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IMA NEWSLETTER # 330

5-30 April 2004

2003-2004 Program

PROBABILITY AND STATISTICS IN COMPLEX SYSTEMS

See <http://www.ima.umn.edu/complex/> for a full description of the 2003-2004 program on Probability and Statistics in Complex Systems: Genomics, Networks, and Financial Engineering

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

General Electric Company joins the IMA

General Electric Company has joined the IMA's list of participating corporations. We welcome Sarah Patch to the IMA Industrial Advisory Board as our contact at GE.

PARTICIPATING INSTITUTIONS: Consiglio Nazionale delle Ricerche (CNR), Georgia Institute of Technology, Indiana University, Iowa State University, Kent State University, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Michigan State University, Mississippi State University, Northern Illinois University, Ohio State University, Pennsylvania State University, Purdue University, Rice 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: ExxonMobil, Ford, General Electric Company, General Motors, Honeywell, IBM, Lockheed Martin, Lucent, Motorola, Schlumberger, Siemens, Telcordia Technologies, 3M.

Version of May 5, 2004

IMA Workshop:

Risk Management and Model Specifications Issues in Finance

12–16 April 2004

Organizers: Marco Avellaneda (Courant Institute), Rama Cont (École Polytechnique),

See <http://www.ima.umn.edu/complex/spring/c7.html>

IMA “Hot Topics” Workshop:

Enhancing the Searching of Mathematics

26–27 April 2004

Organizers: Michael Doob (University of Manitoba), Thomas Fischer (State and University Library Göttingen), Marc Krellenstein (Elsevier), Robert Miner (Design Science, Inc.), Robby Robson (Eduworks Corporation),

See <http://www.ima.umn.edu/complex/spring/searching.html>

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 5–30 APRIL 2004

Monday, April 5

The 3:00 IMA break will be in Lind Hall 400.

Tuesday, April 6

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

IMA POSTDOC SEMINAR, Lind Hall 409:

Monday, April 12

**IMA Workshop:
Risk Management and Model Specifications Issues in
Finance**

12–16 April 2004

Organizers: Marco Avellaneda (Courant Institute), Rama Cont (École Polytechnique),

See <http://www.ima.umn.edu/complex/spring/c7.html>

Some of the most interesting themes in quantitative finance and econometrics have to do with model specification in the broadest sense, including the statistical analysis of market data from multi-asset, multi-currency markets with a high number of state variables but also indirect identification of models from option prices (“model calibration”). The statistical analysis of the distribution of returns often requires advanced techniques, such as nonlinear regression (ARCH/GARCH), nonstationary modeling of time series (to take into account seasonal effects), neural networks and data-mining. In addition to the statistical analysis of multivariate returns, quantitative modeling is also concerned with derivatives and relative-value analysis, which require working with so-called “risk-adjusted” probability distributions. In fact, prices observed at any given time contain “forward looking” information about future cash flows in the form of market prices of traded options.

This means that the models that are used to price and hedge derivatives must be determined partially from econometric information and partially by solving “inverse problems” (in the sense of going from prices to parameters) that reflect current market prices. Inverse problems in asset-pricing theory comprise diverse questions in finance, such as the construction of smooth forward rate curves from interest rate futures, swaps and bond price data, the calculation of “volatility surfaces” from observation of option prices and more generally implying parameters of more complex models from observed option prices. These inverse problems are ill-posed, i.e., exhibit sensitive dependence to input data. This workshop will be centered on robust techniques and algorithms for solving such problems in different market contexts (e.g., fixed income/capital markets derivatives, credit derivatives, commodities market models, etc.), their theoretical foundations, their economic interpretation and the interplay of model identification problems with risk management issues.

Mathematical Areas of Relevance:

- Stochastic differential equations
- Markov Processes
- Ill-posed inverse problems and regularization methods
- Linear and nonlinear Partial Differential Equations
- Optimization: dynamic programming, duality techniques, semidefinite programming
- Duality methods in optimization
- Mathematics of information theory
- Parametric and nonparametric statistics
- Numerical methods and their implementation

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

8:30

Coffee and Registration

Reception Room EE/CS 3-176

9:15 **Douglas N. Arnold, Scot Adams, and Organizers** Welcome and Introduction

9:30 **Marco Avellaneda** A Market-Induced Mechanism for Stock Pinning on Option Expiration Dates
New York University

Abstract: We propose a model to describe stock pinning on option expiration dates. We argue that if the open interest in a particular contract is unusually large, Delta-hedging in aggregate by market-makers can impact the stock price and drive it to the strike price of the option. We derive a stochastic differential equation for the stock price which has a singular drift that accounts for the price-impact of Delta-hedging. According to this model, the stock price has a finite probability of pinning at a strike. We calculate analytically and numerically this probability in terms of the volatility of the stock, the time-to-maturity, the open interest for the option under consideration and a “price-elasticity. constant that models price impact. We also present strong evidence of the validity of the model, based on historical data from 1996-2004.

10:20 **Discussion**

10:30 **Coffee Break** Reception Room EE/CS 3-176

11:00 **Alexandre d’Aspremont** A Moment Approach to the Static Arbitrage Problem on Baskets
University of California, Berkeley

Abstract: We consider the problem of computing upper and lower bounds on the price of a European basket call option, given prices on other similar baskets. We focus here on an interpretation of this program as a generalized moment problem, using results by Berg & Maserick (1984), Putinar & Vasilescu (1999) and Lasserre (2001) on harmonic analysis on semigroups, the K-moment problem and its applications to optimization. These allow us to derive tractable necessary and sufficient conditions for the absence of static arbitrage between basket straddles, hence on basket calls and puts.

11:50 **Discussion**

12:00 **Lunch Break**

1:30 **Thaleia Zariphopoulou** Optimal Investments in Markets with Stochastic Opportunity Sets
University of Texas at Austin

Abstract: A class of optimal investment and consumption models in incomplete market environments will be analyzed. The focus will be on a universal characterization of the optimal portfolios (myopic and excess risky demand) in terms of hedging strategies of supporting pseudoclaims. These claims are written on the market price of risk and are priced by indifference. Recent results on indifference prices will be used for the sensitivity and robustness analysis of the optimal investments. Issues related to model specification, and to the interplay between market incompleteness and risk preferences, will be also discussed.

2:20 **Discussion**

2:30 **Coffee** Reception Room EE/CS 3-176

policy, and choice of organizational form (i.e., closed-end vs. open-end).

Keywords: Nash Equilibrium, Portfolio risk, Mutual Fund Tournaments, Delegated Portfolio Management, Performance Chasing, Managerial Incentives.

Joint work with Ashish Tiwari.

poster **Matthias Graefenhan** A Mathematical Knowledge Base using Coherent Notation
University of Marburg

Abstract:

x

We present an XML based system of mathematical documents currently being developed at the University of Marburg, Germany, which aims at a comprehensive and systematic description of all aspects of pure mathematics. The system consists of numerous documents each devoted to one mathematical topic, which are organized in a highly coherent way. This is achieved through the following features:

1. uniform symbolic notation for all mathematical and logical objects, based on specially created symbols
2. treelike arrangement of the single documents (considered as atomic elements) in order to find each document via a unique path; freely definable further arrangements, e.g. cross references or collections of documents for classroom use
3. elaborate network of interconnections between the atomic elements

The structure of the notation mentioned above enables us to perform searching without the need for extra metadata.

poster **Rituparna Sen** Modeling the Stock Price Process as a Continuous-time
University of Chicago Discrete Jump Process

Abstract: An important aspect of the stock price process, which has often been ignored in the financial literature, is that prices on organized exchanges are restricted to lie on a grid. We consider pure jump models for the stock price process which integrate the randomness of jump times with the discreteness of the jump size. The convergence, estimation, discrete time approximation, and uniform integrability conditions for this model are studied. The effect of stochastic volatility is studied in this setting. A Bayesian filtering technique is proposed as a tool for risk neutral valuation and hedging. This emphasizes the need for using statistical information for valuation of derivative securities, rather than relying on implied quantities.

poster **Yong Zeng** A General Equilibrium Model of the Term Structure of
University of Missouri at Kansas City Interest Rates under Regime-switching Risk

Abstract: This work incorporates the systematic risk of regime shifts into a general equilibrium model of the term structure of interest rates. The model shows that there is a new source of time-variation in bond term premiums in the presence of regime shifts. This new component is a regime-switching risk premium that depends on the covariations between discrete changes in marginal utility and bond prices across different regimes. A closed-form solution for the term structure of interest rates is obtained under an affine model using log-linear approximation. The model is estimated by Efficient Method of Moments. The regime-switching risk is found to be statistically significant and mostly affect the long-end of the yield curve. This is a joint work with Shu Wu at the University of Kansas.

JEL Classification: G12, E43

Key Words: The Term Structure, General Equilibrium, Markov Regime Shifts

poster **Gady Zohar** Excess Yields in Bond Hedging
Technion - Israel Inst. of Technology

Abstract: We explore a dynamic term structure factor model that implicitly allows for arbitrage opportunities, and we estimate it on Treasury data. Using this model we construct instantaneously risk free portfolios, and we write down a formula for their possibly non-zero excess returns. Our model anticipates that such excess returns may be quite large. When testing the performance of these portfolios we find that their returns in practice perfectly match what our model predicts. An important implication of our approach is that hedging against factor risk may involve substantial excess gains

set of model parameters, the population of parameters is updated through cycles of independent random moves followed by “selection” using the calibration criterion. We examine conditions under which such an evolving population converges to a set of calibrated models.

Through an analogy with systems of interacting particles, a “propagation of chaos” result allows us to interpret the result of our algorithm as a random IID sample drawn from the set of calibrated models, whose heterogeneity can be used to quantify the degree of ill-posedness of the inverse problem. Building upon this idea, we propose a minimax measure of model uncertainty for the price of an exotic option which takes into account the value of liquidly traded (“vanilla”) options. Our algorithm yields a computable example of coherent and convex measures of risk, which are compatible with observed prices of benchmark options.

We test this approach both on simulated data and empirical data sets of index and foreign exchange options in the context of diffusion models.

2:20	Discussion	
2:30	Coffee Break	Reception Room EE/CS 3-176
3:00	Raphael Douady Riskdata	Hedge Fund Performance and Risk Profile Analysis: Non-Linear Statistics and Risk Factor Identification

Abstract: Hedge Fund positional transparency has raised a number of issues between investors and Funds of Funds managers on the one hand, and hedge fund managers on the other hand. We show that, in general, this controversy is almost irrelevant, and that, indeed, appropriate statistical techniques allow to extract from historical return series most of the risk information. Moreover, a large part of this information cannot be detected, just knowing the positions of the fund at a given date.

We will, in particular, focus on the importance of taking into account the non-linear relationship between hedge fund returns and market factors. We shall also show the relevance of rolling statistics of the market in the explanation of return series.

3:50	Discussion	
4:00	Coffee Break	Reception Room EE/CS 3-176
4:30	Second Chances	Speakers of the day respond to further questions, suggestions, re-frame their main points, look toward future directions.

Wednesday, April 14

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

9:00	Coffee	Reception Room EE/CS 3-176
9:30	Nicole EL KAROUI Centre de Mathématiques Appliquées Ecole Polytechnique	Max Plus Decomposition of Supermartingale with Application to Portfolio Insurance

Abstract: The classical Doob-Meyer décomposition of supermartingale states the existence of a previsible increasing process A and of a martingale N such that a supermartingale Z can be decomposed into $N = Z + A$.

The Max Plus Algebra is obtained in exchanging the operations $(+, \times)$ into $\max, +$). Therefore, the Max-Plus decomposition becomes :

- find a martingale N and an adapted increasing process Λ with max-plus density $L \in [-\infty, +\infty]$ such that

$$M = \max(Z, \Lambda), \quad \Lambda_t = \sup_{s \leq t} L_s$$

The existence is proved via convex analysis argument.

The martingale M is also characterized as the optimal solution of the following optimisation martingale problem :

- Find the smallest martingale M^* with respect to the stochastic order of their terminal value among the martingales majorizing Z and with initial value Z_0 .

In mathematical terms, let \mathcal{M} be the set of martingales with $M_0 = Z_0$, and T the horizon of the study. The problem is to find $M^* \in \mathcal{M}$ such that for any convex function g

$$E(g(M_T)) \geq E(g(M_T^*)), \quad \forall M \geq Z$$

In Finance, the problem of tailoring a self-financing portfolio V submitted to the American constraint $V \geq F$, where F is the dynamic floor (the guarantee), optimal for some with expected utility criterion on the terminal value may be solved by the previous result, given the optimal solution of the non-constrained problem, and a change of probability measure.

10:20	Discussion	
10:30	Coffee	Reception Room EE/CS 3-176
11:00	Craig Alan Friedman Standard and Poor's and New York University's Courant Institute of Mathematical Sciences	A Financial Approach to Machine Learning with Applications to Credit Risk
11:50	Discussion	
12:00	Lunch Break	
1:30	Michael Stutzer Leeds School of Business	Ockham's Razor Critique of Investor Objective Functions: Neither Samuelson nor Rabin and Thaler Are Right

Abstract: Influential early articles by Paul Samuelson advocated use of expected concave utility of wealth criteria in T-repeated betting and investment problems. He and other founders of modern decision theory viewed their work as normative prescriptions for choice under uncertainty; not just as predictive theories of pre-existing behavior. Results of Rabin (Econometrica, 2000), expounded and applied in Rabin and Thaler (Journal of Economic Perspectives, 2001, pp. 219-232), directly challenged both the prescriptive and predictive usefulness of any expected concave utility criterion in these settings. As a predictive alternative, they advocated the use of loss averse preferences as a substitute for expected concave utility.

While different systems of preference axioms have been found that respectively imply the use of expected utility and loss aversion criteria, they are not normatively convincing. Moreover, neither loss aversion criteria, nor several other

alternatives to expected utility, do anything to solve a problem that plagues both the prescriptive and predictive use of expected utility: prescriptive results critically depend on practically unobservable, adjustable preference parameters, and hence ad-hoc techniques for attempting to indirectly identify them.

As a simpler alternative criterion, this paper proposes the probability of outperforming an observable benchmark the agent wants to beat. This criterion does not suffer from the possible ills of some other probabilistic criteria that were (influentially) critiqued by Samuelson. Large deviations theory is used to show that for suitably large T , this criterion is equivalent to maximizing an expected CRRA (power) habit-formation utility, but with a coefficient of risk aversion that varies endogenously with the alternative evaluated. This eliminates the adjustable curvature parameter used in other expected and non-expected utility (e.g., loss aversion) preference theories, in accord with the scientific principle of parsimonious parameterization called Ockham's Razor.

2:20	Discussion	
2:30	Coffee Break	Reception Room EE/CS 3-176
3:00	Second Chances	Speakers of the day respond to further questions, suggestions, re-frame their main points, look toward future directions.

Thursday, April 15

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

9:00	Coffee	Reception Room EE/CS 3-176
9:30	Peter Tankov Ecole Polytechnique, France	Non-Parametric Calibration of Jump-Diffusion Option-Pricing Models

Abstract: We present a non-parametric method for calibrating jump-diffusion and, more generally exponential Levy models to a finite set of observed option prices. We show that the usual formulations of the inverse problem via nonlinear least squares are ill-posed and propose a regularization method based on relative entropy: we reformulate our calibration problem into a problem of finding a risk neutral exponential Levy model that minimizes a certain weighted sum of the pricing error and the relative entropy of the pricing measure with respect to a chosen prior model. We discuss the numerical implementation of our method using a gradient based optimization algorithm and show both theoretically and via simulation tests on various examples that the entropy penalty resolves the numerical instability of the calibration problem. Finally, we apply our method to data sets of index options and discuss the empirical results obtained.

Joint work with Rama Cont.

10:20	Discussion	
10:30	Coffee Break	Reception Room EE/CS 3-176
11:00	Jean-Pierre Fouque North Carolina State University	Multiscale Stochastic Volatility

Abstract: We consider stochastic volatility diffusion models where volatility is driven by two factors running on short and long time scales respectively. Perturbations techniques, singular and regular, are very efficient to approximate option prices. We show that five parameters are needed to capture the main effects due to stochastic volatility. Furthermore we reduce

the parametrization to four effective parameters which can easily be calibrated to the implied volatility surface. Finally we explain how to use these parameters to price other exotic derivatives. Joint work with G. Papanicolaou, R. Sircar and K. Solna. Papers available at: www.math.ncsu.edu/fouque/PubliFM.

11:50	Discussion	
12:00	Lunch Break	
1:30	Hélyette Geman University Paris Dauphine & ESSEC	Pure Jump Lévy Processes for Asset Price Modelling

Abstract: The goal of the paper is to show that some types of Lévy processes such as the hyperbolic motion and the CGMY are particularly suitable for asset price modelling and option pricing. We wish to review some fundamental mathematic properties of Lévy distributions, such as the one of infinite divisibility, and how they translate observed features of asset price returns. We explain how these processes are related to Brownian motion, the central process in finance, through stochastic time changes which can in turn be interpreted as a measure of the economic activity. Lastly, we focus on two particular classes of pure jump Lévy processes, the generalized hyperbolic model and the CGMY models, and report on the goodness of fit obtained both on stock prices and option prices.

2:20	Discussion	
2:30	Coffee Break	Reception Room EE/CS 3-176
3:00	Second Chances	Speakers of the day respond to further questions, suggestions, re-frame their main points, look toward future directions.
3:30	Walk along the Mississippi, weather permitting	
6:00	Workshop Dinner	Bona, 802 Washington Ave S.E.

Friday, April 16

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

9:00	Coffee	Reception Room EE/CS 3-176
9:30	Francesco Rapisarda Banca IMI	Smiles and Baskets: Multidimensional Dynamics for Basket Options

Abstract: It is known that the Black Scholes model does not price all European options quoted on a given market in a consistent way. In reality the implied volatility generally shows a dependence on both the option maturity and strike. The aim of this talk is to incorporate the effect of this dependence in the pricing and hedging of structured securities, with particular interest on securities dependent on many assets that each show a volatility smile/skew.

We start from the formulation of an embryonic stochastic volatility model and of its projection onto the local volatility

manifold. Both models have the advantage of being as tractable as Black and Scholes', with a combination of simplicity and tractability that make them extremely appealing to practitioners. We then show that these models can be extended in an intuitive way from the univariate to the multivariate setting. In particular in the local volatility version, the resulting theory allows to sample from an entirely new type of dynamics that still enjoys an internal consistency with the observed volatility surfaces for the individual securities, but with strong computational implications on the calculation of prices of European options on baskets of securities.

10:20	Discussion	
10:30	Coffee Break	Reception Room EE/CS 3-176
11:00	David S. Bates University of Iowa and NBER	Maximum Likelihood Estimation of Latent Affine Processes

Abstract: This article develops a direct filtration-based maximum likelihood methodology for estimating the parameters and realizations of affine processes with latent state variables. Rather than working with probability densities, which are not generally known in continuous-time finance models, a procedure is developed for recursively updating the associated characteristic functions of latent variables conditional upon past discrete-time data. Filtered estimates of latent variable realizations are directly generated within the procedure, while the likelihood function of observed data necessary for parameter estimation can be evaluated numerically by Fourier inversion. An application to daily stock index returns over 1953-96 reveals substantial divergences from EMM-based estimates of latent stochastic volatility and jump risk – in particular, more substantial and time-varying jump risk. The relevance for pricing stock index options is discussed.

11:50	Discussion	
12:00	Lunch Break	
1:30	Peter W. Glynn Stanford University	Parameter Estimation Methods for Discretely Observed Markov Processes

Abstract: When Markov processes are continuously observed, it is generally possible to write down the likelihood explicitly. Given the statistical efficiency of maximum likelihood-based methods, the corresponding maximum likelihood estimators are generally then the method of choice for parameter estimation. However, in many settings, the processes of interest are not continuously observed. The difficulty of computing the corresponding transition density that enters the likelihood then creates a tension between what is statistically efficient and what is computationally tractable. In particular, one may need to consider non-likelihood based methods for computing parameter estimates. In this talk, we will discuss some of the mathematical and computational issues that arise at this interface between computation and statistics.

2:20	Second Chances	Discussion and Second Chances: Speakers of the day respond to further questions, suggestions, re-frame their main points, look toward future directions.
3:00	Coffee	Coffee and End of Workshop, Reception Room EE/CS 3-176

Monday, April 19

The 3:00 IMA break will be in Lind Hall 400.

Tuesday, April 20

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

IMA POSTDOC SEMINAR, Lind Hall 409:

11:15 am **Yuhong Yang** Multi-Armed Bandits with Covariates
Iowa State University

Abstract: Suppose that there are K ($K > 1$) possibly biased coins available for play. At each time, you can choose one and only one coin to flip, and win a dollar if you get a head and receive nothing otherwise. Your goal is to obtain as much money as possible. Such a problem is called a multi-armed bandit problem. Bandit problems have applications in clinical trials, scheduling, and automated problem-solving in machine learning. In the literature,

The IMA Postdoc Seminar is organized by
Antar Bandyopadhyay and Gerard Awanou.

Wednesday, April 21

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

11:00 **Hans Foellmer** Recap session on: Reports of Nicole El Karoui
Humboldt Universitat zu Berlin

BROWN BAG SEMINAR, Lind Hall 409:

12:00 **Peter Tankov** Multidimensional Models with Jumps for Finance and Insurance
École Polytechnique

Abstract: Many financial applications, including basket option pricing, portfolio optimization and risk management require a multivariate model with dependence between components, taking into account jumps in price processes. In this talk we describe a general method to model dependence between components of multidimensional Lévy processes (stochastic processes with stationary independent increments) by introducing Lévy copulas. A Lévy copula completely characterizes the dependence structure of a multidimensional Lévy process given the margins. We construct parametric families of Lévy copulas and develop an algorithm for simulating multidimensional Lévy processes using their Lévy copulas. Finally we illustrate our method by showing how it can be used to build multivariate models with jumps for finance and insurance.

The IMA Brown Bag Seminar is organized by
Tim Garoni and Tamon Stephen.

Thursday, April 22

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

COMPLEX SYSTEMS SEMINAR, Lind Hall 409:

1:30 pm **David Heath** Consistency Among Trading Desks
Carnegie Mellon University

Abstract: Banks typically have trading desks, each of which uses its own models and trades a linear subspace of claims. Under what conditions can the bank be sure it doesn't permit arbitrage?

Friday, April 23

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

Monday, April 26

**IMA “Hot Topics” Workshop:
Enhancing the Searching of Mathematics**

26–27 April 2004

Organizers: Michael Doob (University of Manitoba), Thomas Fischer (State and University Library Göttingen), Marc Krellenstein (Elsevier), Robert Miner (Design Science, Inc.), Robby Robson (Eduworks Corporation),

See <http://www.ima.umn.edu/complex/spring/searching.html>

Science, Technology and Medical (STM) publishing is moving rapidly toward the use of XML, and in particular, toward the use of MathML for the encoding of mathematical data. As a result of this shift, best practices are in flux. Once workflows are established, however, the decisions made today may have wide-ranging implications for the long-term value of XML document collections. This is particularly true in the areas of metadata, searching and indexing.

To take advantage of this unusual window of opportunity for improving the infrastructure for searching STM documents, the National Science Digital Library program at the National Science Foundation is sponsoring two conferences over the next two years. This workshop, the first of the two, seeks to bring together experts on searching techniques and managers of STM document collections from both academics and industry.

The purpose of the workshop is two-fold:

- To identify promising ways of better searching mathematical content. Topics will include metadata formats, taxonomies, smart authoring tools, use of MathML, XQuery and related technologies, etc.
- To identify a framework for activity leading to the adoption and deployment of improved mathematical searching. Topics will include assessment of required standards activity, current practices, coordination between authoring tools and publishing tools, legal or business constraints, etc.

The workshop will consist of both presented papers and working sessions. The conclusions of the workshop will be summarized in a position paper, which will be circulated and publicized in the STM community.

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

8:30 **Coffee and Registration** Reception Room EE/CS 3-176

Welcome and Introduction

[Introductory remarks on the goals and format for the workshop]

9:00–10:15 **Presentation by the Organizers:** Envision a Framework for Better Math Searching

10:15–10:30 **Break** Reception Room EE/CS 3-176

Search Techniques and Strategies
[Talks on approaches to math searching]
Robert Miner (Design Science, Inc.)

10:30 **Abdou Youssef** Advanced Math Search: Issues and Techniques
The George Washington University

Abstract: Worldwide efforts are underway to create digital libraries of mathematical contents, such as the Digital Library of Mathematical Functions (DLMF) at the National Institute of Standards and Technology. A fundamental goal of such libraries is to enable users to search not only for text, but also for equations. The mature information retrieval (IR) technology is primarily for text contents. When applied to math search, text IR is inadequate because of its inability to understand mathematical symbols and structures. In this talk, we will identify the issues of building an advanced Math search system, and present techniques for addressing those issues. Some of the techniques are based on current text search technology, while others will be based on emerging XML-based technologies. Some of the math search capabilities that we have already for DLMF developed will be demonstrated in the talk.

11:00 **Michael Trott** Mathematical Searching in the Wolfram Functions Site
Wolfram Research, Inc.

Abstract: In this talk I will give an overview over the Wolfram Functions site. The website functions.wolfram.com is generated from a set of Mathematica notebooks. Mathematica notebooks are structured ASCII files, that can be processed and manipulated by the Mathematica kernel. The notebooks contain about 90,000 mathematical formulas about elementary and special functions in typeset form. Because the formulas are readable and “understandable” by Mathematica, it is possible for the software to completely analyze and classify them with respect to their mathematical structure and occurring functions. A first version of a mathematical search interface to be deployed on the website will be shown and demonstrated.

11:30 **Structured Discussion**

12:00–1:30 **Lunch**

Data and Metadata I

[Talks about metadata for mathematics and its implications for searching]

Robby Robson (Eduworks Corp)

1:30 **Timothy W. Cole** Enriching Metadata for XML Journal Articles through
University of Illinois - Urbana- Extraction of MathML
Champaign

Abstract: Two automated approaches are being investigated. In the first approach we extract all occurrences of MathML contained in full-text of articles included in a sample corpus of XML-encoded sci-tech journal literature published by ACM, AIP, and IEEE-CS (articles include legacy SGML ISO 12083 math fragments previously converted to MathML). We then filter and normalize those MathML fragments recognized as potentially useful for search and discovery, adding the normalized fragments to qualified Dublin Core metadata records describing the articles. The second approach adopts the hierarchical browse vocabulary of the Wolfram Functions Website as a descriptive metadata controlled vocabulary. Function name strings from this vocabulary which occur in a journal article are added to its metadata record, along with the frequency of occurrence. These approaches are seen as having the potential to enhance discoverability of journal articles and facilitate linkages between journal literature and reference mathematics literature (e.g., the Wolfram Functions Website).

2:00 **Su-Shing Chen** Indexing Mathematical Abstracts by Metadata and Ontology
University of Florida

Abstract: Based on earlier results, I will describe some ideas of indexing mathematical abstracts or papers by metadata and ontology. Metadata includes existing subject classification schemes and some recent metadata for electronic records. Ontology is a different approach to index abstracts by clustering them into an information visualization interface so that users may select using ontology as well as metadata.

1. uniform symbolic notation for all mathematical and logical objects, based on specially created symbols
2. treelike arrangement of the single documents (considered as atomic elements) in order to find each document via a unique path; freely definable further arrangements, e.g. cross references or collections of documents for classroom use
3. elaborate network of interconnections between the atomic elements

The structure of the notation mentioned above enables us to perform searching without the need for extra metadata.

Tuesday, April 27

All talks are in Lecture Hall EE/CS 3-180 unless otherwise noted.

Data and Metadata II

[Talks about metadata for mathematics and its implications for searching]

Michael Doob (University of Manitoba)

8:45	Coffee	Reception Room EE/CS 3-176
9:00	TBA	
9:30	Laurent Guillope Cellule MathDoc (CNRS/Université Joseph Fourier, Grenoble) & Université de Nantes	Metadata: Exchange and Fusion

Abstract: The NUMDAM program is a component of the World Digital Mathematics Library (WDML). The metadata description of its content is the basis for efficient navigation on the webbed WDML : of particular importance are links in both directions, from NUMDAM papers to related documents (reviews, cited articles,...) as from bibliographical databases, digital archives and preprints databases. These linkings require free metadata availability: the convenient tools (OAI server, lookup engines,...) may be further reused to merge metadata sets for building partial slices of the WDML. Current projects worked by the Cellule MathDoc of such gateways will be discussed.

10:00	Structured Discussion	
10:30–10:45	Break	Reception Room EE/CS 3-176

Editorial/Production

[Talks about workflow and business issues affecting searching]

Paul Topping (Design Science, Inc.)

10:45	James Crowley SIAM	A Publisher's Perspective on Searching and Metadata
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Abstract: There is diverse array of solution that various publishers, especially scientific societies, are seeking to provide better searching capabilities to the on-line journal literature. Each of these approaches promise improved capability, but come with costs. These will be discussed from the perspective of a scientific society publisher.

11:15	Heinz Kröger FIZ Karlsruhe - Zentralblatt MATH -	Searching Mathematics with Zentralblatt MATH - Overview and Outlook
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IMA/MCIM INDUSTRIAL PROBLEM SEMINAR, 570 Vincent Hall:

1:25pm

Apo Sezginer
Invarium, Inc., San Jose, CA

How to Fit 100-Millon Transistors on a Thumbnail

Abstract: This will be an introductory talk on sub-wavelength optical projection lithography. "Sub-wavelength" refers to the fact that the features in the CPU and memory of your PC are smaller than the wavelength of the light by which those features are printed. Field and wave nature of light are impossible to ignore when imaging in the sub-wavelength scale. Therefore, designing chips today involves EM wave modeling of optical projection. The talk will give a flavor of fundamental limits of resolution, resolution enhancement techniques, approximations and numerical algorithms used to model projection lithography and their shortcomings.

PART III: CURRENT IMA PARTICIPANTS

FIRST YEAR POSTDOCTORAL MEMBERS

NAME	PREVIOUS INSTITUTION
Gerard Awanou	University of Georgia
Karen Ball	Indiana University
Antar Bandyopadhyay	UC Berkeley
Tim Garoni	University of Melbourne
Chuan-Hsiang Han	North Carolina State University
Lea Popovic	UC Berkeley

SECOND YEAR POSTDOCTORAL MEMBERS

NAME	PREVIOUS INSTITUTION
Olga Brezhneva	Russian Academy of Sci.
Herve Kerivin	University Blaise Pascal-France
Tamon Stephen	University of Michigan
Jing Wang	University of Minnesota

POSTDOCTORAL MEMBERS IN INDUSTRIAL MATHEMATICS

NAME	PREVIOUS INSTITUTION	INDUSTRIAL AFFILIATION
Lili Ju	Iowa State University	VA Hospital
Haewon Nam	Texas A & M University	GE
Jun Zhao	Texas A & M University	Schlumberger

LONG TERM VISITORS

NAME	HOME INSTITUTION
Greg Anderson	University of Minnesota
Hee-Jeong Baek	Seoul National University (BK 21 Math-SNU)
Peter Bank	Humboldt University of Berlin
Maury Bramson	University of Minnesota
Rene Carmona	Princeton University
Rama Cont	Ecole Polytechnique
Hans Foellmer	Humboldt Universitat zu Berlin
Shmuel Friedland	University of Illinois - Chicago
Anne Gundel	Humboldt University Berlin
David C. Heath	Carnegie Mellon
Ulrich Horst	Humboldt Universität zu Berlin
Naresh Jain	University of Minnesota
Mohammad Kazim Khan	Kent State University
Hye-Ryoung Kim	Seoul National University (BK 21 Math-SNU)
Hyejin Ku	York University
Thomas G. Kurtz	University of Wisconsin
Jeong Hyun Lee	Seoul National University (SRCCS)
Richard P. McGehee	University of Minnesota
Amir Niknejad	University of Illinois - Chicago
Greg Rempala	University of Louisville
Arnd Scheel	University of Minnesota
Mihai Sirbu	Carnegie Mellon
Srdjan Stojanovic	University of Cincinnati
Peter Tankov	Ecole Polytechnique
Hui Wang	Brown University
Yuhong Yang	Iowa State University
Ofer Zeitouni	University of Minnesota

VISITORS IN RESIDENCE (as of 29 March 2004)

Vilen Abramov	Kent State University	4/10/04 – 4/16/04
Inkyung Ahn	Korea University	4/12/04 – 4/16/04
Stuart Allen	Cornell University	4/25/04 – 4/27/04
Alexandre d'Aspremont	Stanford University	4/10/04 – 4/17/04
Marco Avellaneda	New York University	4/11/04 – 4/16/04
David S. Bates	University of Iowa	4/14/04 – 4/16/04
Florin Bidian	University of Minnesota	4/12/04 – 4/16/04
Hunt McCall Blatz	Advantus Capital Management	4/12/04 – 4/16/04
Jerome Busca	University Paris Dauphine	4/11/04 – 4/16/04
Enrico Capobianco	[None]	4/11/04 – 4/16/04
James B. Carson	RisQuant Energy	4/12/04 – 4/16/04
Su-Shing Chen	University of Florida	4/25/04 – 4/27/04
Yangho Choi	University of Iowa	4/11/04 – 4/16/04
Tim Cole	University of Illinois - Urbana-Champaign	4/25/04 – 4/27/04
James Crowley	SIAM	4/25/04 – 4/27/04
Donald DeLand	Integre Technical Publishing	4/25/04 – 4/27/04
John Anthony Dodson	American Express Financial Advisors	4/12/04 – 4/16/04
Michael Doob	University of Manitoba	4/25/04 – 4/27/04
Sam Dooley	Integre Technical Publishing	4/25/04 – 4/27/04
Raphael Douady	New York University	4/12/04 – 4/14/04
Nicole El Karoui	Ecole Polytechnique	4/11/04 – 4/16/04
Thomas Fischer	State and University Library Goettingen	4/25/04 – 4/27/04
Jean-Pierre Fouque	North Carolina State University	4/10/04 – 4/15/04
Craig A. Friedman	New York University	4/11/04 – 4/16/04
Helyette Geman	ESSEC	4/12/04 – 4/16/04

Paul Glasserman	Columbia University	4/11/04 – 4/16/04
Peter W. Glynn	Stanford University	4/11/04 – 4/16/04
Yevgeny Goncharov	University of Michigan	4/11/04 – 4/16/04
Victor Goodman	Indiana University	4/11/04 – 4/16/04
Matthias Graefenhan	University of Marburg	4/23/04 – 4/28/04
Gerry Grenier	IEEE, Inc.	4/25/04 – 4/27/04
Laurent Guillope	Universitede Nantes	4/25/04 – 4/28/04
Haiming Guo	University of Maryland	4/10/04 – 4/16/04
Bob Hecht	Marcel Dekker, Inc.	4/25/04 – 4/27/04
Alexey Ignatyev	Kent State University	4/10/04 – 4/16/04
Patrick Ion	Math Reviews	4/25/04 – 4/27/04
Victor Isakov	Wichita State University	4/11/04 – 4/17/04
Abu Jalal	University of Minnesota	4/12/04 – 4/16/04
Byeong-Kook Kang	Samsung Securities Co.	4/10/04 – 4/16/04
Prasanth Karumanchi	Purdue University	4/11/04 – 4/16/04
Nigel Kerr	JSTOR	4/25/04 – 4/27/04
Andy Young Han Kim	University of Minnesota	4/12/04 – 4/16/04
Alan King	IBM Corporation	4/10/04 – 4/16/04
Boris Klebanov	Sungard Trading & Risk Systems	4/11/04 – 4/16/04
Igor Kleshchevich	Inera, Inc.	4/25/04 – 4/27/04
Heinz Kroeger	Technische Universität Berlin	4/24/04 – 4/28/04
Ted Kull	SIAM	4/25/04 – 4/27/04
Greg Langmead	Design Science, Inc.	4/24/04 – 4/28/04
Bernard Lapeyre	Ecole Nationale des Ponts et Chaussees	4/11/04 – 4/17/04
Kiseop Lee	University of Louisville	4/11/04 – 4/16/04
Wei Li	University of Iowa	4/11/04 – 4/16/04
Rodrigo J. Lievano	University of Minnesota - Duluth	4/12/04 – 4/16/04
Juyoung Lim	University of Texas - Austin	4/10/04 – 4/16/04
Alexander Lipton-Lifschitz	Credit Suisse/First Boston	4/11/04 – 4/16/04
Gerry Loon	AMS	4/24/04 – 4/27/04
Lori Lorigo	Cornell University	4/25/04 – 4/27/04
Dilip B. Madan	University of Maryland	4/14/04 – 4/16/04
Hantao Mai	University of Maryland	4/11/04 – 4/16/04
Robert Miner	Design Science, Inc.	4/25/04 – 4/27/04
Bill Mischo	University of Illinois - Urbana-Champaign	4/25/04 – 4/27/04
Oana Mocioalca	Purdue University	4/11/04 – 4/16/04
William J. Morokoff	Moodys KMV	4/08/04 – 4/09/04
Marek Musiela	BNP Paribas	4/11/04 – 4/16/04
Jerome Pansera	University of Iowa	4/11/04 – 4/16/04
Edwin Pednault	IBM Corporation	4/22/04 – 4/23/04
Thomas J. Peters	University of Connecticut	4/10/04 – 4/16/04
Huyen Pham	Universite Paris VII	4/11/04 – 4/17/04
Elizabeth B. Porter	Mathsoft Engineering & Education, Inc.	4/25/04 – 4/27/04
Francesco Rapisarda	Banca IMI	4/11/04 – 4/16/04
Robby Robson	Eduworks Corp	4/25/04 – 4/27/04
Yalcin Sarol	Purdue University	4/11/04 – 4/16/04
Bernard Schutz	Albert Einstein Institute	4/25/04 – 4/27/04
Roland Schwänzl	University of Osnabrueck	4/25/04 – 4/27/04
Rituparna Sen	University of Chicago	4/10/04 – 4/16/04
Apo Sezginer	Invarium	4/29/04 – 5/01/04
Neil Soiffer	Design Science, Inc.	4/25/04 – 4/27/04
Seongjoo Song	Purdue University	4/11/04 – 4/15/04
Eugene H. Stanley	Boston University	4/11/04 – 4/16/04
Michael Stutzer	University of Colorado - Boulder	4/13/04 – 4/16/04
Masakazu Suzuki	Kyushu University	4/25/04 – 4/28/04
Eduardo Tabacman	Design Science, Inc.	4/26/04 – 4/27/04

Gary Nan Tie	The St. Paul Companies	4/12/04 – 4/16/04
Paul Topping	Design Science, Inc.	4/25/04 – 4/27/04
Michael Trott	Wolfram Research, Inc.	4/25/04 – 4/27/04
Ryosuke Wada	Otaru University of Commerce	4/10/04 – 4/17/04
Hong Wang	University of Minnesota	4/12/04 – 4/16/04
Xiaodi Wang	Western Connecticut University	4/11/04 – 4/17/04
Stephen Watt	University of Western Ontario	4/25/04 – 4/27/04
Ananda Weerasinghe	Iowa State University	4/11/04 – 4/16/04
Stephen Weimar	Drexel University	4/25/04 – 4/27/04
Eric Weisstein	Wolfram Research, Inc.	4/25/04 – 4/27/04
Hongtao Yang	University of Louisiana at Lafayette	4/11/04 – 4/18/04
Abdou Youssef	The George Washington University	4/25/04 – 4/27/04
Yuhua Yu	Purdue University	4/12/04 – 4/17/04
Thaleia Zariphopoulou	University of Texas - Austin	4/11/04 – 4/16/04
Yong Zeng	University of Missouri - Kansas City	4/11/04 – 4/18/04
Bing Zhang	University of Maryland	4/11/04 – 4/17/04
Tao Zhang	Purdue University	4/11/04 – 4/16/04
Gady Zohar	Technion - Israel Institute of Technology	4/10/04 – 4/16/04

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