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RESEARCH CONFERENCES

ESF-EMS and Mathematics Conference

Perspectives in Discrete Mathematics

Centre de Recerca Matemàtica, Bellaterra • Spain
24-29 June 2012

Chaired by: **Marc Noy**, Universitat Politècnica de Catalunya, ES

<http://www.esf.org/conferences/12390>

Highlights & Scientific Report



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Conference Highlights

Please provide a brief summary of the conference and its highlights in non-specialist terms (especially for highly technical subjects) for communication and publicity purposes. (ca. 400-500 words)

The conference covered several of the main current research topics in Discrete Mathematics, focusing on random structures and probabilistic methods, and on Szemerédi's regularity method. The program gathered many of the specialists in the field, both at the senior and junior level. The invited lectures were delivered by Jacob Fox (MIT), Ben Green (Cambridge), Penny Haxell (Waterloo), Michael Krivelevich (Tel Aviv), Laszlo Lovász (Budapest), Jiri Matousek (Prague), Balazs Szegedy (Toronto), Endre Szemerédi (Rutgers), Carsten Thomassen (TU Denmark), and Nick Wormald (Waterloo). There were 20 contributed talks and 20 posters, selected by an international Scientific Committee chaired by Noga Alon (Tel Aviv). There was an open problem session (the problems discussed are gathered in a report) and a look-forward session, discussing research perspectives in the area. The Catalan Mathematical Society organized a special lecture by Endre Szemerédi, recipient of the 2012 Abel Prize in Mathematics.

The main topics covered in the conference were: the regularity lemma and applications; Extremal combinatorics; Random graphs; Hypergraphs; Graph theory; Ramsey theory; Discrete geometry and geometric graphs; Analytic methods in combinatorics. The interaction between the various topics was very strong and fruitful.

The conference had an unusually high scientific level. Most of the key figures in current research in Discrete Mathematics were present at the conference. Particularly remarkable was the presence of many young researchers presenting top quality results. This reflects the fact that many brilliant young researchers are taking the lead in this area of research. The combination of most prestigious senior and young researchers and the quality of the contributions was definitely one of the highlights of the conference.

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Scientific Report

Executive Summary

(2 pages max)

There were 90 participants, with a high proportion of young researchers. The participants were selected among more than 170 applications. About 70% of the participants were from Europe.

Scientific Content of the Conference

The main topics covered in the conference were:

- Szemerédi's regularity lemma and applications
- Extremal combinatorics
- Random graphs
- Hypergraphs: matchings, packing, cycles
- Graph theory: colourings, flows, graph polynomials
- Ramsey theory
- Discrete geometry and geometric graphs
- Analytic methods in combinatorics

Each of them was amply covered in the conferences and talks. New results were presented, including the solution of some long-standing conjectures, like the Sylvester-Gallai problem on the number of ordinary lines determined by a set of points in the plane, whose impressive solution by Green and Tao was presented in the lecture by Ben Green.

Especially important was the interaction between the different topics, showing a strong unity in contemporary research in Discrete Mathematics. Ramsey's theory is intimately linked to the regularity method, which in turn is strongly connected to extremal combinatorics. A permeating topic is the probabilistic method in combinatorics, initially created by Erdős and Rényi in the 1960s, it has become a fundamental tool in combinatorics. Moreover, as in many areas of mathematics, the probabilistic approach is a distinctive feature of current research. The theory of random graphs has evolved greatly in the last decades and we now have many alternative models, including those for modeling real life networks. Many of the talks and lectures were devoted to random structures: graphs, hypergraphs, trees, permutations, and others. The main challenge is to understand the qualitative properties of large combinatorial structures, using tools from combinatorics, probability and analysis, among others.

From the scientific point of view the conference was a great success. The most important problems in contemporary research were discussed and new lines of research were suggested. The strong interaction among the participants was one of the key aspects of the meeting. The problem and look-forward sessions were extremely lively and fruitful. A preprint was produced compiling the problems presented in the session and is available at the web page of the conference.

Forward Look

(1 page min.)

- *Assessment of the results*
- *Contribution to the future direction of the field – identification of issues in the 5-10 years & timeframe*
- *Identification of emerging topics*

The look-forward session focused on two topics. First, the increasing rate of collaboration among researchers over the internet, exemplified by the Polymath project. This project has already produced some striking results, among them a new proof of the Jewett-Hales theorem. There was a consensus that such initiatives should be strengthened. The second point was the assessment that combinatorics is widening in scope and using more tools and ideas from other areas of mathematics. This was exemplified in the ever increasing role of analysis, measure theory and group theory in key topics such as the regularity method and the theory of graph limits, both amply discussed in several lectures, in particular in the invited lectures by L. Lovasz and B. Szegedy.

- Is there a need for a foresight-type initiative?

Business Meeting Outcomes

- *Election of the Organising Committee of the next conference*
- *Identified Topics*
- *Next Steps*

No next conference is programmed, although a common opinion among the participants was that it would be desirable to organize in 3 or 4 years this kind of conference focusing on the main current research topics.

Atmosphere and Infrastructure

- *The reaction of the participants to the location and the organization, including networking, and any other relevant comments*

The reaction was very positive. The location was perfectly suited for the goals of the conference and CRM staff were very helpful and efficient.

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Date & Author:

January 30, 2013. Marc Noy