Tuesday, July 5, 2022

16:30-17:30	**Aggelos Kiayias**, University of Edinburgh
	Random Walks over Chains of Blocks
17:30-18:00	**Katerina Sotiraki**, UC Berkeley
	Towards post-quantum cryptography
18:00-18:30	**Antonios Varvitsiotis**, Singapore University of Technology and Design
	Multiplicative Updates for Symmetric-cone Factorizations
18:30-19:00	**Giorgos Christodoulou**, Aristotle University
	Truthful mechanisms for scheduling problems

Wednesday, July 6, 2022

09:00-10:00	**Yiannis N. Moschovakis**, UCLA
	Intrinsic complexity
10:00-10:30	**Loukas Georgiadis**, University of Ioannina
	Efficient Algorithms for Graph Connectivity Problems
10:30-11:00	**Archontia Giannopoulou**, National and Kapodistrian University of Athens
	From Structural Graph Theory to Algorithms

16:30-17:00	**Panayotis Mertikopoulos**, CNRS
	The Dynamics of Artificial Intelligence
17:00-17:30	**Andreas Pavlogiannis**, Aarhus University
	Evolutionary Graph Theory: Amplification and Optimization
17:30-18:00	**Christos Tzamos**, University of Wisconsin-Madison
	Strongly Polynomial Time Algorithms for Learning Halfspaces and Approximate Forster Transforms
18:00-18:30	**Manolis Zampetakis**, UC Berkeley
	How to handle Biased Data and Multiple Agents in Machine Learning?
18:30-19:00	**Chara Podimata**, MIT
	Incentive-Aware Machine Learning for Decision Making

Thursday, July 7, 2022

16:00 – 17:00	**Christos Papadimitriou**, Columbia University
	Title: TBA
17:00 – 18:00	**Constantinos Daskalakis**, MIT
	Title: TBA
18:00 - 18:30	**Vaggos Chatziafratis**, University of California Santa Cruz
	On the Hidden Geometry of Datasets and Approximate Metric Embeddings
18:30 – 19:00	**Stratis Ioannidis**, Northeastern
	Spectral Ranking Regression

Second Congress of Greek Mathematicians

Special Session: Mathematics of Computer Science

Titles and Abstracts

Aggelos Kiayias, University of Edinburgh

Title: Random Walks over Chains of Blocks

Abstract: The Bitcoin blockchain protocol for over a decade has stirred a lot of interest in a number of areas including Computer Science, Game Theory, Cryptography and Economics. What kind of math govern the fundamental properties of this protocol? What makes it work and what can be improved? These are some of the questions that we will cover in this talk which covers a nearly decade long deep dive on the mathematical modelling and analysis of this class of protocols.

Katerina Sotiraki, UC Berkeley

Title: Towards post-quantum cryptography

Abstract: The advent of quantum computers places many widely used cryptographic protocols at risk. In response to this threat, the field of post-quantum cryptography has emerged. The most broadly recognized post-quantum protocols are related to lattices. Beyond their resistance to quantum attacks, lattices are instrumental tools in cryptography due to their rich mathematical structure. In this talk, I will provide an overview of celebrated results in the area of lattice cryptography. I will also present my work on understanding the complexity of lattice problems and on constructing lattice-based cryptographic protocols useful in practical scenarios.

Vaggos Chatziafratis, University of California Santa Cruz

Title: On the Hidden Geometry of Datasets and Approximate Metric Embeddings

Abstract: A major goal in data science is to represent a given dataset as "conveniently" as possible, yet as "accurately" as possible. For example, we may want to map each datapoint from the dataset to a point in the x-y plane while preserving their original pairwise distances. We typically measure the "convenience" of the representation based on the dimensionality of the target space (the x-y plane in the example above) and its "accuracy" based on how much distances got distorted. A natural question that arises in this context is "What are the fundamental tradeoffs between dimensionality vs distortion, i.e., convenience vs accuracy?". In this talk, we review some basic results from the area of Metric Embeddings, or more precisely, approximate embeddings of metric spaces, that has been developing rapidly at least since the 1990s, when a new strong motivation for it came from computer science, and which eventually led to beautiful results in the area of Approximation Algorithms.

Loukas Georgiadis, University of Ioannina

Title: Efficient Algorithms for Graph Connectivity Problems

Abstract: Determining or testing the edge or vertex connectivity of a graph, as well as computing notions of connected components and subgraphs, is a classic subject in graph theory, motivated by several application areas, that has been extensively studied since the 1970s. In this talk, we will review several basic notions of graph connectivity, and present recent results for computing k-connected components and maximal k-connected subgraphs in various settings (undirected/directed graphs, static/dynamic graphs), as well as for other related problems. We will also discuss important open problems in this area.

Giorgos Christodoulou, Aristotle University

Title: Truthful mechanisms for scheduling problems

Abstract: Mechanism design, a main branch of Game Theory and Microeconomics, studies a special class of algorithms, called mechanisms, which are robust under selfish behavior. The algorithmic nature of mechanism design was brought to light in the seminal paper by Nisan and Ronen which established the field of algorithmic mechanism design. They proposed as a paradigmatic example the problem of scheduling unrelated machines and they conjectured that there is no deterministic mechanism with good quality guarantees for this problem. Over more than two decades since its formulation, little progress has been made in resolving the Nisan-Ronen conjecture. We will give an overview of results on truthful scheduling and discuss recent progress towards validating the conjecture.

Yiannis N. Moschovakis, UCLA

Title: Intrinsic complexity

Abstract:

Panayotis Mertikopoulos, CNRS

Title: The Dynamics of Artificial Intelligence

Abstract: The recent surge of breakthroughs in machine learning and artificial intelligence has brought to the forefront a tremendous need for new mathematics to serve both as a solid theoretical foundation and as a springboard for further developments. In this talk, we will focus on how machine learning models are actually trained to make predictions and/or generate new data, a problem which is intimately related to the mathematical theory of dynamical systems – not unlike those governing planetary motion or the oscillations of a spring. We will discuss in particular how dynamical systems (in both discrete and continuous time) can be used to analyze and predict the outcome of the training process of an artificial neural network, and we will also examine what type of phenomena that may arise when such systems interact – from attractors to limit cycles and Poincaré recurrence.

Christos Tzamos, University of Wisconsin-Madison

Title: Strongly Polynomial Time Algorithms for Learning Halfspaces and Approximate Forster Transforms

Abstract: We study the problem of PAC learning halfspaces in Valiant's distribution-independent PAC model. This problem is known to be solvable in weakly polynomial time via linear programming. Our main result is the first (improper) learning algorithm for halfspaces that runs in strongly polynomial time. Our approach extends to yield a strongly polynomial algorithm for learning halfspaces in the semi-random Massart noise model. The main new ingredient is an algorithmic result of broader interest beyond learning theory. We give the first strongly polynomial time algorithm that computes an approximate Forster transform of a given dataset, i.e., puts the points in approximate radial isotropic position, or certifies that no such transformation exists.

Manolis Zampetakis, UC Berkeley

Title: How to handle Biased Data and Multiple Agents in Machine Learning?

Abstract: Modern machine learning (ML) methods commonly postulate strong assumptions such as: (1) access to data that adequately captures the application environment, (2) the goal is to optimize the objective function of a single agent, assuming that the application environment is isolated and is not affected by the outcome chosen by the ML system. In this talk I will present methods with theoretical guarantees that are applicable in the absence of (1) and (2) as well as corresponding fundamental lower bounds.

Chara Podimata, MIT

Title: Incentive-Aware Machine Learning for Decision Making

Abstract: As machine learning algorithms are increasingly being deployed for consequential decision making (e.g., loan approvals, college admissions, probation decisions etc.) humans are trying to strategically change the data they feed to these algorithms in an effort to obtain better decisions for themselves. If the deployed algorithms do not take these incentives into account, they risk creating policy decisions that are incompatible with the original policy's goal. In this talk, I will give an overview of my work on Incentive-Aware Machine Learning for Decision Making, which studies the effects of strategic behavior both on institutions and society as a whole and proposes ways to robustify machine learning algorithms to strategic individuals. I will first explain the goals of the different stakeholders (institution, individual, society) in these settings in a unified way and show the various settings I have worked on that belong in the incentive-aware machine learning area such as incentive-compatible algorithms for linear regression and online prediction with expert advice, strategic classification, learning in auctions, and dynamic pricing. I will conclude by looking at the problem from a societal lens and discuss the tension that arises between having decision-making algorithms that are fully transparent and incentive-aware.

Christos Papadimitriou, Columbia University

Title: TBA

Abstract: TBA

Constantinos Daskalakis, MIT

Title: TBA

Abstract: TBA

Andreas Pavlogiannis, Aarhus University

Title: Evolutionary Graph Theory: Amplification and Optimization

Abstract: Diffusion theory studies the spread of novel traits (social memes, influence, atomic spins, genetic mutations, etc) in a population of individuals (robots, people, atoms, genotypes, etc), and has far reaching applications in diverse domains, such as physics, biology and sociology. In this talk we will introduce the Moran and Voter diffusion models, which are standard processes for modeling the stochastic spread of genetic mutations in a structured population, where the structure is represented as a graph (network). The success of trait spread is measured in terms of its fixation probability, i.e., the probability that the novel mutation takes over the population. We will sketch the diverse effects that population structure can have on the fixation probability and fixation time, and present amplifiers, which are graphs with the remarkable property of significantly increasing the fixation probability, thereby amplifying the effect of natural selection. We will conclude with some optimization problems, which are concerned with engineering the network so as to maximize fixation probability.

Archontia Giannopoulou, National and Kapodistrian University of Athens

Title: From Structural Graph Theory to Algorithms

Abstract: The study of Graph Minors theory was sparked by the proof of Kuratowski's theorem, where he characterised all planar graphs as the class of graphs excluding two specific graphs as topological minors, as well as Wagner's Conjecture that all classes of graphs closed under taking minors admit an exact characterisation in terms of forbidding a finite set of graphs as minors. The proof of Wagner's Conjecture by Robertson and Seymour, extending in a series of 23 papers, gave rise to numerous structural theorems, some of which resulted in many algorithmic results and applications. In this talk we will introduce the main structural results and their algorithmic applications and discuss about their extensions on directed graphs and on graphs admitting perfect matchings.

Stratis Ioannidis, Northeastern

Title: Spectral Ranking Regression

Abstract: We consider learning from rankings, i.e., learning from a dataset containing sets of samples and labels indicating their relative order. For example, a medical expert presented with a list of patient files can order them w.r.t. the relative severity of a disease. Rankings are often less noisy than class labels: human experts disagreeing when generating class judgments often exhibit reduced variability when asked to compare samples instead. Nevertheless, the combinatorial nature of rankings increases the computational cost of inference. We present a spectral algorithm that accelerates inference in this ranking regression setting. Our main technical contribution is to show that the so-called Plackett-Luce log-likelihood augmented with a proximal penalty has stationary points that satisfy the balance equations of a Markov process. This allows us to tackle the ranking regression problem via an iterative spectral algorithm computing this stationary distribution efficiently.

Antonios Varvitsiotis, Singapore University of Technology and Design

Title: Multiplicative Updates for Symmetric-cone Factorizations

Abstract: Given a data matrix $X \in R^{m\times n}$ with non-negative entries and a cone **C** in R^k, the cone factorization problem concerns computing $\mathrm{a}_1, \ldots, \mathrm{a}_\mathrm{m}$ in **C** and $\mathrm{b}_1, \ldots, \mathrm{b}_\mathrm{n}$ in **C*** so that $\mathrm{X}_{\mathrm{ij}} = <\mathrm{a}_\mathrm{i}, \mathrm{b}_\mathrm{j}>$ for all I,j. Algorithms for cone factorizations are fundamental to mathematical optimization as they allow us to express convex bodies as feasible regions of linear conic programs. In this talk, we introduce and analyze the symmetric-cone multiplicative update (SCMU) algorithm for computing cone factorizations when **C** is symmetric, i.e., it is self-dual and homogeneous. Symmetric cones are of central interest in mathematical optimization as they provide a common language for studying linear optimization over the nonnegative orthant (linear programs), over the second-order cone (second order cone programs), and over the cone of positive semidefinite matrices (semidefinite programs). The SCMU algorithm is multiplicative in the sense that the iterates are updated by applying a meticulously chosen automorphism of the cone computed using a generalization of the geometric mean to symmetric cones. Using an extension of the Lieb's concavity theorem and the von Neumann's trace inequality to symmetric cones, we show that the squared loss objective is non-decreasing along the trajectories of the SCMU algorithm. When specialized to the nonnegative orthant, the SCMU algorithm corresponds to the seminal algorithm by Lee and Seung for computing Nonnegative Matrix Factorizations.