CAAN 2007

August 14th, 2007
Dalhousie University, Halifax, Canada

The Fourth Workshop
on
Combinatorial and Algorithmic
Aspects of Networking

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General Information

The Internet, because of its size, decentralized nature, and loosely controlled architecture, provides a hotbed of challenges that are amenable to mathematical analysis and algorithmic techniques. This workshop brings together mathematicians, theoretical computer scientists and network specialists in a fast growing area that is an intriguing intersection of Computer Science, Graph Theory, Game Theory, and Networks.

Schedule

Monday, August 13, 2007
(319 Colloquium Room, Chase Building, Studley Campus)

18:00-19:00	Registration (Late arrivals will still be able to register on Tuesday morning.)

Tuesday, August 14, 2007
(319 Colloquium Room, Chase Building, Studley Campus)

8:30-9:15	Registration
9:15-9:30	Opening Address
9:30-10:30	**Long Invited Talk: Peter Winkler** ***Luck vs. Skill***
10:30-11:00	Coffee break
11:00-11:30	**Pawel Pralat** *Cleaning random d-regular graphs with brushes using a degree-greedy algorithm*
11:30-12:00	**Tobias Harks** *Nonadaptive Selfish Routing with Online Demands*
12:00-12:30	**Rob van Stee** *Preemptive scheduling on selfish machines*
12:30-12:45	Conference photo
12:45-14:00	Lunch
14:00-14:30	**Anthony Bonato** *Vertex pursuit games in stochastic network models*
14:30-15:00	**Katerina Potika** *Selfish Routing and Path Coloring in All-Optical Networks*
15:00-15:30	**Aurelio Lopez-Lopez** *A Worst-Case Time Upper Bound for Counting the Number of Independent Sets*
15:30-16:00	Coffee break
16:00-16:30	**Short Invited Talk: Alejandro Lopez-Ortiz** ***Valiant Load Balancing, Benes Networks and Resilient Backbone Design***
16:30-17:00	**Gerold Jaeger** *Improving the Efficiency of Helsgaun's Lin-Kernighan Heuristic for the Symmetric TSP*
17:00-17:30	**Jose Gutierrez Lopez** *Improving Topological Routing in N2R Networks*

(Atrium of the Computer Science Building, Studley Campus)

19:00-21:00	**Reception**

Invited Speakers

Peter Winkler, Dartmouth College, Hanover, NH (long invited talk)

Biography:

Peter Winkler is Professor of Mathematics and Computer Science at Dartmouth College.

A winner of the Mathematical Association of America's Lester R. Ford Award for mathematical exposition, Dr. Winkler is the author of about 125 mathematical research papers and holds a dozen patents in computing, cryptology, holography, optical networking and marine navigation. His research papers are primarily in combinatorics, probability and the theory of computing, with forays into statistical physics.

Dr. Winkler received his BA from Harvard summa cum laude in mathematics, then after a stint in the US Navy, his PhD from Yale as a student of Abraham Robinson and Angus Macintyre. He joined the faculties of Stanford and then Emory University, where he became Professor and Chairman of Mathematics and Computer Science. In 1989 he left academia for industry, returning in 2004.

When not proving theorems or enjoying his family, Winkler is generally found on a squash court or playing and composing ragtime piano music. He collects puzzles both mechanical and mathematical, the latter appearing in a new book called "Mathematical Puzzles: A Connoisseur's Collection." In some circles Winkler is notorious as the inventor of cryptologic techniques for the game of bridge, which have now been declared illegal for tournament play in most of the western world.

Title of talk: **Luck vs. Skill**

Abstract:

Recent legislation in the US regarding gambling over the web has led to renewed interest in the question of which games are games of skill. We take a statistical approach to the problem, defining the skill index of a game to be the average amount of playing time after which variance due to chance and variance due to skill differences are equal.

We then look at tournament results for championship-level duplicate bridge, PGA golf, and duplicate poker, as well as some simulated toy games, to see how their skill indices compare.

Alejandro Lopez-Ortiz, University of Waterloo (short invited talk)

Title of talk:
Valiant Load Balancing, Benes Networks and Resilient Backbone Design

Abstract:

At any given time, the traffic on the network can be described using a traffic matrix. Entry a_{i,j} in the matrix denotes the traffic originating in i with destination j currently in the network. As traffic demands are dynamic, the matrix itself is ever changing. Traditionally network capacity has been deployed so that it can support any traffic matrix with high probability, given the known traffic distribution patterns. Recently the need for resilience and reliabilibility of the network for mission critical data has brought the need for backbone capacity that can support all traffic matrices. In this talk we give an overview of the state of the art on networks and routing schemes with this property.

Abstracts

- Margaret-Ellen Messinger, Richard Nowakowski, **Pawel Pralat**, and Nicholas Wormald.
  Cleaning random d-regular graphs with brushes using a degree-greedy algorithm

In the recently introduced model for cleaning a graph with brushes, we use a degree-greedy algorithm to clean a random d-regular graph on n vertices (with dn even). We then use a differential equations method to find the (asymptotic) number of brushes needed to clean a random d-regular graph using this algorithm. As well as the case for general d, interesting results for specific values of d are examined. We also state various open problems.

- **Tobias Harks** and Lazlo Vegh.
  Nonadaptive Selfish Routing with Online Demands

In this paper, we study the efficiency of selfish routing problems in which traffic demands are revealed online. We go beyond the common Nash equilibrium concept in which possibly all players reroute their flow and form a new equilibrium upon arrival of a new demand.

In our model, demands arrive in n sequential games. In each game the new demands form a Nash equlibrium, and their routings remain unchanged afterwards. We study the problem both with nonatomic and atomic player types and with polynomial latency functions on the edges. We give upper and lower bounds on the competitive ratio of the online routing in terms of the maximum degree of the latency functions, the number of games and in the atomic setting the number of players. In particular, for nonatomic players and linear latency functions it is shown that the competitive ratio is at most $4n\over n+2$. Finally, we present improved upper bounds for the special case of two nodes connected by parallel arcs.

- Leah Epstein and **Rob van Stee**.
  Preemptive scheduling on selfish machines

We consider the problem of scheduling on parallel uniformly related machines, where preemptions are allowed and the machines are controlled by selfish agents. Our goal is to minimize the makespan, whereas the goal of the agents is to maximize their profit. We show that a known algorithm is monotone and can therefore be used to create a truthful mechanism for this problem which achieves the optimal makespan. We extend this result for additional common goal functions.

- **Anthony Bonato** and Changping Wang.
  Vertex pursuit games in stochastic network models

Random graphs with given expected degrees G(w) were introduced by Chung and Lu so as to extend the theory of classical G(n,p) random graphs to include random power law graphs. We investigate asymptotic results for the game of Cops and Robber played on G(w) and G(n,p). Under mild conditions on the degree sequence w, an asymptotic lower bound for the cop number of G(w) is given, and an upper bound is given for certain random power law graphs. We prove concentration results for the cop number of G(n,p) for p as a function of n, in both the dense and sparse cases.

- Ioannis Milis, Aris Pagourtzis, and **Katerina Potika**.
  Selfish Routing and Path Coloring in All-Optical Networks

We study routing and path coloring problems in all-optical networks as non-cooperative games. Especially, we focus on oblivious payment functions, that is, functions that charge a player according to her own strategy only.

We first strengthen a known relation between such games and online routing and path coloring. In particular, we show that the price of anarchy of such games is lower-bounded by, and in several cases precisely equal to, the competitive ratio of appropriate modifications of the First Fit algorithm.

Based on this framework we provide results for two classes of games in ring networks: in Selfish Routing and Path Coloring a player must determine both a routing and a coloring for her request, while in Selfish Path Coloring the routing is predetermined and only a coloring of requests needs to be specified. For these games we prove specific upper and lower bounds on the price of anarchy under various payment functions.

- Guillermo De Ita and **Aurelio Lopez**.
  A Worst-Case Time Upper Bound for Counting the Number of Independent Sets

The problem of counting the number of independent sets of a graph G (denoted as $NI(G)$) is a classic \#P-complete problem for graphs of degree 3 or higher. Exploiting the strong relation between $NI(G)$ and Fibonacci numbers, we show that if the depth-first graph of G does not contain a pair of basic cycles with common edges, then $NI(G)$ can be computed in linear-time over the length of the graph. This determines a new polynomial class for $NI(G)$ which is a superclass of graphs of degree two and without restrictions over the degree of G, but it depends on the topological structure of G.

We design an exact deterministic algorithm for computing $NI(G)$ based on the topological structure of the graph G and applying the well-known splitting rule from Davis and Putnam (D\&P) procedure. D\&P is a familiar method for solving the Satisfiability Boolean Problem.

Our algorithm for computing $NI(G)$ establishes a leading Worst-Case Upper Bound of $O(poly (n,m)* 1.220744^n)$, n and m being the number of nodes and edges of the graph G, respectively. The exact technique reported here can be used to compute the redundancy of any line into a communication network.

- Dirk Richter, Boris Goldengorin, **Gerold Jaeger**, and Paul Molitor.
  Improving the Efficiency of Helsgaun's Lin-Kernighan Heuristic for the Symmetric TSP

Helsgaun has introduced and implemented the lower tolerances (α-values) for an approximation of Held-Karp's 1-tree with the purpose to improve the Lin-Kernighan's Heuristic (LKH) for the Symmetric TSP (STSP). The LKH appears to exceed the performance of all STSP heuristic algorithms proposed to date.
In this paper we improve the Helsgaun's LKH based on an approximation of Zhang and Looks' backbones by tolerances and an extension of double bridges further combined with implementation details by all of which we guide the search process instead of Helsgaun's α-values. Our computational results are competitive and lead to improved solutions for some of the VLSI instances announced at the TSP homepage.

- **Jose Gutierrez**, Ruben Cuevas, Jens Pedersen, and Ole Madsen.
  Improving Topological Routing in N2R Networks

Topological routing is basically table free, and allows for very fast restoration and thus a high level of reliability in communication. It has already been satisfactorily proposed for some regular structures such as Grid or Honeycomb. An initial proposal has also been developed for the N2R structures. This paper proposes a modification of this previous algorithm, and in addition two other alternatives. The three options are systematically analyzed in terms of executing time and path distances, showing that trade-offs are needed in order to determine which algorithm is best for a given case. Also, the possible practical applications the methods could have are discussed for different traffic scenarios.