLGA	U of Minn	SEP 3 2002 – SEP 2 2004
CALDERER, M. CARME	U of Minn	SEP 1 2002 – JUN 30 2003
COULLARD, COLLETTE	Northwestern	SEP 1 2002 – JUN 30 2003
COWSAR, LAWRENCE	Lucent Tech.	FEB 6 2003 – FEB 8 2003
DAESCU, DACIAN	IMA	SEP 1 2002 – JUN 30 2003
DENNIS, JOHN	Rice U	JAN 3 2003 – MAR 31 2003
DIEHL, MORITZ	U of Heidelberg	JAN 12 2003 – MAR 31 2003
DUANE, GREGORY S.	IMA	SEP 1 2002 – JUN 30 2003
EVANS, LISA	U of Minn	SEP 3 2002 – AUG 31 2003
GOPALAKRISHNAN, BALAJI	U of Minn	SEP 3 2002 – SEP 2 2004
JU, LILI	IMA	SEP 3 2002 – SEP 2 2004
KERIVIN, HERVE	U of Minn	SEP 3 2002 – SEP 2 2004
KERN, DANIEL	IMA	SEP 1 2002 – JUN 30 2003
KRYLOV, NICOLAI	U of Minn	SEP 1 2002 – AUG 31 2003
LOWENGRUB, JOHN	U of Minn	SEP 1 2002 – JUN 30 2003
MINUT, AURELIA	IMA	SEP 1 2002 – AUG 31 2003
NAM, HAEWON	IMA	SEP 3 2002 – SEP 2 2004
NG, PEH	U of Minn	AUG 1 2002 – JUL 31 2003
OU, M. YVONNE	IMA	SEP 1 2002 – AUG 31 2003
PARK, JEONG-SOO	Chonnam Natl U, Korea	JAN 3 2003 – FEB 27 2003
PATTERSON, SAMUEL	Carleton	SEP 28 2002 – JUN 30 2003
POWELL, MICHAEL	U of Cambridge	JAN 7 2003 – MAR 11 2003
SANTOSA, FADIL	U of Minn	SEP 1 2002 – JUN 30 2003
SENDIL, M. NURI	Northwestern U	SEP 2 2002 – JUN 30 2003
STEPHEN, TAMON	U of Minn	SEP 3 2002 – SEP 2 2004
SVERAK, VLADIMIR	U of Minn	SEP 1 2002 – AUG 31 2003
VICENTE, LUIS NUNES	Univ de Coimbra	JAN 7 2003 – FEB 1 2003
WANG, JING	U of Minn	SEP 3 2002 – SEP 2 2004
YOSHIKAWA, TOSHIO	IMA	SEP 1 2002 – JUN 30 2003
ZEITOUNI, OFER	U of Minn	SEP 1 2002 – AUG 31 2003
ZHAO, JUN	IMA	SEP 3 2002 – SEP 2 2004

See also URL: <http://www.ima.umn.edu/people/>