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This volume contains revised versions of papers presented at the 26th International Workshop on Combinatorial Algorithms (IWOCA 2015), held October 5–7, 2015, in Verona, Italy.

IWOCA 2015 continued a long and well-established tradition of encouraging high-quality research in theoretical computer science and providing an opportunity to bring together specialists and young researchers working in the area. The IWOCA conference series grew out of a 17-year history of the Australasian Workshop on Combinatorial Algorithms (AWOCA). Previous AWOCA and IWOCA meetings have been held in Australia, Indonesia, South Korea, Japan, Czech Republic, Canada, UK, India, France, and the USA.

We solicited high-quality papers in the broad area of combinatorial algorithms. Topics included: algorithms and data structures (including sequential, parallel, distributed, approximation, probabilistic, randomized, and on-line algorithms); algorithms on strings and graphs; applications (bioinformatics, music analysis, networking, and others); combinatorics on words; combinatorial enumeration; combinatorial optimization; complexity theory; computational biology; compression and information retrieval; cryptography and information security; decompositions and combinatorial designs; discrete and computational geometry; graph drawing and labelling; graph theory.

The Program Committee decided to accept 30 papers, out of a total of 90 submissions. One paper was later withdrawn by the authors. Each submission received at least three, and at most seven reviews. Papers were submitted and reviewed using the EasyChair online system. Authors of accepted papers come from 19 countries, on four continents (Asia, Europe, North America, South America).

The scientific program included three invited lectures, given by:
- Béla Bollobás on “Monotone Cellular Automata”
- Frank Ruskey on “Recent Results about Venn Diagrams”
- Esko Ukkonen on “Identifiability of a String from Its Substrings”

We thank the invited speakers for accepting our invitation and for their excellent presentations at the conference.

The program also included an open problem session, chaired by Martin Milanič and Romeo Rizzi, where seven open problems were presented. These can be found at the open problem collection of IWOCA at http://iwoca.org. This year for the first time, we had a Best Student Paper Award, sponsored by the European Association for Theoretical Computer Science (EATCS). The Program Committee decided to assign this award to the paper “The k-Leaf Spanning Tree Problem Admits a Klam Value of 39” by Meirav Zehavi.

We thank all authors who submitted their work for consideration to IWOCA 2015. We wish to thank the Program Committee and the 153 external reviewers, whose many
thorough reviews helped us select the papers to be presented at IWOCA 2015. The success of the scientific program is due to their hard work.

We also thank the EATCS (European Association for Theoretical Computer Science), the EATCS Italian Chapter, and the AICA (Associazione Italiana per l’Informatica ed il Calcolo Automatico), for their support of the conference.

IWOCA 2015 was organized by the Department of Computer Science of the University of Verona, whose administrative and financial support we gratefully acknowledge.

November 2015

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Invited Talks
Monotone Cellular Automata

Béla Bollobás

University of Cambridge, UK, and
University of Memphis, TN, USA

Cellular automata, introduced in the 1940s by von Neumann, are interacting particle systems. In its simple form, we have a set of sites arranged in a grid-like fashion, with each site in one of finitely many states. Starting with such an ‘initial configuration’, at each time-step the system updates itself according to some fixed local rule: each site goes into a state that depends only on the states of a few nearby sites. Examples include the Ising model of ferromagnetism and simple models of the brain.

A cellular automaton with states 0 and 1, say, is monotone if every site in state 1 remains in state 1 forever. One of the simplest monotone cellular automata is bootstrap percolation with infection parameter $r$, introduced in 1979 by Chalupa, Leith and Reich. This process is an oversimplified model of the spread of an infection on a graph (with 0 meaning ‘healthy’ and 1 ‘infected’), in which a healthy site gets infected if it has at least $r$ infected neighbours. By now, there is a huge literature of bootstrap percolation, with most of the early results due to probabilists, statistical physicists, and computer scientists, and many recent results proved by combinatorialists. I shall present some basic facts about bootstrap percolation, and will describe some important theorems due to Aizenman, Lebowitz, Cerf, Manzo, Cirillo and Holroyd, culminating in some substantial results I have proved with Balogh, Duminil-Copin and Morris.

Recently, with Smith and Uzzell, I introduced a far-reaching generalization of bootstrap percolation on lattices and lattice-like finite graphs. The only assumptions we made about such a process is that it is local, homogeneous and monotone. Surprisingly, much can be proved about these very general processes on $\mathbb{Z}^2$; in particular, Smith, Uzzell, Balister, Przykucki and I classified them into three classes, and proved much about the critical probability in each class. Very recently, Duminil-Copin, Morris, Smith and I have proved much more precise results about the most important class in the classification.

In my lecture, aimed at non-specialists, I shall give a brief introduction to some aspects of cellular automata. I shall assume very little and will keep my lecture simple.
Recent Results About Venn Diagrams

Frank Ruskey
University of Victoria, Canada

An $n$-Venn diagram is a collection of $n$ simple closed curves in the plane that divide it into $2^n$ non-empty regions, one unique region per possible intersection of the interiors/exterior of the curves. If the curves lie in general position, i.e., so that at most 2 curves intersect at a point then it is unknown whether rotationally symmetric diagrams exist for every prime $n$ (the primality of $n$ being an easily proved necessary condition). However, if curves can intersect at 3 or more curves, rotationally symmetric diagrams exist for prime $n$, and the proof relies on a modification of the classic symmetric chain decomposition of the Boolean lattice. In this talk this proof and later developments, such as the enumeration of symmetric Venn diagrams, will be surveyed. Additional open problems in the area of Venn diagrams will be discussed; e.g., can a new curve always be added to a Venn diagram to get a new Venn diagram?
A classic algorithmic challenge in biological sequence analysis, the genome assembly problem asks one to reconstruct the DNA sequence from the short fragments (called reads) that a DNA sequencing instrument samples from the original sequence. The reads are produced in massive amounts but with some reading errors.

The talk discusses the exact version of the problem in which the reads are noiseless. Given a collection $F$ of reads (substrings) sampled from an unknown target string $T$, the problem is to reconstruct $T$ from $F$. If $F$ covers the entire $T$ several times and if the repeated substrings of $T$ are contiguously covered by the reads in $F$, the reconstruction becomes straightforward: Just superpose the reads as suggested by their matching suffixes and prefixes. If, however, there are repeats that are longer than the reads – as is often the case for DNA sequences – the reconstruction becomes ambiguous because there may be several different reconstructions suggested by the reads.

We demonstrate that identifying a unique solution is possible from $F$, if $F$ is the full $k$-mer spectrum of $T$ and $T$ does not contain any 3-repeats of length $k−1$ and not any interleaved pair of 2-repeats of length $k−1$. A finite-state automaton-like representation of the pairwise overlaps of the reads is introduced such that the unique identifiability of $T$ reduces to the uniqueness of the Eulerian path in this representation. Generalization for more realistic $F$ with variable-length reads and non-uniform coverage is considered.

References


1Supported by European Commission grant SYSCOL (UE7-SYSCOL-258236).
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