Guohui Lin (Ed.)

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Computing and Combinatorics

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Banff, Canada, July 2007
Proceedings

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Volume Editor

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Preface

The Annual International Computing and Combinatorics Conference is an annual forum for exploring research, development, and novel applications of computing and combinatorics. It brings together researchers, professionals and industrial practitioners to interact and exchange knowledge, ideas and progress. The topics cover most aspects of theoretical computer science and combinatorics related to computing. The 13th Annual International Computing and Combinatorics Conference (COCOON 2007) was held in Banff, Alberta during July 16–19, 2007. This was the first time that COCOON was held in Canada.

We received 165 submissions, among which 11 were withdrawn for various reasons. The remaining 154 submissions under full consideration came from 33 countries and regions: Australia, Brazil, Canada, China, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong, India, Iran, Ireland, Israel, Italy, Japan, the Netherlands, Norway, Pakistan, Poland, Romania, Russia, Slovakia, South Korea, Spain, Sweden, Switzerland, Taiwan, Turkey, the UK, the USA, and the US minor outlying islands.

After a six week period of careful reviewing and discussions, the program committee accepted 51 submissions for oral presentation at the conference. Based on the affiliations, 1.08 of the accepted papers were from Australia, 7.67 from Canada, 3.08 from China, 1 from the Czech Republic, 2 from Denmark, 1 from France, 5.42 from Germany, 0.08 from Greece, 2.18 from Hong Kong, 0.33 from India, 0.17 from Ireland, 1.83 from Israel, 1.5 from Italy, 2.9 from Japan, 0.17 from the Netherlands, 2.67 from Norway, 0.5 from Poland, 1 from Switzerland, 1 from Taiwan, 0.08 from Turkey, 1.33 from the UK, 12.33 from the USA, and 0.33 from the US minor outlying islands. The program of COCOON 2007 also included three keynote talks by Srinivas Aluru, Francis Y. L. Chin, and Ming Li.

Finally, we would like to express our gratitude to the authors of all submissions, the members of the program committee and the external reviewers, the members of the organizing committee, the keynote speakers, our generous sponsors, and the supporting organizations for making COCOON 2007 possible and enjoyable.

July 2007 Guohui Lin

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Table of Contents

The Combinatorics of Sequencing the Corn Genome

Srinivas Aluru

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Abstract. The scientific community is engaged in an ongoing, concerted effort to sequence the corn (also known as maize) genome. This genome is approximately 2.5 billion nucleotides long with an estimated 65-80team of university and private laboratory researchers under the auspices of NSF/USDA/DOE is working towards deciphering the majority of the sequence information including all genes, determining their order and orientation, and anchoring them to genetic/physical maps. In this talk, I will present some of the combinatorial problems that arise in this context and outline the role of graph, string and parallel algorithms in solving them.

G. Lin (Ed.): COCOON 2007, LNCS 4598, p. 1, 2007.

Online Frequency Assignment in Wireless Communication Networks

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Abstract. Wireless communication has many applications since its invention more than a century ago. The frequency spectrum used for communication is a scarce resource and the Frequency Assignment Problem (FAP), aiming for better utilization of the frequencies, has been extensively studied in the past 20-30 years. Because of the rapid development of new wireless applications such as digital cellular network, cellular phone, the FAP problem has become more important.

In Frequency Division Multiplexing (FDM) networks, a geographic area is divided into small cellular regions or cells, usually regular hexagons in shape. Each cell contains one base station that communicates with other base stations via a high-speed wired network. Calls between any two clients (even within the same cell) must be established through base stations. When a call arrives, the nearest base station must assign a frequency from the available spectrum to the call without causing any interference with other calls. Interference may occur, which distorts the radio signals, when the same frequency is assigned to two different calls emanating from cells that are geographically close to each other. Thus the FAP problem can be viewed as a problem of multi-coloring a hexagon graph with the minimum number of colors when each vertex of the graph is associated with an integer that represents the number of calls in a cell.

FAP has attracted more attention recently because of the following:

a) Online analysis techniques: FAP problem is known to be NP-complete and many approximation algorithms have been proposed in the past. As frequency assignments have to be done without knowledge of future call requests and releases, online algorithms have been proposed and competitive analysis has been used to measure their performance.
b) New technology and application: Wideband Code-Division Multiple-Access (W-CDMA) technology is a new technology used for the implementation of 3G cellular system. Orthogonal Variable Spreading Factor (OVSF) codes are used to satisfy requests with different data rate requirements. FAP with OVSF code trees representing the frequency spectrum becomes an important problem.

G. Lin (Ed.): COCOON 2007, LNCS 4598, p. 2, 2007.

Information Distance from a Question to an Answer

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Abstract. We know how to measure distance from Beijing to Toronto. However, do you know how to measure the distance between two information carrying entities? For example: two genomes, two music scores, two programs, two articles, two emails, or from a question to an answer? Furthermore, such a distance measure must be application-independent, must be universal in the sense it is provably better than all other distances, and must be applicable.

From a simple and accepted assumption in thermodynamics, we have developed such a theory. I will present this theory and will present one of the new applications of this theory: a question answering system.

G. Lin (Ed.): COCOON 2007, LNCS 4598, p. 3, 2007.

A New Field Splitting Algorithm for Intensity-Modulated Radiation Therapy*

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Abstract. In this paper, we present an almost linear time algorithm for the problem of splitting an intensity map of radiation (represented as an integer matrix) into multiple subfields (submatrices), subject to a given maximum allowable subfield width, to minimize the total delivery error caused by the splitting. This problem arises in intensity-modulated radiation therapy (IMRT) for cancer treatments. This is the first field splitting result on minimizing the total delivery error of the splitting. Our solution models the problem as a shortest path problem on a directed layered graph, which satisfies the staircase Monge property. Consequently, the resulting algorithm runs in almost linear time and generates an optimal quality field splitting.

1 Introduction

In this paper, we study a geometric partition problem, called *field splitting*, which arises in intensity-modulated radiation therapy (IMRT). IMRT is a modern cancer treatment technique that aims to deliver highly conformal prescribed radiation dose distributions, called *intensity maps* (IMs), to target tumors while sparing the surrounding normal tissues and critical structures. The effectiveness of IMRT hinges on its ability to accurately and efficiently deliver the prescribed

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