

## REPORT ON IWOCA 2012

**23rd International Workshop on Combinatorial Algorithms  
19–21 July 2012  
Kalasalingam University, Anand Nagar, Tamil Nadu, India**

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IWOCA 2012 was hosted by Kalasalingam University (KLU), picturesquely situated amidst green surrounding hills in India's southernmost province of Tamil Nadu, an hour's plane ride plus an hour's car journey south-west of the bustling (not to say hectic) state capital of Chennai. A panoramic view of the campus is available at

<http://www.ncardmath.com/IWOCA2012/>

The meeting was sponsored and supported financially by the Department of Science & Technology (DST), Government of India, New Delhi; by the Council of Scientific & Industrial Research (CSIR), New Delhi; and by KLU. It was organized by n-CARDMATH, the National Centre for Advanced Research in Discrete Mathematics of India (also sponsored by DST), whose director, **Subramanian Arumugam**, was also cochair of the Programme Committee with the author of this report. The Proceedings, edited by Arumugam & Smyth, will be published by Springer in their *Lecture Notes in Computer Science* series as “post-proceedings” — that is, appearing three or four months after the workshop so as to enable changes to be incorporated that result from discussions with other workshop participants. In addition, authors of accepted papers will be invited to submit full versions of their work to a special issue of the *Journal of Discrete Algorithms*.

IWOCA descends from the original *Australasian Workshop on Combinatorial Algorithms*, first held in 1989, then renamed *International* in 2007 in response to consistent interest and support from researchers outside the Australasian region. The workshop's permanent website can be accessed at

<http://www.iwoca.org/>

where links to previous meetings, as well as to IWOCA 2012, can be found.

Using LISTSERVE and other e-mail lists, the IWOCA 2012 call for papers was distributed around the world, resulting in 88 submitted papers. The Easy-Chair system was used to facilitate management of submissions and refereeing, with three referees selected from the 45-member Program Committee assigned to each paper. A total of 21 papers were accepted, subject to revision, for presentation at the workshop and publication in the LNCS Proceedings; an additional

nine papers were accepted for poster presentation. Authors, titles and abstracts of all 30 accepted contributions are available at the ncardmath website given above. The workshop also featured a problems session, chaired — in the absence of IWOCA Problems Cochairs **Yuqing Lin** and **Zsuzsanna Lipták** — by Professor Arumugam. Old and new problems may be accessed at the main IWOCA website referenced above. Four invited talks (see abstracts below) were given by **Naveen Garg**, **Gonzalo Navarro**, **Rajeev Raman** and **Saket Saurabh**.

The 72 registered participants at IWOCA 2012 hold appointments at institutions in 12 different countries on five continents (Africa, Asia, Europe, North America, South America). The nations represented were

Bangladesh (3), Canada (4), Chile (1), Denmark (1), France (1), India (53), Iran (1), Poland (2), South Africa (1), Taiwan (1), UK (1), USA (3).

Here are brief summaries of the invited plenary talks:

- (1) **Naveen Garg**, Indian Institute of Technology, Delhi, India: *Approximation Algorithms for Graphical TSP* — Given an  $n$ -point metric, the travelling salesman problem is to find the shortest tour that visits all  $n$  points. A classical result of Christofides gives a 1.5 approximation. It is conjectured that a natural LP relaxation, known to be equivalent to a bound of Held & Karp, has an integrality gap of  $4/3$ . In the last year there has been progress on a special case of TSP where the metric is obtained as the shortest path distances in an undirected graph with unit edge lengths. For this version of metric TSP, Saberi & Singh gave an algorithm with an approximation guarantee slightly less than 1.5. This was followed by 1.461 and 1.4 approximations due to Moemke & Svensson, and Sebo & Vygen, respectively. In this talk I discuss the case in which the underlying graph has maximum degree 3; two different papers show how to obtain a  $4/3$ -approximation in this setting.
- (2) **Gonzalo Navarro**, University of Chile: *Indexing Highly Repetitive Collections* — The sharply increasing cost of sequencing technologies are giving way to large databases of thousands of genomes of individuals of the same or neighbouring species. Thus these genomes are highly similar. In this talk I revisit the recent advances in compressed indexing of repetitive sequence collections. Repetitiveness shows up, in different ways, in the structure of the suffix array, in the grammar-compressed size, and in the Lempel-Ziv compressed size of the collection. Each such expression of the repetitiveness has been exploited to give rise to different compressed indices that take advantage of repetitiveness in different ways. I review the merits of the current approaches and the many challenges that lie ahead.

- (3) **Rajeev Raman**, University of Leicester, UK: *Range Extremum Queries* — In range extremum queries, the input consists of  $n$  points that are either elements of a  $d$ -dimensional matrix — that is, their coordinates are specified by the  $1D$  submatrices they lie in — or they are points in  $\mathbb{R}^d$ . Furthermore, associated with each point is a *priority* that is independent of the point's coordinate. The objective is to preprocess the given points and priorities to answer the following queries: given a  $d$ -dimensional rectangle, report the points with maximum (or minimum) priority (*range max query* or, for some fixed parameter  $k$ , report the points with the  $k$  largest (smallest) priorities. The objective is to minimize the space used by the data structure and the time taken to answer the query. This talk surveys recent developments in this area, focussing on the cases  $d = 1, 2$ .
- (4) **Saket Saurabh**, Institute of Mathematical Sciences, Chennai, India: *Polynomial Time Preprocessing using Min-Max Theorems in Combinatorial Optimization* — Data reduction techniques (“preprocessing”) are widely applied to deal with computationally hard problems. The framework of parameterized complexity turns out to be particularly suitable for a mathematical analysis of the efficiency and accuracy of preprocessing heuristics. A kernelization algorithm is a preprocessing procedure that simplifies the instances given as input in polynomial time; the extent of the simplification desired is quantified using the additional parameter. Combinatorial min-max theorems like Hall's theorem, Menger's theorem and techniques from matroid theory have been widely used to obtain polynomial-time algorithms for several problems. In this talk we survey the use of local applications of these classical theorems to obtain polynomial-sized simplifications (or kernels) for NP-hard problems.

Graph theory dominated the contributed talks this year, but there were also several papers dealing with combinatorics on words, perhaps reflecting the increased interest in this topic due to many applications to bioinformatics. Of the 21 accepted papers, 13 dealt with problems in graph theory, six with combinatorics on words, two with applications to data structures.

For the IWOCA Steering Committee (**Costas Iliopoulos**, **Mirka Miller**, and yours truly), the decision to hold IWOCA in India was an experiment, recognizing the undoubted accomplishments of Indian culture over hundreds of years, the contributions of many Indian mathematicians (**Ramanujan**, of course, but not only), and the economic and IT resurgence of recent years. The result was positive. About half of the 88 papers were submitted from Indian institutions: many were out of context. But of the 21 accepted papers, with no compromise on quality, exactly one-third were authored by Indian researchers, as were two-thirds of the

nine poster papers. We anticipate another IWOCA excursion to India sometime in the next decade.

For the overseas participants, IWOCA 2012 was as much a cultural as a combinatorial experience. KLU was founded in 1984 as a private “College of Engineering” by **Thiru T. Kalasalingam**, with the rural location deliberately chosen to provide opportunity to those who otherwise might have very little. In 2006 the college was granted University status by the Indian government. In the large administration building where the conference was held, participants were welcomed in the entrance hall by an elaborate, symmetrical floral pattern, created cooperatively by half a dozen women sprinkling coloured powder on the stone floor, while using no measuring devices whatever. The KLU campus was a refreshing departure from its uncommitted western counterpart: a graceful Hindu temple, much frequented by students, adorned the grounds, and KLU was not ashamed to display signs such as “Good actions are Never lost” to inspire its students. For photos, visit

<http://www.cas.mcmaster.ca/~bill/KLU/>

Also, for the group photo of all the happy participants, again see the `ncardmath` website above.

On the first evening of the conference, participants visited the historic Andal temple in Srivilliputtur, a small town just 10 kms from the KLU campus. On the second evening, participants were treated to a marvellous evening of Indian dance (Tamil Nadu version): athletic and beautiful female dancers with flashing eyes, expressive gestures and bright costumes, enacting traditional Hindu tales to exciting rhythmic music. A post-conference complimentary three-day tour of Tamil Nadu was an attraction much enjoyed by 14 visitors (participants and family members). The first day featured a visit to the overwhelming 14-acre Hindu temple in Madurai, a small Indian city of a million or so inhabitants about an hour’s drive from KLU. Also visited was a museum devoted to Mahatma Gandhi and his successful campaign for Indian independence. The next two days took us west and south on a tour of Tamil Nadu, including

- visits to two high waterfalls, where men and women come for ritual immersion;
- the magnificent residence of a mediæval king;
- an overnight stay at the Ocean View Hotel in Kanyakumari, a delightful town at the southern tip of India.

The participants in the tour were grateful to **Professor S. R. Srikumar**, Principal of the Kalasalingam Institute of Technology, who took time away from his aca-

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demic duties to act as their kind, informed, and attentive shepherd. For a picture gallery of the tour, see

<http://www.dropbox.com/sh/m06hvhf1ywnz8q8/hTsUdZ6BBd?m>

IWOCA meetings are already scheduled for the next three years, through 2015, spread over three continents:

2013 Université de Rouen, France (**Thierry Lecroq & Laurent Mouchard**), 10–12 July. See

<http://iwoca2013.colloques.univ-rouen.fr/>

2014 University of Minnesota, Duluth, USA (**Dalibor Froncek & Mirka Miller**)

2015 University of Newcastle, Australia (**Mirka Miller & Joe Ryan**)