BROCHURE
Multiobjective Optimization Using Metaheuristics

Multiobjective Optimization Using Metaheuristics

March 03rd to 07th, 2018

at

Indian Institute of Technology Kanpur, INDIA

COURSE CO-ORDINATOR
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GIAN Programmes

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.

GIAN Programme: Multiobjective Optimization Using Metaheuristics

Overview

Multi-objective optimization (also known as multicriteria optimization, vector optimization and multi-objective programming) is an area within Operations Research that is concerned with the solution of problems having two or more (normally conflicting) objective functions that need to be optimized simultaneously. Multi-objective optimization has tremendous practical importance, since almost all real-world optimization problems are ideally suited to be modeled using multiple conflicting objectives, as evidenced by an important number of applications currently available in engineering, science and economics. The classical means of solving multi-objective optimization problems were primarily focused on aggregating multiple objectives into a single scalar value. However, the advent of digital computers eventually gave rise to new numerical methods to deal with many complex problems, including those involving multiple objectives, which can now be handled in their original vector form. Metaheuristics on the other hand are high-level search procedures that apply some form of rule or set of rules based on some source of knowledge in order to explore the search space in a more efficient way. Metaheuristics cannot guarantee (in general) convergence to the global optimum, but normally provide reasonably good approximations of it in a reasonable CPU time. Because of their flexibility, generality and ease of use, metaheuristics have become increasingly popular in the last 30 years as optimizers of complex problems. One particular class of metaheuristics that has become quite popular in the last few years is that inspired on biological concepts such as evolution, ants' movements, birds' flight patterns, etc. These approaches are collectively known as bio-inspired metaheuristics. From them, evolutionary algorithms (e.g., genetic algorithms, evolutionary programming and evolution strategies) have been the most popular choice for designing new optimizers. Multi-objective evolutionary algorithms have become increasingly popular in the last 18 years, mainly because of their generality (e.g., they require little specific domain information and are less susceptible to the specific features of the problem to be solved than mathematical programming techniques), their ease of use (the source code of many of them is available in the public domain) and their advantages (e.g., they normally operate with a set of solutions, which makes possible to generate several trade-off solutions with a single algorithmic execution, as opposed to mathematical programming techniques, which normally operate with one solution at a time).

Objectives

The objectives of this advanced level workshop/course titled *Multiobjective Optimization Using Metaheuristics* is multi fold some of which are:

01) Make the participants acquainted with both the main modeling ideas of multiobjective problem formulation as well as the in-depth theoretical knowledge required to solve them.

02) Help the participants understand the history of metaheusristics methods, the important concepts related to the set of rules based on how the metaheuristics techniques work.

03) Acquaint the participants of how to combine the concepts of multiobjective optimization and metaheuristics to solve a variety of theoretically rigorous and practically interesting problems in different domain of applications.

04) Equip the participants with the knowledge to carry out independent projects in the area of multiobjective optimization using metaheuristics in a vast range of areas spanning diverse fields like engineering, management, and sciences.

Course details

The course will cover the fundamental concepts related to multi-objective optimization, as well as different techniques to solve these problems. It will emphasize the research work done in areas of multi-objective evolutionary algorithms and put emphasis on bio-inspired metaheuristics (e.g., particle swarm optimizers, tabu search, artificial immune systems, and differential evolution, among others). Ideas related to Pareto optimality, ideal vector, nadir point, utopian point, etc., will then be discussed. Other concepts related to multi-objective evolutionary algorithms like aggregating functions, decomposition methods, indicator-based approaches, etc. will also be taught. Furthermore ideas related to fitness sharing, clustering, adaptive grids, along with standard test problems adopted to validate multi-objective evolutionary algorithms (ZDT, DTLZ, WFG) will be covered. Both unary and binary performance indicators used to assess performance of multi-objective evolutionary algorithms will be the next focus. Furthermore ideas related to Memetic algorithms and other hybrids that combine multi-objective evolutionary algorithms with local search techniques and extensions of particle swarm optimization, tabu search, differential evolution, etc., will be also be taught. Finally techniques that allow the incorporation of user's preferences into a multi-objective evolutionary algorithm will be covered. To wrap up this course we will go into depth with some of the recent and open research areas within evolutionary multi-objective optimization.

Who can attend the workshop

01) This advanced level course in multiobjective optimization and heuristics is meant for (i) both post graduate & doctoral students who are academically oriented, (ii) faculty members who are well trained in their subject areas and (iii) industry experts who have the domain experience, such that all of them may utilize the concepts in the areas related to multiobjective optimization, mathematical programming, different metaheuristics, etc., for better analysis and decision making.

02) People from fields as diverse as Social Science, Quantitative and Operations Research, Data Sciences, Engineering, Public Policy makers, Government Official, etc., who are keen to utilize the advanced topics of multiobjective optimization and metaheuristics (with their applications) to further their knowledge in their respective academic and professional fields.

03) Professionals from government organization, private sectors, related industries, who are dynamic and are willing to pick up the nuances in the fields of public decision making using variety of such multiobjecive optimization tools along with a repertoire of metaheuristics methods.

04) 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 related to concepts of multiobjective optimization and metaheuristics such that the concepts learned can be successfully used in their respective sphere of functioning in order to contribute more fruitfully.

Benefits for the intended audience

01) The course will undoubtedly equip the participants with innovative problem solving capabilities in different areas of multiobjective optimization using metaheuristics techniques and related areas, through intensive/comprehensive theoretical class lectures as well as hands on tutorials and discussions through advanced course materials and problem solving lectures.

02) Make the participants/students well versed in different theoretical as well as practical nuances of multiobjective optimization and heuristics, through hands on tutorials and problem solving class schedules.

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 in areas related to multiobjecive optimization and metaheuristics techniques.

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Workshop/Class Schedule

Date (dd/mm/yyyy)/Day	Timing	Session No. #/Day	Title	Detailed Description
03-Mar-2018 (Saturday) (1st Day)	0900-1030 hours	1 of 1	Basic concepts (part 1) 1.5 hrs	Concepts such as Pareto optimality, ideal vector, nadir point, utopian point, etc.
	1100-1230 hours	2 of 1	Basic concepts (part 2) 0.5 hrs Multi-objective evolutionary algorithms (part 1) 1 hr	A detailed review of the most relevant multi-objective evolutionary algorithms that have been proposed (Pareto-based, aggregating functions, decomposition methods, indicator-based approaches, etc.)
	1400-1530 hours	3 of 1	*Tutorials/Problem solving*	Based on: Lecture # 01, # 02
	1600-1730 hours	4 of 1	*Tutorials/Problem solving*	Based on: Lecture # 01, # 02
End of day 1				
04-Mar-2018 (Sunday) (2nd day)	0900-1030 hours	1 of 2	Multi-objective evolutionary algorithms (part 2) 1 hr Techniques to maintain diversity (part 1) 0.5 hrs	Fitness sharing, clustering, adaptive grids, etc.
	1100-1230 hours	2 of 2	Techniques to maintain diversity (part 2) 1.5hrs	Fitness sharing, clustering, adaptive grids, etc.
	1400-1530 hours	3 of 2	*Tutorials/Problem solving*	Based on: Lecture # 03, # 04
	1600-1730 hours	4 of 2	*Tutorials/Problem solving*	Based on: Lecture # 03, # 04
End of day 2				
05-Mar-2018 (Monday) (3rd Day)	0900-1030 hours	1 of 3	Test Problems (part 1) 1.5 hrs	Standard test problems adopted to validate multi-objective evolutionary algorithms (ZDT, DTLZ, WFG)
	1100-1230 hours	2 of 3	Test Problems (part 2) 0.5 hrs Performance indicators 1 hr	Both unary (e.g., inverse generational distance, hypervolume, etc.) and binary performance indicators used to assess performance of multi-objective evolutionary algorithms
	1400-1530 hours	3 of 3	*Tutorials/Problem solving*	Based on: Lecture # 05, # 06
	1600-1730 hours	4 of 3	*Tutorials/Problem solving*	Based on: Lecture # 05, # 06
End of day 3				
06-Mar-2018 (Tuesday) (4th Day)	0900-1030 hours	1 of 4	Performance indicators 0.5 hrs Hybrid approaches 1 hr	Memetic algorithms and other hybrids that combine multi-objective evolutionary algorithms with local search techniques
	1100-1230 hours	2 of 4	Other bio-inspired metaheuristics (part 1) 1.5 hrs	Multi-objective extensions of particle swarm optimization, tabu search, differential evolution, etc.
	1400-1530 hours	3 of 4	*Tutorials/Problem solving*	Based on: Lecture # 07, # 08
	1600-1730 hours	4 of 4	*Tutorials/Problem solving*	Based on: Lecture # 07, # 08
End of day 4				
07-Mar-2018 (Saturday) (5th Day)	0900-1030 hours	1 of 5	Other bio-inspired metaheuristics (part 2) 0.5 hrs Incorporation of user's preferences (part 1) 1hr	Techniques that allow the incorporation of user's preferences into a multi-objective evolutionary algorithm (a priori, interactive, a posteriori)
	1100-1230 hours	2 of 5	Incorporation of user's preferences (part 2) 1 hr Open research problems (0.5hrs)	Some of the recent and open research areas within evolutionary multi-objective optimization (e.g., large scale multi-objective optimization, many-objective optimization, indicator-based selection, etc.)
	1400-1530 hours	3 of 5	*Group Presentation/Examination*	Based on whole set of lectures and tutorials
	1600-1730 hours	4 of 5	*Group Presentation/Examination*	Based on whole set of lectures and tutorials

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<u>Information about the instructors</u>

	Carlos A. Coello COELLO is currently full professor with distinction (Investigador Cinvestav 3F) at CINVESTAV-IPN in Mexico City, MEXICO. Dr. Coello has done pioneering research work in an area which is now known as "evolutionary multi-objective optimization", mainly related to the development of new algorithms. He has published over 450 papers in international peer-reviewed journals, book chapters, and conferences. He received the 2007 National Research Award, TWAS Prize 2016, IEEE Kiyo Tomiyasu Award 2013, National Medal of Science and Arts 2012, etc.
	José Rui FIGUEIRA is faculty at University of Lisbon, PORTUGAL, researcher at CEG-IST, Center for Management Studies of Instituto Superior Técnico, PORTUGAL and associate member at LORIA laboratory, Nancy, FRANCE. He obtained his Ph.D. as well as his HDR in from University of Paris-Dauphine FRANCE. His research interests are in decision analysis, IP, network flows and MCDA. His research has been published in journals as OR, EJOR, COR, JORS, AOR, JMCDA, OMEGA, etc. He currently serves as Editor of the Newsletter of the European Working Group on MCDA and one of the coordinators of this group. He is also the Book Editor Section of the EJOR and Associate Editor of JMCDA and of the International Journal of Multi-Criteria Decision Making.
	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

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>.

How to reach Indian Institute of Technology 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) It is Holi <https://en.wikipedia.org/wiki/Holi> during 01-Mar-18/02-Mar-18 so plan you travel accordingly.
03) Drink bottled water, do not take any food/fruits/eatables offered to you or which is not clean.
04) Carry you personal belongings/money/passport carefully.

How to Apply

01) Please check for the application Form and fill up the same.

02) Fill the downloaded application form and send the **filled application form**, **other details** with the required **account payee demand draft** to the address given below, marking the envelope as **GIAN Multiobjective Optimization Using Metaheuristics**.

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**

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

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__Details about payment/accommodation/etc.__

The seats (approximately 50 in number) for the workshop are limited. Hence the applicants are advised to send their application at their earliest convenience. Please fill the attached form, and make the payment of *workshop registration fee* (for amounts see below) through

01) **NEFT transfer**

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
Branch Code:	01161
IFC Code (For NEFT/RTGC:	SBIN0001161
MICR Code:	208002041

Or

02) **A/C Payee Bank DEMAND DRAFT**, payable to **Registrar, IIT Kanpur** and drawn at **State Bank of Indian, Branch: IIT Kanpur (001161)**.

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 hunderd 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

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Accommodation (Available on a payment basis (this amount is not included under *workshop registration fee*))

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

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Important Dates

Round of acceptance/notification	Deadline
1st round (after payment/form is received)	05-Feb-18 (2400 hours (IST))
2nd round (after payment/form is received)	15-Feb-18 (2400 hours (IST))
3rd round (after payment/form is received)	20-Feb-18 (2400 hours (IST))
Workshop	03-Mar-18 to 07-Mar-18

Mark the envelope as: **GIAN Multiobjective Optimization Using Metaheuristics** and send it to

Prof. Raghu Nandan SENGUPTA

Industrial & Management Engineering Department

Indian Institute of Technology Kanpur, Kanpur – 208 016

Uttar Pradesh, INDIA

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Registration Form

GLOBAL INITIATIVE OF ACADEMIC NETWORKS

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Name (Ms./Mrs./Mr./Dr./Prof.):_____

Sex (Male/Female/Others):_____

DoB: _____

Aadhar No: _____

Passport No: _____

Passport issuing country: _____

Passport issuance date (dd/mm/yyyy): _____

Passport expiry date (dd/mm/yyyy): _____

Designation:_____

Paste your latest passport size photograph and sign over it along with date (dd/mm/yyyy)

Address: _____

_____

City: _____ Pin Code: _____

State: _____ Country: _____

Ph: _____(with ISD/STD code)

Cell: _____(with ISD/STD code)

E-mail: _____

Signature: _____ Date (dd/mm/yyyy): _____

Important regarding workshop registration fee

Add **ID photocopy AND bona fide official letter** both duly stamped/signed by head of organization/company/institute/college/university) to claim in which Category/Type of Participation you belong.

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Details of NEFT/RTGS/Demand Draft for workshop registration fee

Payee Bank: _____

Payee bank branch code: _____

Payee bank address with phone/email, etc.:

_____

_____

City: _____ Pin Code: _____

State: _____ Country: _____

Ph: _____(with ISD/STD code)

Fax: _____(with ISD/STD code)

E-mail: _____

NEFT/RTGS/Demand Draft Amount: (INR/USD)_____

NEFT/RTGS/Demand Draft ID/No: _____

NEFT/RTGSDemand Draft date (dd/mm/yyyy): _____

Note

01) Any bank/transfer surcharge/commission/foreign exchange conversion, etc., for the NEFT/RTGS/Demand Draft should be paid by the participant ONLY.

02) Add your CV (maximum two (02) A4 pages) in which you should clearly state why you are keen to attend this workshop.

03) Mark the envelope as: **GIAN Multiobjective Optimization Using Metaheuristics** and send it to

<div align="center">

Prof. Raghu Nandan SENGUPTA

Industrial & Management Engineering Department

Indian Institute of Technology Kanpur, Kanpur – 208 016

Uttar Pradesh, INDIA

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04) Also send an email to raghus@iitk.ac.in with the following scanned copies of (i) registration form, (ii) details of NEFT/RTGS/Demand Draft for workshop registration fee and (iii) NEFT/RTGS/Demand Draft slip/copy.

05) The subject of the mail should be GIAN: Multiobjective Optimization Using Metaheuristics + <Your Full Name>.