6th Athens Colloquium on Algorithms and Complexity - ACAC 2011
August 25 - 26, National Technical University of Athens, Greece

EXTENDED PROGRAM

Thursday, August 25

- **9:15 - 9:30**
  Opening Remarks
- **9:30 - 10:30**
  Invited Session 1
  Aggelos Kiayias, National and Kapodistrian University of Athens
  T.B.A.
- **10:30 - 11:00**
  Coffee Break
- **11:00 - 13:00**
  Session 1
  - **Elias Koutsoupias**, National and Kapodistrian University of Athens
    Scheduling without Payments
    We consider mechanisms without payments for the problem of scheduling unrelated machines. Specifically, we consider truthful in expectation randomized mechanisms under the assumption that a machine (player) is bound by its reports: when a machine lies and reports value Tt_{ij} for a task instead of the actual one t_{ij}, it will execute for time Tt_{ij} if it gets the task—unless the declared value Tt_{ij} is less than the actual value t_{ij}, in which case, it will execute for time t_{ij}. Our main technical result is an optimal mechanism for one task and n players which has approximation ratio $(n+1)/2$. We also provide a matching lower bound, showing that no other truthful mechanism can achieve a better approximation ratio. This immediately gives an approximation ratio of $(n+1)/2$ and $n(n+1)/2$ for social cost and makespan minimization, respectively, for any number of tasks.
  - **Ioannis Caragiannis**, University of Patras and RA Computer Technology Institute
    Computing Approximate Pure Nash Equilibria in Congestion Games
  - **Panagiotis Kanellopoulos**, RA Computer Technology Institute
    On the Efficiency of Equilibria in Generalized Second Price Auctions
    Joint work with Christos Kaklamanis and Maria Kyropoulou.
    In sponsored search auctions, advertisers compete for a number of available advertisement slots of different quality. The auctioneer decides the allocation of advertisers to slots using bids provided by them. Since the advertisers may act strategically and submit their bids in order to maximize their individual objectives,

such an auction naturally defines a strategic game among the advertisers. The efficiency of outcomes in such auctions can be quantified using the notion of the price of anarchy of the corresponding games. In this talk, we will consider the strategic games induced by generalized second price auctions which are widely used by the sponsored search industry. We will present recent results on the price of anarchy of such games over pure Nash and coarse correlated equilibria in the full information setting as well as over Bayes-Nash equilibria in the incomplete information setting.

- **Elias Tsigaridas**, Aarhus University

  Exact Algorithms for Stochastic Games

  Joint work with K.A. Hansen, M. Koucky, N. Lauritzen, and P.B. Miltersen.

  Shapley's discounted stochastic games and Everett's recursive games are classical models of game theory describing two-player zero-sum games of potentially infinite duration. We present algorithms for exactly solving such games based on separation bounds from real algebraic geometry. When the number of positions of the game is constant, the algorithms run in polynomial time and are the first with this property.

- **13:00 - 14:00**
  Lunch Break

- **14:00 - 15:00**
  Invited Session 2
  Dimitrios Thilikos, National and Kapodistrian University of Athens

  Recent advances on Algorithmic Graph Minors

- **15:00 - 15:30**
  Coffee Break

- **15:30 - 17:00**
  Session 2

  - **Loukas Georgiadis**, University of Western Macedonia

    Connectivity, Reachability, and Path-Selection in Graphs

    Joint work with A. Galani, S. Nikolopoulos, L. Palios, and R. Tarjan. Project: Efficient Algorithms for Reachability and Path-Selection Problems with Applications (http://www.icte.uowm.gr/lgeorg/RPS/), funded by the J. S. Latsis Public Benefit Foundation. Parts of these results appear in ICALP 2010, CSR 2011, and ESA 2011.)

    We present an overview of recent results regarding algorithms, complexity, and applications of connectivity, reachability, and path-selection problems in graphs. In such problems we are given an input graph and wish to compute paths connecting specified vertices so that certain requirements are satisfied. This type of problems have numerous applications, including internet routing, geographical navigation, knowledge-representation systems, and program optimization. Specifically, we present results for the following problems:

    * Data Structures for Join-reachability: Process a collection of (directed) graphs so that we can report fast the set of vertices that reach a given vertex in all graphs of the collection.

* Computing pairs of disjoint paths / independent spanning trees: Given a source vertex compute two disjoint paths to a specific target vertex or to every other vertex.
* Testing 2-vertex connectivity / approximating the smallest 2-vertex connected spanning subgraph.

– **Ioannis Lignos**, Durham University

Reconfiguration of Hamiltonian Cycles

For any instance I of a combinatorial problem P, the reconfiguration graph has as vertices the set of feasible solutions, pairs of which are joined by an edge if their difference is minimum. For example, for a graph G, the reconfiguration graphs for the k-colouring problem has as vertices all possible k-colourings of G and pairs of colourings are joined by an edge if the colourings differ on only a single vertex. There has been much interest recently in the study of reconfiguration graphs, particularly in the computational complexity of deciding whether reconfiguration graphs are connected, or whether a pair of given solutions belong to the component. We will review a number of recent results focussing particularly on the Hamiltonian cycle problem. Two Hamilton cycles are adjacent in the reconfiguration graph if they differ only in that a pair of adjacent vertices are "switched". We ask, given a graph G and two hamiltonian cycles C_1 and C_2, is there a path between C_1 and C_2 in the reconfiguration graph; that is, is it possible to transform C_1 into C_2, via a sequence of hamiltonian cycles using the switching operation? We are interested in the complexity of this decision problem, and present a number of results on graphs of bounded degree.

– **Nicolas Boria**, LAMSADE - Université Paris Dauphine

Reoptimization of Maximum Weight Induced Hereditary Subgraph Problems

The reoptimization issue studied in this paper can be described as follows: given an instance I of some problem P, an optimal solution OPT for P in I and an instance I' resulting from a local perturbation of I that consists of insertions or removals of a small number of data, we wish to use OPT in order to solve P in I', either optimally or by guaranteeing an approximation ratio better than that guaranteed by an ex nihilo computation and with running time better than that needed for such a computation. We use this setting in order to study weighted versions of several representatives of a broad class of problems known in the literature as maximum induced hereditary subgraph problems. The main problems studied are max independent set, max k-colorable subgraph max P_k-free subgraph, max planar subgraph and max split subgraph under vertex insertions and deletions. For all these problems we present approximation algorithms and inapproximability bounds.

- **17:00 - 17:30**
Coffee Break

- **17:30 - 18:30**
Session 3

– **Dimitris Letsios**, University of Evry

Speed Scaling on Parallel Processors with Migration

We study the problem of scheduling a set of jobs with release dates, deadlines and processing requirements (or works), on parallel speed-scaled processors so as to minimize the total energy consumption. We consider that both preemption and migration of jobs are allowed. An exact polynomial-time algorithm has been proposed for this problem, which is based on the Ellipsoid algorithm. Here, we formulate the problem as a convex program and we propose a simpler polynomial-time combinatorial algorithm which is based on a reduction to the maximum flow problem. Our algorithm runs in $O(nf(n)logP)$ time, where n is the number of jobs, P is the range of all possible values of processorsśpeeds divided by the desired accuracy and $f(n)$ is the complexity of computing a maximum flow in a layered graph with O(n) vertices. Independently, Albers et al. [AAG11] proposed an $O(n^2 f(n))$-time algorithm exploiting the same relation with the maximum flow problem. We extend our algorithm to the multiprocessor speed scaling problem with migration where the objective is the minimization of the makespan under a budget of energy.

– **Yiannis Giannakopoulos**, National and Kapodistrian University of Athens

Competitive Analysis of Maintaining Frequent Items of a Stream

We study the well-known frequent items problem in data streams from a competitive analysis point of view. We consider the standard worst-case input model, as well as the weaker distributional adversarial setting. We are primarily interested in the single-slot memory case and for both models we give (asymptotically) tight bounds of $\Theta(\sqrt{N})$ and $\Theta(\sqrt[3]{N})$ respectively, achieved by very simple and natural algorithms, where N is the stream's length. We also provide lower bounds, for both models, in the more general case of arbitrary memory sizes of $k \geq 1$.

- **19:30**
  Dinner (Buffet, NTUA Campus)

Friday, August 26

- **9:30 - 10:30**
  Session 4

  – **Iordanis Kerenidis**, CNRS - Université Paris VII

  Optimal Bounds for Quantum Bit Commitment

  To appear at FOCS 2011.

  Bit commitment is a fundamental cryptographic primitive with numerous applications. Quantum information allows for bit commitment schemes in the information theoretic setting where no dishonest party can perfectly cheat. The previously best-known quantum protocol by Ambainis achieved a cheating probability of at most 3/4 [Amb01]. On the other hand, Kitaev showed that no quantum protocol can

have cheating probability less than $1/\sqrt{2}$ [Kit03]. Closing this gap has since been an important and open question. In this paper, we provide the optimal bound for quantum bit commitment. We first show a lower bound of approximately 0.739, improving Kitaev's lower bound. We then present an optimal quantum bit commitment protocol which has cheating probability arbitrarily close to 0.739.

– **Georgios Zois**, Athens University of Economics and Business

Maximum Latency with Energy Budget

We consider the dynamic speed scaling problem of scheduling n jobs with release dates and a given energy budget E on a single processor so as to minimize the maximum latency. We present a polynomial time optimal algorithm for the variant of the problem where all jobs are released at time zero. We prove that in case of arbitrary release dates the problem is strongly $\mathcal{NP}$-hard. Furthermore, we give a polynomial time optimal algorithm for the multi-processor variant of the problem where each job has a unit workload and all the jobs are released at time zero.

- **10:30 - 11:00**
Coffee Break

- **11:00 - 12:30**
Session 5

– **Evanthia Papadopoulou**, University of Lugano

The L_∞ Hausdorff Voronoi Diagram Revisited

We revisit the L_∞ Hausdorff Voronoi diagram of clusters of points, equivalently, the L_∞ Hausdorff Voronoi diagram of rectangles, and present a plane sweep algorithm for its construction that generalizes and improves upon previous results. The structural complexity of the L_∞ Hausdorff Voronoi diagram is shown to be $\Theta(n+m)$, where n is the number of given clusters and m is the number of essential pairs of crossing clusters. The algorithm runs in $O((n+M)\log n)$-time and $O(n+M)$ space, where M is the number of potentially essential crossings; m, M are $O(n^2)$, $m \leq M$, but $m = M$, in the worst case. In practice $m, M \ll n^2$, as the total number of crossings in the motivating application is typically small. For non-crossing clusters, the algorithm runs in optimal $O(n \log n)$-time and $O(n)$-space. The time bound is achieved via data structure augmentation and a preprocessing step based on point dominance in $\mathbb{R}^3$. The L_∞ Hausdorff Voronoi diagram finds applications, among others, in the geometric min cut problem, VLSI critical area analysis for via-blocks and open faults.

– **Dimitris Paparas**, Columbia University

On the Max k-Colored Clustering Problem

Joint work with E. Angel, E. Bampis, E. Pountourakis, and V. Zissimopoulos.

We study the Max k-colored clustering problem, where, given an edge-colored graph with k colors, we seek to find a clustering/coloring of the vertices maximizing the number of matched edges, i.e. the edges whose extremities are colored with the same color as them. We show that the problem is NP-hard even if we restrict the number of colors to be any constant number $k \geq 3$. We also present a polynomial time algorithm for $k = 2$ and a simple $\frac{2}{k}$-approximation algorithm for $k \geq 3$. Finally, we show that if the input graph is a tree then the problem becomes polynomial.

– **Paris Siminelakis**, National Technical University of Athens
Efficient Marketing Strategies for Social Networks

- **12:30 - 13:00**
Coffee Break

- **13:00 - 14:30**
Session 6

– **Christos Kalaitzis**, University of Patras
Enforcing Efficient Equilibria in Network Design Games via Subsidies

The efficient design of networks has been an important engineering task that involves challenging combinatorial optimization problems. Typically, a network designer has to select among several alternatives which links to establish so that the resulting network satisfies a given set of connectivity requirements and the cost of establishing the network links is as low as possible. The MINIMUM SPANNING TREE problem, which is well-understood, is a nice example.

In this paper, we consider the natural scenario in which the connectivity requirements are posed by selfish users who have agreed to share the cost of the network to be established according to a well-defined rule. The design proposed by the network designer should now be consistent not only with the connectivity requirements but also with the selfishness of the users. Essentially, the users are players in a so-called network design game and the network designer has to propose a design that is an equilibrium for this game. As it is usually the case when selfishness comes into play, such equilibria may be sub-optimal. In this paper, we consider the following question: can the network designer enforce particular designs as equilibria or guarantee that efficient designs are consistent with users' selfishness by appropriately subsidizing some of the network links? In an attempt to understand this question, we formulate corresponding optimization problems and present positive and negative results.

– **Katia Papakonstantinopoulou**, National and Kapodistrian University of Athens
Contention Issues in Congestion Games

We study time-dependent strategies for playing congestion games. The players can time their participation in the game with the hope that fewer players will compete for the same resources. We study two models: the boat model, in which the latency of a player is influenced only by the players that start at the same time, and the conveyor belt model in which the latency of a player is affected by the players that share the system, even if they started earlier or later; unlike standard congestion games, in these games the order of the edges in the paths affect the latency of the players. We characterize the symmetric Nash equilibria of the games with affine latencies of networks of parallel links in the boat model and we bound their price of anarchy and stability. For the conveyor belt model, we characterize the symmetric Nash equilibria of two players on parallel links. We also show that the games of the boat model are themselves congestion games. The same is true for the games of two players for the conveyor belt model; however, for this model the games of three or more players are not in general congestion games and may not have pure equilibria.

– **Christos-Alexandros Psomas**, Athens University of Economics and Business

On Worst-Case Allocations in the Presence of Indivisible Goods
Joint work with Evangelos Markakis

We study a fair division problem, where a set of indivisible goods is to be allocated to a set of n agents. Each agent may have different preferences, represented by a valuation function that is a probability distribution on the set of goods. In the continuous case, where goods are infinitely divisible, it is well known that proportional allocations always exist, i.e., allocations where every agent receives a bundle of goods worth to him at least $1/n$. In the presence of indivisible goods however, this is not the case and one would like to find worst case guarantees on the value that every agent can have. We focus on algorithmic and mechanism design aspects of this problem.

In a previous work of Hill, an explicit lower bound was identified, which depends on the number of agents, and the maximum value of any agent for a single good, such that for any instance, there exists an allocation that provides this guarantee to every agent. The proof however did not imply an efficient algorithm for finding such allocations. Following upon the work of [Hill87], we first provide a slight strengthening of the guarantee we can make for every agent, as well as a polynomial time algorithm for computing such allocations. We then move to the design of truthful mechanisms. For deterministic mechanisms, we obtain a negative result showing that a truthful 2/3-approximation of these guarantees is impossible. We complement this by exhibiting a simple truthful algorithm that can achieve a constant approximation when the number of goods is bounded. Regarding randomized mechanisms, we also provide a negative result, showing that we cannot have truthful in expectation mechanisms under the restrictions that they are Pareto-efficient and satisfy certain symmetry requirements.