Abstracts

George Afendras (Aristotle University of Thessaloniki)

The Integrated Pearson Family of distributions and its orthogonal polynomials

An alternative classification of the Pearson family of probability densities is related to the orthogonality of the corresponding Rodrigues polynomials. This leads to a subset of the ordinary Pearson system, the so-called Integrated Pearson Family. Basic properties of this family are presented. For an absolutely continuous random variable X of the Integrated Pearson family, under natural moment conditions, a Stein-type covariance identity of order k holds. This identity is closely related to the corresponding sequence of orthogonal polynomials and provides convenient expressions for the Fourier coefficients of an arbitrary function. Applications of Bessel inequality and Parseval identity produce a wide class of upper/lower variance bounds of $g(X)$, in terms of the derivatives of g up to some order.

Ioannis Antoniou (Aristotle University of Thessaloniki)

From Tensor Product to Entanglement and Quantum Processing

The Tensor Product of Matrices appears in the courses of Kronecker by the end of 19th century. The abstract Algebraic construction of Tensor Product of finite Vector Spaces and Operators provided the mathematical framework for Mechanics of Continua, Electromagnetism and Relativity. The Tensor Product provides also the natural framework for Quantum Statistical Mechanics. The states of coupled systems live in the Tensor Products of the Hilbert Spaces describing the states of individual systems. The Operators of the joint system live in the Tensor Product of the individual Algebras of Operators. This need motivated Analysists to construct the Tensor Product of Hilbert Spaces, Banach spaces as well as Locally Convex Spaces and the Tensor Product of the associated Operator Algebras and Abstract Algebras. These constructions provided solid mathematical framework for the analysis of large (Infinite) Systems in Statistical Mechanics and Quantum Field Theory. Moreover, an unexpected fact was discovered by Einstein in 1936, which manifests even in the simplest case of the Tensor Product of two-dimensional Vector Spaces. The Tensor Product Space may contain vectors which are Non-Separable (cannot be written as Tensor Products of individual Vectors). These Non-Separable Vectors are called Entangled Vectors. We can easily construct orthonormal bases of Entangled vectors. The mathematical possibility of Entangled Vectors implies the bizarre phenomenon of Teleportation which Einstein used as an argument to present Quantum Theory as a theory with absurd conclusions. However Entanglement and Teleportation were not only experimentally confirmed, but provide the main resource for Quantum Processors. The estimation of Entanglement, the Entangling and Disentangling Operators (Gates, Channels) and the Networks of Entangled Systems are presently the tools for Quantum Computing, Quantum Statistics, Quantum Inference, Quantum Learning and Quantum Internet.

Gerassimos Barbatis (National and Kapodistrian University of Athens)

On the Hardy constant of certain non-convex planar domains

Hardy inequalities are integral inequailties with important applications in Partial Differential Equations. In the first part of this talk we present a general overview of Hardy inequalities. In the second part we present results about the value of the Hardy constant of certain non-convex planar domains.

Panagiotis Batakidis (University of Cyprus)

Poisson geometry for the classification of 4-manifolds

Taubes proved that for symplectic 4-manifolds, the Seiberg-Witten invariants represent a count of pseudoholomorphic curves, associating the classification of smooth structures to symplectic structures. To broaden the scope of the symplectic category, Taubes also presented near-symplectic structures by relaxing the non-degeneracy condition. Lefschetz pencils offer another tool to study symplectic manifolds. Blowing up certain points creates then what is called Lefschetz fibrations. They have a finite number of isolated points as singularities and allowing a second type of singularity, we get broken Lefschetz fibrations (bLfs). Auroux, Donaldson and Katzarkov showed a correspondence between near-symplectic structures and bLfs on a 4-manifold. The talk brings in Poisson geometry for near-symplectic structures and bLfs. We construct a singular Poisson structure from a near-symplectic form, (a model for bLfs was known) and compute the Poisson cohomology for both. This is the complex of spaces of solutions to certain systems of linear partial differential equations on the exterior algebra of the tangent bundle. It turns out that the two cohomologies are different, exhibiting the distinctive position of the two structures in open classification problems.

Dimitrios Betsakos (Aristotle University of Thessaloniki)

Angular derivatives and composition operators on Hardy spaces

A holomorphic self-map ϕ of the unit disk D induces a composition operator $T_\phi : f \mapsto f \circ \phi$ for f holomorphic in D. We will present an overview of the theory of these operators. This theory relates the properties of the operators T_ϕ with the geometric properties of ϕ. In a recent work we study the compactness of T_ϕ on the Hardy space when ϕ is a universal covering map.

Nikos Chrisochoides (Old Dominion University)

Parallel Mesh Generation and Adaptivity: Potential Future Directions

Parallel Mesh Generation and Adaptivity (PMGA) dates back to the 1990s and since then has been successfully applied to a wide spectrum of (bio-)engineering applications which span from image guided neurosurgery in health care to planning future missions to Mars in aerospace industry. The primary reasons for such a broad impact are three: (a) large-scale modeling and simulation, (b) real-time analysis and (c) end-user productivity. NASA's "CFD Vision 2030 Study: A Path to Revolutionary Computational Aero-sciences" and "Vision 2040: A Roadmap for Integrated, Multi-scale Modeling and Simulation of Materials and Systems" view PMGA as one of the central building blocks for their future developments. A call to action is made to have other disciplines like Big Brain Data to leverage technologies under development for aerospace industry to revolutionize our understanding of the human brain.

Konstantinos Draziotis (Aristotle University of Thessaloniki)

Elliptic curves and cryptography

Elliptic curves have been widely studied for more than 100 years in number theory and algebraic geometry. They played a prominent role in the proof of Last Theorem of Fermat by Andrew Wiles. Also, we use them to build algorithms for factorization of integer numbers, for primality proving and finally to construct public key cryptographic primitives. In this talk we shall present a basic introduction of elliptic curves as applied in cryptography.

Pantelis E. Eleftheriou (University of Konstanz)

From logic to geometry

”Tame geometry” is a relatively new branch of mathematics, envisioned by Grothendieck in the ’80s, and developed afterwards by model theorists using tools from logic. We discuss several tame geometric settings, such as that of o-minimal structures, and their applications. We also dive briefly into history of logic to trace the first instances of ”tameness” in the work of Gödel’s.

Anestis Fotiadis (Aristotle University of Thessaloniki)

Harmonic Maps Between Surfaces

We study the problem of finding a harmonic diffeomorphism between Riemann surfaces. We prove that this problem is related to the problem of solving the Beltrami equation. Finally, we construct a family of harmonic diffeomorphisms between surfaces of constant curvature.

Athanasios G. Georgiadis, (University of Cyprus)

Analysis on metric spaces associated with operators

Consider the very broad setting of a doubling space associated with a non-negative self-adjoint operator, whose heat kernel enjoys certain Gaussian properties. Without any algebraic or differential structure we establish distributions, polynomials, convolution-type actions and function spaces.

Stamatis Koumandos (University of Cyprus)

On completely monotonic and related functions

We deal with several classes of functions related to completely monotonic functions, such as, absolutely monotonic functions, logarithmically completely monotonic functions, Stieltjes functions and Bernstein functions. We present several examples and applications to special functions. In particular, we study complete monotonicity of the remainders of several asymptotic expansions. In addition, we show that several classes of functions defined by certain integral transforms can be characterized via the order of complete monotonicity of the remainder in their asymptotic expansion.

Dimitris Kugiumtzis (Aristotle University of Thessaloniki)

Time series and complex networks

In many applications, there are sets of synchronously measured quantities at fixed time intervals termed multivariate time series. Examples of such data sets are the electroencephalograms, EEG (measurements of the brain potential at different locations on the scalp or intracranially) and the financial indices, e.g. indices of world financial markets. The main objective is to understand the mechanism that generates the multivariate time series, that is the underlying complex dynamical system. An important step in this direction is the investigation of inter-dependence among the observed variables, commonly known with the terms connectivity (stemming from neuroscience) and causality (stemming from econometrics). Of particular interest are statistics (measures) that estimate only direct causal effects in the presence of other observed variables. The estimated causal effect from one variable to another determines a directed connection between the corresponding nodes in a graph. The graph has the observed variables of the multivariate time series as nodes and it is called complex network. The study of the complex network may reveal structural characteristics of the underlying complex system. I will present these topics with examples from EEG and finance. In particular I will focus on the problem of high-dimensional time series (big data).

Romanos-Diogenes Malikiosis (Aristotle University of Thessaloniki)

The Lonely Runner Conjecture

Suppose that there are n runners with constant pairwise distinct speeds on a circular track of arc length 1. Is it true that each runner gets ”lonely” at some point in time, i.e. his distance to every other runner is at least 1/n? This is the content of the Lonely Runner Conjecture, stated by Wills in 1968. We will present the history of the problem, as well as recent advances most notably by Terence Tao (2017).
In the second part of the talk we will discuss the equivalence of several geometric problems, namely: (a) lines in tori avoiding a smaller ”copy” of the torus, (b) lines avoiding a lattice arrangement of cubes, (c) billiard ball movement in a cube, (d) zonotopes avoiding a lattice. The results we obtain come from the zonotopal setting, the main tool being the Flatness Theorem of Khinchin. The longstanding Lonely Runner Conjecture is of similar nature, and we provide an equivalent formulation in terms of zonotopes which seems promising.
This is joint work with Matthias Schymura.

Michel Marias (Aristotle University of Thessaloniki)

Aspects of Harmonic analysis on manifolds

We will present some classical results of Harmonic Analysis, as Liouville Theorem, Riesz transforms, multipliers theorems, in various geometric contexts as Riemannian manifolds of positive or negative curvature, symmetric and locally symmetric spaces, and weighted graphs.

Mihalis Mourgoglou (Universidad del País Vasco)

Wandering at the interface of Harmonic Analysis, Partial Differential Equations and Geometric Measure Theory

In this talk I will present the most important results of a research line in Analysis that has attracted a lot of attention the last few years and examines some classical PDE objects in non-smooth domains. The heart of the matter is the relation between analytic information for harmonic measure or bounded harmonic functions and the geometry of the domain and its boundary. I will describe the tools that are needed to solve such problems but I will avoid getting into the details. Moreover, I plan to discuss some possible new directions for future research. This talk is intended for non-experts.

Alexandra Papadopoulou (Aristotle University of Thessaloniki)

State Occupancies, First Passage Times and Duration in DNA sequences via semi Markov modelling

The aim of this paper is to study three types of probabilities that are of considerable research interest in semi Markov modelling. These are the probabilities of (a) the state occupancies, (b) first passage time and, (c) duration. For this purpose, we first develop the basic recursive equations for the above probabilities and by applying certain methodologies we provide the corresponding analytic descriptions. Last, the theoretical results are illustrated by applying data from a DNA sequence.

Athanassios I. Papistas (Aristotle University of Thessaloniki)

The Lie algebra of McCool groups

Let G be a group. For every positive integer c, we denote by $\gamma_c(G)$ the c-th term of the lower central series of G. We point out that, $\gamma_2(G) = G'$, the second term of the series is the commutator group of G. Moreover, $gr_c(G) = \gamma_c(G)/\gamma_{c+1}(G)$ for all c. The (restricted) direct sum of the abelian groups $gr_c(G)$ is the associated Lie algebra of G, and is denoted by $gr(G) = \bigoplus_{c\geq 1} gr_c(G)$. Let G be a finitely presented group. One of the main problems in the theory of Lie algebras is the description of $gr(G)$. In other words, how one can obtain a presentation for $gr(G)$ by using a given presentation of G.

Ioannis D. Platis (University of Crete)

From Dido to contemporary sub-Riemannian geometry

We shall present a short chronicle of sub-Riemannian geometry: Emanating from the mythological background of the Isoperimetric Problem, we will pass through Carnot's Thermodynamics, the fundamental theorems of Carathéodory and Chow and heisenberg equations, to end up describing the current results and applications in the field.

Efstratios Prassidis (University of Aegean)

Topological Rigidity of Toric Manifolds

We will show results on the topological rigidity of quasi-toric manifolds. They are manifolds that are the analogues of toric non-singular varieties over $\mathbb{C}$. We will consider the classic case as well the cases over the other two $\mathbb{R}$-division algebras, $\mathbb{R}$ and $\mathbb{H}$. The results state that such manifolds that are homotopy equivalent, either equivariantly or as stratified spaces, they will be homeomorphic in the approproate category.

Chrysostomos Psaroudakis (Aristotle University of Thessaloniki))

Reduction Techniques for the Finitistic Dimension

One of the longstanding open problems in Representation Theory of Finite Dimensional Algebras is the so called "Finitistic Dimension Conjecture". The latter homological conjecture is known to be related with other important problems concerning the homological behaviour and the structure theory of finite dimensional algebras. Our aim in this talk is to present some reduction techniques for the finitistic dimension. In particular, we will show that we can remove some vertices and some arrows from a quotient of a path algebra such that the problem of computing the finitistic dimension can be reduced to a possible simpler algebra. The results will be illustrated with examples. This is joint work with Edward L. Green and Øyvind Solberg (arXiv:1808.03564).

Sotirios Sabanis (The University of Edinburgh)

At the crossroads of Numerical & Stochastic Analysis, Computational Statistics and Data Science

We will discuss how a certain class of novel, explicit numerical schemes for SDEs with nonlinear coefficients is used to generate high-dimensional distributions which are of high interest to data scientists and computational statisticians. We will then shift our focus on key optimization problems, typically appearing in Machine Learning, which are solved with the help of very similar algorithms as above! Our main reference is "N. Brosse, A. Durmus, E. Moulines and S. Sabanis (2017). The Tamed Unadjusted Langevin Algorithm, To appear in Stochastic Processes and Their Applications, arXiv:1710.05559[stat.ME]"

Aristomenis G. Siskakis (Aristotle University of Thessaloniki)

Classical inequalities and later developments

We will start with some classical inequalities on sequence spaces, such as Hardy's inequality and Hilbert's inequality, and will present their counterparts on Banach spaces of analytic functions such as Hardy and other spaces.

Maria Symeonaki (Panteion University of Social and Political Sciences)

Measurement in Social Sciences

One of the numerous or even countless applications of Mathematics in real life is that of composing and executing social research and using mathematical tools to measure vague, fuzzy or abstract concepts and ideas. The so called Quantiative Research incorporates systematic empirical investigations using scientific methods to answer specific questions and it refers to the systematic empirical investigation of social phenomena, using statistical, mathematical or computational techniques. Appropriate mathematical measurement of research variables is central to Quantitative Research since it provides the necessary connection between empirical observation and mathematical expression of quantitative relationships. Quantitative data, usually but not always numerical, requires the use of various statistical procedures of data analysis and interpretations. The difficulties and limitations of such an endeavour will be presented and specific examples will be provided from the field of measuring attitudes, intergenerational social mobility, early job insecurity and school-to-work transitions.

Apostolos Thoma (University of Ioannina)

Markov complexity of monomial curves

The notion of Markov complexity was first introduced by Francisco Santos and Bernd Sturmfels in [1]. In a joint work with Hara Charalambous and Marius Vladoiu in [2] we prove that a monomial curve C in A^3 has Markov complexity $m(C)$ two or three. Two, if the monomial curve is complete intersection, and three otherwise. Recently, in a joint work with Dimitra Kosta [3] we prove that there is no natural number d such that $m(C) \leq d$ for all monomial curves C in A^4. The same result is true even if we restrict to complete intersections. We extend this result to monomial curves in A^n, where $n \geq 4$.

[1] Francisco Santos and Bernd Sturmfels, Higher Lawrence configurations, J. Combin. Theory Ser. A 103, 151–164 (2003).
[2] Hara Charalambous, Apostolos Thoma and Marius Vladoiu, Markov complexity of monomial curves, Journal of Algebra 417, 391-411 (2014).
[3] Dimitra Kosta and Apostolos Thoma, Unboudness of Markov complexity of monomial curves in A^n for $n \geq 4$, arXiv:1809.09932v1.

George Tsaklidis (Aristotle University of Thessaloniki)

The homogeneous Markov System (or, equivalently, the embedded Markov chain) as a continuum. The three-dimensional elastic continuum system

Every attainable structure of the continuous-time Homogeneous Markov System (HMS) with fixed size and state space $S = \{1, 2, \ldots, n\}$ is considered as a particle of n, and consequently the motion of the structure corresponds to the motion of the particle. By adopting a non-restrictive assumption the set of the attainable structures-particles of n can be considered as a continuum; then the evolution of this set corresponds to the motion of the continuum. Under this consideration the concept of the energy can be assigned to the HMS. As an example, the evolution of a three-state HMS is interpreted as the motion of an elastic continuum.

Nikolaos Tziolas (University of Cyprus)

Families of algebraic surfaces of general type

One of the fundamental problems of algebraic geometry is the classification of algebraic varieties up to isomorphism. In this talk I will talk about the classification problem of algebraic surfaces of general type and in particular about pathologies and complications that appear in the case when the surfaces are defined over a field of positive characteristic.