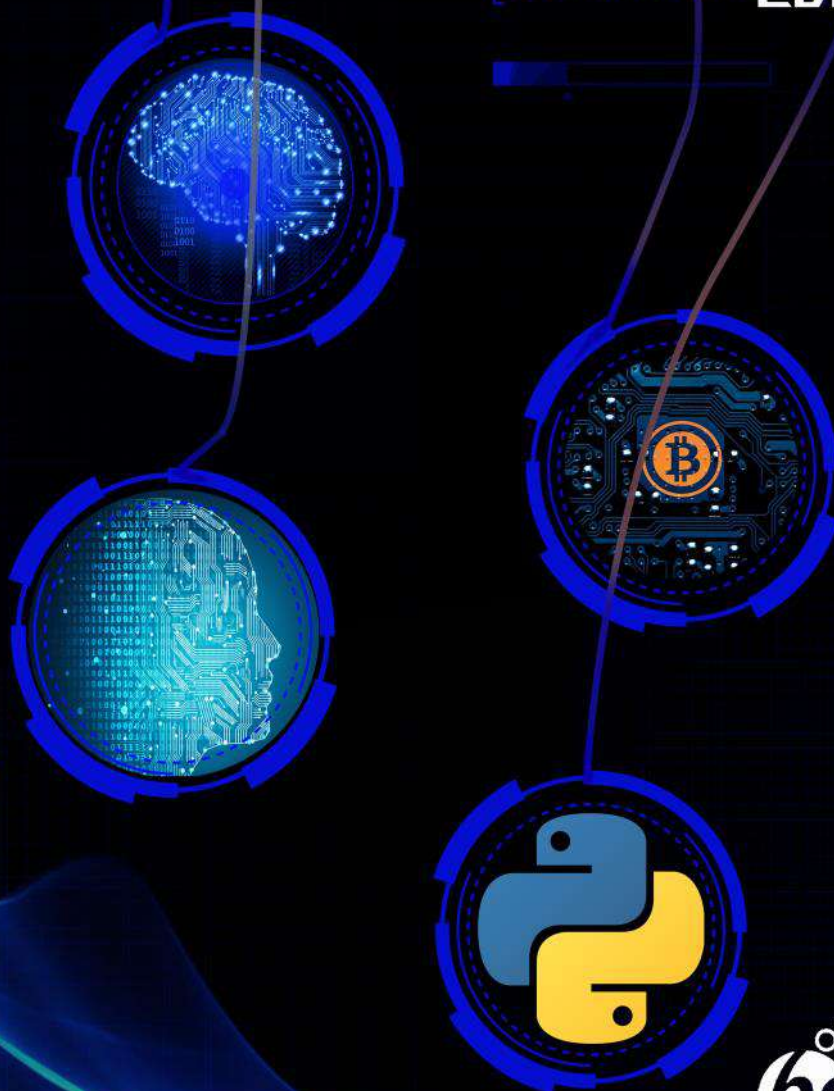


2019 Issue

OPTIMYSTIC

EDITION - 4



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LIT BOMBAY

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हीरक जयंती २०१८
Diamond Jubilee 2018
एक साथ प्रगति की ओर
Achieving Excellence Together

PC: ANIRBAN KARMAKAR

Exhibited in KALADARSHAN 2019



Magazine Credits

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Professor's Insight: Jaideep Singh & Bhaskara Praneeth

Field Trip Content: Ratnesh Srivastav

Goa Trip Content: Mufassir, Ankush , Piyush &
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Mid-way through editing and designing a pile of articles which I was nose deep in and with the thoughts of the zillion things that 'JUST HAD TO BE DONE'; I pulled at my hair for the very first time. This was the first of many such moments (hours)! Putting a magazine together was no cake walk. I along with my editorial team members have spent sleepless nights to make this magazine stand out.

So here we have "OPTIMYSTIC", the annual department magazine of IEOR department for the year 2018-2019. Since this magazine was inaugurated on IEOR day 30th March, 2019, so the theme is "Recent Trends in Operations Research and Management". This magazine not only gives an insight into academic and scholarly achievements of our students but also all the aspects of life being in IEOR, IIT Bombay.

I would like to thank all my editorial team members for helping me pull this through. I express my considerable appreciation to all the authors of the articles in this magazine. These contributions have required a generous amount of time and effort.

Finally, I would like to express my sincere gratitude to our IEOR Student Association — Prof. Manjesh Hanawal and HOD of IEOR department Prof. Narayan Rangaraj for their encouragement, support and for giving us an opportunity to compile this magazine by providing necessary resources to complete our work.

Vibhor Gupta

Joint Secretary — Library and Publications
IEOR, IIT Bombay

Straight from the HOD's Desk

This year has seen IEOR grow in several dimensions. It is a landmark year for the institute, celebrating its 60th Foundation Day and IEOR is happy to be part of the year long celebrations with this special edition of IEOR day and also the magazine.

In faculty news, Prof Manjesh Hanawal has got an Early Career Award from that supports his research over three years to work on the application of machine learning to next-generation wireless networks. Prof. Jayendran Venkateswaran led from the front in organising the flagship event of the OR Society of India, the annual conference, at IIT Bombay in December 2018. Almost the entire IEOR family participated in the talks, discussions, events and overall organisation of this conference, which included four technical workshops, several high quality plenaries and keynotes, panel discussions and attracted participants from all over India and abroad. It was an enriching experience.

Prof. Ashutosh Mahajan continues as Institute Timetable Co-ordinator and will soon be involved in the institute Web services as well.

IEOR is now midway through a training programme for Indian Navy personnel in Naval Operations Analysis. This is a technically challenging area, which is being taken up by IEOR for the first time. The course is being co-ordinated by Prof. Manjesh Hanawal and Prof. Mallikarjuna Rao, with contributions from several faculty and senior research scholars.

The activity footprint continues to expand with activities in consulting, finance, transport and logistics, health care, large public systems, technical aspects of wireless networks and other areas. Collaboration is strong, with many institutes and universities in India and also in Australia, France and Germany. Judging from the visits (to IEOR and by IEOR), requests for our involvement and overall activity, perhaps it is the highest ever outreach so far. It has provided for good opportunities for students as well.

The year also saw the return to the department and talks by our alumni Kishor Patil and Sriram Narayanasami, now wearing different hats. I hope this is the start of an increasing trend. Prof. Awate retired from service after 42 years and this is the first year that IEOR will have a convocation or other significant event without him being on the rolls of the institute. However, he is still associated with us and his detailed history of the IEOR programme is something that all who are associated with the programme should read. Two senior Adjunct Faculty are with us for this year, Dr. Siddhartha SenGupta and Prof. N.Ravichandran, advising students and participating in research and teaching.



Placement for master's students has been good and Ph.D. students Umakanta Pattanayak, Siddhartha Paul and G.Chandramouli have begun their post Ph.D. careers. Ph.D. students have had good international and industry exposure through research visits and their presence in international conferences and technical meetings continues to be strong. This is an area where alumni or others can contribute to build a corpus that the department can use very fruitfully - i.e. supporting research visits and travel by our students, which will enable them to interact with the best in the world in their subject, on equal footing.

Our newest staff member Amlesh Kumar has joined IEOR in December, 2018. We are happy he has started his professional career with IEOR at IIT Bombay.

Student driven initiatives are at an all time high, and a significant mention must be made of the enthusiastic efforts of G.Sec Sameer Agrawal and his team. After a long time, a student's trip was organized. The student quiz, presentations in seminar series, posters, course projects and other activities are noticeably more active and I hope this will continue, together with a push towards greater quality in all aspects. A departmental video has also come out, with a good fraction of the students participating in its making. Thanks to the IDC team that supervised this effort.

Prof. Narayan Rangaraj
Head of Department
Industrial Engineering and Operations Research
IIT Bombay

Contents

1. About the department
2. Growth of IEOR
3. Faculty @ IEOR
4. Recent Trends in Operations Research and Management
5. Ph.D. Research Areas
6. Master Thesis Projects @ IEOR
7. Field Trip
8. SoULS PROJECT @ IIT Bombay
9. Students Solar Ambassador Workshop
10. 51st Annual Convention ORSI and International Conference
11. Professors' Talk
12. Professor's Insight
13. Conferences & Internships 2018-19
14. PhDs graduated recently
15. Placements 2018-19
16. Students Activity Column
17. Department Trip
18. IEORSA Council
19. Alumni Perspective
20. Quiz Time

About the IEOR Department

Industrial Engineering and Operations Research (IEOR) is an academic discipline concerned with making systems more efficient. Often this goal is achieved through the use of modelling and other computational methods.

Industrial Engineering and Operations Research (IEOR) at IIT Bombay offers research-based M. Tech., Ph.D., and M.Sc.-Ph.D. dual degree programmes, and is actively involved in research (including sponsored projects), consulting and continuing education. The discipline offers a blend of theory, modelling, and application, drawing from traditional as well as modern areas of operations research, together with a systems view derived from long-standing principles of industrial engineering. This approach provides a backdrop for technically sound decisions at operational and tactical levels and occasionally at the strategic level, for a variety of organizations. Established as one of the first interdisciplinary programmes in IIT Bombay, IEOR contributes significantly to achieve the goals of IIT through various activities such as offering academic programmes, conducting continuing education programmes (CEP), carrying out research projects of different types.

The IEOR programme also has steady interaction with a wide spectrum of industries and sectors of the economy and society through participation in conferences, hosting visitors from academia and industries, carrying out sponsored projects and placement of students in different sectors etc.

IEOR graduates work in a variety of research labs and industries, including manufacturing, communications, transportation, banking, pharmaceuticals, finance, travel, semiconductor, and business, sports, health, and information technology.

Growth of IEOR

SOME REMINISCENCES ABOUT THE GROWTH OF IEOR INTERDISCIPLINARY PROGRAM AT IIT BOMBAY

September, 2018 - *Prakash Awate*

Formally the interdisciplinary program in IEOR, including initially the MTech-IEOR degree program to begin with, began at IIT Bombay in July. As of December 1975, when I joined IIT Bombay, the institute was actually actively considering starting an interdisciplinary M.Tech Program in Industrial Management, and a large interdisciplinary faculty committee was already involved in that effort; and I also was made a member of that committee. The proposal was finalized and cleared by the Senate in spring of 1976, and we launched the MTech-IEOR program in July 1976. Keeping in mind long term prospects, depth in courses was encouraged in IEOR courses right from the very beginning. The first Ph.D. course in IEOR was taught in autumn semester of 1980. While GATE Exams started in 1980-81, birth of the JAM Exam for BSc in sciences, Mathematics and Statistics and so on, was a long way into the future, as it turned out; and that happened only about 25 years after start of GATE. Recognition of the need for clear and wide opening of opportunities for the graduates of sciences and Mathematics into some branches of Engineering and Technology, and in a way diffusing the very hard dividing lines between sciences and engineering, took quite some time in our country. The decade of 1980's was a very 'happening' decade in terms of real life applicable pioneering developments in Scheduling, Inventory and Queuing systems. In our IEOR interdisciplinary program at IIT Bombay I made every effort, through teaching of courses and guidance of student projects, to keep our B.Tech, M.Tech and some PhD students from Mechanical Engg Manufacturing area also, abreast of many advances in the above areas. A very important development in 1990, for our IEOR IDP, was the joining of Professor Narayan Rangaraj in IEOR IDP. It is always a pleasure in itself, when a B.Tech. from here, after doing PhD abroad at a reputed



university, joins here as a faculty colleague. As a matter of fact Prof. Narayan, who had done B.Tech Mechanical from IITB Bombay and PhD in Non-differentiable Optimization from Johns Hopkins University, had the option of joining either the well established Mechanical Engineering Department of our IIT, or the IEOR IDP here which as of 1990 had only 2 faculty members in IEOR proper other than Prof. Nagarwalla who was about to leave in that year. Professor Narayan, through research and also specialized activities for the Indian Railways, has also played an important part in bringing together and maintaining a balance between a range of interests of faculty in IEOR IDP working in different realms. It turned out that in September 1997 Professor N. Hemachandra joined our IEOR IDP; and so our faculty strength in IEOR then rose to 4, from 1 in July 1997. That was a long journey of full 20 years; and after that there was no looking back. That I must say was a real turning point in the evolution of IEOR IDP at our institute. Incidentally, the occurrence of queries in the institute, about our IEOR program either growing 'faster' or else merging with School of Management, or with Mathematics Department, or with Systems and Control group, continued relentlessly and periodically from early 1990's also till about 2005 or so. Personally, my feeling over the years is that maintaining the interdisciplinary spirit of IEOR and the spirit of open inquiry and a reasonably wide perspective, apart from depth of courses, is also very

important in the long run. Looking forward about our IEOR IDP, I do believe that with core faculty strength of IEOR about to reach and cross ten very soon, it is really probably time to give serious thought towards growing from the status of an IDP to become a full fledged department; which practically can boil down to starting a B.Tech program here in IE & OR. At present, thanks to the initiation of the MSc-PhD program of IEOR pioneered by Professor Hemachandra and with active support from all the IEOR colleagues, and the addition of excellent faculty in IEOR in the last fifteen years, we have a very good core faculty strength now and covering a rich spectrum of areas of their activities.

In the 1990 Iraq war, India was seriously concerned about the potentially harmful impact on India, of large scale burning up of entire oil fields in Kuwait that was being done by Iraqi forces. At that time Indian government had directed the O.R. Group in DRDO to make a clear cut but fast assessment of the situation within 14 days, regarding any possible impact of the large scale Kuwait oilfields' burning on the weather or crops in India. Within 14 days, DRDO constituted and worked in an O.R. team that did the entire project, and informed the government of India that the impact of the oil field fires on India would be negligible. War problems are naturally highly unpredictable and interdisciplinary works are

inevitable in things related to war. During the last four decades we have seen, though not very many, some Indian navy commanders, army colonels and so on coming to IIT Bombay IEOR M.Tech program as sponsored candidates. If our IEOR field itself owes its birth to war efforts, then our IEOR program helping at some time in future our own defence forces in some ways and most significantly through potentially some BTechs in IEOR joining some defence establishments, is something that is really worth pondering about. In crucial times such as war, the relevant metrics and constraints can be quite different as compared to those in leisurely peace times. Only time would tell the shape of the future, and much depends upon the collective thinking and collective will of IEOR faculty. It has been really wonderful to see our IEOR IDP grow from strength to strength, and especially with so many young brilliant faculty joining which brings still stronger hopes.

Faculty @ IEOR

Prof. Nandyala Hemachandra

Research Interests: Operations Research methodologies like Markov decision models, Queuing models, Game theory, etc. Application areas include Communication networks, Supply chains, Financial Engineering, Logistics.

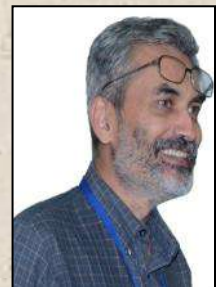
Courses Taught: Engineering Statistics , Data Analytics in Operations, Selected applications of stochastic models, Seminar



Prof. Narayan Rangaraj

Research Interests: Railway Operations Management, Optimisation, Logistics and Supply Chain Management, Pricing and Revenue Management.

Courses Taught: Operations Analysis, Service and Infrastructure Systems, Quantitative Models for Supply Chain Management , Communication Skills -II , Advanced topics in Discrete Optimization.



Prof. Ashutosh Mahajan

Research Interests: Mixed-Integer Linear and Nonlinear Optimization, Algorithms, Software and Applications of Optimization.

Courses Taught: Computer Programming and Algorithms, Discrete Event System Simulation ; IEOR for Health Care; Integer Programming–Theory and Computations, Communication Skills -II



Prof. Manjesh Kumar Hanawal

Research Interests: Communication Networks, Machine Learning, Network Economics

Courses Taught: Online Learning , Data Analytics in Operations Research, Introduction to Stochastic Models



Prof. Jayendran Venkateswaran

Research Interests: Modelling, simulation and analysis of complex systems (viz. supply chains).

Courses Taught: System Dynamics Modelling and Analysis



Prof. K. S. Mallikarjuna Rao

Research Interests: Deterministic and Stochastic control, Game Theory, Viscosity Solutions, Markov Decision Processes, Mathematical Finance

Courses Taught: Service Engineering and Management, Probabilistic Models, Operations Analysis, Discrete Event System Simulation



Prof. Veeraruna Kavitha

Research Interests: Stochastic processes, Queuing Theory, Polling systems, Optimal control, Game theory, Stochastic approximation, Wireless communications.

Courses Taught: Decision Analysis and Game Theory, Modelling and Computational Lab, Introduction to Financial Engineering



Prof. Vishnu Narayanan

Research Interests: Mathematical Programming especially Integer Programming, Convex Optimization, Polyhedral Theory.

Courses Taught: Optimization Models, Optimization Techniques



Prof. P Balamurugan

Research Interests: Machine Learning, Data Mining Problems, Optimization Methods and Algorithms, Applications of Machine Learning and Data Mining in relatively less explored directions.

Courses Taught: Linear Systems , IEOR Lab, Deep Learning: Theory and Practice, Modelling and Computational Lab



Prof. Siddhartha SenGupta

Research Interests: Large scale automated Automated Railway Planning, Transportation planning, Creating value from ICT, Logistics and Supply Chain Management (including Pricing/Revenue Management), Machine Learning and Artificial Intelligence



Recent Trends in Operations Research and Management

Few years back, I was listening to a technical talk by Prof. Balaji from IIT Madras and he started off with a statement having a philosophical tone: “Life is a non-linear optimization problem and we are all trying to maximize happiness”. In practice Operations Research (OR) deals with more tangible problems like improving profits, minimizing costs and increasing market share by helping people and organizations to make better decisions.

The modern field of OR arose during World War II and since then the field has been rapidly growing and evolving over the years. Role of OR is broadening as the world is becoming more intricate and data-driven. People share a lot of data on social media and other internet platforms and even the machines are generating large chunks of data. This factor coupled with increasing computational capability is definitely turning the tide in favor of OR, which is heavily reliant on quality data. Let us have a glance at some of the domains where the OR community is getting more and more involved in different ways compared to what happened in the past.

Digital Supply Networks: The earlier paradigm was digitally enhancing some of the functions in the supply chain network. Now, many organizations focus on developing supply chains whose basic DNA itself is digital. Like the traditional supply chain, the basic idea of delivering the right product at the right place in the right time remains the same, but organizations like Amazon are pushing the limits, putting tremendous pressure on the competitors. The blockchain is a buzzword and there is a good probability that it may come in a big way along the horizon. This can be a good opportunity for OR practitioners.

Overlap of OR with Machine Learning (ML) and Artificial Intelligence (AI): OR was earlier perceived to be distinct and an alternative approach compared to ML and AI but the trend is changing. OR coupled with ML techniques can help in better visualization, processing, and analysis of data. OR aims to make better decisions and AI aims to make human-like decisions and we can sense a good scope for overlap. Many organizations are having interdisciplinary teams comprising of experts from these domains. Professionals with overlapping skills in these areas are likely to be in high demand in the coming years.

Automation and changing manufacturing scenario: Automation of operational processes can save money and improve efficiency. Organizations are in the process of automating many tasks so that employees can be freed up to do more creative tasks and focus on customers. Digital manufacturing and advances in robotics, man-machine interfaces, 3D printing, etc. are creating new developments that are changing the face of manufacturing. Nowadays, even smaller companies are exploring possibilities of automation. In this scenario, better algorithms and tools for decision making will be required.

Advanced analytics: Advanced analytics in organizations revolutionize product/service delivery. Companies like Uber and Airbnb have changed the business dynamics in their domains with their advanced analytics capabilities. These organizations have less physical resources but they are highly valued for their innovative business models and superior data management systems.

OR is going to play a more dominant role in years to come and use of data productively can be the game changer. With continuous adaptation and upgradation, OR practitioners can stay afloat and relevant.

Swapnesh Subramaniam
(Research Scholar)

Ph.D. Research Areas

Puja Sahu
Prof. Nandyala Hemachandra

Research Area: I am working on binary classification of non-linearly separable data using support vector machines (SVM's). It is based on an SVM model which involves representing examples as point in space and my aim is to maximize the gap of dividing these into different categories. The idea of this work is to deal with the performance measure of classification produced by the SVM model. I am able to find and analyse PAC – Bayesian bounds of some classifiers as a measure of efficacy of those classifiers.

Recent Work: I had identified the feasible space of the standard SVM optimization model as a polytope allowing a continuous λ -path to be traced on a subset of its vertices. She has recently worked on PAC– Bayesian performance analysis for the class of binary linear SVM classifiers where the prior and posterior distributions reside on the space of regularization parameter.

Swapnesh S
Prof. Narayan Rangaraj

Research Area: Effective utilization of rolling stock. Proper planning and scheduling using quantitative techniques can be helpful, in the case of large scale upgradations involving movable assets, like rolling stock. There is a possibility of doing the upgradation of the asset in multiple locations and there can be operational constraints involved in executing the process. A model using Integer Programming is proposed for optimizing the execution of these types of upgradations. In addition to the above problem effect of rake standardization on rake utilization is studied, in the context of passenger railway transportation.

Recent Work: Scheduling of retrofit involving movable assets , Effect of standardization on rolling stock utilization.

Anirban Karmakar
Prof. K.S. Mallikarjuna Rao

Research Area: My research topic is Competitive diffusion and influence maximization in networks. We consider multiple players who initially try to influence a set of nodes in a network and these nodes in turn try to influence other nodes in the network on behalf of the players they were influenced by. The objective of the players is to maximize the number of nodes they influence in the network. The problem of influence maximization for a single innovation (or player) is itself NP hard. We started with a simple model of diffusion and analyse the equilibrium structure.

M Venkateswararao K
Prof. Veeraruna Kavitha

Research Area: I am currently working on different problems related polling models such as Serve on the move polling systems , Achievable region of polling systems and Bus bunching. My work mainly focuses on stability and performance of the system.

Applications: Polling systems have many applications in computer communication networks, production system, traffic and transportation systems. Bus bunching is the one of the application in transportation system.

Recent work: The time gap between two successive buses is called headway in transport systems. In moderate/high frequency routes, with moderate/small headways, the random perturbations (traffic conditions, passenger arrivals, etc.), can alter the headway along the route significantly which possibly leads to bunching of buses. Two or more (successive) buses may start travelling together. Bus bunching results in inefficient and unreliable bus service and is one of the critical problems faced by bus agencies. Thus it is imperative to reduce the bunching possibilities (probability). Another important aspect is the expected time that a typical passenger has to wait before the arrival of its bus. If one increases the headway, the bunching chances might reduce, however, may significantly increase the passenger waiting times. We precisely study this inherent trade-off and derive a bus schedule optimal for a joint cost related to all the trips, which is a weighted combination of the two performance measures. We consider a system with Markovian travel times, fluid passenger arrivals and derive dynamic headways which control the bus frequency based on the observed system state. The observation is a delayed information of the time gaps between successive bus arrivals at various stops, corresponding to two earlier (previous to previous) trips. We solve the relevant dynamic programming equations to obtain near-optimal policies, and the approximation improves as the load factor reduces. The near-optimal policy turns out to be linear in previous headway and the (earlier) bus-inter-arrival times. Using Monte Carlo based simulations, we demonstrate that the proposed dynamic policies significantly improve (both) the performance measures, in comparison with the previously proposed partial dynamic policies that only depend upon the headways of the previous trips.

Uday Kumar M

Prof. Veeraruna Kavitha & Prof. Nandyala Hemachandra

Research Area: I work on Risk-sensitive Markov Decision Processes (RSMDP) over an infinite horizon. The problem is to optimize the exponential of discounted cost or reward function scaled by a risk factor on an infinite horizon. The initial work is presented in Value tools Conference on Performance Evaluation 2019 in Spain. In this paper, we developed a methodology and provided an algorithm to construct an epsilon optimal Ultimately Stationary (US) policy for RSMDP under the assumption of bounded rewards. This method also improves the performance and converges faster over the traditional methods. This is shown with an illustration in supply chain control. As an extension to this, we are working on relaxing the assumptions of bounded rewards and also with constraints.

Indrajit Saha
Prof. Veeraruna Kavitha

Research Area: We consider random vector Fixed Point (FP) equations in large dimensional spaces, and study their almost sure solutions. An underlying directed random graph defines the connections between various components of the FP equations. Existence of an edge between nodes i, j implies the i -th FP equation depends on the j -th component. We consider a special case where any component of the FP equation depends upon an appropriate aggregate of that of the random 'neighbour' components. We obtain finite dimensional limit FP equations (in a much smaller dimensional space), whose solutions aid to approximate the solution of the random FP equations for almost all realizations, in the asymptotic limit (as the number of components become large). Our techniques are different from the traditional mean-field methods, which deal with stochastic FP equations in the space of distributions to describe the stationary distributions. In contrast our focus is on almost sure FP solutions. We apply the results to study systemic risk in a stylized large financial network captured by one big institution and many small ones, where our analysis reveal structural insights in a simple manner.

Tejas Ghorpade
Prof. Narayan Rangaraj

Research Area: Freight Transportation Modelling. I am working on transportation modelling under uncertainty. This includes the extension of standard Routing decisions to include the dynamic information. I have been looking at problems like daily route planning with recourse decision for freight railways, dynamic charging decision in Electric Vehicles as well as the empty container movements and balance in the network. For this, alternate ILP models and dynamic heuristic approaches necessary to solve the problems with large data in reasonable time for real time execution are being developed.

Application: Dynamic route planning for freight rail, electric vehicles, container movements, etc.

Ranbir Singh
Prof. Veeraruna Kavitha

Research Area: Branching Processes with Application to Online Social Networks. We study content propagation on a huge online social network such as Facebook, Twitter. We employ a blend of techniques from the well-known theory of branching processes and our newly developed findings to derive the analysis of the content propagation. We explore the use of multi-type branching processes to analyse the viral properties of content in a social network, with and without competition from other sources. We derive and compute various virality measures, e.g., the probability of virality, the expected number of shares, or the rate of growth of the expected number of shares, etc.

Aanchal Panwar

Prof. K.S. Mallikarjuna Rao (IIT Bombay) & Prof. Shubhro Sarkar (IGIDR, Mumbai)

Research Area: I work in the area of auction theory especially on problems related to entry license auctions followed by aftermarket competitions . We study the interplay between bidding and market competition to understand the bidding behaviour in the licensing stage and the output decision in the market. Application of this include privatisation of any industry owned by government. Our main objective is to find the optimal number of entry licenses, while considering the trade off among consumer surplus, producer surplus, and revenue of the government.

Vinod S Khandkar

Prof. Manjesh Hanawal

Research Area: Net neutrality violation detection. The proliferation of Internet technologies has increased the volume of data flow by many folds. The concern over the handling of such ever increasing data volume has triggered the debate worldwide. It has resulted in defining net neutrality principle. It visualizes the Internet as an open and non-discriminating entity with equal treatment to all packets. Network operators are also provided with flexibility to perform traffic management practices (TMPs) under the equal treatment clause. So all packets are equally likely to receive all kinds of treatment. Such traffic management induces differences in performances perceived at the receiving end. Sometimes it is done deliberately which is referred to as non-neutral behaviour. Moreover, it may not be perceivable by the end user. There is another naturally occurring phenomenon called congestion. It also imparts differences in performances perceived at the receiving end. The combined effect of neutral traffic management practices and congestion poses a challenge for detection of net neutrality violation. The PhD research is aimed at development of net neutrality violation detection tool under such challenges. It is based on above mentioned two observations related to TMPs and congestion.

Nimita Shinde

Prof. Vishnu Narayanan & Dr. James Saunderson

Research Area: Semi definite optimization for large-scale problems using low memory. Low memory algorithms for semi definite programs via sampling: The work aims to find a near-optimal solution of a large-scale problem utilizing low memory. The idea is to keep track of a sample of the solution which retains as much information as possible.

Ravi Kant Rai
Prof. K.S. Mallikarjuna Rao

Research area: Game Theory. I work on Combinatorial Games and its bidding aspects.

Applications: Game theory has several applications to Income Taxation, Health Insurance provision and education. It also has wide application in auction design.

Recent Work: Recently, I have come up with an optimal strategy for different games like Duidoku, Gambling Tic-Tac-Toe, etc. I am currently working on bidding version of NIM game.

Fehmina Malik
Prof. Manjesh K. Hanawal

Research Area: Fehmina's area of research is Economics in the internet, specifically she is interested in network neutrality. She has studied the differential pricing in the internet and how it impacts Quality of Service (QoS) perceived by end users in the network. She studied under competition between Content Providers (CPs), which CP would prefer differential pricing and how Internet Service Provider revenue is affected.

Recent Work: Currently she is working on the problem of revenue sharing between providers in the internet using moral hazard framework as multi-leader follower game, where ISP's investment in the network benefits CPs by increasing their revenue. She aims to compare the benefits of individual providers and system in the neutral and non-neutral regime.

Akash Saha
Prof. P. Balamurugan

Research Areas: My research relates to solving classification and regression in supervised learning problems. This involves models learning from training data and performing tasks on test data. I am working on possible ways to incorporate kernel methods in a functional setting. Incorporating kernel methods with deep learning could provide new avenues of research.

Applications: The extension of kernel methods in a functional setting would be useful in sound and video analysis. The methods could find niche applications provided the scalability.

Recent Work: I have studied possible extensions of kernel methods in functional setting. I am trying to develop scalable algorithms for learning problems with inputs and outputs as functional data.

Chhavi Sharma
Prof. Vishnu Narayanan & Prof. P. Balamurugan

Research Areas: We are working on network-based distributed optimization. Distributed optimization is an optimization technique to solve large-scale problems by dividing them into smaller subproblems. These subproblems are solved separately and simultaneously with periodic information exchanges. This technique is widely used in various fields, for example, big data science, crowdsourcing, power grids network, classification problems, etc. We are trying to design an efficient accelerated algorithm to solve complex optimization problems in a decentralized manner.

Sasanka Sekhar Maiti

Prof. N. Hemachandra

Research Areas: Empirical analysis on inter-bank payment and settlement systems in India. The analysis includes policy assessment of public authorities, scope/need of improvements through oversight mechanism and regulations and recommending remedial measures supported by data analysis.

Sandhya Tripathi

Prof. Nandyala Hemachandra

Research Area: For classification problems, in current scenario, where crowdsourcing is the in thing, there is a high chance of the labels being incorrect (flipped) due to lack of expertise or annotation error etc. Sandhya is interested in devising cost sensitive (misclassification cost is class dependent) algorithms which are tolerant to label noise.

Recent Work: She has proposed two algorithms which are useful when there is different misclassification cost and the data is corrupted with symmetric label noise. The algorithms are both empirically and theoretically grounded. Some work on the role of Shapley value in binary classification is done. It is in the direction of explainable AI where cooperative game theory is used to understand or interpret the contribution of features.

Arun Verma

Prof. Manjesh K. Hanawal

Research Area: I am working on the online machine learning in particular unsupervised cost-sensitive sequential decision-making problems with limited feedback information. Currently, I am developing adaptive algorithms that exploit problem structure to optimally trade-off between cost and learning when the effectiveness of predictors are unknown.

I am also working on best arms identification problem in Multi-Player Multi-Armed Bandits and their applications in wireless Ad Hoc Networks like finding the best channels for user's communication.

Manoj Kumar

Prof. Narayan Rangaraj & Prof. Santosh Noronha

Research Areas: I am trying to apply sequential decisions in health care problems. The sequential decision is generally used in stochastic models, where the random nature of decisions being captured. Sequential decision problems are those problems where decisions will be taken sequentially to arrive at one stage from another, and the present decisions affect our future decisions and profit. These are applicable in health care because of the random nature of patients health conditions and other processes like a surgical process, diagnosis of cancer and liver transplant.

Prashant Palkar

Prof. A. Mahajan

Problem description: Prashant's research involves designing parallel heuristics and exact algorithms for solving MINLPs. He is also addressing interesting theoretical questions on guaranteed scalability of parallel algorithms. He implements his algorithms in MINOTAUR, an open-source MINLP framework. He also works with scientists from Argonne National Laboratory, USA on mixed-integer derivative-free optimization

Research Area: This research has impact on problems from numerous classical engineering and management applications and new fields like cyber security, brachytherapy, protein folding, robotics, network design, block layout design, etc.

Recent Research: He has designed and implemented shared-memory parallel nonlinear branch and bound and branch-and-cut algorithms and is presently using his framework to devise 'scalable' branching and node selection schemes with theoretical guarantees. On the other hand, he has designed a novel algorithm for optimizing convex black-box functions over bounded integer lattice. This approach works in absence of any derivative information and has a theoretical convergence proof.

Meenarli Sharma

Prof. A. Mahajan

Problem description: Meenarli is working on convex MINLPs, mainly on reformulations techniques that exploit problem structures to obtain tight convex relaxations. She is also looking at practical enhancements of linearization-based algorithms. She is one of the developers of MINOTAUR, an open-source framework for solving MINLPs. She is also working on a source inversion mixed-integer partial differential equation constrained optimization problem (MIPDECO) in collaboration with Dr. Sven Leyffer at Argonne National Laboratory USA.

Applications: This work has a wide spectrum of applications in engineering, economics, finance, and management.

Recent Research: She is devising practically effective methods for generating and adding tight inequalities in a branch-and-cut framework. Also, she is developing a trust-region based improvement heuristic for solving large convex MIPDECO problems..

Utkarsh Verma

Prof. Narayan Rangaraj

Research area: Utkarsh is working on the Kidney Exchange Program (KEP) where incompatible donor-recipient pairs participate in a paired exchange registry which permits mutual exchange of compatible kidneys between incompatible pairs. In addition to this, he is aiming at fusing KEP with deceased donor (DD) allocations to maximise the number of transplants and improve the quality of matches.

Recent work: He has developed integer programming models and algorithms to solve the kidney exchange program where the objective was to maximize the number of transplants over a network consisting of incompatible pairs considering the quality of matches which increase the expected graft survival of the transplanted kidney. He and his collaborators has developed a web based application which will allow nephrologists to use his models and algorithms in a user friendly manner. Also, he is trying to create mathematical models and framework for international kidney exchanges where multiple countries can share their data to optimize the number of transplants within a global registry. .

Master Thesis Projects @ IEOR

S.N o.	Name	Project Title	Supervisor
1	Panot Jigar Bhaishankar	Supply Chain Management in a Technology-Based Intervention in Rural Areas: Operational Process Design & Performance	Prof. Jayendran Venkateswaran
2	Inderjeet Singh	Anomaly Detection using Machine Learning Techniques (Class-Imbalance Problem)	Prof. N. Hemachandra
3	Rajat Mishra	System Dynamics Modelling of Energy Access Initiative	Prof. Jayendran Venkateswaran
4	Setu Hitesh Dave	Matrix Completion Problem	Prof. Vishnu Narayanan
5	Piyush Mittal	Electrical Vehicle Routing Problem	Prof. Manjesh Hanawal
6	Maheshwari Mayank Kamal Kishore	Competition Over Social Network with Partial Information	Prof. Veeraruna Kavitha
7	Sameer Agrawal	Forecasting in Hotel Industry	Prof. Manjesh Hanawal
8	Sufiyan Gulzar Adhikari	Driving Scene Recognition for Advanced Driver Assistance System in Heavy Vehicle	Prof. Manjesh Hanawal & Prof. P Balamurugan
9	Katre Sudhindra Jitendra	Performance Variability in MINLP Optimization	Prof. Ashutosh Mahajan
10	Vinay Chourasiya	Cut Generation & Management for Mixed Integer Nonlinear Optimization	Prof. Ashutosh Mahajan
11	Karan Patel	Queuing with Losses (Supermarket Model)	Prof. Veeraruna Kavitha
12	Vibhor Gupta	Illiquid Assets and Systemic Risk in a Large Financial Network	Prof. Veeraruna Kavitha & Prof. N. Hemachandra
13	Ashutosh Kushwaha	Detection of Diabetic Retinopathy in Color Fundus Images using Convolutional Neural Network	Prof. P Balamurugan
14	Nishant Mani Tripathi	Deep Neural Network for Financial Portfolio Management	Prof. P Balamurugan
15	Abhishek Kumar Sinha	Consensus Protocols in Block Chain	Prof. K.S. Mallikarjuna Rao
16	Jaswant Singh	Diagnosis of Heart Diseases Using Deep Neural Network	Prof. P Balamurugan
17	Mulay Pravin Tatyaram	Efficient Plan for Supplying Solar Lamp Kit to Assembly & Distribution Centers	Prof. Jayendran Venkateswaran
18	Amrutkar Gaurav Anil	Handling High Cardinality Features in Tree/Rule Based Classification	Prof. Narayan Rangaraj & Dr. Siddhartha SenGupta
19	Pawar Darshan Devidas	Bus Route Design in an Integrated & Multimodal Transit System	Prof. Narayan Rangaraj
20	Sourav Mondal	Runtime Estimation for Railway Timetabling	Prof. Narayan Rangaraj & Dr. Siddhartha SenGupta
21	Vhatkar Manjunath Shrinivas	Risk of Heart Disease Prediction after Dialysis	Prof. P Balamurugan & Prof. Narayan Rangaraj
22	Saurav Adhikari	Dynamic Pricing Strategies in the Indian Domestic Airlines	Prof. Narayan Rangaraj & Dr. Siddhartha SenGupta
23	Hitesha Nemade	Application of DES to Paint Shop	Prof. Ashutosh Mahajan

FIELD TRIP

Jawaharlal Nehru Port Trust (JNPT)

The IE 602 (Service Engineering and Management) course is designed to bridge the gap between Management and Engineering background as it basically deals with the topics which involves Managerial objectives to be achieved by applying Engineering methods. A few situations for this can be considered as decision making about selection of products for production among different available choices so as to maximize the profit using the available resources and ful-

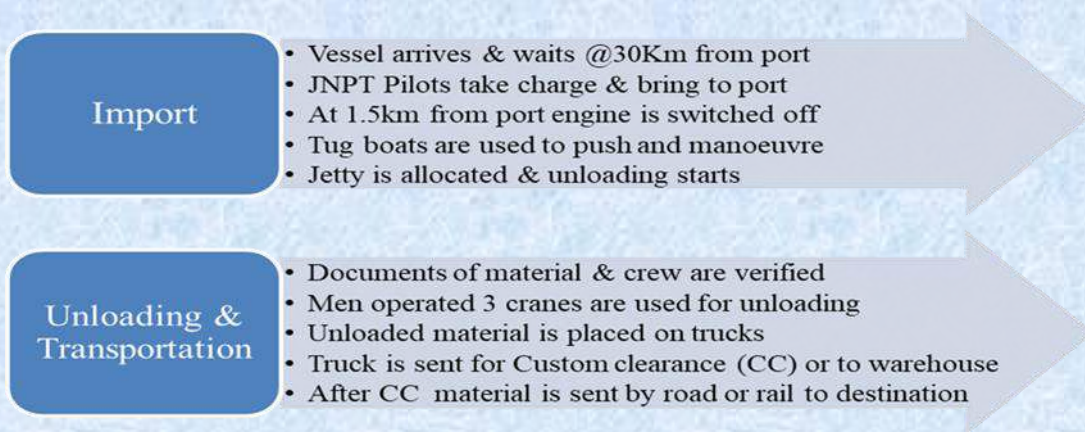
filling demand, optimizing the routes for transportations with best available resources, preferences for work completion methodology etc. In almost every scenario IEOR techniques are used for meeting the Socio-Eco (Societal and Economic constraints as per the situations provided) requirements. Students of this course have to do projects, so to bring more life to the projects, industry oriented projects have to be chosen therefore a visit to JNPT was organized on 7th February, 2019



Image: Professors and students with JNPT officials @ JNPT

by Prof. N. Ravichandran and Prof. K.S. Mallikarjuna Rao. At JNPT we were briefed by the chief engineer who gave us the overview of operations going on there. According to him, JNPT is biggest port in India in terms of container handling. Around 55% of the country's

containerized cargo handled at major port i.e. approximately 4 million TEUs (Twenty-foot equivalent units) in container throughput per year. Here, if we describe the whole process of JNPT functions and operations then it will be too lengthy, we will have a holistic overview as



Below. Same procedure is followed for export but in reverse order viz. collection of consignment, CC, loading and shipping. As of then, JNPT had 5 terminals, 4 dealt with containers and other was Liquid cargo terminal. Container terminals were being operated by JNPCT, DP WORLD, GTIPL & NSIGT and Liquid terminal jointly by BPCL and IOCL.

After the holistic overview of its functioning, further let's have some insight of the few operations being performed there which uses IEOB methodology/techniques:

1. Scheduling of Pilots: According to the scheduled arrival and departure of ships, scheduling of pilots, crew members & tug boats for bringing in or departing ships from JNPT are done.

2. Allocation of Jetty: Depending on the vessels, jetty allocation is done such that the vessels of particular consignee/firm are brought to that jetty.

3. Allocation of Vessel: The nature of items within container influences allocation of different vessels.

4. Stacking of Containers: A single vessel can be loaded with Containers from different sources/vendors. Not only these containers are from different vendors located at different locations but also consignment is for different destinations. Depending on source and destination locations, stacking of containers are done accordingly so that at any particular port, the Containers meant to be emptied there are unloaded without disturbing stacking of other containers.

5. Loading & Unloading of Containers: Firstly unloading is done by men operated three cranes allocated for each jetty at each terminal. Afterwards loading is done as per the defined stack-

ing preferences.

6. Movement of containers within port: As per the destined location of customer and service selected by them, containers are moved to warehouse for excise, documentation and other formalities and then arranging for its secondary travel by either rail or road.

7. Dry Ports: These acts as dummy ports located at different location of country (far from sea) which facilitates the paper work and handing over of consignment to port authorities. These ports improves the movement of imports and exports, reducing the time-consuming sorting and processing of containers inland which is performed away from congested seaports.

At last we were briefed by JNPT Management where discussion was about the probable areas which need improvement to curb the non-value added operations so as to increase the overall efficiency and effectiveness of JNPT so that they move in direction of achieving their goals of being among top 10 ports worldwide, handling 10 TEUs by 2022 and most efficient port in India. Below are the some areas/topics which students who visited JNPT are willing to take as project: Transportation, Warehouse utilization, Jetty Utilization, Pilot Scheduling, Stacking of container in vessels, lead time reduction, Study of Dry port facility, Asset utilization, Digitization & Automation etc.

After the visit we took the feedback from the students regarding usefulness of this visit. Approximately 77% rated 4 out of 5 while remaining gave 5. All felt, this visit provided a good exposure about industrial operations & functioning. We thank Prof. N. Ravichandran, Prof. K.S. Mallikarjuna Rao and IEOB department for organizing this visit.



The idea of the SoULS initiative started taking form in 2012 when Prof. Chetan Singh Solanki and Prof. Jayendran Venkateswaran started asking themselves why children in rural India are still studying in kerosene light and what could they do about it. The aim of the initiative then was to provide clean study light to school children and a viable alternative seemed to be solar lamps. However, despite the inception of solar power in the 1990s, it has not really taken off and common reasons cited for this were slow adoption, lack of local skills, unaffordability and that rural people cannot adapt to technology. Nevertheless, the Million Solar Urja Lamp (SoUL) program (MSP) was initiated believing in reliability and technology of solar power. So in early 2014, SoULS started with the support of the Ministry of New and Renewable Energy (MNRE) as well as with other partners like Tata, Idea cellular etc., with an initial aim of distributing 1 Million solar lamps at affordable prices to rural children. The key concepts struck upon for scaling this up were Localization, Affordability and Saturation.

The entire process of this project from assembly, distribution and maintenance of the solar lamps was localized. This not only helps in employment generation and reducing the cost of the process, but also builds the locals' confidence in solar Photovoltaic (PV) technology. Non-governmental

organizations (NGOs) were selected as the institutional partners for implementing the project. These NGOs are selected based on certain criteria and their knowledge of the people, the culture, language and the region make implementation smoother. These NGOs identify the people from across a block and coordinate with IIT Bombay to give the necessary training regarding the entire process thereby ensuring good quality while managing operations



and finances called SoUL Repair Centers (SRCs).

By the end of 2016, solar power which was once considered almost impossible to adopt had been distributed through 1 Million Lamps under the SoUL Program. The program thereon evolved to Solar Urja through Localization for Sustainability (SoULS) initiative with a bigger target of 7 Million. This time the emphasis was less on

distribution and more on creating an ecosystem of local entrepreneurs and distributors that would help provide clean energy access in rural India.

Until now, localization was done for assembling, distribution and maintaining the solar lamps, while manufacturing of parts was done elsewhere. To take it one step further, the Dungarpur Renewable Energy Technologies Pvt. Ltd. (Durga Energy) was set up at Dungarpur (Rajasthan), with IIT Bombay as the knowledge and technology partner. This is a private limited solar module manufacturing company which is managed and operated by tribal women. These women have undergone rigorous training in technology and operations to operate the company. The company aims at promoting quality off-grid solar solutions in a sustainable manner, for both the company and the community. This initiative provides employment to 200 local people at Dungarpur, with 50-75 locals provided direct employment, and about 125 locals supported indirectly.

SoULS initiative, for meeting the target of 7 million lamps, around 350 most eligible blocks out of around 1700 blocks had to be chosen based on their socio-economic criteria such as rural enrolment percentage, kerosene usage, number of people belonging to backward classes etc. These commendable required rigorous Industrial Engineering and Operations Research skills and the IEOR department at IIT Bombay played a big role in facilitating this. Along with Prof. Jayendran Venkateswaran, a number of IEOR students worked tirelessly on various problems surrounding SoULS. Students of IEOR developed a framework under which suitable blocks were selected. In addition, there were issues such as how to cluster these blocks and how to allocate these blocks to Assembly and Distribution Centre for efficient supply chain management, how to allocate these Assembly and Distribution Centers to suppliers, What will be the efficient supply plan for supplying solar lamp kits to Assembly and Distribution Centers, After Saturation of



Assembly and Distribution Centers and Repair and Maintenance work can Providers (Assemblers and Distributors) become solar entrepreneur and what will be key barriers for them to become solar entrepreneur, how to improve the efficiency of after-sales services, All these questions were answered using approaches in IEOR.

Thus with a noble, lofty aim and a scientific approach provided by IEOR for tackling challenges, SoULS is transforming rural lives. Moreover, SoULS has become a live example of the application of Industrial Engineering and Operations Research.

Students Solar Ambassador Workshop

If students, in their early age, learn to make their own solar devices and use them, not only they will likely to be future users of the solar energy but they will also be promoting its usage in their own generations and become Student Solar Ambassadors. Keeping this in mind, as a part of IIT Bombay's Diamond Jubilee Celebration- Student Solar Ambassadors Workshop was organized by SoULS, IIT Bombay and Techfest (IIT Bombay) on the 150th Birth Anniversary of Mahatma Gandhi, 2nd October 2018.

In this unique one-day training program over 5,000 students from more than 100 schools came together at IIT Bombay campus and learnt to assemble their own solar study lamps designed to help them to fulfill their study light needs. In addition to these 5000 students, more than 1 lakh students from every State and Union Territory in the country participated in this event. IIT Bombay and the MNRE entered the **Guinness World Records** for 'Most LED lights lit simultaneously'. At a Pan India level, IIT Bombay and the MNRE entered the India Book of Records for 'Largest Assembly & Demonstration of Led Lamps at Multiple Venues on a Single Day'.



51st Annual Convention ORSI and International Conference

The 51st Annual Convention of the Operational Research Society of India (ORSI) and International Conference (hereafter, ORSI 2018) was conducted at Victor Menezes Convention Centre (VMCC), IIT Bombay, Mumbai, India, from 16th -19th December 2018. ORSI-2018 was organised jointly by ORSI-Mumbai chapter and IIT Bombay, and was sponsored by Optym (Gold sponsor), JDA, Palisade, Spashta Technologies, Opex Analytics, Springer Publisher and IIT Bombay Diamond Jubilee office. The theme of ORSI-2018 was **"Emerging Trends in Operations Research and Management Science"**. The event saw a total of about 215 participants, and included students, faculty members, industry professionals and consultants. The conference saw participants from 7 countries: India, USA, Canada, France, Belgium, Nigeria, and South Korea. A total of 119 presentations were held, including 7 keynote lectures as well as ORSI Endowment Lecture, 10 invited talks, 91 contributed papers in parallel sessions, 4 workshop/tutorial sessions and 6 on-the-spot Blitz talks. The main conference spanned three days, 17th to 19th December 2018, with pre-conference tutorials/workshops held on 16th December 2018.

The conference was inaugurated by Prof. P. V. Balaji, Dean (R&D) IIT Bombay and Prof. Vijay Chandru (IISc), President-ORSI, with the inaugural keynote presented by Prof. Suvrajeet Sen (University of Southern California). The event also saw keynote presentations by Prof. Nicholas Hall (President-INFORMS), Prof. Luis Rabelo (University of Central Florida), Prof. Eitan Altman (INRIA, France), Prof. Vittal Prabhu (Penn State), Prof. Kavita Raman (Brown University) and Dr. Sven Leyffer (Argonne National Labs). Prof. Sandeep Juneja (TIFR, India) presented the ORSI



Endowment Lecture (instituted by Prof. P. Rajasekar Reddy). Invited talks were given by Prof. N. Ravichandran (IIMA), Prof. Vijay Chandru (IISc), Prof. V. Kavitha (IITB), Dr. Satyam Sahay (John Deere), and our sponsors. Several interesting papers on methodology as well as applications were presented during the parallel sessions, which were organised into tracks on 'Optimisation Methods and Applications', 'Stochastic Models', 'Simulation & Statistics', 'Data Analytics & Machine Learning', 'Game Theory', 'Supply Chain', 'Transportation & Logistics', 'Inventory', 'Quality', 'Scheduling', 'Pricing & Revenue Management', 'Health Care', and 'Urban Planning & Ecology'.

The final round for the ORSI's newly constituted Best Practice Award was also held during the conference. A total of six finalists, from TCS, Tata Steels, IBM and JSW, presented their work, which was evaluated by a panel of jury. All finalists received a citation from ORSI and a book by Springer. The first place was won by Tata Steels (Team: Satish Agarwal, Shweta Srivastava et. al.) for their work on "Prediction of coke strength post reaction using time series modelling".

A panel discussion was held on the broad theme of the conference. The panel members included Prof. Y. Narahari (IISc), Dr. Girikant Avadhunala (SAP-India), Dr. Arvind Kumar (Optym) and Dr. Badri Narayan (Indian Railways). They gave their views on how the field of Operations Research may evolve in the near and long term, given the various technological developments, especially in the area of data sciences and machine learning. The discussion was moderated by Prof. Narayan Rangaraj (IITB)

Workshop tutorials were conducted on Sunday, 16th December as a pre-conference event. Sessions of 3 hours each were conducted on the topics "Design of markets and service systems with strategic agents" by Prof. Krishnamurthy Iyer (Cornell University), "Introduction to Machine Learning", by Prof. Manjesh Hanawal & Prof. N. Hemachandra (IITB), and "Risk modelling and optimisation using simulation" by Prof. Pankaj Dutta (IITB), while the "Workshop on Computational Optimisation" by Prof. Ashutosh Mahajan & team (IITB) was for 5 hours. About 30 participants attended each session.

An exhibit hall was arranged in the foyer of VMCC, with booths by the sponsors JDA, Palisade, Spahsta, Springer and Optym, showcasing their products and services. Further, a stage was arranged in the exhibit hall for Blitz talks, featuring on-the-spot information sharing during breaks by any participant. There were a total of 6 blitz talks. Students of IEOR, IIT Bombay, conducted Puzzle-of-the-Day contest, featuring one puzzle on each day of the conference. A cultural evening was also organised as part of the conference events, performed by students of IIT Bombay.

The Annual General Body Meeting of ORSI was also held during the conference, where Prof. Vijay Chandru (IISc), President ORSI, handed over the responsibilities and welcomed Prof. Goutam Dutta (IIMA) as the new President of ORSI for the

term 2019-2020. In the ORSI awards ceremony, Prof. Y. Narahari (IISc) was felicitated with the M. C. Puri award. The P. C. Mahalanobis award for educators was presented to Prof. P. K. Ray (IIT Kharagpur) under Engineering category, Prof. R. K. Mohanty under Management category and Prof. Goutam Dutta (IIMA) under Operations Research category. Other notable attendees at the conference included Prof. M. R. Rao (ISB), Dr. Raj Sivakumar (Jet Airways), Prof. Sankarshan Basu (IIMB), Dr. Sanjay Kumar (IBM), Dr. Mathirajan (IISc), Dr. Siddhartha Sengupta (IITB/TCS), among others.

The conference organisers also promoted eco-sensitivity through simple initiatives. As part of the registration kit a high quality notebook, pen and pencil, all three made from recycled paper, were provided to the conference participants. Use of small bottled water was eliminated and instead filtered water in reusable water bottles and paper cups were used during the conference. Also, a survey was used to better estimate the food requirement of the participants, which helped reduce food wastage significantly during the ORSI 2018 conference.



Professor's Insight !!!

1. Why did you choose academics over industry?

- *No particular reason. In those days, the main job option open for people with a Ph.D. was academics, as there were very few positions in industry (at least in India). That is not the case anymore – I get far more enquiries for our Ph.D. graduates than before. The issue is why I did my Ph.D. in the first place. But that is a different question.* — **Prof. Narayan Rangaraj**
- *I don't know much about the industry. At some point during my PhD, academics seemed to be a natural career path to me, and I followed that.* — **Prof. Vishnu Narayanan**
- *I love academics; that's the only reason. The other reason was that I got an offer to do Ph.D., had I not got the offer, I might have chosen an industry.* — **Prof. Ashutosh Mahajan**
- *Academics fascinate me, excite me, lure me.* — **Prof. Veeraruna Kavitha**
- *Just for the sheer freedom it gives to perceive whatever that excites you.* — **Prof. Manjesh Hanawal**
- *There was no choice to be made. I was very keen to be a teacher from a very young age. I was very ignorant about the industry to really think of getting into it.* — **Prof. N. Ravichandran**
- *Liking for Academics. I worked for some 6 months in Siemens Information Systems Ltd as OR Consultant as my thesis is being evaluated and was exploring positions in Academia and was clear that I liked Academics much more.* — **Prof. Nandyala Hemachandra**
- *I did my graduation in IT from Thiagarajar College of Engineering, Madurai, then I worked in TCS. I came to IISC mainly because I didn't find my job that challenging. For me, learning never stops. I'm a constant learner and want to see things from different perspectives.* — **Prof. P Balamurugan**
- *Industry was never on my radar during my studies.* — **Prof. K. S. Mallikarjuna Rao**

2. For this ever-changing world what do you think the qualities that your students should possess?

- *Attention to detail, ability to learn new things and being able to work with others* — **Prof. N. Rangaraj**
- *Focus, focus, focus. Cannot emphasize this enough.* — **Prof. Vishnu Narayanan**
- *Student must be open to work on various domain, on various problems. These days, no matter how small a problem is, it is important to excel in whatever problem u work on regardless of its size and rewards. Also develop the habit of focusing enough on any problem.* — **Prof. Ashutosh Mahajan**
- *Honesty* — **Prof. Veeraruna Kavitha**
- *Hard working, passionate to excel, and never-give-up attitude.* — **Prof. Manjesh Hanawal**
- *Curiosity, Hardworking nature, Sincerity, and of course talent if applicable.* — **Prof. Nandyala Hemachandra**

- *The learning should not stop. Should be able to move out of their comfort zone. Build in ability to be flexible and adaptable to whatever changes that occur around them.* — **Prof. N. Ravichandran**
- *Ability to self-learn, Knowledge & practice of the Process of Science, Strong ethical character.* — **Prof. Sengupta**
- *Independent style of thinking and functioning is one of the major motivations for me to choose Academics. Possibly, industries also provide such environments these days, but to me Academics would be the right place to expect such freedom.* — **Prof. P. Balamurugan**
- *Persistence and thirst to learn apart from sincerity* — **Prof. K. S. Mallikarjuna Rao**

3. What kind of professors did you like as a student?

- *In those days, professors were the major source of whatever little knowledge we gained in a subject (books were not that easy to procure and even photocopying was a big effort and there was no internet). So I was forced to like most of them, as they knew something about some or other subject. I think I liked those whose classes resulted in good notes (i.e. who said something worth writing down. This could include different aspects, such as a logical flow of thought or interesting sidelights on a subject.* — **Prof. Narayan Rangaraj**
- *Looking back, my best teachers were not the entertaining teachers. They were the ones who tried to convey difficult ideas and made sure that if the student did the hard work, the student would succeed. The best teachers were the ones who would leave some work (with sufficient directions) for the student to complete so that the student could figure the rest on their own.* — **Prof. Vishnu Narayanan**
- *The profession is such that over the years we become very focused on our areas and that has its charm and I admire when professors were happy with what they were doing in life.* — **Prof. Ashutosh Mahajan**
- *Some teachers take you into a different world in most of their classes. I loved such teachers and used to look forward to their classes.* — **Prof. Veeraruna Kavitha**
- *Caring, humble, and technically sound.* — **Prof. Manjesh Kumar Hanawal**
- *Liked all to different degrees, except a couple who showed favoritism.* — **Prof. N. Ravichandran**
- *Scholarship, Commitment towards academics, Integrity (Perhaps, I was not that clear about these aspects in those days, but, surely these qualities appealed a lot to me.* — **Prof. N. Hemachandra**
- *I do not have any hard answer to this question. 'Quality' is very subjective. To me, anyone who stays curious and has the will to constantly learn and explore, is a lifelong student.* — **Prof. P. Balamurugan**
- *When I look back, the professors (and teachers) whom I remember are those who gave me food for thought.* — **Prof. K. S. Mallikarjuna Rao**

Professor's Talks/Seminars

Prof. K. S. Mallikarjuna Rao

1. "Stable Matchings", Workshop on Frontiers of Development Economics, Dibrugarh University, Dibrugarh, March 21, 2018
2. A Series of four lectures on "Measure Theory", Department of Mathematics, Dibrugarh University, Dibrugarh, March 21 - 24, 2018
3. "Robustness against Entry in Network Games", Network Science in Economics and Finance, IIM Ahmedabad 19th December, 2018
4. Graph Colouring and Anti-Coordination Games, Workshop on Game Theory and applications in Computer Science and Economics Ashoka University, 5—6 September, 2018
5. How to call a Spade by a Spade?, International Workshop on Game Theory and Networks Dibrugarh University 15th September, 2018
6. Market Design and Matching, McKinsey Knowledge Centre, Gurgaon 8th October, 2018
7. Uniqueness and decentralised algorithms in Marriage Markets, Department of Economics Indian Institute of Technology Kanpur, 11th October, 2018

Prof. P. Balamurugan

1. Talk on multi-structure SVM at JTG Summer School, IITB during July 2018
2. Talk on fundamentals of Deep Learning in TEQIP sponsored Faculty Development Program at Thiagarajar College of Engineering during October 2018
3. Talk on Machine Learning Possibilities for Oil and Gas Industry at BHGE, Bengaluru during November 2018
4. Enthuse 2.0 talk for Undergraduate students at IITB to motivate them towards research in Machine Learning, during January 2019
5. Talk on Advanced Neural Networks for Computer Vision in TEQIP sponsored Workshop on Visual Computing at Thiagarajar College of Engineering during February 2019
6. Talk on Deep Learning Fundamentals in TEQIP sponsored Machine Learning workshop at NIT Andhra Pradesh during March 2019

Prof. Veeraruna Kavitha

1. WSON Abstract

We consider random vector fixed point (FP) equations in large dimensional spaces, and study their almost sure solutions. An underlying directed random graph defines the connections between various components of the FP equations. Existence of an edge between nodes i, j implies the i -th FP equation depends on the j -th component. We consider a special case where any component of the FP equation depends upon an appropriate aggregate of that of the random 'neighbour' components. We obtain finite dimensional limit FP equations (in a much smaller dimensional space), whose solutions aid to approximate the solution of the random FP equations for almost all realizations, in the asymptotic limit (as the number of components become large).

2. ORSI's talk Abstract

A queuing system with heterogeneous customers. One class of customers is eager; these customers are impatient and leave the system if service does not commence immediately upon arrival. Customers of the second class are tolerant; these customers have larger service requirements and can wait for service. In this paper, we establish pseudo-conservation laws relating the performance of the eager class (measured in terms of the long run fraction of customers blocked) and the tolerant class (measured in terms of the steady state performance, e.g., sojourn time, number in the system, workload) under a certain partial fluid limit. This fluid limit involves scaling the arrival rate as well as the service rate of the eager class proportionately to infinity, such that the offered load corresponding to the eager class remains constant. The workload of the tolerant class remains unscaled. Interestingly, our pseudo-conservation laws hold for a broad class of admission control and scheduling policies. This means that under the aforementioned fluid limit, the performance of the tolerant class depends only on the blocking probability of the eager class, and not on the specific admission control policy that produced that blocking probability.

Prof. Nandyala Hemachandra

At AI Reasoning, IBM Research Labs, Bengaluru and Dept of Computer Science and Automation, IISc:

Title: Cost sensitive learning using data with symmetric label noise

Abstract: In binary classification framework, we are interested in making cost sensitive label predictions in the presence of uniform/symmetric label noise. We first observe that Bayes classifiers are not (uniform) noise robust in cost sensitive setting. To circumvent this impossibility result, we present two schemes; unlike the existing methods, our schemes do not require noise rate. The first one uses uneven margin squared loss function, which can handle cost sensitivity arising due to domain requirement or class imbalance or both. However, we observe that Bayes classifiers are also not cost sensitive and noise robust. We show that regularized ERM of this loss function over the class of linear classifiers yields a cost sensitive uniform noise robust classifier as a solution of a system of linear equations. We also provide a performance bound for this classifier. The second scheme that we propose is a re-sampling based scheme that exploits the special structure of the uniform noise models and uses in-class probability estimates. Our computational experiments on some UCI datasets with class imbalance show that classifiers of our two schemes are on par with the existing methods and in fact better in some cases w.r.t. Accuracy and Arithmetic Mean, without using/tuning noise rate. We also consider other cost sensitive performance

Conferences & Internships



UTKARSH VERMA

- Verma U and Rangaraj N "Heuristic solution and analysis of Kidney exchange program" 29th European Conference on Operational Research (EURO 2018), July 8-11th 2018, Valencia, Spain.
- Verma U and Rangaraj N "A heuristic approach for kidney exchange program" 8th VOCAL Optimization Conference: Advanced Algorithms, December 10-12th 2018, Esztergom, Hungary.
- Billa V, Verma U, Usulumarty D, Rangaraj N, Kumar R, Sanap G, Kothari J and Bichu S "A novel method to increase the kidney donorpool: A fusion model linking the deceased donor waitlist to a paired kidney exchange program" Indian J Transplant 2018;12:187-92

- Gave a talk on "Optimal play in Duidoku Game" at Combinatorial Game Theory colloquium held at LISBON, Portugal on January 24, 2019
- Gave a talk on "Who wins the Gambling Tic-Tac-Toe" at Recreational Mathematics Colloquium held at Lisbon, Portugal on January 29, 2019
- Presented a Poster on "Bidding Tic-Tac-Toe" at International Workshop on Game Theory and Networks held at Dibrugarh University



RAVI KANT RAI



ARUN VERMA

- 3 months Internship at Conduent Labs India, Bangalore from August 13 to November 9, 2018
- Presented his work titled, "Online Algorithm for Unsupervised Sensor Selection" at AISTATS 2019
- Presented his work titled, "Distributed Algorithms for Efficient Learning and Coordination in Ad Hoc Networks" accepted at WiOPT 2019
- Awarded Raman-Charpak Fellowship 2018
- Best poster award at AUAPAF 2018, Tsinghua University
- Awarded ACM-India/IARCS and Microsoft travel grant for attending

- Cost sensitive learning in the presence of symmetric label noise, To appear in the proceedings of PAKDD 2019, Macau
- Attended Neuro-Inspired computation course at IRCN, University of Tokyo, Japan. Also, presented poster titled "GAN based label noise robust classification" Duration: 21st March - 24th March 2019
- Workshop on Learning Theory, TIFR, Mumbai. Poster title: "Cost sensitive learning in the presence of Symmetric Label Noise"
- Workshop on Games on Networks and Queues, IIT Bombay. Poster Title: "Equilibrium points and equilibrium sets of some GI/M/1 queues"



SANDHYA TRIPATHI



PRASHANT PALKAR

- "A globally convergent simulation-based optimization with integer constraints", 23rd International Symposium on Mathematical Programming 2018, Bordeaux, France, July 01 – 06, 2018
- "Mixed Integer Derivative Free Optimization", 2018 Mixed Integer Programming Workshop, Greenville, SC, USA, June 18 – 21, 2018.

- "Inversion of Convection-Diffusion PDE with Discrete Source: Mixed Integer PDE Constrained Optimization, 23rd International Symposium on Mathematical Programming 2018, Bordeaux, France, July 01 – 06, 2018
- "Automatic reformulation techniques for mixed-integer nonlinear programs", 2018 Mixed Integer Programming Workshop, Greenville, SC, USA, June 18 – 21, 2018



MEENARLI SHARMA

PhDs graduated recently

Dr. Siddhartha Paul

Years @ IITB: 2010-2018

Degree Pursued: M.Sc.-Ph.D. (Dual Degree)

What I remember the most: My first day and final convocation day @ IITB

What do I miss: My IITB friends, the campus life, and interactions with my supervisor

What kept me going: Motivation and support of my family

Achievements related to academic: Published two journals and five conference papers

Ph.D. Thesis: Medicine Supply Chain Management in Response to an Infectious Disease Outbreak

Job title, Role Description and name of my employer:

Job Title: Operations Research Consultant

Role:

- Working on R & D for developing mixed-integer programming models for inventory management of perishable goods in Pyomo
- Worked on developing solutions for network optimization, demand forecasting, and order allocation for a global logistics company
- Used machine learning techniques for up-sell and cross-sell analysis of products in an agriculture company
- Used regression and classification analysis for predicting the amount of product returns and ranking customers based on the likelihood of return
- Built anomaly detection model to predict the customers to be churned and the key-driving factors

Employer Name: Antuit India Pvt. Ltd.

Typical working day @ my Employer: Includes some of the following. Working on R & D projects, building analytical models, data analysis, and finally presenting the results

What did I learn @ IEOR IITB: Fundamental and advanced IEOR topics, Research, etc.

My Advice: It is a privilege and great opportunity to study at such a great institute. So, try to make most out of it.

Ph.D. Thesis: Medicine Supply Chain Management in Response to an Infectious Disease Outbreak Name: Dr. Siddhartha Paul Supervisor: Prof. Jayendran Venkateswaran The overall goal of this dissertation is twofold, (i) to model and analyse the effect of medicine supply chain on the dynamics of infectious diseases (a.k.a. epidemics); (ii) improving the drug supply chain management to minimize the impact of an epidemic. The effect of drug shortages on the infectivity parameter estimation of antiviral treatable disease epidemics is evaluated using an illustrative dataset. Simulation-based analyses show that a given outbreak can be caused by either (i) a high infectivity parameter with a sufficient and timely supply of medicines or (ii) a low infectivity parameter and poor supply of medicines. Also, the use of a stand-alone epidemic model is found to overestimate the disease transmissibility. A compartmental epidemic is integrated with multi-echelon supply chain models to further investigate the impact of the medicine supply chain on the epidemic dynamics. In integrated models, medicine demands for the supply chain are generated from the disease model, and the medicine supply rate controls the recovery rate of patients in the disease model. It is found that supply chain aspects have a significant effect on the epidemic

dynamics. Some improvement schemes for supply chain management are also highlighted. All plausible behaviours of the integrated epidemic-supply chain model, under deep parameter uncertainty, are explored using exploratory modelling and analysis. The experiment is conducted for six different categories of epidemics, classified based on the disease transmissibility. Further, scenario discovery analysis has been used to identify the key input parameters' combination and their respective ranges responsible for a specific worst-case scenario. Finally, a couple of robust inventory management policies are proposed in order to alleviate an epidemic. A generic framework is developed, comprising a hospital, forecasting, and an inventory management module for medicine stock management of any regional level hospital during both regular and epidemic season.

Dr. G. Chandra Mouli

Years @ IITB: Dec 2010 to March 2019

Degree Pursued: Ph.D.

What I remember the most: Learning a lot of stuff especially open source ones.

What do I miss: Cool life of IITB, Linux

What kept me going: Never give up attitude

Achievements related to academic: Created an open source solver named "bcscgds"

Ph.D. Thesis: Novel Computational Approaches for Blackbox Optimization

Job title, Role Description, and name of my employer: Data Scientist, JDA Software.

Typical working day @ my Employer: Flexible timings.

What did I learn @ IEOR IITB: A lot; ranging from theoretical aspects to computational stuff.

My Advice: Don't give up and keep learning from your failures. You will eventually succeed.

Abstract: Many real-world optimization problems lack necessary information about the nature of underlying function and constraints. Such problems are commonly referred to as black box derivative-free optimization problems. They lack gradient information and are generally plagued by non-smoothness and presence of noise. On top of that, the computational cost of function evaluation is quite high, which severely restricts the application of traditional gradient-based approaches and metaheuristics to these problems. In the first part of this work, we proposed a new approach called Scaled Conjugate Gradient-based Mesh Adaptive Direct Search (SCG-MADS) for solving the unconstrained derivative-free optimization problems. A basic framework for the mesh adaptive direct search is composed of two parts, poll step, and search step. We suggested a new method for generating equiangular directions during the poll step, while for the search step we suggested the use of scaled conjugate gradient for computing new points. In the second part of this work, we extended the approach to handle bound constraints. We also proposed the use of quadratic models in conjugation with SCG-MADS to utilize any possible structural information. The proposed methods show good performance for high dimensional problems which are quite challenging in this area. The computational results show that both the proposed approaches are promising and competitive with respect to standard solvers.

Dr. Umakanta Pattanayak

Ph.D. Thesis: Geometry of Mixed Integer Hulls of Convex Sets

Achievement: Excellence in Ph.D. Research Award

PLACEMENTS 2018-19

Sr. No.	M.Tech./ M.Sc.	Name	Company	Profile
1	M.Tech.	Abhishek Kumar Sinha	ANZ Bank	Modelling Analyst
2	M.Sc.	Richa Dhingra	McKinsey Knowledge Centre	Analyst
3	M.Tech.	Inderjeet Singh	NEC Japan	Research Security
4	M.Sc.	Shivangi Saklani	Procter & Gamble	Associate Manager Product Supply
5	M.Sc.	Aakash Banik	Exxon Mobil	Engineer Upstream
6	M.Tech.	Vinay Chourasiya	Exxon Mobil	Engineer Upstream
7	M.Sc.	Saumya Suri	Citibank	Analyst
8	M.Sc.	Alisha Arora	DHL Supply Chain India Pvt. Ltd.	Management Trainee
9	M.Tech.	Jigar Panot	DHL Supply Chain India Pvt. Ltd.	Management Trainee
10	M.Tech.	Saurav Adhikari	DHL Supply Chain India Pvt. Ltd.	Management Trainee
11	M.Tech.	Mayank Maheshwari	Axis Bank	Manager
12	M.Tech.	Sudhindra J. Katre	Boeing India	Data Scientist
13	M.Sc.	Vishal Dawar	TransUnion CIBIL Limited	Manager - IT
14	M.Tech.	Nishant Mani Tripathi	Capital First Ltd	Business Analyst
15	M.Tech.	Gaurav Amrutkar	HSBC Global Service Centre	Analyst
16	M.Tech.	Jaswant Singh	TCS R&D	System Engineer
17	M.Tech.	Piyush Mittal	TCS R&D	System Engineer
18	M.Tech.	Vibhor Gupta	TCS R&D	System Engineer
19	M.Tech.	Ashutosh Kushwaha	Flytxt Mobile Solutions Pvt. Ltd.	Deputy Manager
20	M.Tech.	Karan Patel	ICICI Lombard General Insurance Company Ltd.	Manager-Business Analyst
21	M.Tech.	Setu Hitesh Dave	Curl Analytics	Junior Data Scientist
22	M.Tech.	Sufiyan Gulzar Adhikari	Curl Analytics	Junior Data Scientist
23	M.Tech.	Pravin Mulay	JDA Software Pvt Ltd.	Business Consultant
24	M.Tech.	Sourav Mondal	JDA Software Pvt Ltd.	Business Consultant
25	M.Tech.	Sameer Agrawal	Hilabs	Data Scientist
26	M.Tech.	Rajat Mishra	Sheorey Digital Systems Pvt. Ltd.	OR Analyst
27	M.Tech	Manjunath Vhatkar	Redefine Global	Product Manager

Students Activity Column

LIFE @IEOR

Students of IEOR department are provided with an energetic and friendly environment which gels the newly inducted and the previous ones. The focus is on the all-round development of the students viz. Academics, Cultural and Sports. The guidance & experience of seniors motivates and enlightens



Academic Workshops

1. PYTHON:

This workshop was held on August 19, 2018 for the PG freshers' of IITB to introduce the foundations of coding in Python. Python is the most preferred programming language these days as it supports multiple programming paradigms, including object-oriented,

imperative programming styles. Python is known for its ease of developing your own tools and as well as for developing secured websites and programs. It also has tons of libraries that helps throughout your journey in the field of programming. Hence, it provides an excellent platform to work with Python is used pretty

much wherever a programmer, who knows Python, wants to focus on solving a problem instead of struggling with implementation details. It was conducted by Post Graduate Aca-

ademic Council (PGAC) in collaboration with Institute student companionship programme (ISCP) & Institute research student companionship programme (IRSCP).

“Saathi haath badhana...”

Together we learn ..

Together we Excel..!

2. MATLAB:

MATLAB workshop was held on September 2, 2018. It was an institute level workshop conducted by post graduate academic council (PGAC) in collaboration with Institute student companionship programme (ISCP) & Institute research student companionship programme (IRSCP). This workshop

was conducted for the PG freshers' of IITB to give them basic idea of coding in MATLAB. Matrix Laboratories popularly known as MATLAB is a high level programming language. It is used to perform various type of computational processes such as matrix manipulations, plotting of mathematical functions,

algorithm implementation and interfacing of user defined programs to the programs written in different computer languages such as JAVA, C, Python etc.

3. LATEX:

LaTeX workshop was held on October 6, 2018. This was an institute level workshop conducted by post graduate academic council (PGAC) in collaboration with Institute student companionship programme (ISCP) & Institute research student companionship programme (IRSCP)

LaTeX is a versatile word processing software widely used for technical writing, and it is completely free. We can use it to write letters, reports, and prepare presentations.



Cultural Activities

Farewell for Outgoing Batch:

A farewell was organized by IEORSA for the year 2018 batch of M.Tech and PhD students on 7th May 2018. IEOR faculty members joined in to spend some time with them. Sameer Agrawal, General Secretary of IEORSA, was the presenter for the evening. The graduating students introduced them-

selves briefly, shared their experience in IEOR and on campus, and shared their future plans. They were then presented with gifts by faculty members. Some fun games were also organized. The faculty members shared their thoughts and blessed the outgoing batch with their advice. A vote of thanks was given by the

presenter, then followed by a group photograph & dinner.

“Achchha Chalte Hain...

... Kbhi Alvida Na Kahana!”

An everlasting bond between

Senior & Junior

Orientation for new Entrants:

A new beginning starts with joining of new members in our IEOR family. For these newly admitted students, the orientation session was organized on 15th July 2018. The new students and present students briefly introduced themselves. Prof. N. Hemachandra gave a brief overview of IEOR interdisciplinary programme. Prof. A. Mahajan, the faculty adviser for M.tech students, Prof N. Hemachandra, faculty

adviser for MSc PhD and Prof V Kavitha, faculty adviser for PhD students, talked about course and other academic

“SUSWAGATAM.....!!!”

Welcome to the IEOR

family Fellas, a new world begins now.

requirements. All faculty members then introduced themselves. This is followed by an

informal interaction between the new students and the new students and the IEORSA and ISCP (Institute students Companion Programme) teams. Then the Senior students explained the semester registration process and provided assistance for the same.

Students Activity Column

Fresher's Welcome:

IEORSA organized fresher's welcome get together on 5th August, 2018. The event started with the wishes to newcomers from our faculty for their stay on the campus. This was followed by an informal introduction of students. Students were arranged in four groups and various group games were played and final winner of games Sohan Punia awarded



as the Best Freshie. Overall evening was full of fun and interactions among IEOR students.



Teacher's Day Function:

members, and seek their bless-



IEOR students organized a function on 5th September on the occasion of Teacher's day. Students took the opportunity to share experiences, express gratitude towards faculty

ings. Some Pictionary games were organized.



Dussehra Pooja:

IEOR staff and students organized Dussehra pooja on 18th October 2018. The evening started with aarti and some bhajans. Prasad was distributed after the pooja.

Students Activity Column

Diwali celebration:

The time when we miss our home most is the time of the festival. IEORSA organized Diwali celebration on 8th November to make us feel like home in IEOR. All staff, faculty members and students participated



in the celebration. The evening started with the Laxmi pooja followed by an open mic and then some games. Some competition like rangoli and Diya painting were also organized.



Convocation:

Graduation is a reflection of past hard work and successes as well as hope for the future endeavour.

To make this more memorable Convocation is organized on August 11th, 2018.

The event started with the introduction of guests and

their wishes for students.

Convocating students were

Umakanta Pattanayak was

awarded '*Excellence in PhD Re-*

search'

Award

whereas

Arun

Rama-

murthy

was

awarded the Institute

Silver Medal.



presented with their degree.

Students Activity Column

Cultural participation :

Students actively participated in various

cultural events in the institute.

Aman and Suyog participated in debate and Hindi poem



competition respectively organized by PG Cult. Utkarsh Singh

participated in Picturesque, organized by lifestyle club. Suyog

IITB, Symphony.

Satyam Verma and Jaswant



Dhamal machao...

played the harmonica in Surbhar organised by music club of

Singh participated in PG cult phase 2.

Farewell to Prof P.G. Awate:

A farewell function was organized by the department for Prof P. G. Awate on August 20th, 2018. Prof P.G. Awate is one of the founding members of IEOR.



All faculty, staff, students and some alumni joined in the function. Prof N. Rangarajan introduced Awate sir and shared his memories with him. Faculty members and students also shared

their memorable moments with Awate sir. In the end, Awate sir shared his experience with IEOR and IIT Bombay.

*Ye Karwan yuhi
Badhta rahe...!*



Sports

IIT Bombay offers enormous opportunities in sports to its students where one can avail the world class facilities. All it requires is to have hunger of exploring and learning new sports. Being a department of 100+ students we have shown our presence in almost 15+ Post Graduate General Championships (PG GCs) and tried to

build a sports spirit. Some of the well-known PG GCs in which we participated were Cricket, Basketball, Volleyball, Football, Badminton, Chess, Table tennis, Swimming, Athletics and Hockey. It's not that easy to secure good position without effort and practice so we sweated a lot to bag number of medals. Some of the

players of our department participated in various sports events in inter-IIT and outside IIT. Girls from our department stepped out to make their presence stroked with enthusiasm and fighting to be the best. So with active participation from the overall department we secured 6th rank in PG GCs tally in the Institute.

Mallikarjuna Reddy of M.Tech is one of the best Athletes of



our department. He bagged 3 medals in PG GCs and Institute event (Silver in 10km Cycling,

Bronze in both Biathlon & 5km Running. Besides this he participated in events outside of the institute; completed three full Marathons, more than 10 Half Marathons and also actively participated in Swimming & Cycling.

If we look into our team performance then we achieved medals in some of the events.

Silver Medal (Chess PG GC Girl's);

Participants: *Shiksha Singhal, Nimita Shinde, Fehmina Malik, Aanchal Panwar and Khushboo Agarwal.*

Silver Medal (Volley Ball Boys);

Participants: *Prashant Palker, M Venkateswararao K,*



Students Activity Column

*Setu Dave, Jaswant Singh,
Vinay Chourasiya, Ashutosh
Kuswaha, Utkarsh Singh and
Santosh Nanabhau.*

Bronze Medal (Table Tennis);
Participants: *Meenarli Sharma,
Prashant Palker, Sameer
Agrawal, Indrajit Saha & Ankit.*



Thoughts of our Stars about Sports:

Through sport we learn to work together, to cope with winning and losing, and to strive to be the best. Participation in sport and physical activity positively impact physical and mental health. Furthermore, due to the regular involvement in sports, one can have higher self-image and confidence levels, improved teamwork and communication skills, and leadership skills that can lead to achievement opportunities in any area of life.

Aanchal Panwar
(Joint Secretary Sports-Girls)

In our department, students are enthusiastic about sports and they understand its importance and keep balance between studies and sports.

Jaswant Singh
(Joint Secretary Sports- Boys)

In fitness, there are no shortcuts. It involves immense discipline and hard work.

Sathish Kumar
(Inter-IIT player)

Practicing and participating in inter-IIT are among my memorable times in IIT. For me sport is always a good means of entertainment as well as a way to physical activity. Playing sports refreshes me and as a bonus it keeps me connected with a lot of people. In addition, it feels good to be a part of our institute sports teams.

Meenarli Sharma
(Inter-IIT player)

"Kheloge Kudoge banoge
NAWAB...!
Health rahegi hamesha
LAJAWAB..!"

Playing different sports helps me keep my physique and mind fresh, I like and take it as a routine that complements my profession. An implication of this, I compete in PG Sports,

Inter-IIT Sports Meets etc. which has helped polish various dimensions in my personality: presence of mind, directed preparation and practice, always focusing on basics, being calm but pushing the limits in clutch situations and most importantly, working with teammates having different skills but the same goal.

Prashant Palker
(Inter-IIT player)

Grab the opportunity and give your time to build a sportsmanship in you. Once you passed out, the only memories you have is your learning experience.

Arun Verma
(Inter-IIT player)

Fitness is a way of life. Try to achieve it through whatever sport you like and excel.

Mallikarjuna Reddy
(Endurance Athlete)



Inputs: Mufassir, Ankush , Piyush & Darshan

सैर कर दुनिया की गाफिल, ज़िंदगानी फिर कहाँ
ज़िन्दगी गर कुछ रही तो ये जवानी फिर कहाँ

Ismail Meruthi

Living the life means exploring the world and best way to do that is to travel. When you travel, you discover new things, new feelings and new ways to see this world.

So, hop on the backseat as we drive you through our trip.

Feb 28, 2019:

After our mid-semester exams, we were all very excited for our most awaited departmental trip to Goa. With lots of enthusiasm, we, group of 40 students, reached Thane Railway Station to board Mangalore Express train for our night journey to Goa. We didn't even realized how our train journey passed as we were too involved in random activities like singing, playing music, different games and clicking lots of pictures.

March 1, 2019:

As we stepped out of train at *Karmali* Railway Station early morning, cold breeze left us shivering. We were mesmerized by natural beauty all around us. The place was clean and beautiful with small hills on one side and river on the other. The morning sunrays gave us the required warmth.

From there, we boarded the bus to reach our beach house located just a few steps away from *Anjuna* Beach. Our beach house was a perfectly chosen destination to accommodate our big group of 40. As soon as we reached, everyone rushed to *Anjuna* Beach. Some of us couldn't resist playing handball, some enjoyed walking along the shore, while few sat peacefully to observe the undulating waves of the sea.

We hired different vehicles (Scooties, Bikes, and Thars) to explore the best in Goa. Our first destination was *Aguada Fort* where we spent few hours enjoying the majestic grandeur view of the sea from the height. All of us were very excited to give the best pose in every possible manner. We then visited *Basilica of Bom Jesus Church* and *Se Cathedral Church*. The churches had huge architecture with beautiful pictures which took us back to the ancient period of *St. Francis Xavier*. After dusk, we headed to *Mangeshi Temple*. On the way back to our beach house, we stopped at *Our Lady of Immaculate Conception Church* which was dressed in captivating lights. We had mouth-watering dinner prepared by chef at the beach house, after which some of us chose to rest while others left for night crawling at *Anjuna Beach*.

March 2, 2019:

Most of us decided to go for Scuba Diving and water sports for which we woke quite early. We stepped on the boat and wore life jackets as we

were taken to *Island de Grande* which was a 1 hour journey from *Candolim Beach*. Instructors guided us throughout the diving as we explored the breath-taking underwater life. We had a serene experience in Scuba Diving. After diving, we stayed in the waters for hours. Each one of us prayed to be there for eternity.

In the evening, we all went to *Chapora Fort* and enjoyed the blissful sunset one can ever experience in Goa. In the night, we visited the most happening *Saturday Nite Bazaar* which had musical performances by local artists, stalls offering unique musical instruments, handicrafts, idols and sculptures, etc. Also visited the *Baga beach* which was famous for its glamorous nightlife.

March 3, 2019:

We got up a bit late. As soon as we had our breakfast, we packed our bags and meals for our further journey. We hired a Bus to explore more of South Goa. Enroute, we stopped by *Indian Naval Aviation Museum*. This museum contains exhibits

that showcase the evolution of the Indian Naval Air Arm over decades. The Naval Aviation Museum is the only of its kind in Asia.

We had a surprise pizza party in the bus on the way to our final destination and had a great time playing musical games along with different musical instruments where we sang our heart out. Our final destination, *Palolem Beach*, was one of the best beaches of Goa. As we landed, it felt like we entered into great artistic imagination of a beautiful painting of sunset in front of our eyes. We couldn't resist ourselves playing handball along the seashore. We left this place with heavy heart as it was the time to say goodbye to Goa. We didn't forget to capture this precious moment.

We headed to *Canacona Railway Station* to board *Matsyagandha Express* train which got us back to where we started this memorable journey. We had our reservations in different coaches and hence the fun part was to serve our packed meals to all.



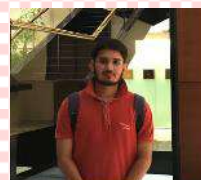
IEORSA Council 2018-19



Prof Manjesh Hanawal
President



Aanchal Panwar
Joint Secretary – Sports Girls



Mayank Maheshwari
Joint Secretary – Academics



Jaswant Singh
Joint Secretary (Sports-Boys)



Sameer Agrawal
General Secretary



Vibhor Gupta
*Joint Secretary
(Library and Publications)*



Rajat Mishra
*Joint Secretary
(Culturals)*



Manjunath Vhatkar
*Joint Secretary
(HR)*

ALUMNI PERSPECTIVE

Q. How different is your life in corporate world and how do u manage it?

Ans. When I left the institute, I didn't know what I am going to be today. You make a 5 year plan rather than 25 year plan. Last 13 years I have spent in shipping industry. And constantly learning through all leadership roles and watching other leaders.

Q. What did you enjoy the most in IEOR?

Ans. The fact that I got stipend helped. It is a multidisciplinary programme and hence there's an opportunity to learn in multiple disciplines. I sat in library or in any classes and used to study any topic.

Q. How do you relate IEOR academics to industry?

Ans. If you think you can take the learnings from here and apply it directly in the industry, then you will be disappointed. What your approach should be - "Given a problem, can u solve it".

Q. Can you recall any incident related to Professor Awate?

Ans. I have a deep, deep respect for Professor Awate. He was my guide, every week we met on Saturday for 2 hours. He used to give ideas which I would research further in the library. And next week I gave whatever research I did on the ideas given by him and he would praise me for the ideas. Irony is that, he himself gave those ideas but still was humble enough to give me credit.

Q. You believe that convergence of different technologies is going to change the industry. Can you elaborate on the same?

Ans. Different technologies, AI, Deep research in Health-care and pharma if combined with tech would create multiple possibilities. Facial recognition is alright but what can you do with the face recognized. It is certainly an area to explore with tremendous possibilities.

Q. What are the opportunities for start-ups in IEOR fields?

Ans. Starting-up has really become easy now. Biggest challenge that I see is determining the problem that is really important to solve for the customer. Having a good idea and building upon that, constantly adapting with the needs of customer.

Q. How do you get best out of your colleagues?

Ans. You have to always inspire people and let them know what is possible. You need to challenge them with problems that they believe they cannot solve.

Q. What is your inspiration behind following philosophy and social work?

Ans. This started from my mother, she was a school teacher. She left behind some of her savings saying that interest from that money should be used for social work. Earlier I started with funding the large NGOs, but now I think it is better to get involved directly and try to be of help.

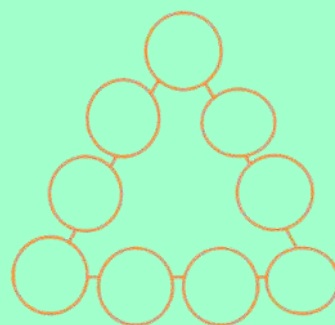
Mr. Sriram Narayan Swamy

Quiz time

1. A man is standing on the island. A benevolent genie presents three boxes, 23 white marbles and 7 black marbles and instructs the man, “You may distribute the marbles into the boxes in any way you see fit, but you must use all of the marbles. Once you finish, you will choose a box at random and then choose a marble from that box at random. If the marble is white, then I will help you to escape from this place”. Assuming the man distributes the marbles in his best interest, what is the probability that he escapes the island?

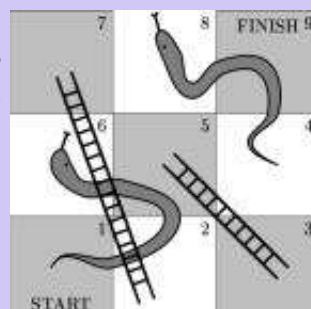
2. Ramesh and Suresh are good friends and quite intelligent too. Suresh searched for a good two player game and came up with the above game and the description for the same is as follows-

“Each player alternatively fills a number in each cell. Numbers ranging from 1-9 can be used without repetition. To win, the player who can make one of the edges to have sum equal to 20 wins the game (all circles on the claimed edge should be filled). The game gets over if one of the edges is completely filled and the sum of that particular edge is 20 and the player filling the last circle of the same edge is the winner.”

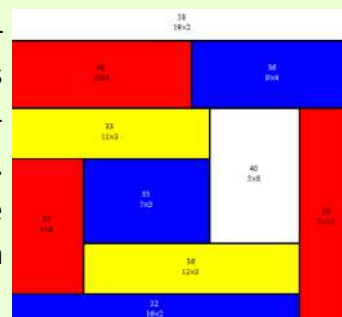


3. A simplified version of “snakes and ladders” is played on a board of nine squares shown below. At each turn, the player tosses a fair coin and advances one step if the coin lands heads and two steps if the coin lands tails. Assume that only one player plays the game.

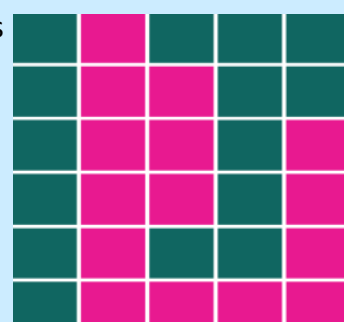
- How many turns on average does it take to complete the game?
- What is the probability that a player finishes the game without landing on a snake head?



4. Partition a 5*5 square into multiple non-congruent, integer-sided rectangles such that the difference between the largest and smallest area rectangles is minimum. As shown is an example of 19*19 square with best such partition. The difference of maximum and minimum area rectangles is $40 - 32 = 8$. There can be multiple such solutions. After such a partition for 5*5 square what is the minimum difference between the largest and the smallest area rectangles?



5. Divide the shape above into **six contiguous**, five-square districts. What is the maximum possible number of districts with a pink majority?

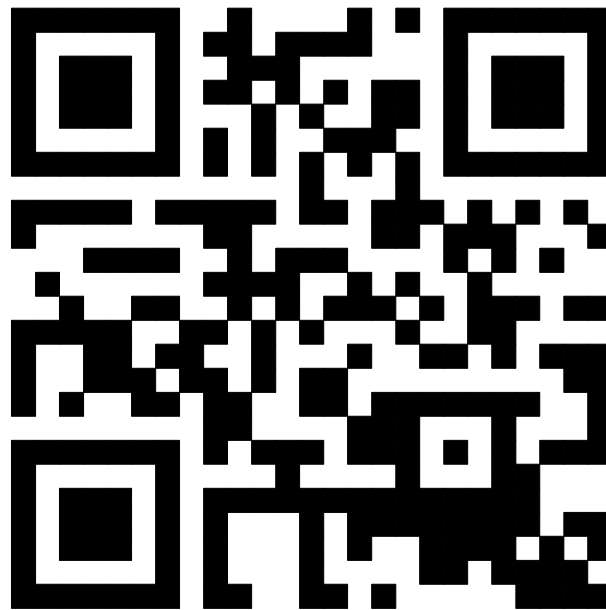


6. A person wants to sell his house. At the beginning of each week he receives an offer, which must be accepted or rejected immediately. Once an offer is rejected, it is lost forever. Assume that successive offers are independent of each other and take on values 38000, 40000, and 42000 with respective probabilities $1/2$, $3/8$ and $1/8$. In each week, a maintenance cost is also incurred if the house remains unsold. In the n -th week, this cost is equal to $50(0.99)^n$. What policy should be followed in order to maximize the expected total profit?

A policy is a rule for choosing an action at each point in time. For simplicity assume that the action specified by a policy at particular time depends only on the current state of the system.

7. A random chess knight makes each permissible move with equal probability. If it starts in a corner, how many moves on average will it take to return?

Hint: This problem can be viewed as a random walk on a graph. The vertices are the squares of the chessboard and the edges are the moves that the knight can make.



Scan me for the Answers



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