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Preface

This volume contains the papers presented at LAGOS 2023, the XII Latin-American Algorithms, Graphs and Optimization Symposium, held on September 18–22, 2023 in Huatulco, Mexico.

LAGOS is the union of two Latin-American conferences: the Brazilian Symposium on Graphs, Algorithms and Combinatorics (GRACO) and the Latin-American Conference on Combinatorics, Graphs and Applications (LACGA). The previous editions of LAGOS were held in Fortaleza, Brazil (GRACO 2001), Santiago, Chile (LACGA 2004), Angra dos Reis, Brazil (GRACO 2005), Puerto Varas, Chile (LAGOS 2007), Gramado, Brazil (LAGOS 2009), Bariloche, Argentina (LAGOS 2011), Playa del Carmen, Mexico (LAGOS 2013), Fortaleza, Brazil (LAGOS 2015), Marseille, France (LAGOS 2017), Belo Horizonte, Brazil (LAGOS 2019), and São Paulo, Brazil (LAGOS 2021).

There were 84 submissions. Each submission was reviewed by at least three Program Committee members, and some were reviewed by additional external reviewers. The committee decided to accept 43 papers, and selected the following two papers to share the Best Paper Award.

- Nina Kamčev and Mathias Schacht.
  Canonical colourings in random graphs.
- José Diego Alvarado Morales, Yoshiharu Kohayakawa, Patrick Morris, and Guilherme Oliveira Mota.
  A canonical Ramsey theorem with list constraints in random graphs.

Among the remaining submissions, 14 papers appear in the proceedings as three-page Brief Announcements.

We would like to thank the keynote speakers Federico Ardila (San Francisco State University, USA), Maria Axenovich (Karlsruhe Institute of Technology, Germany), Ruy Fabila (Cinvestav, Instituto Politécnico Nacional, Mexico), Celina de Figueiredo (Universidade Federal do Rio de Janeiro, Brazil), Pavol Hell (Simon Fraser University, Canada), Jesús de Loera (University of California Davis, USA), Deborah Oliveros (Universidad Nacional Autónoma de México, Mexico), Gelasio Salazar (Universidad Autónoma de San Luis Potosí, Mexico), Maya Stein (Universidad de Chile, Chile), Jayme Szwarcfiter (Universidade Federal do Rio de Janeiro, Brazil).

We would like to thank the authors who submitted their work to LAGOS this year. Also, the Program Committee members and subreviewers for their valuable and insightful reviews and comments. We are very grateful to the organization team, led by Adriana Hansberg and Amanda Montejano, who made the conference possible together with their local organization team. We are also grateful to the Scientific Committee composed of Adriana Hansberg, Amanda Montejano, Luis Montejano, Miguel Pizaña, and Jorge Urrutia for selecting the keynote speakers, and to the Steering Committee members Flavia Bonomo, Manoel Campêlo, Guillermo Durán, Celina de Figueiredo, Martín Matamala, and Miguel Pizaña, for overseeing the continuity of the LAGOS series.

The conference has received valuable support from the Universidad Nacional Autónoma de México, through the Instituto de Matemáticas, and the DGAPA Project PAPIIT IG100822, as well as from the Sociedad Matemática Mexicana. The EasyChair system was effectively used to handle the submission of papers and to manage the review process.

Cristina G. Fernandes, Universidade de São Paulo, Brazil
Sergio Rajsbaum, Universidad Nacional Autónoma de México, Mexico.
Program Committee Chairs

Peer-review under responsibility of the scientific committee of the XII Latin-American Algorithms, Graphs and Optimization Symposium
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- Rita Zuazua, Universidad Nacional Autónoma de México, Mexico

Plenary talks

Keynote speaker: *Federico Ardila*
Title: The geometry of geometries: matroid theory, old and new

Abstract: The theory of matroids or combinatorial geometries originated in linear algebra and graph theory, and has deep connections with many other areas, including field theory, matching theory, submodular optimization, Lie combinatorics, and total positivity. Matroids capture the combinatorial essence that these different settings share. In recent years, the (classical, polyhedral, algebraic, and tropical) geometric roots of the field have grown much deeper, bearing new fruits. My talk will survey, in an accessible manner, some recent successes. I will discuss joint work with Carly Klivans, Graham Denham, and June Huh.

Keynote speaker: *Maria Axenovich*
Title: Forbidding subgraphs in the hypercube

Abstract: One of the central problems in graph theory is finding, for a given graph H, the extremal function $ex(n, H)$, that is the largest number of edges in an n-vertex graph that contains no isomorphic copy of H as a subgraph. While determining the asymptotic behaviour of $ex(n, H)$ remains a challenge in general, we know exactly what graphs have positive Turán density, i.e., for what graphs H is $ex(n, H)$ a positive proportion of the total number of edges on n vertices. An analogous function $ex(Q_n, H)$, the largest number of edges in a subgraph of the n-dimensional hypercube Q_n that contains no isomorphic copy of H, is much less understood. In particular, we even do not have any characterisation for graphs H that have a positive hypercube Turán density. In this talk I will report on some recent progress on $ex(Q_n, H)$ and show connections between this function and other problems in extremal combinatorics.

Keynote speaker: *Ruy Fabila*
Title: Token graphs, reconstruction and automorphisms

Abstract: Let G be a graph on n vertices and $1 \leq k \leq n-1$ an integer. The k-token graph of G is the graph whose vertices are all k-subsets of vertices of G, where two of them are adjacent if and only if their symmetric difference is an edge of G. Suppose we are given a graph F. We are interested in both the theoretical and algorithmic problem of determining if there exists an isomorphism f from F to $F_k(G)$. This isomorphism is called a k-token reconstruction of F. In this talk we explore recent results on this problem and explain a somewhat surprising relationship between the "uniqueness" of the k-token reconstructions of F, and the relationship between the automorphism group of $F_k(G)$ and that of G.

Keynote speaker: *Celina de Figueiredo*
Title: A perfect path from computational biology to quantum computing

Abstract: I will revisit my contributions to the P versus NP millennium problem and the computational complexity of combinatorial problems, especially those arising in Computational Biology and Quantum Computing, through 20 PhD theses, mine and of my students. I will explain how the dichotomy NP-complete versus polynomial-time of long-standing problems together with their multivariate analysis is settled. Yet, intriguing questions remain.

Keynote speaker: *Pavol Hell*
Title: Graph homomorphism dichotomies

Abstract: I will offer personal reminiscences on the graph theoretic origins of the 1993 Feder-Vardi Dichotomy Conjecture, proved in 2017 by Bulatov and by Zhuk. Then I will describe some recent work and open problems on other versions of graph homomorphism dichotomy.

Keynote speaker: *Jesús de Loera*
Title: What is the best way to slice a convex polytope?

Abstract: I will discuss two old classical problems in computational geometry:

1. Given a d-dimensional convex polytope P, what is the best slice of P by a hyperplane? Here best can mean many possible things, e.g., a slice with the largest volume? Or a slice with the largest number of vertices? etc. This touches on classical work by Bourgain, Ball, Koldobsky, Milman, and many other mathematicians.
2. As we slice P with hyperplanes we create many combinatorially different $(d-1)$-slices, which are also polytopes of course. E.g., for a 3-dimensional regular cube there are four combinatorial types of slices (triangles, quadrilaterals, pentagons, hexagons). How many different ones are there for a polytope P? How can we count them all? Can we give lower/upper bounds on their number? What are extremal cases?

I will explain a powerful new algorithmic framework that answers these problems (and others) in polynomial time when $\dim(P)$ is fixed. Moreover, we show the problems have hard complexity otherwise. This is joint work with Marie-Charlotte Brandenburg (MPI/KTH) and Chiara Meroni (Harvard/ETH).

Keynote speaker: *Deborah Oliveros*
Title: Tverberg type Theorems: The study of partitions of points as simplicial complexes

Abstract: Tverberg Theorem is one of the most beautiful theorems in discrete geometry. This theorem could be interpreted as a Ramsey type result, as follows: If you have sufficiently many points in the Euclidean space, there exists always a way of partitioning them in such a way that the intersection pattern is a complete graph. We will discuss possible ways of generalizing this theorem as well as some interesting applications.

Keynote speaker: *Gelasio Salazar*
Title: From two dimensions to three dimensions: applications of graph theory to knot theory

Abstract: If we project a knot to a plane we obtain a 2-dimensional curve, a *shadow* of the knot. We are interested in the following general question: which properties of a knot can be obtained from its shadow? In this talk we will illustrate how standard techniques from topological and extremal graph theory can be used to investigate this problem. No previous knot theory knowledge is expected from the audience (and very little knot theory knowledge should be expected from the speaker).

Keynote speaker: *Maya Stein*
Title: Oriented trees in digraphs

Abstract: This talk will survey conditions that can guarantee the existence of a given oriented tree in a digraph D. In particular, we will be interested in conditions on the minimum semidegree or on the minimum number of edges of D.

Keynote speaker: *Jayme Szwarcfiter*
Title: On edge domination of graphs

Abstract: Denote by G an undirected simple graph, with vertex set V, and edge set E. An edge $e \in E$ *dominates* itself and every edge adjacent to e. A set $E' \subseteq E$ is an *(edge)* dominating set of G, if each edge of E is dominated by some edge of E'. The domination is called *efficient* if each edge is dominated exactly once, and is called *proper* if each edge of $E \setminus E'$ is dominated exactly once. In this talk, we survey and describe complexity results on these three types of edge domination. In special, we consider the class of graphs where each edge is contained in some triangle. We mention hardeness and polynomial-time cases on subclasses of this class, for edge domination problems.