

A Summary of Dagstuhl Seminar 09041 (18-23 January 2009) entitled
Hybrid and Robust Approaches to Multiobjective Optimization

Organizers: Kalyanmoy Deb, Salvatore Greco, Kaisa Miettinen and Eckart Zitzler

The seminar “Hybrid and Robust Approaches to Multiobjective Optimization” was a sequel to two previous Dagstuhl seminars (04461 in 2004 and 06501 in 2006). The main idea of this seminar series has been to bring together two contemporary fields related to multiobjective optimization – Evolutionary Multiobjective Optimization (EMO) and Multiple Criteria Decision Making (MCDM) – to discuss critical research and application issues for bringing the entire field further and for fostering future collaboration.

This particular seminar was participated by 53 researchers actively working in multiobjective optimization. The purpose of the seminar was to discuss two fundamental research topics related to multiobjective optimization: interactive methods requiring optimization and decision making aspects to be integrated for a practical implementation and robust multiobjective methodologies dealing with uncertainties in problem parameters, objectives, constraints and algorithms. The seminar was structured to have more emphasis on working group discussions, rather than individual presentations, so that the open and free environment and facilities of Schloss Dagstuhl could be fully utilized. Figure 1 shows the schedule followed during the five days of the seminar.

Schedule for Dagstuhl Seminar 09041 (18-23 January 2009)						
	Sunday (18.01.2009)	Monday (19.01.2009)	Tuesday (20.01.2009)	Wednesday (21.01.2009)	Thursday (22.01.2009)	Friday (23.01.2009)
09:00-10:30	Arrival	Organization Introduction WG Formation Common Talk 1	Common Talk 3 Common Talk 4	WG Presentations (20 min each) Rearrange WGs	Common Talk 5 Common Talk 6	WG Presentations III and IV 45 min. each
10:30-10:45				Coffee/Tea		
10:45-12:15		WG Discussion I (Four Groups)	WG Discussion III (Four Groups)	WG Discussion V (Two Themes)	WG Discussion VII (Two Themes)	Wrap-up Next Dagstuhl
12:15-14:00				Lunch		
14:00-15:30		WG Discussion II (Four Groups)	WG Discussions IV (Four Groups)	Photograph (14:00) Hiking	WG Discussion VIII (Two Themes) Coffee/Tea	Departure
15:30-16:00		Coffee/Tea				
16:00-17:30		Common Talk 2 Common Disc. I	Common Discussion II		WG Presentations I and II	
18:00-20:00	Arrival Reception dinner			Dinner		
20:00-21:30			Popular Talks on 'Evol. and Facts of MCDM/EMO'	WG Discussions VI (Two Themes)	Wine and Chesse Party (ESTECO)	

On Monday (18 January 2009), the day was started with a warm welcome (needed due to cold January weather in Germany) to the participants. After a short introduction to the tentative program of the week, Dagstuhl facilities and seminar practices, the organizers formed four working groups in the following areas:

1. **EMO in Robust Multiobjective Optimization (EMO+RMO):** This working group focused on topics related to evolutionary multiobjective optimization and robust/reliability oriented methods. Related topics on evolutionary single-objective optimization and any aspects of robustness consideration within an evolutionary framework were also discussed.

2. **MCDM in Robust Multiobjective Optimization (MCDM+RMO):** This working group focused on topics related to multiple criteria optimization and decision-making, taking into account the principles of robust/reliable recommendations. The group discussed the meaning and the ways of implementation of the concepts of robustness and reliability in the context of multiple criteria decision analysis and that of single- or multi-objective optimization, with a particular attention to interactive methods of evolutionary multiobjective optimization.
3. **EMO in Interactive Multiobjective Optimization (EMO+IMO):** This working group focused on topics related to evolutionary multiobjective optimization and interactive methods involving MCDM techniques, decision makers, mathematical programming methods and others. Any hybrid method involving EMO, including local searches, was of interest to this group.
4. **MCDM in Robust and Interactive Multiobjective Optimization (MCDM+RIMO):** This working group focused on considering robustness and related issues in the context of interactive multiple criteria decision making, in different stages of the decision process.

Before the tea break, Masahiro Inuiguchi delivered an invited talk on Fuzzy/possibilistic programming approaches in relations with MCDM, RMO, EMO, and IMO. Thereafter, the participants disbursed into four working groups to make an in-depth discussion on their respective topics. In the afternoon, another invited talk was presented by Joshua Knowles entitled 'The meaning of robustness in EMO'. The day was ended with brief presentations from the working groups summarizing the discussions of different subgroups that had been formed.

On Tuesday, two common invited talks were presented, first by Roman Slowinski entitled 'A new robust interactive EMO using dominance based rough set approach' followed by Juergen Branke's talk entitled 'EMO for searching robust and reliable solutions'. The working groups assembled for further discussions. In the evening, merits and demerits of EMO and MCDM practices were discussed and interesting insights of their working principles were brought out. After dinner, an interesting session was organized in which Pekka Korhonen and Jyrki Wallenius presented a history of events detailing 'Evolution and Facts of MCDM'. Thereafter, Carlos Fonseca, Carlos Coello and Hisao Ishibuchi presented the growth and focus of the EMO field.

On Wednesday morning, working group moderators presented a brief summary of their groups' discussions to the rest of the participants. Then, participants were divided into two major groups to enable crossbreeding of ideas.

1. EMO, MCDM and Robust Multiobjective Optimization
2. EMO, MCDM and Interactive Multiobjective Optimization

At the start of the group discussions, it was felt that each of these two groups should then split into smaller subgroups and focus on some common topics of interests between EMO and MCDM researchers. The first group was divided in three

subgroups: two subgroups on robustness in scheduling and routing and one subgroup on robustness in engineering design and finance. The second group was renamed as Working Group on Interactivity and it was divided to the following three subgroups: Interaction styles and preference models in transfer from MCDM to EMO, Many objectives in interactive methods and Multi-objective trajectory optimisation. After a round of discussions, a group photograph of the seminar participants was taken and the participants went for hiking in the afternoon. In the evening after dinner, subgroups assembled for another round of working group discussions over their topics.

On Thursday morning, there were two invited common talks: Margaret Wiecek presented a lecture on 'Efficient sets of multiobjective complex systems' and Silvia Poles on 'Multiobjective robust design optimization and polynomial chaos'. Group discussions went on as usual for the rest of the day. In the evening after dinner, a wine and cheese get-together sponsored by ESTECO was arranged, in which some enthusiastic participants wrote and composed a song on the Dagstuhl seminar.

Finally, on Friday morning, all subgroups made presentations of their discussions and the new song "Robust" was presented. Some participants felt that the group discussions were too open-ended this time and working towards a more tangible outcome, such as a book (like that in 2006 seminar), would have been more fruitful. However, ideas of further collaboration e.g. in the form of journal papers were raised in the subgroups and a lot of enthusiasm was in the air. Furthermore, everyone expressed interests to come again for another Dagstuhl seminar.

Overall, the seminar provided a free atmosphere for everyone to speak and discuss freely about her or his research interests and ideas for considering robust and interactive methods for multiobjective optimization. Several future collaborative research strategies were planned involving researchers from both EMO and MCDM fields. It is hoped that in the next Dagstuhl seminar on the topic some of these collaborative research efforts will be presented.

Kalyanmoy Deb
Salvatore Greco
Kaisa Miettinen
Eckart Zitzler