International Symposium on Applied Optimization and Game Theory Models

Program and Abstracts

Organized by

Indian Statistical Institute, Delhi Centre

January 9-11, 2013

ISAOGTM13

Organized by

Indian Statistical Institute,

SQC & OR Unit, Delhi Centre

Contents

Welcome to ISAOGTM13

On behalf of the organizers of ISAOGTM13, I welcome you in the *International Symposium on Applied Optimization and Game-Theoretic Models during* January 9-11, 2013 at Indian Statistical Institute, Delhi Centre. This international symposium aims to promote research in the area of Applied Optimization and Game theory by bringing together world-leading experts and other specialists of the field along with young scholars. This will be an event under the project on *Optimization & Reliability Modeling* and it will take place at Indian Statistical Institute Delhi Centre. This event will provide an excellent opportunity to disseminate the latest major achievements and to explore new directions and perspectives, and is expected to have a broad international appeal, dealing with topics of fundamental importance in applied optimization and other related sciences (Economics, Physics, Engineering). In this symposium we mainly focus on classical and modern optimization theory, algorithms (local and global aspects), stochastic optimization, structured optimization, as well as related topics in applied mathematics, including game theory. This symposium also seeks for applied contributions on modeling and optimization in the fields of logistics, manufacturing, and supply chain management where robust and/or stochastic models are used to provide decision support.

The symposium topics include (but not limited to):

- Linear and Nonlinear Programming
- Multi-Objective Optimization
- Global Optimization
- Optimization Problem in Statistics
- Network analysis and Optimization
- Optimization Problems in Graph Theory
- Nonsmooth Optimization
- Complementarity problems and Variational inequalities
- Combinatorial Optimization
- Robust Optimization

- Stochastic Optimization
- New developments in Classical Combinatorial Optimization Problems (Knapsack, Vehicle Routing & Scheduling, Traveling salesman problem)
- Game theory
- Reliability optimization
- Optimization techniques for game problems
- Application of Optimization Models to finance and Economics

A special session titled ***Professor Santosh N. Kabadi Memorial session*** will be organized on ***Combinatorial Optimization*** to recall the memory of our dear friend ***Professor Santosh N. Kabadi, University of New Brunswick, Canada*** who was a frequent visitor to Indian Statistical Institute Delhi Centre and passed away in a tragic drowning accident in the River Ganga in Haridwar,

This symposium also intends to bring out a publication of selected and refereed papers *in Special issue in* ***Annals of Operations Research &*** *Special issue in* ***International Game Theory Review***. Information about social events will be available to you at the time of registration.

S. K. Neogy
Organizing Committee Chair

Committees

Organizing Committee

S. K. Neogy (Organizing Committee Chair), R.B. Bapat, A. K.Das, A. Gupta, B. Pradhan, Anup Dewanji, D. Sengupta, A. Bandyopadhyay, Arunava Sen, R. Chakraborty

Programme Co-ordinating Committee

S. K. Neogy, Prabal Roy Chowdhury, A. K. Das, S. K. Mishra (BHU, Varanasi)

Advisory Committee

A. Majumdar, D. K. Manna, S. K. Mishra (BHU, Varanasi)

Facilities Committee

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International Symposium on
Applied Optimization and Game-Theoretic Models

Program Overview

Registration: 9:30-10:00 (Auditorium)

Inaugural Session Details

January 9, 2013 Time: 10:00 -10:30 Venue: Auditorium

Welcome address, Opening Remarks, About symposium

Sessions Details

Parallel Sessions

January 9, 2013 Time: 11:00 -13:00 Venue: Auditorium

Invited Session I

Chairman : Jean B. Lasserre, LAAS-CNRS and Institute of Mathematics,University of Toulouse, Toulouse, France

1.	Zdenek Dostal (VSB-Technical University of Ostrava, Ostrava, Czech Republic) Optimal QP and QPQC algorithms and applications
2.	Jean B. Lasserre, (LAAS-CNRS and Institute of Mathematics,University of Toulouse, Toulouse, France) Inverse Polynomial Optimization
3.	Jiyuan Tao (Loyola University , Maryland, Baltimore, USA) On the completely-Q property for linear transformations on symmetric cones
4.	Yasunori Kimura (Toho University, Funabashi, Japan) Approximation of a fixed point of an operator defined on a geodesic space

January 9, 2013 Time: 11:00 -13:00 Venue: Conference Room

Technical Session-I A

Chairman : T parthasarathy, *Chennai Mathematical Institute and Indian Statistical Institute Chennai*

1.	**A.K. Bhurjee_,** G. Panda, **(Indian Institute of Technology Kharagpur, India)** Optimality and Duality for Interval Optimization Problem
2.	S. K. Mishra Vivek Laha (Banaras Hindu University) **and Bader Al-Shamary (Kuwait University)** On nonsmooth V-invexity and vector variational-like inequalities in terms of the Michel-Penot subdifferentials
3.	**Archana Khurana,** Tripti Verma **(Guru Gobind Singh Indraprastha University, Delhi)** Solving Impaired Flow Multi-Index Transportation Problem With Axial Constraints
4	S. K. Mishra and **Vinay Singh** (Banaras Hindu University, Varanasi-221005, India) Multiobjective Programming Problems involving Generalized V-pseudo-invexity
5	**Anusuya Ghosh and** Vishnu Narayanan (,Indian Institute of Technology Bombay) Characterizations of semidefinite representable sets
6	S K Mishra, Vivek Laha, **Yogendra Pandey** (Banaras Hindu University, Varanasi-221005, India) Vector optimization problem and epsilon vector variational-like inequality

January 9, 2013 Time: 11:00 -13:00 Venue: Seminar Room 2

Technical Session-I B

Chairman : **Tiru S. Arthanari, *University of Auckland, Auckland, New Zealand***

1.	**S. K. Chhillar** and S.C.Malik**,** Department of Statistics, M.D. University, Haryana India) Reliability Modeling of a Cold Standby System with Priority to Repair over Maintenance Subject to Random Shocks.
2.	**Ashish Kumar** and S.C. Malik (Department of Statistics, M.D. University, Haryana, India) Cost- Benefit Analysis of a Computer System with Priority to Preventive Maintenance over the H/W Repair Activities Subject to MOT and MRT
3.	**Jayesh B. Shah** and M.N Patel (Gujarat University,Ahmedabad) Bayesian approach to inference in reliability studies based on multiply Type II censored data from a Rayleigh distribution
4	**Jitender Kumar,** M.S. Kadyan and S.C. Malik (Kurukshetra University, Kurukshetra India), Reliability Modelling of Single-Unit System with Degradation and Preventive Maintenance
5	**J.K. Sureria** and S.C. Malik (Department of Statistics, M. D. University, Haryana, India)Stochastic Analysis of a Computer System with Arrival Time and Priority to H/w Repair over S/w Replacement
6	**Ramniwash,** M.S. Kadyan* and Jitender Kumar (Kurukshetra University, Kurukshetra India) Reliability And Cost-Benifit Analysis Of A Single-Unit System Subject To Warranty Period

Lunch : Guest House Lawn Time 13:00 – 14:00

January 9, 2013 Time: 14:00 -15:30 Venue: Auditorium

Invited Session II A

Chairman : Michel Grabisch, Universit´e Paris I, Paris

1.	**Sandeep Juneja** (Tata Institute of Fundamental Research, Mumbai) The Concert Queueing Game: Processor Sharing Regime
2.	**T E S Raghavan (University of Illinois at Chicago, USA).** Policy Improvement algorithms for zero sum ARAT stochastic games with discounted and Cesaro payoffs.
3.	**Nandyala Hemachandra,** (Indian Institute of Technology Bombay, India) A model for equilibrium in some firm-market interactions

January 9, 2013 Time: 14:00 -15:30 Venue: Conference Room

Invited Session II B

Chairman : Shiv Prasad Yadav (Deptt. of Mathematics, Indian Institute of Technology Roorkee)

1.	***Pankaj Gupta (*Department of Operational Research, University of Delhi, Delhi)** Behavioral portfolio selection models based on financial and ethical considerations
2.	**Reshma Khemchandani[a], Avikant Bhardwaj[b], Suresh Chandra[b] ([a]Royal Bank of Scotland IDC, Gurgaon (India), [b]Indian Institute of Technology, Delhi India)** Single Asset Optimal Trading Strategies with Stochastic Dominance Constraints
3.	**S.C. Malik,** (M.D. University, Rohtak-124001, Haryana India) Reliability Modeling of an Integrated H/W and S/W System with Preventive Maintenance and Priority Subject to Maximum Operation and Repair Times

January 9, 2013 Time: 15:45 -17:30 Venue: Auditorium

Invited Session III

Chairman: Jiyuan Tao, Loyola University , Maryland, Baltimore, USA

1.	**Dusan Ku and Tiru S. Arthanari (University of Auckland, Auckland, New Zealand)** On Double Cycling for Container Port Productivity Improvement
2.	**Aparna Mehra (Department of Mathematics, Indian Institute Of Technology, Delhi)** Gap Function and Error Bounds for Variational Inequality and Its Variants
3.	**C. S. Lalitha (Department of Mathematics,** University of Delhi South Campus, **New Delhi-110021** Subgradients using Henig Proper Efficiency in Set-Valued Optimization

January 9, 2013 Time: 15:45 –17:45 Venue: Conference Room

Technical Session II

Chairman: Zdenek Dostal (VSB-Technical University of Ostrava, Ostrava, Czech Republic)

1.	**Ankush Agarwal** and Sandeep Juneja (Tata Institute of Fundamental Research, Mumbai) Nearest Neighbor Based Estimation Technique for Pricing Bermudan Options
2.	**Dipti Dubey,** Suresh Chandra, Aparna Mehra (Indian Institute of Technology Delhi) Integrating Bipolarity in Fuzzy Linear Programming with Several Objective Functions
3.	C.S.Lalitha and **Mansi Dhingra** (Department of Mathematics, University of Delhi, India.) Constrained optimization reformulations and relaxation methods for generalized Nash equilibrium problems using nonmonotone inexact line search
4.	S. K. Mishra and **B. B. Upadhyay(**Banaras Hindu University, Varanasi-221005, India) Some relations between vector variational inequality problems and nonsmooth vector optimization problems
5	**Mrinal Janay and** Geetanjali Panda (Department of Mathematics, Indian Institute of Technology,Kharagpur, India) Solution of Interval Geometric Programming Problem
6.	**Dinesh KumarYadav** and Sant Sharan Misha(Department of Economics and Statistics, Vikas Bhawan, Faizabad, UP India) Ratio Optimization Of Profit Per Unit Cost For Lost Customers

January 9, 2013 Time: 18:15 –20:15 Venue: Auditorium

Cultural Programme: Classical Music

Dinner : Guest House Lawn Time 20:30 – 21:30

Professor *Santosh N. Kabadi Memorial session*

January 10, 2013 Time: 10:00 -11:45 Venue: Auditorium

Invited Session IV

Chairman: R. Chandrasekaran (The University of Texas at Dallas)

1.	**R. Chandrasekaran,** M. Dawande, M. Baysan (The University of Texas at Dallas) Graph Labelings
2	**R.B.Bapat** (Indian Statistical Institute, Delhi Centre) On a quadratic programming problem involving distances in trees.
3	**Prabha Sharma** (Deptt. of CSE &IT, ITM University, Gurgaon) Local Search Does Work

January 10, 2013 Time: 10:00 -11:45 Venue: Conference Room

Technical Session III

Chairman: Agnieszka Rusinowska, Paris School of Economics – CNRS, Centre d'Economie de la Sorbonne, Paris, France

1.	**Prasenjit Mondal &** Sagnik Sinha(Jadavpur University, Kolkata, India)An Ordered Field Property For One Player Control Finite Semi-Markov Games
2.	**John Mathew** and R K Amit (Department of Management Studies, Indian Institute of Technology Madras, Chennai India) Some Results in the Competitive Newsvendor Model
3.	**Mahima Gupta,** B.K. Mohanty (Indian Institute of Management Lucknow) Products selection in E-Commerce-A Fuzzy logic based game theoretic approach
4	**Arindum Mukhpadhyay,** Adrijit Goswami (Department of Mathematics, Indian Institute of Technology Kharagpur, India) Stock-out averse newsvendor game: Applications to Pharmaceuticals
5	**Harinam Singh (**School of Social Sciences, Indira Gandhi National Open University,) Cooperative Games And Economic Application

January 10, 2013 Time: 12:00 -13:00 Venue: Auditorium

Invited Session V A

Chairman: T. Parthasarathy, Chennai mathematical Institute and Indian Statistical Institute Chennai.

1.	**Reinoud Joosten** (University of Twente, The Netherlands) Long-run strategic advertising and short-run Bertrand competition
2.	Michel Grabisch[13] **and Agnieszka Rusinowska**[23] **[1] Paris School of Economics, Universit´e Paris I Panth´eon-Sorbonne, [2] Paris School of Economics – CNRS [3]Centre d'Economie de la Sorbonne,Paris, France**) Lattices in social networks with influence

January 10, 2013 Time: 12:00 -13:00 Venue: Conference Room

Invited Session V B

Chairman: R. B. Bapat, Indian Statistical Institute Delhi

1.	**C. Srinivasan** (University of Kentucky, USA) Neural Network related optimization issues
2.	**B.S.Panda** (Department of Mathematics, Indian Institute of Technology Delhi) Griggs and Yeh's Conjecture on L(2,1)-Labeling of Graphs

Lunch : Guest House Lawn Time 13:00 – 14:00

January 10, 2013 Time: 14:00 -15:15 Venue: Auditorium

Invited Session VI A

Chairman: T E S Raghavan (University of Illinois at Chicago, USA).

1.	**Jerzy A. Filar** (joint work with Vladimir Ejov and Justin Beck) (Flinders University Bedford Park, South Australia, Australia), Games, Incompetence, Training & Related Parametric Analysis
2.	**Michel Grabisch** (Paris School of Economics, Universit´e Paris, Paris) The core of games with restricted cooperation

January 10, 2013 Time: 14:00 -15:30 Venue: Conference Room

Invited Session VI B

Chairman: Prabha Sharma (Deptt. of CSE &IT, ITM University, Gurgaon)

1.	**K S Mallikarjuna Rao** (Indian Institute of Technology Bombay, India) A game theoretic view of the smallest enclosing and intersecting ball problems
2.	**Kusum Deep** (Department of Mathematics, Indian Institute of Technology Roorkee) A new Genetic Algorithm to solve Sudoku Puzzles
3.	**B.K.Mohanty** (Indian Institute of Management, Lucknow), Game Theory Under Fuzzy Environment

January 10, 2013 Time: 16:00 -17:30 Venue: Conference Room

Invited Session VII

Chairman: S. K. Neogy, Indian Statistical Institute Delhi Centre

1.	**T. Parthasarathy** (Chennai Mathematical Institute, Chennai, India & Indian Statistical Institute, Chennai, India) Relationship between Q-property of a given matrix A and the Q-property of some linear tranformation defined through A
2.	**K.C. Sivakumar** (Department of Mathematics, Indian Institute of Technology Madras, Chennai India)Nonnegative Generalized Inverses of Certain Classes of Matrices and Applications to Linear Complementarity Problems
3.	**A. K. Das** (Indian Statistical Institute, Kolkata) Almost Fully Copositive and Fully Semimonotone Matrices in Linear Complementarity Theory

January 10, 2013 Time: 16:00 -18:00 Venue: Auditorium

Technical Session IV

Chairman: Reinoud Joosten **(University of Twente, The Netherlands)**

1.	**Amita Sharma** and Aparna Mehra (Department of Mathematics,Indian Institute of Technology Delhi, India) An Overview of the Momentum Strategies in Finance
2.	***Anjana Gupta***[1], *Aparna Mehra*[2], *S. S. Appadoo*[3]*(*[1] Delhi Technological UniversityDelhi, India, [2]Indian Institute of Technology Delhi, 3University of Manitoba, Winnipeg, MB R3T5V4 Canada.) Mixed Solution Strategy For MCGDM Problems Using Entropy/Cross Entropy In Interval-Valued Intuitionistic Fuzzy Environment
3.	B.S. Panda, **Arti Pandey** (Indian Institute of Technology Delhi) Outer-connected domination in graphs Complexity and Approximation Hardness
4	Vishnu Narayanan**, Kunal Sharma(**Indian Institute of Technology, Bombay, India**)**Design of Survivable Communication Networks
5.	**Mukesh Kumar Mehlawat** (Department of Operational Research, University of Delhi, Delhi, India) Asset portfolio optimization using analytical hierarchy process and multi-choice goal programming
6	S.K.Suneja (Miranda House, University of Delhi, Delhi-11000) and **Bhawna Kohli**(Department of Mathematics,University of Delhi), Duality for Multiobjective Fractional Programming Problem Using Convexifactors

Symposium Dinner: January 10, 2013, Time: 20:00
Note: Bus leaves from Indian Statistical Institute campus on January 10, 2013 for India International Centre at 19:30

January 11, 2013 Time: 10:00 -11:30 Venue: Auditorium

Invited Session VIII A

Chairman: Jerzy A. Filar (Flinders University Bedford Park, South Australia, Australia)

1.	**Agnieszka Wiszniewska-Matyszkiel** (Institute of Applied Mathematics and Mechanics, Warsaw University, Poland) On new concepts of equilibria in games with imperfect information and ambiguity about future and their applications in economics and ecology
2.	Prasenjit Mondaly **& Sagnik Sinha** (Mathematics Department, Jadavpur University, Kolkata-India) On Average Reward Semi-Markov Decision Processes: An Example
3.	**Philippe Uyttendaele** and Frank Thuijsman (Maastricht University, Department of Mathematics, Maastricht, The Netherlands) Evolutionary Games and Local Dynamics

January 11, 2013 Time: 10:00 -11:30 Venue: Conference Room

Invited Session VIII B

Chairman: Yasunori Kimura (Toho University, Funabashi, Japan)

1.	**J. Dutta (Indian Institute of Technology Kanpur, India)** Stationarity Concepts for single stage SMPCC problem.
2.	**S. K. Mishra and Yogendra Pandey (Banaras Hindu University, Varanasi, India)** On Duality For Mathematical Programming Problems With Equilibrium Constraints
3.	**Shiv Prasad Yadav** (Deptt. of Mathematics, Indian Institute of Technology Roorkee) Data envelopment analysis and its applications

January 11, 2013 Time: 11:45 -13:15 Venue: Conference Room

Invited Session IX A

Chairman: S. K. Mishra (Banaras Hindu University, Varanasi, India)

1.	**P C Jha, (**Department of Operational Research University of Delhi) Joint Optimization of Procurement and Distribution in Supply Chain Management
2	**Sanjeet Singh** and Nivedita Haldar (Indian Institute of Management Calcutta, , India) **A New Method to Solve Bi-level Quadratic Linear Fractional Programming Problems**
3	C.S. Lalitha and **Prashanto Chatterjee** (University of Delhi) A study of well-posedness and stability in vector optimization problem using Henig proper efficiency

January 11, 2013 Time: 11:45 -13:15 Venue: Seminar Room 2

Technical Session V A

Chairman: **Prabal Roy Chowdhury, Indian Statistical Institute Delhi Centre**

1.	**Debasis Mondal** (Indian Institute of Technology Delhi) Private provision of public good game and endogenous inequality
2	**Diganta Mukherjee**,(Indian Statistical Institute, Kolkata) Identity, Envy and Resource Loss
3	**Rajlakshmi Mallik** (NSHM Business School, Kolkata) Being Credit Rationed: Perception and Transaction Cost

January 11, 2013 Time: 11:45 -13:15 Venue: Auditorium

Technical Session V B

Chairman: Tiru S. Arthanari, ***University of Auckland, Auckland, New Zealand***

1.	**Ritwik Bhattacharya,** Biswabrata Pradhan, Anup Dewanji (Indian Statistical Institute, Kolkata), On Optimum Life Testing Plans In Presence of Progressive Censoring : A Cost Function Approach
2	K.K.Thampi (Department of Statistics, SNMC, M.G.University, Kerala-683516, INDIA) Finite time Ruin Probability of the Compound Renewal Model with Constant Interest rate and Weakly Negatively Dependent Claims**.**
3	Sadia Samar Ali (Fortune Institute of International Business, New Delhi) A Value Adding Approach To Reliability Under Preventive Maintenance
4	**To be announced later**

Lunch : Guest House Lawn Time 13:15 – 14:00

January 11, 2013 Time: 14:00 –16:00 Venue: Auditorium

Technical Session VI A

Chairman: Tiru S. Arthanari, ***University of Auckland, Auckland, New Zealand***

1.	Bani Mukherjee **and Krishna Prasad** (Department of Applied Mathematics, Indian School of Mines, Dhanbad, India) Optimal production inventory model for deteriorating items with production disruption and shortage
2	**Prerna Manik**, Anshu Gupta, P. C. Jha (Department of Operational Research, University of Delhi, Delhi) Multi Stage Promotional Resource Allocation for Segment Specific and Spectrum Effect of Promotion for a Product Incorporating Repeat Purchase Behavior
3	**Pratiksha Saxena**, Tulsi Kushwaha (Gautam Buddha University, Greater Noida India) Simulation Tool for Inventory Models: SIMIN
4.	**Chirag J. Trivedi** and Y. K. Shah. (Gujarat University, India) An Analytical Order level Lot size Inventory Model With Random Lead time When Quantity Received Is Uncertain
5	S. R. Singh**& Anuradha (**D. N. College Meerut**)** Perishable Inventory Model with Two type of Retailers under Inflation
6	**Hari Ram Prajapati1 (**Centre for Studies in Economic and Planning, Central University of Gujarat, India) An Application of Game Theory in Strategic Decision of Marriage Occurrence

January 11, 2013 Time: 14:00 –16:00 Venue: Conference Room

Technical Session VII A

Chairman: S. K. Mishra (Banaras Hindu University, Varanasi, India)

1.	**Rajni Goyal** And Shiv Prasad Yadav (Indian Institute Of Technology Roorkee, Roorkee-, India.) A New Approach With Biasedness To Construct Balanced Boolean Functions Having The Best Trade-Off Between Nonlinearity And Autocorrelation For 7 Variables
2	**Sujeet Kumar Singh** And Shiv Prasad Yadav (Indian Institute Of Technology Roorkee, Roorkee-, India.) A New Approach for Solving Intuitionistic Fuzzy Transportation Problems of Type-2
3	Sanjeet Singh and **Surya Sarathi Majumdar** (Indian Institute of Management Calcutta, Joka, Kolkata, India.) Efficiency improvement strategy under constant sum of inputs with restricted weights
4.	S. K. Mishra and **Vivek Laha** (Banaras Hindu University, Varanasi, India) On characterizing the blunt minimizers of epsilon convex programs
5	Vinay Singh, B. B.Upadhyay and Y.Singh (Banaras Hindu University, Varanasi) India Sufficiency and duality in differentialble multiobjective programming involving generalized type-I functions
6	S.K.Mishra and **Kalpana Shukla** (Banaras Hindu University, Varanasi) Parametric Dual Models for Semi-infinite Discrete Minimax Fractional Programming Problems Involving Generalized $V-\rho$ Invex Functions.

ABSTRACT OF THE PAPERS

Inverse Polynomial Optimization

Jean B. Lasserre

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Let $\mathbf{P}$: $\min\{f(\mathrm{x}) : \mathrm{x} \in \mathbf{K}\}$ be a polynomial optimization problem where $\mathbf{K} \subset \mathbb{R}^n$ is a compact basic semi-algebraic set and $f \in \mathbb{R}[\mathrm{x}]$. The *inverse optimisation* problem associated with $\mathbf{P}$ and a given feasible point $\mathrm{y} \in \mathbf{K}$, consists of solving :

$$\mathrm{INV}-\mathbf{P}: \quad \min_{\tilde{f} \in \mathbb{R}[\mathrm{x}]} \{ \|\tilde{f} - f\| \ : \ \mathrm{y} = \arg\min_{\mathrm{x}} \{\tilde{f}(\mathrm{x}) \ : \ \mathrm{x} \in \mathbf{K}\}\},$$

where $\|\cdot\|$ is a norm of $\mathbb{R}[\mathrm{x}]$. That is, one searches for a polynomial $\tilde{f} \in \mathbb{R}[\mathrm{x}]$, as close to f as possible, and for which the given point $\mathrm{y} \in \mathbf{K}$ is a global optimal solution of $\min\{\tilde{f}(\mathrm{x}) : \mathrm{x} \in \mathbf{K}\}$.

• We first provide a numerical scheme for solving $\mathrm{INV}-\mathbf{P}$. In particular, one computes a polynomial $\tilde{f}_d$ with a-priori fixed degree d (= $\deg f$ if desired) and with the following properties :
(a) $\mathrm{y} \in \mathbf{K}$ is a global optimal solution of $\min\{\tilde{f} \ : \ \mathrm{x} \in \mathbf{K}\}$, with a Putinar's certificate of optimality of size bounded a-priori.
(b) $\tilde{f}_d$ minimizes $\|g - f\|$ among all $g \in \mathbb{R}[\mathrm{x}]_d$ having property (a) :

• In addition, $\tilde{f}_d$ is an optimal solution of an SDP whose size is controlled by the a-priori maximum size imposed to the Putinar's certificate of optimality. Finally, we show that when minimizing the ℓ_1-norm $\|g-f\|_1$, one obtains a *canonical sparse* optimal solution $\tilde{f}_d$ whose explicit form is provided.

Optimal QP and QPQC algorithms and applications

Zdenek Dostal

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We first review our results in the development of optimal algorithms for the minimization of a strictly convex quadratic function subject to separable convex inequality constraints and/or linear equality constraints. A unique feature of our algorithms is the theoretically supported bound on the rate of convergence in terms of the bounds on the spectrum of the Hessian of the cost function, independent of representation of the constraints. When applied to the class of convex QP or QPQC problems with the spectrum in a given positive interval and a sparse Hessian matrix, the algorithms enjoy optimal complexity, i.e., they can find an approximate solution at the cost that is proportional to the number of unknowns. The algorithms do not assume representation of the linear equality constraints by full rank matrices.

The efficiency of our algorithms is demonstrated first on the problems of academic interest, such as the variants of the knapsack problem or the problem to find the projection onto the intersection of a small number of hyperplanes and a cube with up to five millions variables. Then we present the results of the solution of contact problems of elasticity with or without friction by our TFETI domain decomposition method. We report the numerical scalability of our algorithms, i.e., their capability to find an approximate solution in a number of matrix-vector multiplications that is independent of the discretization parameter. Both numerical and parallel scalability of the algorithms is documented by the results of numerical experiments with the solution of contact problems with tens millions unknowns and analysis of industrial problems.

References:

[1] Z. Dostal, *Optimal Quadratic Programming Algorithms, with Applications to Variational Inequalities*, 1st edition, Springer US, New York 2009, SOIA 23

[2] Z. Dostal and T. Kozubek, An optimal algorithm with superrelaxation for minimization of a quadratic function subject to separable constraints with applications, *Math. Program.*, Ser. A (2012) 135:195–-220

[3] Z. Dostal, T. Kozubek, A. Markopoulos, T. Brzobohaty, V. Vondrak, P. Horyl, Theoretically supported scalable TFETI algorithm for the solution of multibody 3D contact problems with friction, *Computer Methods in Applied Mechanics and Engineering* 205-208 (2012) 110-120

[4] Z. Dostal, D. Horak, T. Kozubek, P. Vodstrcil, On R-linear convergence of semi-monotonic inexact augmented Lagrangians for bound and equality constrained quadratic programming problems}. Submitted

On the completely-Q property for linear transformations on symmetric cones

Jiyuan Tao
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In this talk, we introduce ultra and super SSM-(cone GUS)-properties for linear transformations on Euclidean Jordan algebras. We show that the Jordan quadratic strict semi-monotonicity (JQSSM)-property is equivalent to the completely-Q-property for linear transformations on any Euclidean Jordan algebra. Also, we discuss some interconnections between the {SSM}-property, the Jordan linear SSM (JLSSM)-property, and the completely-Q property on a Euclidean Jordan algebra.

Approximation of a fixed point of an operator defined on a geodesic space

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Fixed point theory has various aspects closely related to the theory of nonlinear optimization such as convex minimization problems, equilibrium problems, variational inequality problems, and others. In particular, approximation of fixed points of a nonlinear operator has been investigated by a large number of researchers. In this work, we consider several types of iterative scheme converging to a solution to such problems. The operators we focus on is defined on a complete geodesic space which has the metric curvature bounded above. Since this type of space has rich geometric structures, a number of useful results has been proved recently. We will show the details of this kind of geodesic spaces and obtain some iterative sequences converging to a solution to our problem.

The Concert Queueing Game: Processor Sharing Regime

Sandeep Juneja

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We first survey the evolving literature on the concert/cafeteria queueing problem. This problem corresponds to determining the equilibrium arrival profile of non-cooperative customers selecting their arrival times to a queue where the service opens at a specified time. The customers are allowed to arrive before or after this time; they prefer to not wait and be served as soon as possible. This problem has a variety of queuing applications including how people queue at airport, movie theaters, passport offices, ration lines, etc. This also captures the settings where large computational jobs are sent to servers that open for service at a specified time. Substantial literature is devoted to studying the more tractable fluid version of this problem, that is, each customer is considered an infinitesimal particle, resulting in a non-atomic game between customers. This allows for explicit determination of the unique equilibrium arrival profile in many such settings as well as the associated socially optimal centralized solution. The knowledge of both then allows the computation of price of anarchy in the system. The literature thus far focuses on queues with the first come first serve service discipline. In this paper we again consider the fluid regime and extend the analysis to the case where the service discipline is processor sharing, or equivalently, random order service. The former is relevant in computational settings while the latter is a good approximation to settings where a customer is selected more or less at random by the server.

Keywords: Queueing Games, Nash Equilibrium, Processor Sharing, Random Order Service, Fluid Queues.

Policy Improvement algorithms for zero sum ARAT stochastic games with discounted and Cesaro payoffs.

T E S Raghavan

University of Illinois at Chicago, USA.

Zero sum Additive reward additive transition (ARAT) stochastic games possess orderfiled property. The talk will be on a policy improvement algorithm for both discounted and Cesaro payoffs, The policy improvement algorithm for the discounted case was given by Zamir Syed in his PhD thesis at UIC (1999) . For the Cesaro payoffs, the algorithm presented here is via a lexicographic policy iteration procedure This is based on a recent joint work with Matthew Bourque of UIC.

A model for equilibrium in some firm-market interactions

Nandyala Hemachandra,

Indian Institute of Technology Bombay, India.

We propose a model for interaction between market and firm where the demand depends on the Quality of Service offered by the firm. We show that, under fairly mild conditions, an equilibrium point or an equilibrium set exists when the operational decisions of the firm are modelled as average reward multi-chain Markov decision models. We consider a model for vehicle relocation system as an illustrative example.

Keywords: fixed points, multi-chain MDPs, parametrized MDPs, Quality of Service, vehicle relocation, large scale LPs

On Double Cycling for Container Port Productivity Improvement

Dusan Ku and Tiru S. Arthanari

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University of Auckland, Auckland, New Zealand

Sea side container port operations give rise to different scheduling and resource allocation problems. Loading and unloading container ships are the main activities at the seaside of a container port. Turnaround time of vessels is contingent upon how fast these operations are performed. How the quay cranes, used for these activities, are scheduled can affect the turnaround time of a vessel. Double cycling concept is an operation strategy of loading the containers into ships as they are unloaded, thus improving the efficiency of a quay crane as well as the container port. Goodchild (2005) and Goodchild and Daganzo (2006) describe the double-cycling problem and solve the problem of a single hatch after formulating it into a two machine flow shop problem. Song (2007) studies the issue of when to engage into the double cycling sequence after reflecting on the practical issue of double cycling in container ports, and gives the results of an actual experiment done in Busan, South Korea. Song reports that the average double cycle productivity rate is 24 per cent over that of single cycle operation, with a minimum of 17 per cent and a maximum of 38 per cent.

A mixed integer programming formulation to minimize the number of operation cycles of a quay crane for discharging and loading containers in a ship-bay is given and studied in Zhang and Kim (2009). They extend the scope of double cycling to multiple ship bays, as opposed to the aforementioned studies only on a single ship bay, and propose to solve the problem using a heuristic algorithm, called GRASP, to overcome the computational burden of the branch and bound method.

In this paper we point out a flaw in this formulation that lets cycles that are not implementable. A counter example is provided. In addition the paper discusses the need for imposing constraints arising from real world requirements like safety, administrative convenience and other practice related issues, to the formulations aiming at double cycling.

Data envelopment analysis and its applications

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Data envelopment analysis (DEA) is a non-parametric and linear programming based technique which evaluates the relative efficiencies of homogeneous decision making units (DMUs) on the basis of multiple inputs and multiple outputs. So, far I have applied it to UP Transport Sector and Healthcare Sector with Dr. Shivi Agarwal, and Education Sector of our country with Dr. Preeti Tyagi. Today, I will present my talk on some features of DEA and its application to the Banking Sector. This work is being carried out for Ph.D. program by Ms. Jolly Puri under my supervision

Gap Function and Error Bounds for Variational Inequality and Its Variants".

Aparna Mehra

Department of Mathematics,

Indian Institute Of Technology, Delhi

Hauz Khas, New Delhi-110016, India

The talk will concentrate on variational inequalities (VI), quasi-variational inequalities, inverse variational inequalities and establish relationships between them and optimization problems via gap functions. There are various gap functions that we shall be focusing on in this talk. Also, these gap functions enable us to provide bounds on the sequential solutions of these VIs and exact solutions of associated VIs. We shall also be providing the glimpse of evolutionary variational inequalities which are set up in abstract Hilbert spaces. New dimensions that can be explored in future are also talked about.

Professor *Santosh N. Kabadi Memorial session*

January 10, 2013 Time: 10:00 -11:45 Venue: Auditorium

Professor Santosh N. Kabadi Memorial session is organized on ***Combinatorial Optimization*** to recall the memory of our dear friend *Professor Santosh N. Kabadi, University of New Brunswick, Canada*

Professor ***Santosh N. Kabadi at Indian Statitical Institute Delhi Centre***

SANTOSH N. KABADI joined the Faculty of Business Administration in 1985 and is a member of the Quantitative Methods area. He teaches Quantitative Analysis and Statistical Techniques for Business in the BBA program and Business Data Analysis and Research Methods in the MBA program. Dr. Kabadi received the UNB Merit Award in 2002 for his performance in research, service, and teaching. He received the Faculty of Business Administration's Excellence in Research Award in 2001 and 2006 for outstanding performance across his career. He also received the UNBF MBA Society's Professor Recognition Award in 2002. His areas of research interest are combinatorial optimization, mathematical programming, production/operations management, network flows, matroid theory, and the design of online/offline algorithms. Dr. Kabadi has produced over 40 refereed journal articles or book chapters. His scholarship has appeared in journals such as: Discrete Applied Mathematics, Discrete Mathematics, European Journal of Operations Research, Information Processing Letters, Linear Algebra and its Applications, Operations Research, Operations Research Letters, Opsearch, and Sankhya. (Source: http://www.unb.ca/fredericton/business/professors/kabadi.html)

Graph Labelings

R. Chandrasekaran, M. Dawande, M. Baysan

The University of Texas at Dallas

(with contributions by Santosh. N. Kabadi)

Dedicated to

Santosh Naryan Kabadi

(1956-2010)

Given an undirected graph G=[V,E], positive integers k_v for $v \in V$ and t, and an alphabet Σ, an assignment to each vertex $v \in V$ of a set $L_v \subseteq \Sigma$, such that (i) $|L_v| \leq k_v \quad \forall v \in V$; and (ii) each label $\alpha \in \Sigma$ is used no more than t times, is said to be a *feasible labeling*. An edge e={i,j} is said to be *covered* by a feasible labeling if $L_i \cap L_j \neq \varnothing$. G is said to covered by a feasible labeling if it covers each edge $e \in E$. In this talk, we are interested in checking if a given graph can be covered for $k_v = 2$ for all $v \in V$ and for t=3.

On a quadratic programming problem involving distances in trees.

R.B.Bapat

Indian Statistical Institute, Delhi Centre

Let T be a tree and let D be the distance matrix of the tree. The problem of finding the maximum of $\mathbf{x}^t\mathbf{D}\mathbf{x}$ subject to **x** being a nonnegative vector with sum **1** occurs in many different contexts. These include some classical work on the transfinite diameter of a finite metric space, equilibrium points of symmetric bimatrix games and maximizing weighted average distance in graphs. We show that the problem can be converted into a quadratic programming problem with a positive definite matrix and hence can be processed by the Lemke's algorithm. Some observations about the algorithm are noted. This is joint work with *S. K.Neogy*.

Local Search Does Work.

Prabha Sharma

Deptt. of CSE &IT, ITM University, Gurgaon.

Richard Karp in his talk at IIT Kanpur asked for reasons behind unreasonable success of heuristics in solving some hard combinatorial optimization problems.

The famous examples are:

1. Large Travelling Salesman problems can be solved by Quick Tour Construction methods, Local Improvement methods or Cutting Plane methods.
2. Local Improvement methods find near-optimal solutions to graph-bisection problems.
3. The greedy set cover algorithm typically gives solutions within a few percent of the optimal.

'Randomised Local Search' of Kaveh and Punnen has given very good results for Quadratic Assignment problems.

For NP-hard scheduling problems such as, Minimising Completion Time Variance of Jobs on a single machine, Minimising Makespan of Deteriorating Jobs and Minimising Mean Absolute Deviation of Completion Times and a few more, it was possible to design a two-phase Local Search Algorithm which took only a polynomial number of steps in the number of jobs and obtained a locally optimal solution that dominates an exponential number of feasible schedules.

Reasons for success are exploitation of the structure of the problem and choice of a suitable neighborhood. The idea here is to explain how the structure of the above mentioned scheduling problems was exploited and to explore other reasons for the success of local search algorithms wherever they have been effective.

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Games, Incompetence, Training & Related Parametric Analysis.

Jerzy A. Filar, FAustMS

(joint work with Vladimir Ejov and Justin Beck)

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In classical strategic game theory the payoffs are fully determined directly by players' choices of strategies. However, a player may not be capable of executing a chosen strategy due to lack of skill/capability otherwise known as "incompetence". A common approach to dealing with incompetence is to devote resources to "training/learning" that may be in the form of investment in new technologies or capabilities.
In practice, such efforts will rarely eliminate incompetence completely but can reduce it to more acceptable levels, especially if other players do not invest in similar incompetence reduction strategies. Of course, in general, all participants may engage in these training activities and the problem of how to model and assess the benefits (if any) of these training efforts leads to many fascinating questions in game theory and optimization as well as to some, mathematically very challenging, parametric analysis problems. Indeed, it is natural to conjecture that – depending on the structure of solutions to these analyses – incompetence may easily induce "tacit", or even formal, cooperation in the behaviour of otherwise non-cooperative players.
In this presentation we outline some approaches to the modelling, analysis and solution of instances of this difficult class of problems. In particular, a method for examining incompetence in certain games is introduced, examined and illustrated. Along with the derivation of general characteristics, a number of interesting special behaviours are identified. The latter are shown to be the result of special forms of the game and/or the incompetence matrices.

In addition, we consider a class of parametric optimisation problems that arise naturally in this context. We demonstrate that in certain situations, even small changes in a parameter can lead to dramatic changes in optimal solutions. We outline a recent, unified, theory for determining when this phenomenon arises. Surprisingly, perhaps, this theory relies on some powerful results and techniques – such as those of Gröbner bases and complex algebraic varieties – developed by pure mathematicians but rarely used in the kind of practical applications that stimulated these investigations.

The core of games with restricted cooperation

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In cooperative game theory, for a given set of players N, TU-games are functions $v : 2^N \to \mathbb{R}$ which express for each nonempty coalition $S \subseteq N$ of players the best they can achieve by cooperation. Capacities, widely used in decision making, are monotone TU-games.

In the classical setting, every coalition may form without any restriction, i.e., the domain of v is indeed 2^N. In practice, this assumption is often unrealistic, since some coalitions may not be feasible for various reasons, e.g., players are political parties with divergent opinions, or have restricted communication abilities, or a hierarchy exists among players, and the formation of coalitions must respect the hierarchy, etc.

Many studies have been done on games defined on specific subdomains of 2^N, e.g., antimatroids [1], convex geometries [3, 4], distributive lattices [6], or others [2, 5]. In this paper, we focus on the case of distributive lattices. To this end, we assume that there exists some partial order $\preceq$ on N describing some hierarchy or precedence constraint among players, as in [6]. We say that a coalition S is feasible if the coalition contains all its subordinates, i.e., $i \in S$ implies that any $j \preceq i$ belongs to S as well. Then by Birkhoff's theorem, feasible coalitions form a distributive lattice. From now on, we denote by $\mathcal{F}$ the set of feasible coalitions, assuming that $\emptyset, N \in \mathcal{F}$.

The main problem in cooperative game theory is to define a rational solution of the game, that is, supposing that the grand coalition N will form, how to share among its members the total worth $v(N)$. The core is the most popular solution concept, since it ensures stability of the game, in the sense that no coalition has an incentive to deviate from the grand coalition. In the field of decision making, the core of capacities is also a well-known concept, as it is the set of probability measures compatible with the capacity. For a game v on a family $\mathcal{F}$ of feasible coalitions, the core is defined by

$$C(v) = \{x \in \mathbb{R}^n \mid x(S) \geq v(S), \forall S \in \mathcal{F}, x(N) = v(N)\}$$

where $x(S)$ is a shorthand for $\sum_{i \in S} x_i$. When $\mathcal{F} = 2^N$, the core is either empty or a convex bounded polyhedron. However, for games whose cooperation is restricted, the study of the core becomes much more complex, since it may be unbounded or even contain no vertices (see a survey in [7]). For the case of games with precedence constraints, it is known that the core is *always* unbounded or empty, but contains no line (i.e., it has vertices). The problem arises then, to select a significant bounded part of the core as a reasonable concept of solution, since unbounded payments make no sense.

A simple remedy to this problem is to select a bounded face of the core, by imposing additional equality constraints $x(S) = v(S)$ for all S in some collection $\mathcal{N}$, so that to exclude any extremal ray in the core [11, 8]. We call $\mathcal{N}$ a normal collection, making

the convention that $N \notin \mathcal{N}$, and we call *restricted core* w.r.t. $\mathcal{N}$ the resulting polytope, denoted by $C_{\mathcal{N}}(v)$. Taking the union of all possible restricted cores (i.e., all possible bounded faces) gives the so-called *bounded core*, denoted by $C^b(v)$ [10].

Within the set of normal collections, those which are *nested*, i.e., which form a chain in $\mathcal{F}$ are of particular importance. Also, we consider *minimal* normal collections, i.e., for which no subcollection is normal. We denote by $\mathcal{MNNC}\mathcal{F}$ ($\mathcal{F}$ the set of minimal nested normal collections. There exist remarkable normal collections, obtained by simple algorithms operating on the minimal or maximal elements of $(N, \preceq)$, the partial order on the players.

The case of convex games is of particular interest, since the bounded core can be expressed in an irredundant way. Our main result is the following [9].

Theorem 1. *1. For any convex game v and any nested normal collection $\mathcal{N}$ of $\mathcal{F}$, $C_{\mathcal{N}}(v) \neq \emptyset$. Moreover, if v is strictly convex, then* $\dim C_{\mathcal{N}}(v) = n - |\mathcal{N}| - 1$.

2. For any convex game v,

$$C^b(v) = \bigcup_{\mathcal{N} \in \mathcal{MNNC}(\mathcal{F})} C_{\mathcal{N}}(v).$$

Moreover, no term in the union is redundant if v is strictly convex.

3. Let $\mathcal{N}$ be a normal collection of $\mathcal{F}$. If v is strictly convex, then $C_{\mathcal{N}}(v) \neq \emptyset$ if and only if $\mathcal{N}$ is nested.

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Neural Network related optimization issues.

C. Srinivasan

University of Kentucky, USA.

In this talk, after a brief introduction to feed forward neural networks, optimization issues indeveloping efficient and generalizable neural networks are discussed. We have focused on problems relating to the minimal number of neurons needed for a self-learning Neural Network to successfully learn and to perform statistical computations like computing Mahalanobis Distance.

A game theoretic view of the smallest enclosing and intersecting ball problems

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Given a finite set of closed convex sets $S_1,\dots, S_k$ in a normed linear space, we study the problem of finding a ball with the smallest radius enclosing/intersecting all S_i's. These problems have several applications in operations research, especially in facility location.

We show that these problems can be viewed as a game, and show that the centre of the optimal sphere corresponds to saddle points of the payoff function of the game. We show that several classes of these problems can be solved as linear programming problems.

A joint work with Prof. Vishnu Narayana.

A new Genetic Algorithm to solve Sudoku Puzzles

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The popular Japanese number puzzle “Sudoku” is interesting but challenging due to its easy rules and difficult phenomenon to solve it. Although a number of approaches exist for solving a given Sudoku puzzle, it becomes a challenge among the research to solve it by Genetic Algorithms. In this talk a new *Genetic Algorithm* is presented to solve a given Sudoku puzzle. In this, the fitness function is modeled in a new way along with puzzle-character-dependent constraints. The Genetic Algorithm is made “Retrievable”, since the population is reinitialized after a certain number of generations in order to retrieve from the premature convergence. Sample puzzles have been considered for comparison with the previously published results by GA.

Relationship between Q-property of a given matrix A and the Q-property of some linear tranformation defined through A

T. Parthasarathy

Chennai Mathematical Institute, Chennai, India
&
Indian Statistical Institute, Chennai, India

In this talk we are concerned with three linear transformations namely Liyapunov,Stein and Multiplicative transformations . They are defined through a fixed marix A. If they have as a linear transformation Q-property, is it true that A is a Q-matrix in the LCP sense? We want to analyse this problem in some detail and make a few comments.

Nonnegative Generalized Inverses of Certain Classes of Matrices and Applications to Linear Complementarity Problems

K.C. Sivakumar

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In this talk, the author considers a new class of matrices, in terms of certain linear complementarity problems, typically applicable for singular matrices. For invertible matrices, this class is a subclass of Q-matrices. Employing nonnegativity of certain generalized inverses, matrices belonging to this class are identi_ed. In the process, certain results, well known for Q-matrices are generalized.

Keywords: Q-matrix; Moore-Penrose inverse; group inverse; nonnegativity.

Almost Fully Copositive and Fully Semimonotone Matrices in Linear Complementarity Theory

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Complementarity model provides a unifying frame-work for several optimization problems. We present some results for two new classes of matrices for which PPTs are either in C0 (E0) or almost C0 with at least one PPT almost C0. The classes studied have algorithmic significance and if these classes satisfy some additional conditions then these classes are processable by Lemke's algorithm for linear complementarity problem. This talk also deals the current status of Stone's conjecture on fully semimonotone matrices. The observations made on PPT based new classes will motivate further applications of PPTs in matrix theory and mathematical programming.

Single Asset Optimal Trading Strategies with Stochastic Dominance Constraints

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In this paper, we develop optimal trading strategies for the risk averse investor by minimizing the expected cost and the risk of execution. We present quadratic programming formulation that includes stochastic dominance constraints to render the preference relationship attitude of both risk neutral and risk averse investors. We also present a cutting plane approach to facilitate computational advantage in solving it. The efficacy of the algorithm is shown with the help of numerical examples.

Keywords: Optimal trading strategy, Second order stochastic dominance, Market impact, Risk aversion.

Joint Optimization of Procurement and Distribution in Supply Chain Management

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Globalization of economy has brought new dimensions in market competitiveness as well as trade policies for the industry. Further participation of international players in retail industry turned traditional retail industry upside down. Successive technology substitutions have brought edge cutting competition in the market. The quality and price of the product can not be compromised by any company to sustain in the market. The only way out to such a scenario, the total incurred cost is reduced by managing cost of procurement, inventory holding and transportation. Since retail industry has multiple brand products i.e. their own brands as well as other branded products, companies take advantage of bulk procurement discounts and freight discounts keeping inventory at optimum level. Numerous number of research articles are available in literature on the joint optimization of procurement/inventory & distribution coordination in Supply chain. Different modes of

transportation, namely truckload (TL) & less than truckload (LTL) as well as freight discount policies are used incorporating all-units and incremental quantity discount structures are discussed in the literature. Further the single source - multi destination procurement distribution as well as multi source - multi destination procurement distribution are explained. Finally, single stage - multi destination two stage procurement distribution coordination is discussed in which transportation of first stage & second stage avails the facility of freight discount and TL & LTL respectively.

Behavioral portfolio selection models based on financial and ethical considerations

Pankaj Gupta

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As a field of study, portfolio selection which began with the mean–variance model has since then primarily relied on financial criteria to determine the asset quality. However, it has been observed that not all the relevant information for portfolio selection can be captured in terms of financial criteria only. The other criteria might be of equal, if not greater, importance to the investor. Thus, the portfolio selection models have been extended to incorporate the psychological preferences and the biases of the investor as well. Here, we discuss a comprehensive three-stage multiple criteria decision making framework for portfolio selection based upon financial and ethical criteria simultaneously. It may be noted that the ethical investment movement that began from the USA in 1960s has gained tremendous momentum the world over recently. The growing instances of corporate scams and scandals have made it incumbent upon the investors to consider the quality of governance of corporations and ethicality of their conduct. Indeed, there has been a spate of reforms relating to corporate laws and capital markets all over the world. Also, the investors are becoming conscious of the desirability of ethical evaluation of the assets. The growing influence of institutional investors has reinforced this consciousness. Hence, the research in the area must take cognizance of these developments to construct models that accord due consideration to ethical criteria besides the financial criteria. We use multiple methodologies toward the purpose. Analytical hierarchy process technique is used to obtain the ethical performance score of each asset based upon investor-preferences. A fuzzy multiple criteria decision making method is used to obtain the financial quality score of each asset based upon investor-ratings on the financial criteria. Three hybrid portfolio optimization models are developed to obtain well diversified financially and ethically viable portfolios. These models have maximization of financial goal as main objective and differ in the way the ethical goal is pursued by the investor.

Long-run strategic advertising and short-run Bertrand competition

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We model and analyze strategic interaction over time in a duopoly. Each period the firms independently and simultaneously take two sequential decisions. First, they decide whether or not to advertise, then they set prices for goods which are imperfect substitutes.

Not only the own, but also the other firm's past advertisement efforts affect the current sales potential of each firm. How much of this potential materializes as immediate sales, depends on current advertisement decisions. If both firms advertise, sales potential turns into demand, otherwise part of it `evaporates' and does not materialize.

We determine feasible rewards and equilibria for the limiting average reward criterion. Uniqueness of equilibrium is by no means guaranteed, but Pareto efficiency may serve very well as a refinement criterion for wide ranges of the advertisement costs.

Keywords: advertising, externalities, average rewards, equilibria.

Lattices in social networks with influence*

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The paper presents an application of lattice theory to the framework of influence in social networks. We consider a two-action model of influence in a social network in which agents have to make their yes-no decision on a certain issue. Every agent is preliminarily inclined to say either 'yes' or 'no', but due to influence by others, the agent's decision may be different from his original inclination. We consider the relation between two central concepts of this model: influence function and follower function. The structure of the set of all influence functions that lead to a given follower function appears to be a distributive lattice. We also investigate a dynamic model of influence based on aggregation functions and provide a general analysis of convergence in the
model. Possible terminal classes to which the process of influence may converge are terminal states (the consensus states and non trivial states), cyclic terminal classes and unions of Boolean lattices.

Keywords: social network, influence, influence function, follower function, distributive
lattice, aggregation function, convergence, terminal class Running head: Lattices in social networks with influence

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Evolutionary Games and Local Dynamics

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In the classical approach of evolutionary game theory, the so called replicator dynamics are the driving force behind the development of a population in time. In such models the population usually consists of a continuum of individuals that each belong to a finite number of types. Individuals meet randomly and these interactions have an impact on the fitness of their types. The fitness payoffs are given in a fitness matrix. Types that are doing better than average increase in number, while the types that are doing worse decrease. The fact that individuals meet randomly implies that the population is homogeneously distributed and the location of these individuals plays no role. In this paper we examine what happens when individuals do have a specific location and only interact with their local neighborhood. Moreover, the fitness matrix may well depend on the location. Thus, the process will be driven by local rather than global circumstances. Think for example of patch formation in plants, where species adapt to the resources locally available while competing with each other. We explore the effect of these adaptations to the development of the population and compare the possibilities using local replicator dynamics with those using global replicator dynamics.

On new concepts of equilibria in games with imperfect information and ambiguity about future and their applications in economics and ecology

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This paper presents new concepts of equilibria which can be applicable in dynamic game theoretic problems usually not taken into account in game theoretic modelling of various aspects of real life problems in which players do not have perfect information about the game they play.

The questions they are designed to answer to are as follows.

- Can beliefs of players about future values of some parameters being results of players choices cause this future values behave according to their beliefs?
- Can it happen if it is againt the objective knowledge about e.g. the dynamics of the system?
- Can such players' behaviour be sustainable even if it does not lead to Nash or correlated equilibrium?
- What is the mechanism?
- Can such beliefs be self-verifying? Is it possible that player will believe they play a Nash equilibrium?

The class of games under consideration are discrete time dynamic games in which players have imperfect information about the game thay play. Players can observe the state variable changing in response to a statistic of players' decisions and past values of this statistics, and form some expectations about its future values based on their observations and best respond to their expectations. Expectations may have various forms: either they are probability distribution of future scenarios as a result of history and player's choice of decision or they constitute sets of scenarios regarded as possible. A general model is built, encompassing both games with finitely many players as well as games with infinitely many players.
The concept of pre-belief-distorted Nash equilibrium (pre-BDNE) in which players best respond to their observations, belief-distorted Nash equilibrium (BDNE) being a pre-BDNE at which the beliefs cannot be falsified during the play and various concepts of self-verification of beliefs are introduced. All these
concepts have different definitions for each form of beliefs.
The relations between BDNE and Nash or subjective Nash equilibria are examined as well as the existence.

The following examples can be used to illustrate the concepts and their properties.

- A simple ecosystem constituting a common property of its users. We assume that the number of users is large and that every player may have problems with assessing his/her marginal

inuence on the aggregate extraction and, consequently, the future trajectory of the state of the resource.

- A repeated minority game being a modification of the El Farol problem. There are players who choose each time whether to stay at home or to go to the bar. If the bar is overcrowded, then it is better to stay at home, the less it is crowded the better it is to go.

- A model of a market describing either Cournot oligopoly or competitive market (considering these two cases as one model is not a coincidence). Players may have problems with assessing their actual share in the market and, therefore, their actual influence on prices.

- A repeated prisoners dilemma. At each stage each of two players assesses possible future reactions of the other player to his/her decision to cooperate or defect at this stage.

Keywords: multi stage and repeated games, games with continuum of players, n-player dynamic games, Nash equilibrium, belief-distorted Nash equilibrium, subjective equilibrium, self-confirming equilibrium, self-verification of beliefs, common ecosystem, Cournot oligopoly, competitive equilibrium, minority game, prisoner's dilemma.

Stationarity Concepts for single stage SMPCC problem.

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In this talk we discuss a certain class of single stage stochastic programming problem with complementarity constraints. This is in fact a stochastic programming problem whose feasible set is the solution set of a generalized stochatic complementarity problem. It is important to note that most important constraint qualifications like the Mangasarian-Constraint qualification does not hold for such classes of problem. Thus in this talk we consider three types of problem with smooth, convex and locally Lipschitz data. We show under what conditions one can define suitable constraint qualification which are stable in nature and for which the set of multipliers are bounded. We discuss the weak stationarity condition for the three classes of problem and devise the associated constraint qualification. For the smooth SMPCC problem we show that strong stationarity holds under Abadie type constraint qualification.

Subgradients using Henig Proper Efficiency in Set-Valued Optimization

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In this paper we introduce a notion of subgradient of a set-valued map using the notion of Henig proper efficiency. We study some of its properties and compare our result with some existing notions. Apart from presenting existence results some optimality conditions are also developed for a set-valued optimization problem.

On Duality For Mathematical Programming Problems With Equilibrium Constraints

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In this paper, we consider the Mathematical programming problem with equilibrium constraints (MPEC) and introduce Wolfe-type dual and Mond-Weir-type dual for the MPEC. We establish weak and strong duality theorems relating to MPEC and the Wolfe as well as Mond-Weir type dual problems under convexity assumption.

Keywords Mathematical programming with equilibrium constraints, Sufficient optimality condition, Duality.

Griggs and Yeh's Conjecture on L(2,1)-Labeling of Graphs

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An $L(2,1)$-labeling of a graph $G = (V, E)$ is a function $f : V(G) \to \{0, 1, 2, \ldots\}$ such that $|f(u) - f(v)| \geq 2$ whenever $uv \in E(G)$ and $|f(u) - f(v)| \geq 1$ whenever u and v are at distance two apart. The span of an $L(2,1)$-labeling f of G, denoted as $Span(f)$, is the maximum value of $f(x)$ over all $x \in V(G)$. The $L(2,1)$-labeling number of a graph G, denoted as $\lambda(G)$, is the least integer k such that G admits a $L(2,1)$-labeling of span k. Griggs and Yeh [1] have conjectured that $\lambda(G) \leq \Delta^2(G)$ for a graph G with maximum degree, $\Delta(G)$, at least two. This conjecture is still open. However, several results are available in the literature (see [2]). In this talk, we will discuss the recent development on this conjecture and related problems.

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Game Theory Under Fuzzy Environment

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In this article, a method has been proposed to solve a game theory problem under fuzzy environment. Conventional game theory problems have crisp numbers or values as their entries in the payoff table. In real world problems, however, the entries in the pay-off table are defined linguistically or qualitatively. For example, in car purchasing problem, if a person chooses a strategy to purchase a fuel efficiency car, this may lead to a payoff "*substantial gain*". In another case the payoff may be "*somewhat OK*". In these types of situations it is necessary to deal with a game theory problem having imprecise pay-off table. The tools available in fuzzy sets help us to quantify the qualitatively defined terms in the payoff table. Further, while choosing a strategy, in the game theory problem, a decision maker may not be certain which strategy is

superior to another and to what extent. In realistic situations, a player or a decision maker may think that a particular strategy is somewhat OK. In the similar way, another strategy may be considered as quite appropriate to the present situation. Therefore, in addition to the entries in the payoff table, one may need to deal with the choosing of the available strategies which are defined in imprecise forms by the decision makers. Again the theory of fuzzy sets helps to represent the imprecisely defined strategies. In this paper we have considered two situations; (1) fuzzy payoff table and (2) Fuzzily defined strategies.

Without loss of generality, we take here the payoff entries as well as the available strategies as fuzzy numbers. The mixed strategy approach of zero-sum game with pay-offs and the strategies as fuzzy numbers define a fuzzy game theory problem. As, in the case of game theory, in our model also, we take different fuzzy probabilities for selection of the strategies. This procedure converts the fuzzy game theory problem into a linear programming problem with crisp parameters. Briefly the procedure is mentioned below. Let the payoff table of the game theory problem is as given below.

$$\begin{array}{c} \\ \widetilde{R_1} \\ \widetilde{R_2} \\ \vdots \\ \widetilde{R_m} \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} \widetilde{a_{11}} & \widetilde{a_{12}} & \ldots & \widetilde{a_{1n}} \\ \widetilde{a_{21}} & \widetilde{a_{22}} & \cdots & \widetilde{a_{2n}} \\ \vdots & & \ddots & \vdots \\ \widetilde{a_{m1}} & \widetilde{a_{m2}} & \cdots & \widetilde{a_{mn}} \end{bmatrix} \end{array}$$

In the above matrix $\widetilde{aij}$'s and $\widetilde{R_m}$'s fuzzy numbers.

In order to make the above fuzzy game theory model to the conventional one, we need to transform the fuzzy numbers $\widetilde{aij}$'s and $\widetilde{R_m}$'s into their equivalent numeric counterparts. For this we need to use the procedure of converting a fuzzy number to its nearest possibilistic mean value. The procedure of the above conversion is as given below.

A γ-level set of a fuzzy number is defined by a crisp set $[A]^{\gamma} = \{x: \mu(x) \geq \gamma\}$. Further we have $[A]^{\gamma} = [a_1(\gamma), a_2(\gamma)]$. Where $a_1(\gamma)$ and $a_2(\gamma)$ are the lower and higher bounds of the γ-level set of the fuzzy number A. The lower and upper possibilistic value ($M_*(A)$ $M^*(A)$) of the fuzzy subset A is given as:

$M\_^*(A) = 2\int_0^1 \gamma(a_1(\gamma)\, d\gamma$ and $M^*(A) = 2\int_0^1 \gamma(a_2(\gamma)\, d\gamma$

The possibilistic mean value $\bar{M}(A) = \frac{M_*(A)+M*(A)}{2}$

The possibilistic mean value is the equivalent crisp possibilistic value of the fuzzy number A.

The conversion of a fuzzy number to its equivalent possibilistic mean value helps us to convert the fuzzy game theory problem into its crisp format. This is done by converting each of the payoff value and the strategies to its equivalent possibilistic mean value.

The replacement of fuzzy payoffs and strategies makes the fuzzy game theory problem into a conventional game theory. Now by using the mixed strategy approach of zero-sum game we can solve the above fuzzy game theory problem.

On Average Reward Semi-Markov Decision

Processes: An Example

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Average reward finite semi-Markov decision processes (SMDP) with a general multichain structure are considered. An example is provided where the SMDP has a value but no optimal stationary/Markov policy (strategy) exists. However, a semi-Markov optimal policy exists for this example.

Keywords: semi-Markov decision processes, average reward criterion, multichain structure, semi-Markov policies/strategies.

Reliability Modeling of an Integrated H/W and S/W System with Preventive Maintenance and Priority Subject to Maximum Operation and Repair Times

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The main concentration of this talk is on the development of a reliability model for an integrated h/w and s/w system using the concepts of redundancy, preventive maintenance, priority and maximum repair time. Two identical- units of the integrated system are taken up in which one unit is initially operative and the other is kept as spare in cold standby. In each unit h/w and s/w fails independently from normal mode. A single server is called immediately to conduct repair activities. If server unable to repair the h/w in a pre-specific time (called maximum repair time), the h/w is replaced by new one giving some replacement time. The s/w is replaced by new version if it is outdated (called s/w failure). Priority to h/w repair is given over s/w replacement. The failure time of h/w and s/w follows negative exponential distributions while the distributions of preventive maintenance, repair and replacement time are taken as arbitrary with different probability density functions. The expressions for several reliability measures are derived in steady state adopting semi-Markov process and regenerative point technique. The graphical study of mean time to system failure (MTSF) and profit function has also been made giving particular values to various parameters and costs.

Key Words: Integrated h/w and s/w System, Preventive Maintenance, Maximum Operation and Repair Times, Reliability Measures and Profit Function.

Optimality and Duality for Interval Optimization Problem

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This paper addresses a nonlinear optimization problem whose objective function and constraints are interval valued functions. These interval valued functions are expressed in terms of parameters. Sufficient optimality conditions and duality results are derived.

Keywords: Interval optimization; Partial order relations; Efficient solution; Duality; Sufficient optimality conditions.

An Overview of the Momentum Strategies in Finance

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In this paper, we first describe some of the existing strategies which try to capture the momentum of return pattern and then will propose our momentum strategy separately. We used the regression analysis proposed by Fama-MacBeth to capture the statistical significant of our momentum strategy on the real data from S&P CNX Nifty index, India. After examining the results statistically, we then design the optimization model for further improving the proposed momentum strategy. Extensive computational results and in- sample and out-of-sample analysis are carried out to compare the financial performance of the our propose momentum strategy on real data from S &P CNX Nifty index.

Keywords: Portfolio optimization, regression, momentum, in-sample and out-of-sample

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Mixed Solution Strategy For MCGDM Problems Using Entropy/Cross Entropy In Interval-Valued Intuitionistic Fuzzy Environment

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Although several weight determining methods have been studied for multiple criteria group decision making (MCGDM) problems under intuitionistic fuzzy environment, in the present study, besides the criteria values provided by the decision makers (DMs), we propose to also use the historical data of alternatives-criteria to compute the criteria weights. This is a reasonable thought as the past information may influence the decision makers' choice of entries in their respective alternatives-criteria decision matrices. To this aim, we introduce a novel mixed solution strategy to derive the criteria final weight vector. Initially, the alternatives-criteria decision matrices provided by the DMs are taken to involve interval-valued intuitionistic fuzzy numbers (IVIFNs). The entropy measure for IVIFNs, studied by Ye [33], is used to aggregate these decision matrices. We also introduce a new definition of cross entropy for IVIFNs and used it to rank the alternatives. Finally, an example is presented to illustrate the proposed approach.

Keywords. Multiple criteria group decision making; interval-valued intuitionistic fuzzy number; weight vector; entropy; cross entropy.

Nearest Neighbor Based Estimation Technique for Pricing Bermudan Options

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Option is a _nancial trading instrument which gives the holder the right to initiate a transaction when it is `exercised'. Bermudan option is a kind of option which allows the holder to exercise at pre-speci_ed time instants where the aim is always to maximize the payo_ upon exercise. The pricing of such an option can be mathematically formulated as an optimal stopping problem. In most practical cases, the underlying dimensionality of Bermudan options is high and the numerical methods for solving partial differential equations as satisfied by the price process become inapplicable. In the absence of analytical formula for option price, a popular approach is to solve the Bermudan option-pricing problem approximately using dynamic programming via estimation of the so-called continuation value function. In this article we develop a nearest neighbor estimator based technique, which gives biased estimators for the true option price. We provide general algorithms for constructing lower and upper

biased estimators which can be used to construct valid confidence intervals. The computation of lower biased estimator is straightforward and relies on suboptimal exercise policy generated using the nearest neighbor estimate of the continuation value function. The upper biased estimator is similarly obtained using likelihood ratio weighted nearest neighbors. We analyze the convergence properties of mean square error of the lower biased estimator. We develop order of magnitude relationship between the simulation parameters and computational budget in an asymptotic regime as the computational budget increases to infinity. We also study the dependence of dimensionality of the problem on optimal rate of convergence.

Perishable Inventory Model with Two type of Retailers under Inflation

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A deterministic inventory model for a deteriorating item is explored in an inflationary environment for an infinite planning horizon. In daily life, almost all the perishable products such vegetables, fruits dry fruits etc. lost their freshness day to day due to deterioration. Deterioration is (damage, spoilage, dryness etc.) is a very natural phenomena for every thing in the world. In this paper, we have take two types of retailers whose demands are constant and stock dependent respectively. Here, shortages are taken but can't be fulfill deterioration is considered as constant. After calculating all the related costs we analyzed the total profit. Numerical examples have been presented to explain the theory.

Keywords: Inventory, constant deterioration, inflation and two types of retailers with constant and stock dependent demand.

Characterizations of semidefinite representable sets

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The feasible regions of semidefinite programming problems are the semidefinite representable sets. Our aim is to characterize the semidefinite representable sets in a finite dimensional affine space, as convex sets, certain of whose projections and sections are semidefinite representable. This work continues the results of Klee [Kle59], which gives us some necessary and sufficient conditions for a convex set in affine space to be polyhedral. As, semidefinite representable sets are generalizations of polyhedra, our aim is to extend few results from [Kle59], which characterizes the polyhedral sets as convex sets, whose sections and projections are polyhedral.

Keywords: semidefinite programming, semidefinite representable sets, j-flat, j-section, j-projection, polyhedra

Solving Impaired Flow Multi-Index Transportation Problem With Axial Constraints

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In this paper we consider a multi-index transportation problem with axial constraints when there is a restriction on total flow. We give a solution procedure to find out the optimal basic feasible solution of the given problem by solving an equivalent transformed transportation problem by adding two additional rows and two additional columns. The solution method would be very useful for the transportation of heterogeneous commodities and for the case of emergency situations, when the total flow in the market needs to be impaired. We also show that the optimal basic feasible solution obtained by our procedure is better than that obtained by Bandopadhyaya and Puri (1988) for the same problem as taken by them thereby, it results that the solution obtained by them is not optimal as claimed.

Stock-out averse newsvendor game: Applications to Pharmaceuticals

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The sophisticated behavior of the customers, availability of variety of products, stiff competition and product obsolescence results in limited selling period and uncertainty in demand for a product. In that context, the Newsvendor models have found increasing applicability in supply chain management (SCM). Various surveys observed that business managers' inventory decisions intentionally deviate from normal optimal solution creating oscillatory amplification of demand in the supply chain. For example, a retailer attempts to avoid shortages to maintain his goodwill; a pharmacist cares about the fact that unavailability of some vital medicine may be tragic to patients. Such a phenomenon is known as stock-out aversion. This paper applies game theoretic approach to investigate a situation where multiple newsvendors with stock-out aversion preferences are competing for inventory from a risk-neutral supplier. Under the assumption of allocation of the total demand among the newsvendors by the supplier is proportional to their order quantities, we have established the existence of Nash equilibrium and its uniqueness.

Keywords: Newsvendor, Stock-out aversion, Game theory, Utility.

Outer-connected domination in graphs : Complexity and Approximation Hardness

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A subset $D \subseteq V$ of a graph $G = (V, E)$ is called an *outer-connected dominating set* of G if for all $v \in V$, $|N_G[v] \cap D| \geq 1$, and the induced subgraph of G on $V \setminus D$ is connected. The MINIMUM OUTER-CONNECTED DOMINATION PROBLEM is to find an outer-connected dominating set of minimum cardinality of the input graph G. Given an integer k and a graph $G = (V, E)$, the OUTER-CONNECTED DOMINATION DECISION PROBLEM is to decide whether G has an outer-connected dominating set of cardinality at most k. The OUTER-CONNECTED DOMINATION DECISION PROBLEM is known to be NP-complete for general graphs and even for bipartite graphs. In this paper, we strengthen this NP-completeness result by showing that the OUTER-CONNECTED DOMINATION DECISION PROBLEM remains NP-complete for Perfect Elimination Bipartite graphs. We, then, prove that MINIMUM OUTER-CONNECTED DOMINATION PROBLEM cannot be approximated within a factor of $(1-\epsilon)ln((|V|-1)/2)$ for any $\epsilon > 0$, unless NP $\subseteq$ DTIME$((|V|-1)/2)^{O(\log\log((|V|-1)/2))}$. We show that MINIMUM OUTER-CONNECTED DOMINATION PROBLEM is APX-complete for bipartite graphs with bounded degree 7. Finally, we propose a linear time algorithm for computing a minimum outer-connected dominating set of a chain graph, a subclass of perfect elimination bipartite graphs.

Keywords: Domination, outer-connected Domination, bipartite graphs, perfect elimination bipartite graphs, chain graphs, NP-completeness, APX-completeness.

Cost- Benefit Analysis of a Computer System with Priority to Preventive Maintenance over the H/W Repair Activities Subject to MOT and MRT

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This paper concentrates on the cost- Benefit analysis of a computer system of two-identical units having independent failure of h/w and s/w components. Initially one unit is operative and other is kept as spare in cold standby. There is a single server who visits the system immediately whenever needed. The server conducts PM of the unit after a maximum operation time. He repairs the unit at its h/w failure up to a maximum repair time. If the server is unable to repair the h/w components in the unit in maximum repair time then components are replaced immediately by new one. However, only replacement of the s/w components has been made at their failure. The priority is given to the

preventive maintenance over repair activities of the h/w. The time to failure of the components follows negative exponential distribution whereas the distribution of preventive maintenance, repair and replacement time are taken as arbitrary. The expressions for some important measures of system effectiveness have been derived using semi-Markov process and regenerative point technique. The graphical behaviour of the results has also been shown for a particular case.

Key Words: Computer System, Reliability Model, Preventive Maintenance, Maximum Operation and Repair Times, Priority, Cost- Benefit Analysis and Replacement.

On nonsmooth V-invexity and vector variational-like inequalities in terms of the Michel-Penot subdifferentials

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In this paper, we establish some results which exhibit an application for Michel-Penot subdierential in nonsmooth vector optimization problems and vector variational-like inequalities. We formulate vector variationallike inequalities of Stampacchia and Minty type in terms of the Michel-Penot subdierentials and use these variational-like inequalities as a tool to solve the vector optimization problem involving nonsmooth V-invex function. We also consider the corresponding weak versions of the vector variational-like inequalities and establish various results for the weak efficient solutions.

Keywords: Michel-Penot subdierential Generalized convexity Nonsmooth optimization Efficient solution Vector variational inequalities

Some relations between vector variational inequality problems and nonsmooth vector optimization problems using quasi efficiency

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This paper deals with the relations between vector variational inequality problems and nonsmooth vector optimization problems using the concept of quasi efficiency. We identify the vector critical points, the weak quasi efficient points and the solutions of the weak vector variational inequality problems under generalized approximate convexity assumptions. To the best of our knowledge such results have not been established till now.

Keywords: Nonsmooth vector optimization; Quasi efficiency; Vector variational inequality; Approximate convexity.

Duality for Multiobjective Fractional Programming Problem Using Convexifactors

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In this paper, the concept of ∂^*-quasiconvexity is introduced by using convexifactors. Mond-Weir type and Schaible type duals are associated with a multiobjective fractional programming problem and various duality results are established under the assumptions of ∂^*-pseudoconvexity and ∂^*-quasiconvexity.

An Analytical Order level Lot size Inventory Model With Random Lead time When Quantity Received Is Uncertain

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In conventional EOQ model, it is implicitly assumed that, when purchaser orders and pays for Q units then the supplier supplies Q units only. But in today's modern business world, in order to survive progress and to achieve highly ambitious targets or to come out the problems of over stocking, supplier announces various sales promotional schemes. Here we have considered a scheme in which, if purchaser orders and pays for Q units then the supplier supplies (1+p)Q units, $0 \leq p \leq 1$. An EOQ model is developed when lead time is random variable (assumed to follow normal distribution) under random input with shortages. Effect of various parameters on procurement quantity and total cost of inventory system is with the hypothetical numerical example.

Key words: Random Variable, Normal Distribution, EOQ model, EOQ with and without shortages, Lead time.

Private provision of public good game and endogenous inequality

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This paper models a simple voluntary provision to public good game in a general equilibrium set up. A group of rich people donate to a public consumption good that benefits both the rich and poor people in the economy. All people work and earn their living. Even though poor people don't donate directly to the public good, any change in the size of the poor people's population would affect the aggregate contribution. Intuition is, any increase in the size of the non-contributors (poor people) would lower their relative wage. This would raise the income inequality between rich and poor and make the production of the private goods more cheaper. Cheaper private good will increase their relative demand. Reduced demand for the public good would then crowd-out private donations that finances the public goods production. This results in a situation where increasing inequality is associated with reduced private donations.

Earlier results in the literature on private provision of public good used to argue that any change in the non-contributors population size would not affect the aggregate contribution. Also this literature mostly focus on exogenous income inequality by varing endowment size. Our papers generalises on both fronts. First it shows that the neutrality of the aggregate contribution to non-contributors size is no longer valid once production is taken into consideration. Second, it enriches the literature by making inequality endogenous and thereby making the contributors - noncontributors division endogenous in the economy.

Keywords: Group size, Public good provision, Technological change, Endogenous inequality, Monopolistic competition, Voluntary contribution.

Identity, Envy and Resource Loss

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This paper looks at society divided into two groups where personal assets as well as group specific values influences the individuals' utility (positively for own group's value and possibly otherwise for the other group's value). Individual resource allocation problem may lead to underinvestment in production of assets and excessive diversion of resources into wasteful destructive activities. As a result, the net utility is lowered for all individuals. On the economic front, such usage of resource boosts the "black market" economy and results in dead weight loss. Because in equilibrium both the personal as well as social value created is smaller, on the social front these activities encourage social disintegration.

Keywords: Conflict, Envy, Externality, Identity

Ratio Optimization Of Profit Per Unit Cost For Lost Customers

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In the current competitive financial scenario, economic performance measures are panacea to study any system. Ratio analysis of parameters involved therein provides such authentic tools to judge and compare the various performance measures among various systems / firms. Thus, in this investigation we consider a queueing system with finite capacity and propose the ratio analysis of profit and cost for lost customers. Consequently, we optimize profit per unit cost with respect to arrival and service parameters of the system using non-linear technique of optimization by developing the computing algorithm. Sensitivity analysis and its elegant observations have also been carried out, with the help of tables and graphics, enabling the model more realistic and comprehensive.

Integrating Bipolarity in Fuzzy Linear Programming with Several Objective Functions

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In this paper, we propose an alternative approach to model fuzzy multi-objective linear programming problems (FMOLPPs) from a perspective of bipolar view in preference modeling. The fuzzy constraints in a fuzzy multi-objective linear programming problem (FMOLPP) are viewed as negative preferences for describing what is somewhat tolerable while the objective functions of the problem are viewed as positive preferences for depicting satisfaction to what is desirable. This approach enables us to handle fuzzy constraints and objectives separately and combine them in distinct ways. An optimal solution of a FMOLPP is the one which maximizes the overall satisfaction of positive preferences provided it satisfies all the negative preferences at least up to their consistency degree along with the coherence condition.

Keywords: Fuzzy multi-objective linear programming; bipolarity ; aggregation operator.

Cooperative Games And Economic Application

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The game theory of an arbitrary set of players or agents is created by John von Neumann and Oskar Morgenstern in 1944. Game theory is a toolkit for examining situations where decision makers influence each other. However, game theory's main applications concern with society: economic study for example, auctions, bargaining, market competition, etc. The game theory is divided in two main approaches the cooperative and the non-cooperative games. Cooperative game theory allows one to understand aspects of all these problems from a fresh and unifying perspective that treats users as players in a game. This paper surveys cooperative game theory when players have incomplete or asymmetric information, especially when the cooperative game with transferable utility and nontransferable utility games are derived from economic models. It also analyses the economic applications of cooperative games in an Indian economy.

Keywords: Cooperative game; TU - game; NTU – game.

An Application of Game Theory in Strategic Decision of Marriage Occurrence

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Game Theory illustrates an independent and interdependent decision-making practice of human behaviour. It studies the formal conflict and co-operation between two players. The concept of game theory is applicable in all the situations wherever the actions of agents are interdependent. These agents may be individuals, groups, firm etc. It also provides a language to formulate structures, analyse and understand the strategic scenarios. This paper examines the decision making process of marriage occurrences in India by using Expected Utility Theory (EUT). There are two important players, one are the parents of bridegroom and the second are the parents of bride's. The decision

about marriage is usually taken with the satisfaction of both the parties in terms of utility. This study is based on observation of my own marriage and on the applied game theory for analysing the strategic decision of both families.

Key Word: Game theory, Expected Utility, Marriage Occurrence and Strategic Decision.

Bayesian approach to inference in reliability studies based on multiply Type II censored data from a Rayleigh distribution

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In this study, we have derived Bayes estimators of the parameter, reliability and hazard function of Rayleigh lifetime model based on multiply Type II censoring under squared error loss function (SELF) in nice closed form. Highest posterior density (HPD), maximum likelihood estimators (MLE) and credible intervals are also obtained. A numerical example is presented for comparison of the above estimators. We observed that for certain choice of hyper parameters the posterior risks of Bayes estimators are smaller than corresponding variance of ML estimators. Also, we observed that the posterior risk of Bayes estimators are very sensitive with respect to hyper parameter b rather hyper parameter a.

Keywords. Bayesian estimation; Hyper Parameters; Credible interval; Hazard function; HPD; MLE; Multiply Type II censoring; SELF.

Reliability Modelling of Single-Unit System with Degradation and Preventive Maintenance

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The present paper focuses on the development of a reliability model for a single-unit system in which unit fails completely either directly from normal mode or via partial failure. The partially failed operating unit is shutdown after a maximum operation time for preventive maintenance (PM). There is a single server who attends the system immediately whenever needed to conduct preventive maintenance at partial failure stage and repair at completely failure of the unit. The unit works as new after PM. The unit becomes degraded after repair. The server inspects the degraded unit at its failure to see the feasibility of repair. If the repair of the degraded unit is not feasible, it is replaced by the new unit. The distribution of failure, maximum rate of operation, preventive maintenance, inspection and repair times are arbitrary. The regenerative point technique is adopted to drive the expressions for some reliability and economic measures. The graphical behaviour of mean time to system failure (MTSF), availability and profit analysis has also been shown for a particular case.

KeyWords: Preventive Maintenance, Degradation, Inspection and Profit Analysis.

Stochastic Analysis of a Computer System with Arrival Time and Priority to H/w Repair over S/w Replacement

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The purpose of the present paper is to analyse stochastically a reliability model of a computer system of two identical units with the concepts of priority and arrival time of the server. Initially one unit is operative and the other is kept as spare in cold standby. Each unit comprises h/w and s/w components which may have independent failure from normal mode. There is a single server who takes some time to arrive at the system to repair the unit at its h/w failure whereas he visits immediately at s/w failure.

The replacement of the s/w at its failure is made by new one giving some replacement time. The server finishes all the jobs including h/w repair before leaving the system. Priority is given to the h/w repair over the software replacement. The failure time of the unit due to h/w and s/w follows negative exponential distribution while repair, replacement and arrival time of the server are arbitrarily distributed with different probability density functions. All random variables are statistically independent and uncorrelated to each other. The expressions for various reliability and economic measures are derived in steady state using semi-Markov process and regenerative point technique. Graphs are drawn to depict the behavior of MTSF, availability and profit function considering particular values of various costs and parameters. The MTSF and profit of the present model have also been compared with that of the model Malik and Sureria [2012].

Keywords: Computer System, Independent Failure of H/w and S/w, Priority to H/w Repair, Replacement of S/w, Arrival Time of the Server and Stochastic Analysis.

Parametric Dual Models for Semi-infinite Discrete Minimax Fractional Programming Problems Involving Generalized $V-\rho$ Invex Functions.

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In this paper we have considered two dual models with somewhat limited constraint structures, and prove weak, strong, and strict converse duality theorems under two sets of generalized convexity conditions.

Finite time Ruin Probability of the Compound Renewal Model with Constant Interest rate and Weakly Negatively Dependent Claims.

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This paper established a simple asymptotic formula for the finite ruin probability of a compound renewal risk model with constant interest force. We assume that the claim sizes are Weakly Negatively Dependent (WND) and identically distributed random variables belonging to the class of Regularly

varying tails. The results obtained have extended and improved some corresponding results of related papers.

Keywords : Finite time ruin probability, Dependent compound renewal model, Weakly negatively dependent, Regular variation.

Optimal production inventory model for deteriorating items with production disruption and shortage

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This study develops production inventory model for deteriorating items with production disruption. The production disruption is a common phenomenon of production industries in a dynamic environment of business. The optimal production time play a vital role for smooth running and optimizing the profit of a manufacturing industry. In this paper, it is assume that item is deteriorating with a constant rate and production rate changes at different time. The demand rate is assumed as a constant. Here production is conducted with four different rates at different inventory level. The presentmodel has been solved analytically to minimize the average cost of the system. The classical optimization technique is used to derive an optimal solution. A numerical example has been carried out to analyze the behavior of the model.

Keywords: Inventory, Shortage, Demand, Production, Deterioration.

Design of Survivable Communication Networks

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Any communication network can be represented as a graph. Standard network design problems deal with assigning capacities to the edges of the graph representing the network. Frequently, the inequalities used to define these problems are cutset inequalities which enforce that the demand across the cut should be satisfied by the combined capacity of edges of the cut.

In our survivable network design problem, we consider survivability constraints which imply that in the case of the deletion of any single edge in the cut, the reserved capacities of the remaining edges should be large enough to satisfy the demand across the cut. We examine the polyhedron described by Bienstock and Muratore (2000) for the case of a single edge failure and develop a relation between the polyhedron and its linear relaxation in terms of Chv´atal inequalities.

Keywords: Network design, integer programming, combinatorial optimization.

Products selection in E-Commerce-A Fuzzy logic based game theoretic approach

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This paper presents a fuzzy logic based game theoretic approach to select the product for the buyers in online marketplace. The absence of real time interaction between the buyers and sellers makes it difficult to select the product as per buyers' requirements from a large assortment of products available in the market. The buyers' requirements in multiple attributes which are generally expressed by them in vague, imprecise terms are represented with the help of fuzzy sets. The products that scale very low in any attribute in comparison to most of the products available in the market, are eliminated from the consideration set by using an appropriate fuzzy linguistic quantifier. This filtration problem is modeled as a 0-1 programming problem. It is quite possible that the products available in the market may not meet the buyers' expectation in all the attributes fully and they have to compromise on the performance of the products in some attributes. The attribute that is compromised more in the market has higher trade off value in comparison to less compromised objectives/attributes and thus the product that performs higher in the higher compromised attribute is valued more. The selection of appropriate product that meets the buyer's requirements in multiple attributes in a given market condition is formulated as a two-person zero sum non-cooperative game.

Keywords: Multiple Attributes, Fuzzy Sets, Game theory, Products selection

Constrained optimization reformulations and relaxation methods for generalized Nash equilibrium problems using nonmonotone inexact line search

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Two constrained optimization reformulations of the generalized Nash equilibrium problem (GNEP) are presented in this paper, using an extended regularized Nikaid^o{Isoda function. One is a nonsmooth reformulation whose global minima are the solutions of GNEP whereas the other is a smooth reformulation such that its global minima are the normalized Nash equilibria of GNEP. An algorithm to find normalized Nash equilibria for the given GNEP based on relaxation method with nonmonotone inexact line search technique is given. Some numerical illustrations are also provided.

Keywords Generalized Nash equilibria , Constrained optimization re-formulations, Regularized Nikaido-Isoda function, Normalized Nash equilibria, Relaxation method, Nonmonotone line search

Solution of Interval Geometric Programming Problem

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This paper addresses a Geometric Programming Problem where the objective function and constraints have interval parameters. A methodology is developed to transform this model to a general optimization problem, which is free from interval uncertainty. Relationship between the solution of the original problem and the transformed problem is established.

Keyword Interval valued function; preferable solution; preference function；

Asset portfolio optimization using analytical hierarchy process and multi-choice goal programming

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Real-life portfolio selection problems are complex in nature. In fact, the conflicts among objectives and the incompleteness of available information make it almost impossible to build a reliable mathematical model for representation of investor-preferences by considering single aspiration level for each goal. Also, in some situations the investor would like to make a decision on the problem, with the goal that can be achieved from some specific aspiration levels (i.e., one goal mapping many aspiration levels). In the present study, we integrate analytic hierarchy process and multi-choice goal programming (MCGP) as a decision aid to obtain an optimal asset allocation that better suit the investor-preferences. According to the function of multiple aspirations provided by MCGP, the decision maker may set multiple aspirations for each goal to find the optimal asset allocation. An empirical study is included to illustrate the usefulness of the proposed approach in real-world applications of portfolio selection.

Keywords: Portfolio selection; Multi-criteria decision making; Multi-choice goal programming; Analytical hierarchy process

A study of well-posedness and stability in vector optimization problem using Henig proper efficiency

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In this article, we study the well-posedness and stability of a vector optimization problem in terms of it's Henig proper efficient solutions. We first justify the importance of the notion of set-convergences in the study of well-posedness for vector optimization problems. This is done by establishing an

equivalence between the well-posedness of the vector problem and the upper Hausdor_ convergence of a minimizing sequence of sets associated with the problem. Further, we establish some suficient conditions for the well-posedness of a convex vector problem. This is further extended to establish that quasiconvex vector problems are well-posed. Finally, we establish a stability result in terms of upper semicontinuity of the solution map. This is achieved by considering perturbed problems with continuous objective function where we assume certain set-valued maps associated with the perturbed problems to be upper semicontinuous.

Keywords: vector optimization; Henig proper efficiency; well-posedness; Hausdor_ convergence; upper semicontinuity.

Simulation Tool for Inventory Models: SIMIN

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In this paper, an integrated simulation optimization model for the inventory system is developed. An effective algorithm is developed to evaluate and analyze the back-end stored simulation results. This paper proposes simulation tool SIMIN (Inventory Simulation) to simulate inventory models. SIMIN is a tool which simulates and compares the results of different inventory models. To overcome various practical restrictive assumptions, SIMIN provides values for a number of performance measurements. This tool is programmed in JAVA and is based on analytical approach to guide optimization strategy. Objective of this paper is to provide a user friendly simulation tool which gives optimized inventory model results. Simulation is carried out by providing the required values of input parameters and result is stored in the database for further comparison and study. Result is obtained in terms of the performance measurements of classical models of inventory system. Simulation results are stored in excel file and it also provides graphical results to compare the outcome. This simulation tool is interfaced with an optimization procedure based on classical models of inventory system. With the specified examples, the simulation results are obtained and analyzed rigorously. The result shows that input parameters, total system costs and capacity should be considered in the design of a practical system.

Keywords: Simulation, JAVA, Queuing models, Performance Measures, calling population.

Multi Stage Promotional Resource Allocation for Segment Specific and Spectrum Effect of Promotion for a Product Incorporating Repeat Purchase Behavior

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Promotion plays a very important role in determining fate of the product. It voices product qualities and persuades potential customers to purchase the product. But in today's large, broad and diverse markets every customer has individual needs, preferences, resources and behavior. It is difficult and impractical for companies to cater to all customers alike. This calls for market segmentation. Once the market is broken into segments, companies can carry out differentiated market promotion in each segment. Product is also promoted in the entire market using mass market promotion that influences each segment with a fixed spectrum. Promotional resources available with any firm are limited, and so must be used judiciously. In this paper, we formulate mathematical programming problem which optimally allocates differentiated and mass promotional effort resources dynamically in the segments in order to maximize the sales under budgetary and minimum sales aspiration level constraint on each segment where the market is subject to repeat purchasing. The planning horizon is divided into multi-time periods and the adoption pattern is studied in each period and accordingly resources are distributed in respect of current market behavior. The optimization model has been further extended to incorporate minimum aspiration level constraint on total sales from all the segments. The formulated non linear programming problem is solved using differential evolution algorithm. Applicability of the model is illustrated with the help of a numerical example.

Keywords: Market segmentation, Differentiated market promotion, Mass market promotion, Spectrum effect, Promotional effort allocation, Repeat purchase, Non linear programming problem, Differential evolution

An Ordered Field Property For One Player Control Finite Semi-Markov Games

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Two person finite semi-Markov games with discounted and limiting average (undiscounted) payoffs are considered where the transition probabilities and the transition time distributions do not depend on the actions of a fixed player at all states. For the discounted games in this class, we prove that ordered field property holds and that there exist optimal/Nash equilibrium stationary strategies for the two

players for the zero-sum/non zero-sum games. However, if only the transition probabilities are controlled by one player, the ordered field property does not hold for this class. For the undiscounted case, we prove the ordered field property in the uni-chain case. A one step algorithm for the discounted one player control zero-sum semi-Markov games is given.

Keywords. Semi-Markov games, discounted and limiting average payoffs, one player control

Some Results in the Competitive Newsvendor Model

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In this paper, we compute and analyze equilibria of the competitive newsvendor model under symmetric and asymmetric demand forecast information. We show that the Nash equilibrium computed in the symmetric demand information case is inefficient. To mitigate this inefficiency, we propose that the newsvendors use correlated equilibrium through some communication device.

Being Credit Rationed: Perception and Transaction Cost

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Recent studies are focusing more on explaining credit rationing as a demand side phenomenon rather than solely as a supply side or lender driven phenomenon. This paper develops two alternative models that explain the emergence of credit rationing from the demand side of the credit market in terms of personal loan transaction cost and borrower perception. While both the models incorporate these two features of the credit markets of developing countries, they consider two different aspects of project characteristics – productivity and size. In either case the models show how credit market conditions force borrower decisions that result not only in credit rationing in the traditional sense but also in the form of discouraged borrowers. Specifically the models explain why discouraged borrowers may exist

even among the relatively larger borrowers or borrowers with access to more efficient projects unlike traditional wisdom.

Key Words: Credit Rationing, Discouraged Borrowers, Perception, Personal Transaction Cost, Informal loans, Formal loans

A New Approach With Biasedness To Construct Balanced Boolean Functions Having The Best Trade-Off Between Nonlinearity And Autocorrelation For 7 Variables.

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Many desirable properties are known for Cryptographically strong Boolean functions. It is difficult task to get optimal trade-off among such properties. In this piece of work, we have focused on nonlinearity, balancedness and autocorrelation, and explored an evolutionary multiobjective approach with biasedness to construct balanced Boolean functions having the best trade-off among them. By including biasedness, we can get desired set of solutions instead of all solutions. Biasedness diverts the solutions towards the desired region. So, we get only the solutions that are desired. In this paper, we present NSGA-II and suggest a biased sharing technique which can be used to construct desired Boolean functions of 7 variables by the proposed method.

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Keywords: Evolutionary Multi-objective Optimization, NSGA-II, Boolean functions,Biasedness, Cryptography

Reliability And Cost-Benifit Analysis Of A Single-Unit System Subject To Warranty Period

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This paper deals with the reliability analysis of a single-unit system subject to the concept of warranty period. There is a single repairman who visits the system immediately whenever required. The exponential, distribution of failure time and general distribution for repair time is considered. Supplementary variable technique is adopted to drive the expressions for some reliability measures.

Tables are drawn to depict the behavior of reliability, mean time to system failure (MTSF), availability and profit of the system model.

KeyWords: Reliability, Single unit system, Warranty period and Cost-benefit Analysis.

On Optimum Life Testing Plans In Presence of Progressive Censoring : A Cost Function Approach

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Life testing plans play a signi_cant role in reliability and survival analysis studies. Due to limited number of testing units or highly expensive testing units or time constraint, we cannot continue the experiment until all the failures are observed. So censoring becomes inheritably significant and efficient methodology to estimate model parameters of underlying distributions. In this article, we discussed the determination of optimum life testing plans in presence of progressive and progressively hybrid censoring by minimizing the total cost associated with the experiment. The cost components are (1) cost of failed items, (2) cost of duration of the experiment, (3) cost due to imprecision (variance) of the estimates of the unknown parameters of the lifetime distribution under consideration, and (4) cost of running the experiment with a sample size. It is shown that the proposed cost function is scale invariant for some selected distributions. Optimum solution cannot be obtained analytically. We propose a method for obtaining the optimum solution and consider exponential and Weibull distributions for illustration. Finally, a well-planned sensitivity analysis is studied in order to analyze the effect of mis-specification of parameter values and cost components on the optimal solution.

A Value Adding Approach To Reliability Under Preventive Maintenance

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No equipment (system) can be perfectly reliable in spite of the utmost care and best efforts on the part of the designer and manufacturer. For a large number of systems, maintenance is a must, as it is one of the effective ways of increasing the reliability of the system. Two fold maintenance are: corrective and preventive maintenance. It is generally assumed that preventive maintenance action is less costly than a repair maintenance action. Folk wisdom supports the notion that higher quality translates into lower maintenance costs (as well as other components of life-cycle costs) for the users. We examine this proposition in some detail on the basis of a failure-time model that relates conformance quality to reliability. We know that maintenance plays an important role in reliability theory and it increases the lifetime of an item or system at lower cost. In this paper, we have shown how preventive maintenance affects on different life-time distributions.

Keywords: Reliability function at time‘t’, Reliability function under preventive maintenance, Weibull distribution, Gamma distribution, Normal distribution

A New Method to Solve Bi-level Quadratic Linear Fractional Programming Problems

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In this paper, we have developed a new method to solve bilevel quadratic linear fractional programming (BLQLFP) problems in which the upper-level objective function is quadratic and the lower-level objective function is linear fractional. In this method a BLQLFP problem is transformed into an equivalent single-level quadratic programming (QP) problem with linear constraints by forcing the duality gap of the lower-level problem to zero. Then by obtaining all vertices of the constraint region, which is a convex polyhedron, the single-level QP is converted into a series of finite number of QP problems with linear constraints which can be solved by any standard method for solving a QP.

The best among the optimal solutions gives the desired optimal solution for the original bi-level programming problem. Theoretical results have been illustrated with the help of a numerical example.

Keywords: Bi-level Programming, Stackelberg Game, Quadratic Programming, Linear Fractional Programming, Dual Problem, Quadratic Linear Fractional Problem

Reliability Modeling of a Cold Standby System with Priority to Repair over Maintenance Subject to Random Shocks

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A two identical unit cold standby system has been considered to study the effect of random shocks on reliability and economic measures. Initially, one unit is operative and other is kept as spare in cold standby. The operative unit suffers a random shock with some probability. A single server facility is available in the system for maintenance and repair of the failed unit. The unit undergoes for preventive maintenance if it is affected by the impact of shocks. However, repair of the unit is done when it fails due to some other reasons. Priority to repair of the failed unit is given over maintenance. Maintenance and repair are assumed as perfect. Random shocks and failure times of the unit are exponentially distributed while maintenance and repair times are taken as arbitrary with different probability density functions. Some reliability characteristics of the system model are derived in steady state using semi-Markov process and regenerative point technique. The graphical study has been made for mean time to system failure (MTSF), availability and profit giving arbitrary values to various costs and parameters.

Keywords: Reliability, Cold Standby System, Random Shocks, Maintenance, Repair, Priority and Profit Analysis.

A New Approach for Solving Intuitionistic Fuzzy Transportation Problems of Type-2

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In this paper, we formulate a transportation problem in which costs are Triangular Intuitionistic fuzzy numbers. Intuitionistic fuzzy methods are developed to find starting basic feasible solution in terms of triangular Intuitionistic fuzzy numbers. Intuitionistic fuzzy modified distribution method is proposed to find optimal solution. The method is illustrated by a numerical example.

Keywords: Triangular Intuitionistic fuzzy number, Intuitionistic fuzzy transportation problems of type-2, optimal solution.

Efficiency improvement strategy under constant sum of inputs with restricted weights

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In this paper, we have formulated Data Envelopment Analysis models and developed an algorithm to reduce the inputs in an inefficient decision making unit when the specific inputs are under the constant sum constraint, and when the parameter weights are restricted. The excess input is reallocated to other DMUs without any reduction in their efficiency. These DEA models and methods developed in this work will help decision makers in developing an optimal strategy to transfer excess input to other DMUs. Theoretical results have been illustrated with a numerical example.

Keywords: DEA, constant sum of inputs, efficiency, linear programming, assurance region, fixed proportion, restricted multipliers

On characterizing the blunt minimizers of epsilon convex programs

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In this paper, we study the minimization of a differentiable epsilon convex function over a convex set and provide several new and simple characterizations of the set of all epsilon blunt minimizers of the extremum problem. By using the basic properties of the differentiable epsilon convex functions, we characterize the set of all epsilon blunt minimizers. We also present some characterizations of epsilon straight functions and characterizations of the epsilon blunt minimizers of epsilon straight functions over a convex set are obtained. The results of this paper extend and give approximate version of various results present in literature.
Keywords Epsilon convexity, Epsilon blunt minimizers, Solution sets, Characterizations, Epsilon monotonicity

Multiobjective Programming Problems involving Generalized V-pseudo-invexity

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In this paper, we introduce new class of functions by combining V-invex functions due to Jeyakumar and Mond (1992) and pseudoinvex-I, pseudoinvex-II, KT-pseudoinvex-I, KT-pseudoinvex-II and FJ-pseudoinvex-II due to Arana-Jimenez *et al.* (2008). We prove that in order for KT points to be efficient solutions it is necessary and sufficient that the functions involved in multiobjective programming problem belong to one of the new class of functions, namely V-pseudo-invex-I, V-pseudo-invex-II, KT-V-pseudo-invex-I, KT-V-pseudo-invex-II and FJ-V-pseudo-invex-II. Our results extend the results of Arana-Jimenez *et al.* (2008) to wider class of functions. Moreover, the particular case of our results will be corresponding results of scalar problems.

Sufficiency and duality in differentialble multiobjective programming involving generalized type-I functions

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In this paper, some new classes of generalized (G,C,ρ) - convex type-I functions are introduced for differentiable multiobjective programming. These functions are then utilized to establish sufficient optimality condition for the multiobjective optimization problem. We consider a mixed dual model and establish the weak and strong duality theorems.

Keywords Multiobjective programming; (G,C,ρ) - convex, Efficient solution;Type-I functions;Generalized convexity;Mixed duality

Vector optimization problem and epsilon vector variational-like inequality

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In this paper we study a relationship between epsilon quasi efficient solution of vector optimization problem and a solution of epsilon vector variational-like inequality under the assumption of generalized epsilon convexity.

Keywords Epsilon Generalized Convexity, Epsilon Quasi Efficient Solution, Epsilon Vector Variational Inequalities, Vector Optimization Problems

This symposium also intends to bring out a publication of selected and refereed papers *in Special issue in* ***Annals of Operations Research &*** *Special issue in* ***International Game Theory Review***.

Annals of Operations Research

Special Volume: Optimization Models with Economic and Game Theoretic Applications Annals of Operations Research

Special Issue of International Game Theory Review on Applied Optimization and Game-Theoretic Models