14th International Congress on Computational and Applied Mathematics

29 SEPTEMBER-2 OCTOBER 2009
Kervansaray Lara, Antalya / TURKEY

CERTIFICATE OF PARTICIPATION

This is to certify that

TERTIA DELIA NOVA

has participated in the 14th International Congress on Computational and Applied Mathematics on 29 September-2 October 2009, Antalya, Turkey.

Prof.Dr. Marc Goovaerts
Chair of the Scientific Committee

Prof.Dr. Ömer L. Gebizlioglu
Chair of the Organizing Committee

14th International Congress on Computational and Applied Mathematics

29 SEPTEMBER-2 OCTOBER 2009
ANTALYA / TURKEY

23 August 2009

Dear Tertia Delia Nova,

Thank you for your kind interest in participating to **ICCAM2009** congress.

Regarding your intention to present a paper at the congress, I am pleased to inform you that, on the basis of the abstract you sent to us, your paper has been accepted for oral presentation in the scientific sessions of ICCAM2009.

Title of the abstract	:	Control strategy of avian influenza based on modeling and simulation
Co-Author(s)	:	H. Mawengkang, M. Watanabe
Duration of presentation	:	20 minutes

Please kindly note that we will need to have received your presentation file by September 20, 2009 for the arrangement of presentation streams in the sessions.

For your convenience, a data projector and computers will available in each meeting room. Should you have any further particular requirements with respect your presentation, please do not hesitate to contact us.

We are looking forward to meeting you in Antalya, TURKEY.

Yours sincerely,

Prof. Dr. Omer L. GEBIZLIOGLU
On behalf of the Organizing and Scientific Committees

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Dekan Fakultas Peternakan Universitas Andalas dengan memberi tugas kepada yang tersebut di bawah ini:

N a m a :	Ir. Tertia Delia Nova Si
NIP :	131 623 496
Pangkat / Golongan	Pembina/ IV/a
Jabatan	Lektor Kepala
Fakulats	Peternakan Universitas Andalas

Untuk mengikuti : International Congress on Computationnal and Applied Mathematics 2009 di Antalya, Turkey sebagai pemakalah 28 September s/d 2 Oktober 2009 atas sponsor Dikti.

Demikian surat tugas ini di buat untuk dapat dipergunakan sebagaimana semestinya.

Padang 12 Oktober 2009
Dekan

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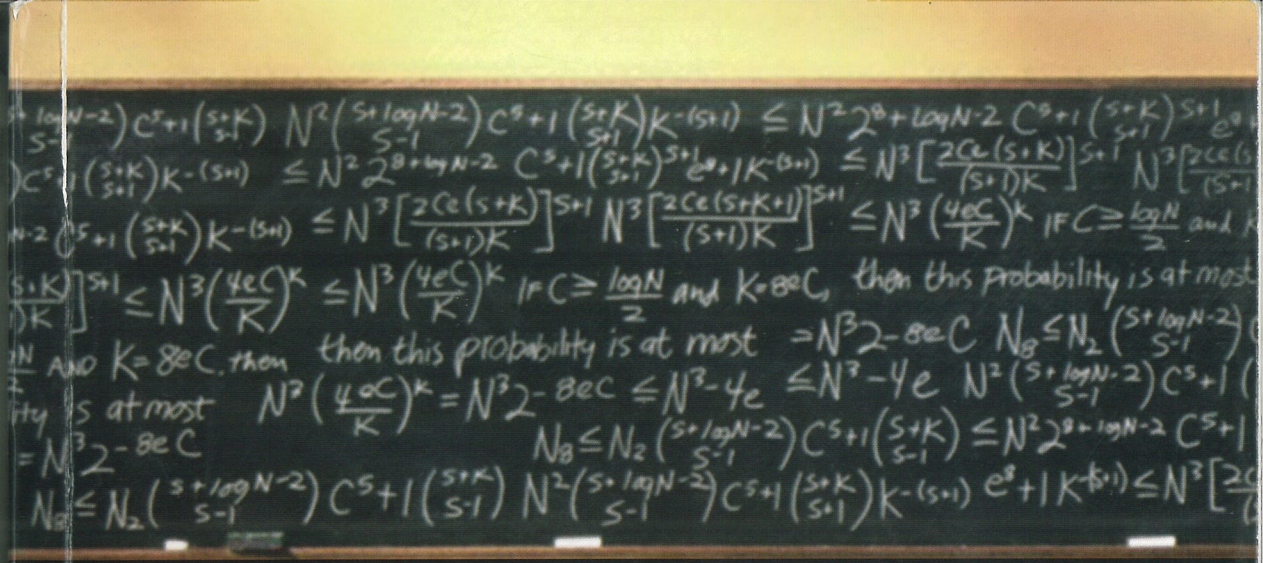
ICCAM 2009 PROGRAMME AND SUBMITTED ABSTRACTS BOOK



14th International Congress on Computational and Applied Mathematics

29 SEPTEMBER-2 OCTOBER 2009

ANTALYA / TURKEY

PROGRAMME AND SUBMITTED ABSTRACTS BOOK

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14th International Congress on Computational and Applied Mathematics (ICCAM2009)

29 September-2 October, 2009
Antalya, Turkey

Congress Programme

29 September 2009, Tuesday

12:00-18:00 Registration

16:00-18:00 Tutorial Session
Place: Hall 1
- "Global Optimization In Practice"
  Janos D. Pinter

18:30-20:00 Welcome Cocktail
Place: Cocktail Hall

30 September 2009, Wednesday

08:30-09:00 Registration

09:00-09:30 Opening Session
Place: Hall 1
Welcome and Opening Talks

09:30-10:30 Invited Talk Session
Place: Hall 1
Chair: Marc Goovaerts
- "Dependence Modelling With Copulas"
  Roger B. Nelsen

10:30-11:00 Tea-Coffee Break

11:00-12:30 Parallel Sessions 1

Session1.1: Applied Probability and Stochastic Processes I
Place: Hall 1
Chair: Refail Kasımbeyli
- Andrei Bourchtein, L. Bourchtein
  Dependence of the PageRank vector on the artificial links
- Serkan Eryilmaz, Funda Iscioglu
  Multi-state system reliability under stress-strength setup
- Agah Kozan, H. Tanil
  On distributions of bottom m scores after ℓth change
- Guvenc Arslan
  A Variant of the Choquet-Deny Theorem with Application to Characterizaiton

Session1.2: Computational Methods in Physical and Social Sciences I
Place: Hall 2
Chair: Masai Watanabe
- Canan Bozkaya, Tulay Kocabıyık
  Streamwise oscillations of a cylinder beneath a free surface: Part 1. Free surface effects on vortex formation modes
- Canan Bozkaya, Tulay Kocabıyık
  Streamwise oscillations of a cylinder beneath a free surface: Part 2. Free surface effects on fluid forces
- Nail Akhmediev, J. M. Soto-Crespo, A. Ankiewicz
  Rogue waves: power of mathematics in understanding the phenomenon
- Ali Reza Ashrafi , M. Saheli
  The Eccentric Connectivity Index of Nanotubes and Nanotori

Session1.3: Differential Equations I
Place: Hall 3
Chair: Bulent Karasozen

- Mesliza Mohamed, H.B. Thompson, M. Jusoh
  First-Order Three-Point Boundary Value Problems at Resonance
- Pavel Krutitskii
  Boundary value problems for the Helmholtz equation in domains bounded by closed curves and open arcs
- Adem Kilicman, Hassan Eltayep, Fudziah Ismail
  On the Partial Differential Equations with Non-Constant Cefficients and Convolution Method
- Gulnur Celik Kizilkan, Kemal Aydin
  Step size strategies on the numerical integration of the systems of differential equations

Session1.4: Mathematical Programming I
Place: Hall 4
Chair: M.Fernanda P.Costa

- Eren Ozceylan, T. Paksoy
  Modeling Facility Location and Supplier Selection with Supplier's Product Quality and Contract Fee for Strategic Supply Chain Design
- Sureyya Ozogur Akyuz, G. Ustunkar, G. W. Weber
  On Numerical Optimization Methods for Infinite Kernel Learning
- Alireza Davoodi
  A DEA based approach for solving the multiple objective shortest path problem
- Fatma Yerlikaya Ozkurt, G.W. Weber, A. Ozmen
  Robustification of CMARS

Session1.5: Numerical Analysis and Software I
Place: Hall 5
Chair: Kuniyoshi Abe

- Suzan Cival Buranay, A.A. Dosiyev
  A high accurate difference-analytical method for solving Laplace's equation on polygons with nonanalytic boundary conditions
- Kamile Sanli Kula, Fatih Tank, Turkan Erbay Dalkilic
  An Application of a New Fuzzy Robust Regression Algorithm to Actuarial Science
- Fudziah Ismail, A. Karimi, N. Md Ariffin, M. Abu Hassan
  Comparison of Exponentially fitted Explicit Runge-Kutta methods for Solving ODEs
- Fereidoon Khadem, M. A. Fariborzi Araghi
  Numerical Integration of a Fuzzy Riemann Double Integral

12:30-13:30 **Lunch Break**

13:30-15:45 **Parallel Sessions 2**

Session2.1: Approximation and Interpolation I
Place: Hall 1
Chair: Gulen B. Tunca

- Halil Gezer, H. Aktuglu
  Statistical Convergence for Set-Valued Functions
- Elias Berriochoa, A. Cachafeiro
  Hermite-Birkhoff interpolation problems on the roots of the unity
- Liping Yang, X. Xie
  Weak and strong convergence theorems for a finite family of $I-$asymptotically nonexpansive mapping
- Serife Bekar, H. Aktuglu
  q-Statistical Convergence
- Anvarjon Ahmedov, Norashikin Abdul
  Approximation of the functions from $LLog^2(S^N)$ by Fourier-Laplace series
- Yunus Hassen, Barry Koren
  A novel 2D finite-volume method for advection problems with embedded moving-boundaries

Session2.2: Numerical Linear Algebra I
Place: Hall 2
Chair: Marc Goovaerts

- Venancio Tomeo, Jesus Abderraman
  Explicit Representation of Hessenbergians: Application to General Orthogonal Polynomials
- Fatih Yilmaz, Humeyra Kıyak, Irem Gurses, Mehmet Akbulak, Durmus Bozkurt
  The Powers of Anti(2k+1)-Diagonal Matrices and Fibonacci Numbers
- Fatih Yilmaz, Humeyra Kıyak, Irem Gurses, Mehmet Akbulak, Durmus Bozkurt
  On computing powers for one type of matrice by Pell and Jacobsthal Numbers
- Hasan Huseyin Gulec, N. Taskara, K. Uslu
  On the properties of generalized Fibonacci and Lucas numbers with binomial coefficients
- Seiji Fujino, Y. Kusakabe, M. Harumatsu
  IDR-based relaxation methods for solving linear systems
- Kensuke Aishima, T. Matsuo, K. Murota, M. Sugihara
  A Shift Strategy for Superquadratic Convergence in the dqds Algorithm for Singular Values

Session2.3: Optimization I
Place: Hall 3
Chair: Ana Maria A.C.Rocha

- Lino Costa, Isabel Espírito Santo, Edite M.G.P. Fernandes
  A Hybrid Genetic Pattern Search Augmented Lagrangian Method for Constrained Global Optimization
- Herman Mawengkang
  Production Planning under Stochastic Demand for Fish Processed Product at North Sumatera Province, Indonesia
- Mahnaz Mirbolouki, F. Hosseinzadeh Lotfia, N.Nematollahi, M.H. Behzadi, M.R. Mozaffari
  Centralized Resource Allocation with Stochastic Data
- Ana Maria A. C. Rocha, Tiago F. M. C. Martins, Edite M. G. P. Fernandes
  On the augmented Lagrangian methodology in a population based global optimization algorithm
- Eman Hamad Al-Shemas, A. Hamdi
  A Regularized Modified Lagrangian Method for Nonlinearly Constrained Monotone Variational Inequalities
- Miguel Gabriel Villarreal-Cervantes, Carlos Alberto Cruz-Villar, Jaime Alvarez-Gallegos
  A new multiobjective differential evolution strategy for scattering uniformly the Pareto solution set for designing mechatronic systems

Session2.4: Special Functions
Place: Hall 4
Chair: Patricia J.Y.Wong

- Lidia Fernandez, T. E. Perez, M. A. Pinar
  On Koornwinder classical orthogonal polynomials
- Rabia Aktas, A.Altın, F. Taşdelen Yeşildal
  A note on a family of two variable polynomials
- Cem Kaanoglu, Mehmet Ali Ozarslan
  Some generalizations of multiple Hermite polynomials via Rodrigues formula
- Emine Ozergin, M.A. Ozarslan, A. Altin
  Extension of Gamma, Beta and Hypergeometric Functions
- Onur Karaoglu, Ayse Betul Koc, Haldun Alpaslan Peker, Yildiray Keskin, Yucel Cenesiz, Galip Oturanc, Sema Servi
  Application of Padé approximation of differential transform method to the solution of prey and predator problem
- Pablo Sanchez-Moreno, A. Zarzo, J.S. Dehesa
  Jensen divergence based on Fisher's information

Session2.5: Statistics and Data Analysis I
Place: Hall 5
Chair: Ismihan Bayramoglu

- Mustafa Cagatay Korkmaz, Coskun Kus, Asir Genc
  Weibull-Negative Binomial Distribution
- Yeliz Mert Kantar, Birdal Senoglu, Omer L. Gebizlioglu
  Comparison of a New Robust Test and Non-parametric Kruskal-Wallis Test in One-way Analysis Of Variance Model
- Neslihan Iyit, A. Genc

General Linear Model (GLM) Approach to Repeated Measurements Data Involving Univariate Analysis of Variance (ANOVA) and Multivariate Analysis of Variance (MANOVA) Techniques

- Alper Sinan, A. Genc
  Comparing Estimation Results in Nonparametric and Semiparametric Models
- Noor Akma Ibrahim, N. Poh Bee
  Confidence Intervals for Mean Time to Failure in Two-Parameter Weibull with Censored Data
- Tutut Herawan, Mustafa Mat Deris
  Rough Set-based Functional Dependency Approach for Clustering Categorical Data

15:45-16:15 **Tea-Coffee Break**

16:15-18:30 **Parallel Sessions 3**

Session 3.1: Mathematical Modeling, Analysis, Applications I
Place: Hall 1
Chair: Alejandro Zarzo

- Turkan Erbay Dalkilic, Aysen Apaydin
  Parameter Estimation by ANFIS in Cases Where Outputs are Non-Symmetric Fuzzy Number
- Fatemesadat SalehiS.M.H. Karimian, H. Alisadeghi
  A Multizone Overset Algorithm for the Solution of Flow around Moving Bodies
- Nihal Yokus, E. Bairamov
  Spectral Singularities of Sturm-Liouville Problems with Eigenvalue Dependent Boundary Conditions
- Zeynep Eken, S.Sezer
  Vague DeMorgan Complemented Lattices
- Zainidin Karimovich Eshkuvatov
  Approximating the singular integrals of Cauchy type with weight function on the interval
- Bulent Karasozen, Ayhan Aydin
  Lobatto IIIA-IIIB Discretization for the Strongly Coupled Nonlinear Schr\"odinger Equation

Session 3.2: Approximations and Interpolation II
Place: Hall 2
Chair: Miguel Angel Fortes

- Hussain Mohammed Al-Qassem , L. Cheng, Y. Pan
  Rough oscillatory singular integrals on R^n
- Raffaele D'Ambrosio, E. Esposito, B. Paternoster
  Exponentially fitted two--step hybrid methods for y''=f(x,y)
- Nazri Mohd Nawi, Rozaida Ghazali, Mohd Najib Mohd Salleh
  Improving the Gradient based search Direction to Enhance Training Efficiency of Back Propagation based Neural Network algorithms
- F. Tasdelen Yesildal, Gurhan Icoz
  On Linear positive operators including q-Konhauser Polynomials
- Veronica Biga, Daniel Coca, Visakan Kadirkamanathan, Stephen A. Billings
  An Alternative Region-Based Active Contour Model Using Cauchy-Schwartz Divergence
- Gulen Bascanbaz Tunca, Yalcin Tuncer
  On Chlodovsky variant of multivariate beta operator

Session 3.3: Nonlinear Equations and Mathematical Modeling
Place: Hall 3
Chair: Ersan Akyıldız

- Enes Yilmaz, M. U. Akhmet, D. Arugaslan
  Stability analysis of recurrent neural networks with deviated argument of mixed type
- Turgut Tollu, N. Taskara, K. Uslu
  The Periodicity of Solutions of a Rational Difference Equations x(n+1)=[p(n).x(n-k)+x(n-(k+1))]/[q(n)+x(n-(k+1))] with (k+1)th Periodic Coefficients
- Emine Hekimoglu, N. Taskara, K. Uslu
  On the behavior of solutions of a rational system x(n+1)=1/[y(n-1)] , y(n+1)=x(n-1)/[x(n).y(n-2)]
- Behzad Ghanbary, Jafar Biazar
  A modification on some improved Newton's method without direct function evaluations
- Patricia J. Y. Wong, Fengmin Chen
  Error Inequalities for Discrete Hermite Interpolation
- Josep Arnal
  Parallel Newton-like methods for solving systems of nonlinear equations

Session 3.4: Computational Methods in Physical and Social Sciences II
Place: Hall 4
Chair: Jose M.Matias

- Demet Ersoy, V. Yakhno
  Deriving Elastic Fields in an Anisotropic Bi-material
- Sengul Kecelli, V. Yakhno
  A Boundary Value Problem of the Frequency-Dependent Maxwell's System for Layered Materials
- Sevgi Yurt Oncel, Omer L. Gebizlioglu, Fazil Aliyev
  Multiple Logistic Regression A Study on the Multiple Logistic Regression Analysis To Determine Risk Factors For The Smoking Behavior
- Yoji Otani, M. Watanabe, L. Ying, K. Yamamoto, Hashentuya
  Numerical simulation of tsunami generated in North Pacific Ocean near Japan
- Ata Olah Abbasi, B. Vosoughi Vahdat
  A new numerical method for solving 2D Electrical Impedance Tomography Inverse Problem
- Tertia Delia Nova, H. Mawengkang, M. Watanabe
  Control strategy of avian influenza based on modeling and simulation

Session 3.5: Mathematical Programming II
Place: Hall 5
Chair: Venancio Tomeo

- Eren Ozceylan, T. Paksoy, N.Y. Pehlivan
  Fuzzy Optimization of A Multi Stage Multi Item Closed-Loop Flexible Supply Chain Network Under Fuzzy Material Requirement Constraints
- Gerhard-Wilhelm Weber, E. Kropat, C.S. Pedamallu
  Identification, Optimization and Dynamics of Regulatory Networks under Uncertainty
- Erkki Laitinen , I. Konnov, O. Kashina
  Multi-Criteria Optimization for Distribution of Spatial Resources
- Mahnaz Mirbolouki, F.Hosseinzadeh Lotfi, G.R. Jahanshahloo, M.H. Behzadi
  Finding Efficient and Inefficient Outlier Layers by Using Skewness Coefficient
- Hendaru Sadyadharma, Z. Nasution, H. Mawengkang
  Multi-Objective Optimization Model for Solving Risk-Based Environmental Production Planning Problem in Crude Palm Oil Industry
- Sacha Varone, David Schindl
  Staff scheduling with priority constraints

1 October 2009, Thursday

09:00-10:00 **Invited Talk Session**
Place: Hall 1
Chair: Gerhard Wilhelm Weber

- "NULISS:Non-Uniform Local Interpolatory Subdivision Surfaces"
  Lucia Romani

10:00-10:30 **Tea-Coffee Break**

10:30-12: 45 **Parallel Sessions 4**

Session 4.1: Mathematical Modeling, Analysis, Applications II
Place: Hall 1
Chair: Alireza Ashrafi

- Fatma Tasdelen Yesildal, Burak Sekeroglu, H.M. Srivastava
  Some Properties of Q-Biorthogonal Polynomials
- İsmail Yaslan
  Positive solutions for nonlinear first-order m-point boundary value problem on time scale
- Fengmin Chen, Patricia J. Y. Wong
  Error Estimates for Discrete Spline Interpolation
- Masaji Watanabe, F. Kawai
  Computational analysis for microbial depolymerization processes of xenobiotic polymers based on mathematical models and experimental results
- Tahir Khaniyev, I. Unver, Z. Mammadova
  Asymptotic Results for a Semi-Markovian Random Walk with a Normal Distributed Interference of Chance

- Mustafa Kahraman, Nurgul Gokgoz, Hakan Oktem
  A Model of Vascular Tumor Growth by Hybrid Systems

Session 4.2: Applied Probability and Stochastic Processes II
Place: Hall 2
Chair: Roger B. Nelsen

- M.R. Akramin M. Mazwan Mahat, A. Juliawati, A.H. Ahmad, A.R.M. Rosdzimin
  Probability Failure Analysis for Cracked Structure
- Burak Uyar, H. Tanil
  On exceedances based on the list of top m scores after ℓth change
- Jose M. Matias, T. Rivas, C. Ordonez, J. Taboada
  Functional Approach Using New $L^{\ast }a^{\ast }b^{\ast }$ color functions to evaluate colour changes in granites after desalination using different methods
- Ceren Eda Can, M. Rainer
  On LIBOR and swap market models: calibration to caps and swaption markets
- Zhaoning Shang, Marc Goovaerts
  Analytical Recursive Algorithm for Path-dependent Option Pricing with Stochastic Time
- Rovshan Aliyev, T.Kesemen , T.Khaniyev
  On the Semi-Markovian Random Walk with Delay and Weibull Distributed Interference of Chance

Session 4.3: Computational Methods in Physical and Social Sciences III
Place: Hall 3
Chair: Hassan Yousefi-Azari

- Jisheng Kou, Xiuhua Wang, Yitian Li
  A nonlinear preconditioner for Jacobian-free Newton-Krylov methods
- Ludmila Bourchtein, Andrei Bourchtein
  A splitting semi-implicit scheme for large-scale atmospheric dynamics model
- Dogan Yildiz, Atif Evren
  Multilevel Factor Modeling as an Alternative in Evaluating the Performance of Statistics Education in Turkey
- Selcuk Han Aydin, M. Tezer Sezgin
  Stabilized FEM Solution of Steady Natural Convection Flow in a Square Cavity
- Hanieh Khalili Param , F. Bazdidi
  Investigation of Large Eddy Simulation and Eddy-Viscosity Turbulence Models Applicable to Film Cooling Technique
- Eun Heui Kim, C. Lee, B. Englert
  Transonic problems in multi-dimensional conservation laws

Session 4.4: Mathematical Programming III
Place: Hall 4
Chair: Herman Mawengkang

- Masoud Allame, B. Vatankhahan, S. Abbasbandy
  Modified iteration methods to solve system Ax=b
- Eren Ozceylan, T. Paksoy
  A Multi-Objective Mixed Integer Programming Model for Multi Echelon Supply Chain Network Design and Optimization
- Ali Osman Cibikdiken, Kemal Aydin
  Effect of Floating Point Aritmetic on Monodromy Matrix Computation of Periodic Linear Difference Equation System
- Mohammad Hassan Behzadi, F. Hosseinzadeh Lotfi, N. Nematollahi, M. Mirbolouki
  Ranking Decision Making Units with Stochastic Data by Using Coefficient of Variation
- Gurkan Ustunkar, S. Özöğür-Akyüz, U. Sezerman, G. W. Weber, N. Baykal
  Application of Advanced Machine Learning Methods For SNP Discovery in Complex Disease Association Studies
- Ulas Ozen, S. A. Tarim, M. K. Dogru, R. Rossi
  An Efficient Computational Method for Non-Stationary (R,S) Inventory Policy with Service Level Constraints

Session 4.5: Statistics and Data Analysis II
Place: Hall 5
Chair: Fatih Tank

- Senol Erdogmus, E. Koc, S. Ayhan
  A Comprehensive Kansei Engineering Algorithm: An application of the university web page design

- Guvenc Arslan, I. Ozmen, B.O. Turkoglu
  A JAVA Program for the Multivariate Zp and Cp Tests and Its Application
- Ovgu Cidar, Y. Tandogdu
  Smoothing the Covariance Based on Functional Principal Component Analysis
- Yucel Tandogdu
  Functional Predictor and Response Variables Under Non-Gaussian Conditions
- Mustafa Cagatay Korkmaz, Coskun Kus, Asir Genc
  Exponential-Negative Binomial Distribution
- Tutut Herawan, Mustafa Mat Deris
  Soft Set Theory for Maximal Association Rules Mining

12:45-13:45 **Lunch Break**

13:45-14:45 **Invited Talk Session**
Place: Hall 1
Chair: Omer L. Gebizlioglu

- "Ordered Random Variables-Recent Developments"
  Ismihan Bayramoglu

15:30-19:00 **Tour to the old town fortress/marina and museum visit**

20:00 **Congress Dinner**

2 October 2009, Friday

09:00-10:30 **Parallel Sessions 5**

Session 5.1: Mathematical and Computational Finance
Place: Hall 1
Chair: Jan Dhaene

- Koen Van Weert, Jan Dhaene, Marc Goovaerts
  Approximations for Optimal Portfolio Selection Problems
- Gerhard-Wilhelm Weber, Kasirga Yildirak, Efsun Kurum
  A Classification Problem of Credit Risk Rating Investigated and Solved by Optimization of the ROC Curve
- Muhammed-Shahid Ebrahim, Ike Mathur
  Structuring Pension Funds Optimally
- Refail Kasimbeyli, G. Ozturk, O. Ustun
  Multi-class classification algorithms based on polyhedral conic functions and application to companies listed on the Istanbul Stock Exchange

Session 5.2: Cryptography
Place: Hall 2
Chair: Ersan Akyıldız

- Ferruh Ozbudak, M. Cenk
  Efficient Multiplications in $\mathbb{F}_{5^m}$ and $\mathbb{F}_{7^m}$
- Baris Bulent Kirlar
  On the elliptic curves $y^2=x^3-c$ with embedding degree one
- Mohammed Mahmoud Jaradat
  On the basis number of the lexicographic product of two graphs and some related problems
- Frank J. Kampas, Janos D.Pinter
  Nonlinear Optimization in Mathematica with MathOptimizer

Session 5.3: Differential equations II
Place: Hall 3
Chair: Josep Arnal

- Muhammad Asif Gondal, A. Ostermann
  Exponential Runge--Kutta methods for option pricing in jump-diffusion models
- Mesliza Mohamed, M. Jusoh
  Discrete First-Order Four-Point Boundary Value Problem
- Yucel Cenesiz, Y. Keskin, A. Kurnaz
  The Solution of the Bagley-Torvik Equation with the Generalized Taylor Collocation Method

Control strategy of avian influenza based on modeling and simulation

Tertia Delia Nova

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Faculty of Animal Husbandry, Andalas University, West Sumatera
Limau Manis, Padang
INDONESIA

(Joint work with: H. Mawengkang, M. Watanabe)

Abstract: Since outbreaks of bird flu (avian influenza) spread widely in 2003, poultry farms have been under constant threat by loss due to the disease characteristic of domestic birds. Source of the disease is the influenza virus H5N1 endogenous to wild birds. Unlike wild birds, infection of virus to domestic birds brings serious symptoms leading to death. In a production process of a poultry farm, the entire population of domestic birds is balanced with the capacity of the farm by supply of new healthy birds and by shipping of healthy birds to be products. Some of infected birds die of the disease while others stay alive. However regardless of being alive or dead, infected birds remain as a source of infection unless they are completely disposed of. These factors have been taken into account to construct a model consisting of nonlinear ordinary differential equations. Populations of susceptible birds and infected birds are unknown variables of those differential equations. Analysis of the model has led to the conclusion that the most effective measure against outbreak of bird flu within poultry farm is constant removal of infected birds, and that removal of infected birds can solely prevent an outbreak of bird flu. The analysis has also shown that vaccination is effective in conjunction with removal of infected birds, and that vaccination cannot prevent an outbreak without removal of infected birds. Study of mechanism for outbreak of bird flu is continued from the previous study, and a control strategy of avian influenza based on modeling and simulation is proposed. In particular, spatial effects are taken into accounts in modeling and simulation. In practice, so-called rapid test is conducted to detect infection of bird flu. It is a spot-check in which samples are taken randomly from the bird population of a farm. If one bird is found positive for infection, all the birds in the farm are disposed of. The result of previous study shows that it is necessary to dispose of infected birds only, not all the birds in the farm.[1] This conclusion is examined with spatial effects taken into consideration in modling and simulation.

References

1. Tertia Delia Nova, Herman Mawengkang, Masaji Watanabe, Modeling and analysis of bird flu outbreak within a poultry farm, Submitted.

Session 3.5: Mathematical Programming II

Chair: Venancio Tomeo
Place: Hall 5

Control Strategy of Avian influenza Based on Modeling and Simulation

Tertia Delia Nova
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1 INTRODUCTION

Since outbreaks of bird flu (avian influenza) spread widely in 2003, poultry farms have always been threatened by loss due to the disease characteristic of domestic birds. Source of the disease originates in the influenza virus H5N1 endogenous to wild birds. Unlike wild birds, infection of virus to domestic birds leads to serious symptoms that often result in death. Such loss due to infection increases the cost of production per individual. Not only the direct consequence of loss due to infection of bird flu, there are also secondary effects that can harm poultry production, one of which is decrease in demand due to biased view that the bird flu is a zoonosis infectious to human consuming product from domestic birds.

Transmission of bird flu involves three factors, existence of avian influenza virus as the source of the disease, poultry as host, and environment as medium. It is likely to provide opportunities for infection of the virus under inappropriate supervision in handling poultry products and sanitation of entry-exit, *etc.* Vaccination reduces the risk of infection both for humans and for domestic animals. Vaccinated chickens shed much fewer viruses when infected. However a downside of vaccination of chickens emerges in export trade (Breytenbach, 2005).

In this study, a mathematical model is analyzed to investigate effects of vaccination and removal of infected birds. In the following sections, a mathematical model is proposed to analyzed time evolution of susceptible birds and infected birds. Then dominant states of dynamics are determined. Analysis of the model shows that an intrusion by bird flu into a farm wipes out the entire population without removal of infected birds. It also shows that the state free of infection can be maintained with proper removal of infected birds.

2 MODELING INFECTION PROCESS

When a poultry farm is contaminated by bird flu, the population of domestic birds are divided into two

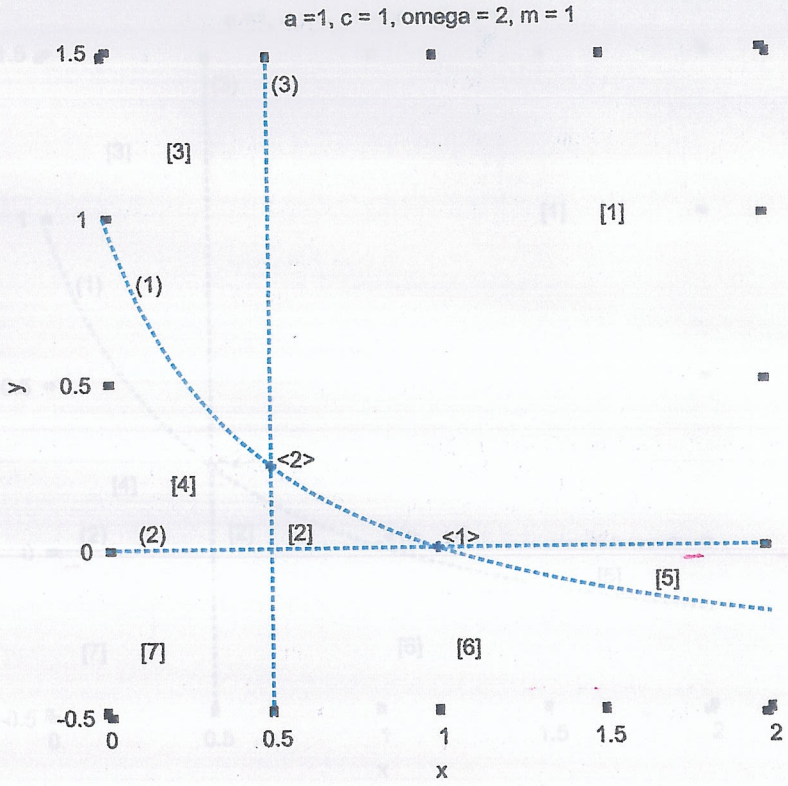


Figure 1: Null clines and stationary points for $c\omega - m > 0$. $a = 1$, $c = 1$, $\omega = 2$, $m = 1$. (1): $y = \frac{a(c-x)}{a+\omega x}$, (2): $y = 0$, (3): $x = \frac{m}{\omega}$, [1]: $\frac{dx}{dt} < 0$, $\frac{dy}{dt} > 0$, [2]: $\frac{dx}{dt} > 0$, $\frac{dy}{dt} > 0$, [3]: $\frac{dx}{dt} < 0$, $\frac{dy}{dt} < 0$, [4]: $\frac{dx}{dt} > 0$, $\frac{dy}{dt} < 0$, [5]: $\frac{dx}{dt} < 0$, $\frac{dy}{dt} < 0$, [6]: $\frac{dx}{dt} > 0$, $\frac{dy}{dt} < 0$, [7]: $\frac{dx}{dt} > 0$, $\frac{dy}{dt} > 0$, $<1>$: $(c, 0)$, $<2>$: $\left(\frac{m}{\omega}, \frac{a(c\omega - m)}{\omega(a+m)}\right)$.

of the stationary point for all $t \geq 0$. Then the stationary point is said to be stable. A stationary point is said to be unstable unless it is stable. In addition to being stable, suppose that there is a neighborhood of the point (ξ, η) with the following property. Any solution $(x(t), y(t))$ that starts from a point in the neighborhood at $t = 0$,

$$\lim_{t \to \infty} (x(t), y(t)) = (\xi, \eta).$$

Then the stationary point is said to be asymptotically stable.

The stability of a stationary point $(x, y) = (\xi, \eta)$ depends on the eigenvalues of the Jacobian matrix, which we call A. It is asymptotically stable when all the eigenvalues of A have negative real parts, and it is unstable when at least one eigenvalue has a positive real part (E. A. Coddington, 1984). Let λ_- and λ_+ be the eigenvalues of A. Then

$$\lambda_\pm = \frac{\mathrm{tr}A}{2} \pm \frac{\sqrt{(\mathrm{tr}A)^2 - 4\det A}}{2} \qquad (13)$$

where

$$\mathrm{tr}A = -(a + \omega\eta) + \omega\xi - m, \qquad (14)$$

and

$$\det A = -(a + \omega\eta)(\omega\xi - m) + (a + \omega\xi)\omega\eta. \qquad (15)$$

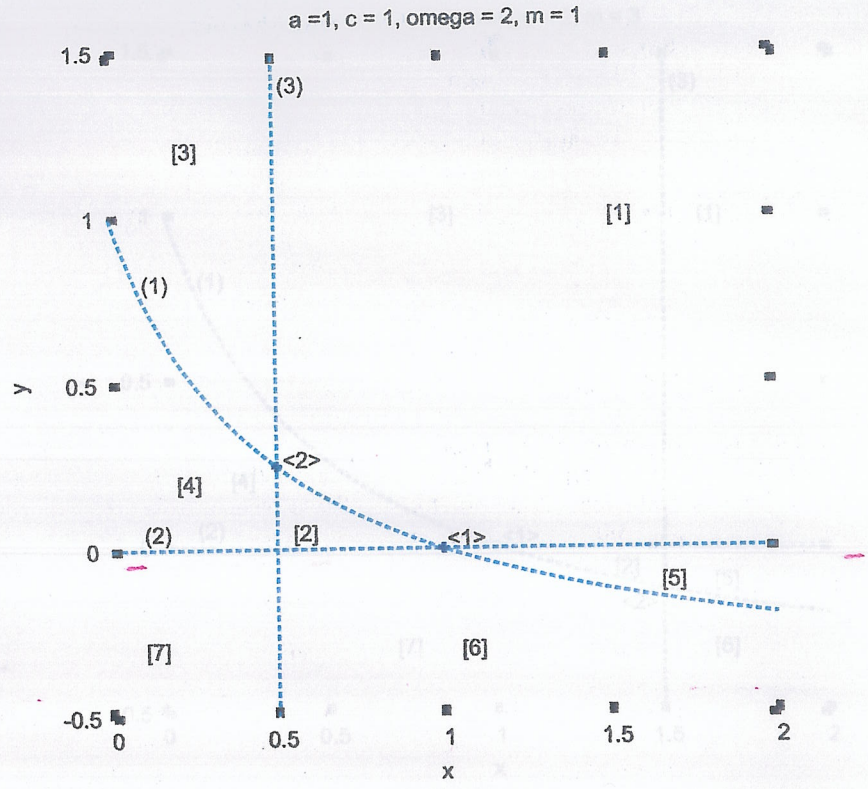
It follows that the steady state solution is asymptotically stable if and only if $\mathrm{tr}A < 0$ and $\det A > 0$.

4 DYNAMICS OF INFECTION

For the Stationary point (8), equations (13) - (15) lead to

$$\lambda_- = -a, \qquad \lambda_+ = \omega c - m.$$

Under the condition (11), the stationary point (8) is unstable. Under the condition (12), the stationary point is asymptotically stable.



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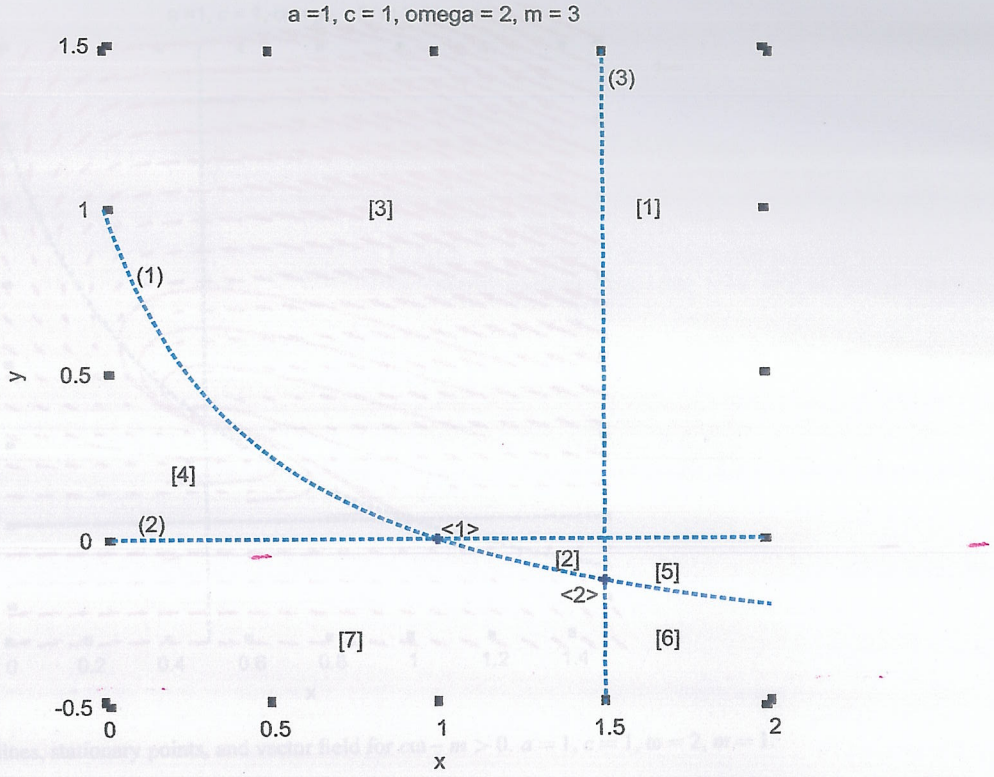

Figure 2: Null clines and stationary points for $c\omega - m < 0$. $a = 1$, $c = 1$, $\omega = 2$, $m = 3$. (1): $y = \frac{a(c-x)}{a+\omega x}$, (2): $y = 0$, (3): $x = \frac{m}{\omega}$. [1]: $\frac{dx}{dt} < 0$, $\frac{dy}{dt} > 0$, [2]: $\frac{dx}{dt} < 0$, $\frac{dy}{dt} > 0$, [3]: $\frac{dx}{dt} < 0$, $\frac{dy}{dt} < 0$, [4]: $\frac{dx}{dt} > 0$, $\frac{dy}{dt} < 0$, [5]: $\frac{dx}{dt} < 0$, $\frac{dy}{dt} < 0$, [6]: $\frac{dx}{dt} > 0$, $\frac{dy}{dt} < 0$, [7]: $\frac{dx}{dt} > 0$, $\frac{dy}{dt} > 0$, $<1>$: $(c, 0)$, $<2>$: $\left(\frac{m}{\omega}, \frac{a(c\omega-m)}{\omega(a+m)}\right)$.

For the stationary point (9), equations (14) and (15) become

$$\mathrm{tr}A = -\frac{a(a+c\omega)}{a+m} < 0, \qquad \det A = a(c\omega - m).$$

Under the condition (11), $\det A > 0$, and the stationary point (9) is asymptotically stable. It is unstable when the inequality (12) holds.

When the inequality (11) holds, the stationary point (8) is unstable, and the stationary point (9) is asymptotically stable. In particular, small perturbation of the stationary point (8) leads to convergence to the stationary point (9). When the inequality (12) holds, the stationary point (8) is asymptotically stable, and the stationary point (9) is unstable. In this case, small perturbation of the stationary point (8) does not affect the state. Figures 3 and 4 show the dynamics of the system (3), (4) under the conditions (11) and (12), respectively. Vectors defined by the right hand sides of the system (3), (4) are plotted. The figures also show some trajectories generated numerically together with the null clines and the stationary points. Those trajectories are generated numerically using the fourth-order Adams-Bashforth-Moulton Predictor-Corrector in PECE mode in conjunction with Runge-Kutta Method to generate values of approximate solution at the first three steps (Lambert, 1973).

5 DISCUSSION

It has been shown in Section 4 that perturbation of the stationary point (8) of the system (3), (4) leads to convergence to the steady state (10) when $m = 0$. Note that the stationary point (8) corresponds to the state free of infection. Note also that the stationary point (10) corresponds to complete infection where all the birds are infected. This result leads to the conclusion that intrusion of bird flu leads to infection of the en-

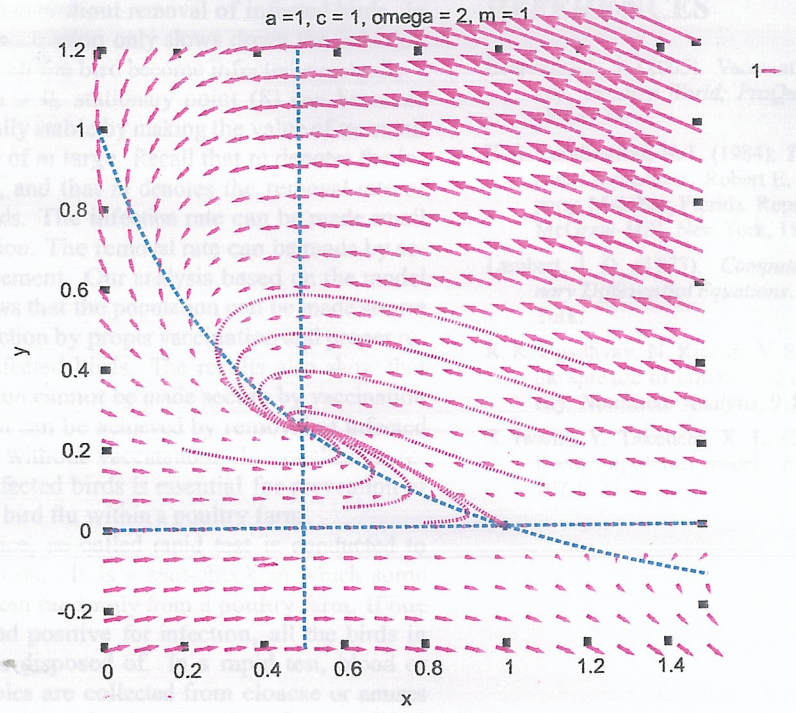

Figure 3: Null clines, stationary points, and vector field for $c\omega - m > 0$. $a = 1$, $c = 1$, $\omega = 2$, $m = 1$.

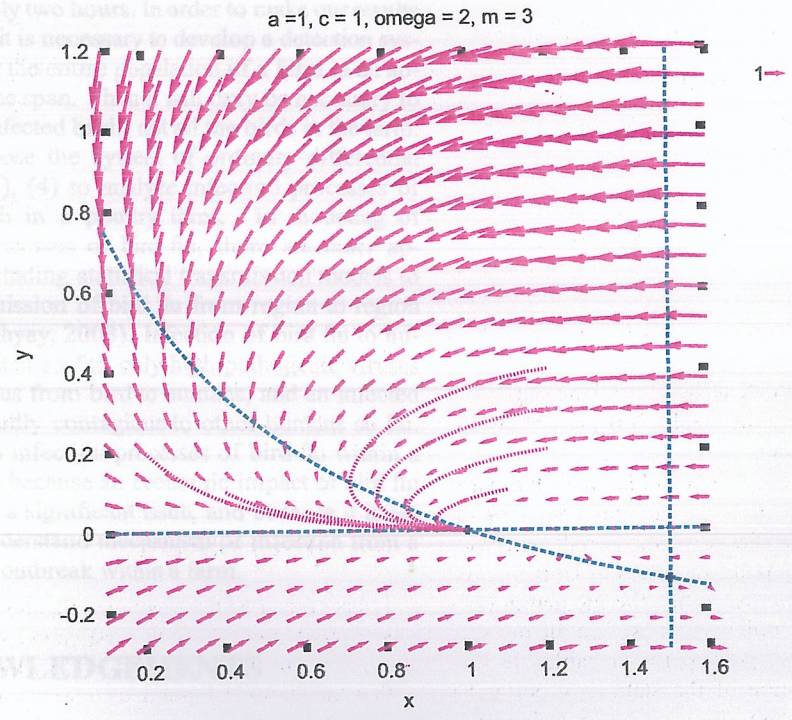

Figure 4: Null clines, stationary points, and vector field for $c\omega - m < 0$. $a = 1$, $c = 1$, $\omega = 2$, $m = 3$.

tire population without removal of infected birds. In this case, vaccination only slows down the infection process, but all the bird become infected eventually.

When $m > 0$, stationary point (8) can be made asymptotically stable by making the value of ωc small or the value of m large. Recall that ω denotes the infection rate, and that m denotes the removal rate of infected birds. The infection rate can be made small by vaccination. The removal rate can be made by secure management. Our analysis based on the model (3), (4) shows that the population can be made secure against infection by proper vaccination and proper removal of infected birds. The results also show that the population cannot be made secure by vaccination alone. But it can be achieved by removal of infected birds alone without vaccination. In conclusion, removal of infected birds is essential for prevention of outbreak of bird flu within a poultry farm.

In practice, so-called rapid test is conducted to detect infection. It is a spot-check in which some birds are taken randomly from a poultry farm. If one bird is found positive for infection, all the birds in the farm are disposed of. In a rapid test, blood or serum samples are collected from cloacae or anuses by swabs, and kept in glycerol to be taken to a laboratory for analysis. Analysis of serum takes approximately forty five minutes, while analysis of dirt takes approximately two hours. In order to make our results practicable, it is necessary to develop a detection system to cover the entire population of a farm in an appropriate time span. Then it will only be necessary to dispose of infected birds, not all the birds in the farm.

We propose the system of ordinary differential equations (3), (4) to analyze infection processes of bird flu with in a poultry farm. In modeling of infection processes of bird flu, there are other approaches including statistical transmission models to study transmission of bird flu from region to region (R. K. Upadhyay, 2008). Infection of bird flu to humans is limited so far, only high pathogenic viruses are contagious from bird to humans, and an infected human is hardly contagious to other humans so far. We focus on infection processes of bird flu within a poultry farm because an economic impact of bird flu on a farm is a significant issue, and because it is essential to understand mechanism of infection from a source to an outbreak within a farm.

ACKNOWLEDGEMENTS

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