

# BROCHURE

## *Data Analytics for Operations Research*



## *Data Analytics for Operations Research*

<[http://home.iitk.ac.in/~raghus/GIAN\\_DAOR/](http://home.iitk.ac.in/~raghus/GIAN_DAOR/)>

November 14<sup>th</sup> to 18<sup>th</sup>, 2018

at

Indian Institute of Technology Kanpur, INDIA



### **COURSE CO-ORDINATOR**

Prof. Raghu Nandan SENGUPTA

Industrial & Management Engineering Department

Indian Institute of Technology Kanpur, INDIA

Ph: +91-512-333-6607; Cell: +91-99843-86557; Email: [raghus@iitk.ac.in](mailto:raghus@iitk.ac.in)

# **BROCHURE**

## ***Data Analytics for Operations Research***

### **GIAN (Global Initiative of Academic Networks)**

*GIAN (Global Initiative of Academic Networks)* is a Government of India (GoI) approved program in Higher Education aimed at tapping the talent pool of scientists and entrepreneurs, internationally to encourage their engagement with the institutes of Higher Education in India so as to augment the country's existing academic resources, accelerate the pace of quality reform, and elevate India's scientific and technological capacity to global excellence.

### **Data Analytics for Operations Research**

#### **Overview**

Data Analytics is the scientific process of transforming data so that we can develop insights for making enhanced and prudent decisions. Operations Research (OR) is concerned with developing modeling and analysis tools to help make better decisions. OR modeling was always informed by statistical methodologies, and the new data analytics techniques are having a similar impact. This advanced course on Data Analytics for Operations Research is focused on exploring the synergy between these two domains of knowledge: tools for efficiently solving optimization problems that arise in data analytics, and understanding how to use insights from modern data analytics to design improved decision making models. We will survey a range of data analytics techniques including regression, classification, clustering, and Bayesian models, and a range of optimization techniques, including linear, integer and non-linear optimization, large scale optimization, and optimization under uncertainty.

#### **Objectives**

Today, the data underlying many practical decision making problems is in tera and peta bytes, and in order to develop good decision making methodologies, one needs an excellent background in three different areas: modern statistical and machine learning techniques for data analysis, optimization modeling and methods, and large scale computing and data base management. This course titled Data Analytics for Operations Research is envisioned to give the students an in-depth and rigorous grounding in modern methods in large-scale optimization and data analytics. Participants of this course will be given the theoretical rigour and practical experience necessary for solving data-driven decision problems in a wide variety of application areas, e.g. business analytics, data science, project management, and portfolio management.

# **BROCHURE**

## ***Data Analytics for Operations Research***

### **Course details**

Regression, Logistic regression, LASSO, Classification, Support vector machines (SVMs), Clustering, Bayesian Models, Markov Chain Monte Carlo (MCMC) methods, Linear and convex optimization, integer optimization, stochastic and robust optimization.

### **Intended Audience**

- 01) Academically oriented good post graduate and doctoral students, well trained faculty members, who have an aptitude and interest in Statistics, Mathematics, Engineering, Social Science, Quantitative and Operations Research, Data Sciences, etc., and are keen to utilize the advanced topics of Data Analysis and Operations Research to further their knowledge in their respective academic and professional fields.
- 02) Dynamic professionals from government organization, private sectors, related industries, working in areas related to data analytics, data science, etc., who wish to gain extensive knowledge in fields, related to mathematical modeling, statistical techniques, optimization, operations research, machine learning, etc.
- 03) People in academia and industry (e.g., health, logistics, social networking, government organization, airline, computing, ICT firms, etc.,) or anyone keen to gain expertise in areas of Big Data usage, through development of statistical software, application of quantitative methods, etc., in their respective sphere of functioning in order to contribute more fruitfully.

### **Benefits for the intended audience**

- 01) Equip the participants with innovative problem solving capabilities in different areas of data analysis using existing and new tools from Operations Research through interactive class lectures and discussions through advanced course materials.
- 02) Make the participants/students well versed in different theoretical as well as practical nuances of data analysis using concepts of operations research, statistical techniques and machine learning through hands on tutorials.
- 03) Build as well as enhance the existing ambit of knowledge and skill sets of the participants/students through rigorous theoretical as well as problem solving methods.

# BROCHURE

## *Data Analytics for Operations Research*

### Workshop/Class Schedule

Instructors: (i) Garud IYENGAR (GI), Columbia University, USA; (ii) Kalyanmoy DEB (KD), MSU, USA; (iii) Sandeep JUNEJA (SJ), TIFR, INDIA and Raghu N. SENGUPTA (RNS), IIT Kanpur, INDIA

Date/Day	Timing hours	Session No. #/Day	Title	Detailed Description
14-Nov-18 (Wednesday) (1 <sup>st</sup> Day)	1000-1130	1/1	Regression	Linear regression, bias-variance decomposition, subset selection
	1200-1330	2/1	Regression (contd)	Shrinkage methods, e.g. ridge regression and LASSO. Convex quadratic programs with constraints. Convex optimization problems and global optimality
	1500-1630	3/1	Regression (contd)	Sparsity via $L_1$ norms and linear optimization, Mixed 0-1 quadratic optimization problems, Regularization as robust optimization
	1700-1830	4/1	<i>Tutorials/Problem solving</i>	Based on: Lecture # 01, # 02, # 03
<b>End of day 1</b>				
15-Nov-18 (Thursday) (2 <sup>nd</sup> day)	0900-1030	1/2	Regression (contd)	Regression with a Gaussian process prior. Logistic regression and Generalized Linear Models (GLMs)
	1100-1230	2/2	Classification	k-nearest neighbors, Optimal Bayes classifier, Naive Bayes, Empirical risk minimization (ERM), Gradient descent and stochastic gradient descent algorithms for large scale ERM
	1400-1530	3/2	Support Vector Machines (SVMs)	Classification and regression using SVMs, Kernel methods and the kernel "trick", Hilbert spaces and Representing Kernel Hilbert Spaces (RKHS), Constrained convex programs and Alternating Direction Method of Multipliers (ADMM)
	1600-1730	4/2	<i>Tutorials/Problem solving</i>	Based on: Lecture # 05, # 06, # 07
<b>End of day 2</b>				
16-Nov-18 (Friday) (3 <sup>rd</sup> Day)	0900-1030	1/3	Resampling Methods for model assessment and selection	Resampling Methods for model assessment and selection, cross-validation methods
	1100-1230	2/3	Bootstrapping Aggregation (Bagging)	Classification and regression trees (CART), Random forests
	1400-1530	3/3	Clustering Algorithms	Clustering Algorithms, k-means, k-medoids and kernel k-means clustering, Mixed 0-1 linear programs
	1600-1730	4/3	<i>Problem solving</i>	Based on :Lecture # 09, # 10, # 11
<b>End of day 3</b>				
17-Nov-18 (Saturday) (4 <sup>th</sup> Day)	0900-1030	1/4	Dimension Reduction Methods	Principal components analysis (PCA), kernel PCA, SVD and numerically stable methods for SVD
	1100-1230	2/4	Matrix decomposition techniques	Non-negative matrix decomposition, Page Rank, Matrix decomposition using nuclear norm, ADMM for matrix decomposition
	1400-1530	3/4	Expectation-Maximization (EM) Algorithm	EM Algorithm, Applications include clustering via normal mixture models, the general EM algorithm via Kullback-Leibler divergence
	1600-1730	4/4	<i>Tutorials/Problem solving</i>	Based on: Lecture # 13, # 14, # 15
<b>End of day 4</b>				
18-Nov-18 (Sunday) (5 <sup>th</sup> Day)	0900-1030	1/5	Expectation-Maximization (EM) Algorithm (contd)	Applications to revenue management and pricing
	1100-1230	2/5	Empirical likelihood methods	Comparison with Bayesian methods, Information divergence, distributionally robust optimization
	1400-1530	3/5	Optimal transport methods	Wasserstein metric and robust optimization
	1600-1730	4/5	Group Presentation/Examination	N/A

## BROCHURE

### *Data Analytics for Operations Research*

#### Information about instructors/special invitees



**Garud IYENGAR** is a Professor in the Industrial Engineering and Operations Research Department at Columbia University, USA. He completed his B.Tech from Indian Institute of Technology Kanpur, INDIA in 1993. He has an M.S. (1995) and PhD (1998) from Stanford University. His research interests are broadly in information theory, control and optimization. His published works span a diverse range of fields, including information theory, applied mathematics, computer science, operations research, economics and financing engineering. His current projects focus on the areas of large scale portfolio selection, systemic risk management, quantitative marketing, smart grids, sports analytics, and systems biology



**Kalyanmoy DEB** is Koenig Endowed Chair Professor at Department of Electrical and Computer Engineering in Michigan State University (MSU), USA. He also holds joint appointments at Department of Mechanical Engineering and at Department of Computer Science and Engineering at MSU. Prior to his joining MSU, he was at IIT Kanpur. Prof. Deb's research interests are in evolutionary optimization and their application in optimization, modeling, and machine learning. He was awarded the Infosys Prize, TWAS Prize in Engineering Sciences, CajAsturMamdani Prize, Distinguished Alumni Award from IIT Kharagpur, Edgeworth-Pareto award, Shanti SwarupBhatnagar Prize in Engineering Sciences, and Bessel Research award and Humboldt Fellowship from Germany. He has been awarded an honorary doctorate degree from University of Jyväskylä, Finland. He is fellow of IEEE, ASME, and three Indian science and engineering academies. He is also an IEEE Distinguished Lecturer. He has published over 400 research papers and two text-books on optimization with a Google Scholar citation of 71,000 with h-index 88. His NSGA-II paper on multi-objective optimization published by IEEE Trans. on Evolutionary Computation has received more than 6,000 Web of Science citations in 2015 and is judged as the most highly cited papers from India. He is in the editorial board on 20 major international journals. More information about his research contribution can be found from <http://www.egr.msu.edu/~kdeb>

## BROCHURE

### *Data Analytics for Operations Research*



***Sandeep JUNEJA*** is a Professor and Dean at School of Technology and Computer Science in TIFR, INDIA. He received his B.Tech from IIT Delhi and MS and PhD from Stanford University, USA. Thereafter he worked with American Credit Indemnity in USA. From 1996 for six years he was a faculty members at IIT Delhi, INDIA after which he moved to TIFR, Mumbai, INDIA. His research interest lie in applied probability, Monte Carlo methods and gametheoretic analysis of quesues. He is currently on the editorial board of Stochastic Systems, He is the receipient of the IBM faculty partnership award in the year 2001-2002



***Raghu Nandan SENGUPTA*** is a faculty in the IME department, IIT Kanpur, INDIA. His research interests are in Sequential Analysis, Statistical & Mathematical Reliability, Optimization and its use in Finance. His research work has been published in Metrika, EJOR, Sequential Analysis, CSDA, Communications in Statistics: Simulation & Computation, Quantitative Finance, FCDS. He has been awarded IUSSTF Fellowship 2008, EMEA-ERASMUS MUNDUS Fellowship 2011, EU-NAMASTE-ERASMUS MUNDUS Fellowship 2014 and DAAD Research Fellowship 2015 & 2017

## **BROCHURE**

### ***Data Analytics for Operations Research***

### **Indian Institute of Technology Kanpur, INDIA**



Indian Institute of Technology, Kanpur (IIT Kanpur) is one of the premier technical institutions established in 1959 by the Government of India with the collaboration of a consortium of nine universities from the USA. IIT Kanpur goal and mission is to provide meaningful education, to conduct original research of the highest standard and to provide leadership for the growth of this country. At present IIT Kanpur has a sprawling residential campus of 1055 acres with about 3500 undergraduate and 1500 postgraduate students, 400 faculty members and more than 1500 supporting staff. The institute has a well designed faculty building, fully equipped classrooms, seminar and conference rooms, computer science building, biological sciences building, residential quarters for the faculty & staff members, hostels for the students, an excellent library, etc. The presence of lush green trees, manicured lawns, wide roads make the campus picturesque and well endowed. IIT Kanpur has always strived to develop itself into an institution of excellence in education and research in consonance with the contemporary and future needs of India. The institute has made special efforts to recruit talented faculty on a worldwide basis and admits students in the different programs from all over the country by a very careful selection process. In addition to offering formal undergraduate, post-graduate and Ph.D. programs, the institute has also been involved in continuing education and research & development in areas of value to both the industry and the society. The vision of the institute is to emerge as an international centre of excellence in all facets of technical and management education by being a melting pot of academia, industry and research, but at the same time being rooted in Indian ethos and societal values. For ease of navigation one can find a detailed map of the campus at Map of the campus: <[https://www.iitk.ac.in/tkic/MAP/IITK\\_Map.pdf](https://www.iitk.ac.in/tkic/MAP/IITK_Map.pdf)>.

# **BROCHURE**

## ***Data Analytics for Operations Research***

### **Industrial & Management Engineering Department**



The Department of Industrial & Management Engineering (IME) at Indian Institute of Technology Kanpur (IIT Kanpur), INDIA was established with the aim of synergizing technology with management in a comprehensive manner so that the knowledge gained may be used for the benefit of the society at large. The journey started in 1988 with the Ph.d and M.Tech programmes, and in 2001 the department introduced the MBA programme. IME department also has the BTech-MTech/BS-MTech/BTech-MBA/BS-MBA programs. Another flag ship program of the department is the VLFM program which is jointly run by IIT Kanpur, IIT Madras and IIM Calcutta. The focus of the department is to develop techniques and the skills sets relevant to students with diverse backgrounds, and who may wish to subsequently pursue a career in academics or in different technical and managerial positions in Industrial & Management Engineering related industries. The department covers a whole gamut of areas in Industrial & Management Engineering, that includes Operations Research, Operations Management, Production & Supply Chain Management, Quantitative Methods & Decision Making, Marketing/Services Management, Business/Social Media Analytics, Innovation & Entrepreneurship, Organizational/Human Resource Management, Business Economics, Infrastructure & Public Systems, Financial Markets and Models, Enterprise Information and Knowledge Systems, etc.

One can look at the map of the campus: <[https://www.iitk.ac.in/tkic/MAP/IITK\\_Map.pdf](https://www.iitk.ac.in/tkic/MAP/IITK_Map.pdf)> to find where we are located.



# **BROCHURE**

## ***Data Analytics for Operations Research***

### **How to reach IIT Kanpur, INDIA**

The campus of IIT Kanpur is located off the Grand Trunk Road (NH-91) near Kalyanpur, about 16 km west of Kanpur city one of the biggest in the state of Uttar Pradesh of INDIA.

**From New Delhi to Kanpur:** To reach Kanpur one can avail either train from New Delhi station (NDLS) to Kanpur Central Railway station (CNB) or take a flight from Indira Gandhi International Airport/New Delhi Airport (DEL) to Chaudhary Charan Singh International Airport (LKO).

**From Kanpur Central Railway station (CNB):** Kanpur Central Railway station (CNB) is well connected to most cities in North, East and Central India. It is located on the Delhi-Kolkata train route and all major trains between these cities usually pass through Kanpur. The campus is located at a distance of about 20 kilometers from the Kanpur Central Railway Station (CNB), hence participants (one should always exit from platform # 01) can pre-book the taxi <<https://www.iitk.ac.in/estateoffice/data/taxi-details.pdf>>. Typical cost for campus taxis will be Rs. 400 (+35 Parking ). It is also possible to hire taxis (about Rs. 350)/Ola (about Rs. 250)/Autorickshaws (about Rs. 250) to IIT Kanpur campus from the Kanpur Central Railway Station (CNB). It takes about 40 minutes to drive from Kanpur Central Railway Station (CNB) to IIT Kanpur <<https://www.google.co.in/maps>>.

**From Lucknow Chaudhary Charan Singh International Airport (LKO):** Chaudhary Charan Singh International Airport (LKO) is located about 80 kms from IIT Kanpur. Participants can pre-book the taxi <<https://www.iitk.ac.in/estateoffice/data/taxi-details.pdf>> . Typical cost will be Rs. 1800. Once can also book pre-paid (about 1700)/Ola (about 1700). It takes about 2 hours to drive from Chaudhary Charan Singh International Airport (LKO) to IIT Kanpur <<https://www.google.co.in/maps>>.

### **Important for Participants (Especially Foreigners)**

- 01) Check the weather during your visit.
- 02) Drink bottled water, do not take any food/fruits/eatables offered to you or which is not clean.
- 03) Carry you personal belongings/money/passport carefully.

# BROCHURE

## *Data Analytics for Operations Research*

### How to Apply, Payment Details, Important dates

01) Please check the blank format of [ONLINE](#) application first (sample give below) and be ready with the following, (i) Amount paid via NEFT; (ii) Bank details from where NEFT payment has been made; (iii) NEFT payment ID; (iv) NEFT payment date; (v) Passport size photograph (.jpg format); (vi) ID/bona fide letter of institute/university/organization.

02) NEFT payment details

Bank A/C: 10426002126  
Name of A/C Holder: Registrar, IIT Kanpur  
GSTIN Number: 09AAAJI0169A3ZL  
Bank Name: State Bank of India (SBI) <<https://www.sbi.co.in/>>  
Branch: IIT Kanpur, Kanpur – 208016, INDIA  
Ph: +91-512-333/392/679-0592  
Email: [sbi.01161@sbi.co.in](mailto:sbi.01161@sbi.co.in)  
Branch Code: 01161  
IFC Code (For NEFT/RTGC): SBIN0001161  
MICR Code: 208002041  
SWIFT Code: SBININBB499

03) Important Dates

Round of acceptance/notification	Deadline
1 <sup>st</sup> round (after payment/form is received)	15-Oct-18 (2359 hours (IST))
2 <sup>nd</sup> round (after payment/form is received)	31-Oct-18 (2359 hours (IST))
3 <sup>rd</sup> round (after payment/form is received)	10-Nov-18 (2359 hours (IST))
Workshop	14-Nov-18 to 18-Nov-18

04) For any further information and any queries, you are welcome and also advised to get in touch with faculty co-ordinator:

Prof Raghu Nandan SENGUPTA  
IME Department, IIT Kanpur, Kanpur 208 016, INDIA  
Ph: +91-512-2596607; Cell: +91-99843-86557  
Email: [raghus@iitk.ac.in](mailto:raghus@iitk.ac.in)

# BROCHURE

## *Data Analytics for Operations Research*

### Details about payment/accommodation/etc.

Seats for the workshop are limited. Hence the applicants are advised to do their online registration along with workshop registration fee payment at their earliest convenience.

#### Note

- The *workshop registration fee* includes course materials, notes, reading material, kit for the workshop, access to net facilities, snacks and lunch (in between the workshop for ALL the five (05) days of the workshop). The details of *workshop registration fee (inclusive of GST charges as per norm)* are as follows

Category/Type of Participation	Workshop registration fee
Foreign national	USD 500 (five hundred only)
Industry Professionals	INR 15,000 (fifteen thousand only)
Faculty members	INR 10,000 (ten thousand only)
Students (MSc/MTech/Phd/MPhil,MBA etc.)	INR 5,000 (five thousand only)

- Participants are required to bring their own laptops for the hands-on sessions.
- Accommodation is available on a payment basis (this amount is not included under *workshop registration fee*) and information about types of stay is available below

S No.	Type	Details
01	Visitors' Hostel (VH) < <a href="http://www.iitk.ac.in/vh/">http://www.iitk.ac.in/vh/</a> >	VH (Boarding and Accommodation Charges for Visitors' Hostel & Rental Charges for Facilities at VH & Allied Services < <a href="http://www.iitk.ac.in/vh/update/VH_Rent_2014-2015-21.pdf">http://www.iitk.ac.in/vh/update/VH_Rent_2014-2015-21.pdf</a> >)
02	Visitors' Hostel (VH) < <a href="http://www.iitk.ac.in/vh/">http://www.iitk.ac.in/vh/</a> >	VH-Extension (Tariff Plan for Main Auditorium & Boarding and Accommodation Charges for Visitors' Hostel Extension < <a href="http://www.iitk.ac.in/vh/update/VH_Rent_2014-2015-22.pdf">http://www.iitk.ac.in/vh/update/VH_Rent_2014-2015-22.pdf</a> >)
03	Students' Hostel < <a href="https://www.iitk.ac.in/dosa/">https://www.iitk.ac.in/dosa/</a> >	N/A

- Breakfast and dinner costs has to be borne by the participants during the duration of stay at IIT Kanpur for the workshop and rates are very nominal (e.g.: <http://www.iitk.ac.in/vh/Rate-Revision-of-Catering-Charges-of-VH.pdf>, or Hostel food (which is a maximum of Rs. 100/- per meal)).

# BROCHURE

## *Data Analytics for Operations Research*

**Sample registration form (information has to be filled ONLINE)**



## *Data Analytics for Operations Research*

Name (Ms./Mrs./Mr./Dr./Prof.): \_\_\_\_\_

Sex (Male/Female/Others): \_\_\_\_\_

DoB (dd/mm/yyyy): \_\_\_\_\_

ID Card No. \*: \_\_\_\_\_

Position/Designation: \_\_\_\_\_

Official Address: \_\_\_\_\_

City: \_\_\_\_\_ Pin Code: \_\_\_\_\_ State: \_\_\_\_\_ Country: \_\_\_\_\_

Ph: \_\_\_\_\_ (with ISD/STD code) Cell: \_\_\_\_\_ (with ISD)

E-mail: \_\_\_\_\_

NEFT/SWIFT Amount: (INR/USD)\*\* \_\_\_\_\_

NEFT/SWIFT Ref. No.: \_\_\_\_\_ NEFT/SWIFT date (dd/mm/yyyy): \_\_\_\_\_

Payee Bank: \_\_\_\_\_ Payee bank branch code: \_\_\_\_\_

Payee bank address with phone/email, etc.: \_\_\_\_\_

City: \_\_\_\_\_ Pin Code: \_\_\_\_\_ State: \_\_\_\_\_ Country: \_\_\_\_\_

Signature: \_\_\_\_\_ Date (dd/mm/yyyy): \_\_\_\_\_

### **Passport details for foreign participants**

Passport Number: \_\_\_\_\_ Issuing country: \_\_\_\_\_

Issue date (dd/mm/yyyy): \_\_\_\_\_ Expiry date (dd/mm/yyyy): \_\_\_\_\_

### **Note\*\*/\*\*:**

- (i) For ID Card No. add institute/university/organization/etc., or ANY relevant authentic proof.
- (ii) Bank/transfer surcharge/commission/foreign exchange conversion, etc., for the NEFT/SWIFT to be paid by the participant ONLY.

Latest passport  
size photograph  
would come here