



THE ATHENS INSTITUTE FOR EDUCATION AND RESEARCH

# Abstract Book

**18<sup>th</sup> Annual International Conference on  
Statistics: Teaching, Theory &  
Applications  
1-4 July 2024 Athens, Greece**

**Edited by  
Timothy M. Young & Olga Gkounta**

2024



Abstracts  
18<sup>th</sup> Annual International  
Conference on Statistics:  
Teaching, Theory & Applications  
1-4 July 2024, Athens, Greece

Edited by  
Timothy M. Young & Olga Gkounta

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## Preface

This book includes the abstracts of all the papers presented at the 18<sup>th</sup> Annual International Conference on Statistics: Teaching, Theory & Applications (1-4 July 2024), organized by the Athens Institute for Education and Research (ATINER).

A full conference program can be found before the relevant abstracts. In accordance with ATINER’s Publication Policy, the papers presented during this conference will be considered for inclusion in one of ATINER’s many publications only after a blind peer review process.

The purpose of this abstract book is to provide members of ATINER and other academics around the world with a resource through which they can discover colleagues and additional research relevant to their own work. This purpose is in congruence with the overall mission of the association. ATINER was established in 1995 as an independent academic organization with the mission to become a forum where academics and researchers from all over the world can meet to exchange ideas on their research and consider the future developments of their fields of study.

To facilitate the communication, a new references section includes all the abstract books published as part of this conference (Table 1). I invite the readers to access these abstract books –these are available for free– and compare how the themes of the conference have evolved over the years. According to ATINER’s mission, the presenters in these conferences are coming from many different countries, presenting various topics.

**Table 1.** *Publication of Books of Abstracts of Proceedings, 2010-2024*

Year	Papers	Countries	References
2024	32	17	Young and Gkounta (2024)
2023	41	24	<a href="#">Young and Gkounta (2023)</a>
2022	34	22	<a href="#">Young and Gkounta (2022)</a>
2021	38	19	<a href="#">Papanikos (2021)</a>
2020	44	25	<a href="#">Papanikos (2020)</a>
2019	28	15	<a href="#">Papanikos (2019)</a>
2018	31	19	<a href="#">Papanikos (2018)</a>
2017	29	16	<a href="#">Papanikos (2017)</a>
2016	21	14	<a href="#">Papanikos (2016)</a>
2015	36	18	<a href="#">Papanikos (2015)</a>
2014	35	21	<a href="#">Papanikos (2014)</a>
2013	60	33	<a href="#">Papanikos (2013)</a>
2012	43	27	<a href="#">Papanikos (2012)</a>
2011	78	33	<a href="#">Papanikos (2011)</a>
2010	28	15	<a href="#">Papanikos (2010)</a>

It is our hope that through ATINER's conferences and publications, Athens will become a place where academics and researchers from all over the world can regularly meet to discuss the developments of their disciplines and present their work. Since 1995, ATINER has organized more than 400 international conferences and has published over 200 books. Academically, the institute is organized into 6 divisions and 37 units. Each unit organizes at least one annual conference and undertakes various small and large research projects.

For each of these events, the involvement of multiple parties is crucial. I would like to thank all the participants, the members of the organizing and academic committees, and most importantly the administration staff of ATINER for putting this conference and its subsequent publications together.

**Gregory T. Papanikos**  
**President**

## **Editors' Note**

These abstracts provide a vital means to the dissemination of scholarly inquiry in the field of Statistics. The breadth and depth of research approaches and topics represented in this book underscores the diversity of the conference.

ATINER's mission is to bring together academics from all corners of the world in order to engage with each other, brainstorm, exchange ideas, be inspired by one another, and once they are back in their institutions and countries to implement what they have acquired. The *18th Annual International Conference on Statistics: Teaching, Theory & Applications* accomplished this goal by bringing together academics and scholars from 17 different countries (Austria, Bosnia and Herzegovina, Bulgaria, Chile, China, France, Germany, India, Israel, Mexico, Romania, Serbia, Switzerland, Taiwan, Türkiye, UK, USA), which brought in the conference the perspectives of many different country approaches and realities in the field.

Publishing this book can help that spirit of engaged scholarship continue into the future. With our joint efforts, the next editions of this conference will be even better. We hope that this abstract book as a whole will be both of interest and of value to the reading audience. May it be a stimulus for further research and the progress of the discipline.

**Timothy M. Young & Olga Gkounta**  
**Editors**

**18<sup>th</sup> Annual International Conference on Statistics:  
Teaching, Theory & Applications, 1-4 July 2024, Athens,  
Greece**

**Organizing & Scientific Committee**

All ATINER's conferences are organized by the Academic Council. This conference has been organized with the assistance of the following academic members of ATINER, who contributed by reviewing the submitted abstracts and papers.

1. Gregory T. Papanikos, President, The Athens Institute & Honorary Professor, University of Stirling, U.K.
2. Timothy M. Young, Director, Center for Data Science (CDS), Emeritus Professor, The University of Tennessee, USA & CEO and President, T.M. Young Institute, LLC, USA.
3. Codruta Simona Stoica, Head, Mathematics & Statistics Unit, The Athens Institute & Professor and Vice-Rector, Aurel Vlaicu University of Arad, Romania.
4. Ampalavanar Nanthakumar, Director, Sciences Division, The Athens Institute & Professor, State University of New York (Oswego), USA.

# FINAL CONFERENCE PROGRAM

## 18<sup>th</sup> Annual International Conference on Statistics: Teaching, Theory & Applications, 1-4 July 2024, Athens, Greece

### PROGRAM

#### Monday 1 July 2024

08.30-09.30

Registration

09.30-10.00

Opening and Welcoming Remarks:

- o **Gregory T. Papanikos**, President, The Athens Institute.

#### 10:00-11:30 Session 1

**Moderator: Timothy M. Young**, Director, Center for Data Science (CDS), Emeritus Professor, The University of Tennessee, USA & CEO and President, T.M. Young Institute, LLC, USA.

1. **Shunpu Zhang**, Chair, Department of Statistics and Data Science and Professor, University of Central Florida, USA.  
*Title: Ranking by Pairwise Comparison with Preference of Orders.*
2. **Liang-Ching Lin**, Professor, National Cheng Kung University, Taiwan.  
*Title: LIMOS – LightGBM Interval Merton’s One-period-portfolio Selection.*
3. **Philippe Thomas**, Associate Professor, University of Lorraine / CRAN, France.  
*Title: Adjusting the Balance between Alpha and Beta Risks in NN Classifiers.*
4. **Mihail Mateev**, Chief Assistant Professor, UACEG – Sofia, Bulgaria.  
*Title: Implementing Image Analysis with Azure AI Vision and Open AI for Predictive Analysis.*

#### 11:30-13:00 Session 2

**Moderator: Shunpu Zhang**, Chair, Department of Statistics and Data Science and Professor, University of Central Florida, USA.

1. **Codruta Stoica**, Professor, Aurel Vlaicu University of Arad, Romania.  
*Title: On Evolution Cocycles Associated to Control Systems.*
2. **Dimitris Christodoulou**, Teaching Professor (Retired), University of Massachusetts Lowell, USA.  
*Title: Euclid Absent from the Standard Model of Particle Physics.*
3. **Nadya Morozova**, Researcher, CNRS, Institute Gustave-Roussy, France.  
*Title: Developmental Graphs Comparison Strategy for Analysis of Pattern Formation and Phylogeny.*

#### 13:00-14:30 Session 3

**Moderator: Codruta Simona Stoica**, Head, Mathematics & Statistics Unit, The Athens Institute & Professor and Vice-Rector, Aurel Vlaicu University of Arad, Romania.

1. **Gordon Brooks**, Professor, Ohio University, USA.  
**Nina Adjanin**, Assistant Professor, Northwest Missouri State University, USA.  
*Title: Using Human-Friendly Scheffé Comparisons to Explore Group Differences in One-way ANOVA.*
2. **Jian Song**, Professor, OWL University of Applied Sciences and Arts, Germany.  
*Title: Application of Statistics in Evaluation of State of Health and Lifetime of Electrical and Electronic Components.*
3. **Kelvin Tsoi**, Associate Professor, The Chinese University of Hong Kong, Hong Kong.  
*Title: Long-term Benefits of Blood Pressure Management on Memory Complaint Reduction: A Time Series Analysis in a 4-year Prospective Cohort in Hong Kong.*

14:30-15:30 Lunch

**15:30-17:00 Session 4**

**Moderator: Gordon Brooks**, Professor, Ohio University, USA.

1. **Viktorija Taroudaki**, Associate Professor, Eastern Washington University, USA.  
**Michael Winer**, Associate Professor, Eastern Washington University, USA.  
**Michael Battista**, EHE Distinguished Professor of Mathematics Education, Ohio State University, USA.  
*Title: Using an Online Dynamic Geometry Curriculum to Gain Insights into Preservice Elementary Teachers' Learning of the Properties of Quadrilaterals.*
2. **Mahsa Allahbakhshi**, Assistant Professor, Pontificia Universidad Católica de Chile, Chile.  
*Title: Pedagogical Innovation to Enhance Mathematical Learning and Cross-Disciplinary Skills in Incoming Mathematics Faculty Students.*
3. **Carlos Rojas**, Assistant Professor, Pontificia Universidad Católica de Chile, Chile.  
*Title: The Academic Portfolio as an Assessment Purpose-Driven Tool in the Training of Primary School Teachers in Mathematics.*
4. **Ivonne Pallares-Vega**, Professor, Autonomous University of the State of Morelos, Mexico.  
*Title: Some Thoughts on Teaching Set Theory.*

**20:30-22:30**

**Athenian Early Evening Symposium (includes in order of appearance: continuous academic discussions, dinner, wine/water, music)**

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**Tuesday 2 July 2024**

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**08:45-10:30 Session 5**

**Moderator: Mahsa Allahbakhshi**, Assistant Professor, Pontificia Universidad Católica de Chile, Chile.

1. **Fawzi Benmessaoud**, AI Program Director, Indiana University – Purdue University Indianapolis, USA.  
**Mohamed Habib Agrebi**, Researcher, Indiana University – Purdue University Indianapolis, USA.  
*Title: FazBoard: An AI-Educational Hybrid Intelligent Teaching & Learning System.*
2. **Evangelos Xevelonakis**, Head of Center for Data Science & Technology, HWZ University of Applied Science, Switzerland.  
*Title: Identifying Sustainability Efforts in Company's Reports Using Text Mining and Machine Learning.*
3. **Yun Zhou**, Associate Professor, National University of Defense Technology, China.  
*Title: CycleTTA: Continuous Cyclical Test Time Domain Adaptation.*
4. **Craig Teerlink**, Assistant Professor, VA Informatics and Computing Infrastructure, USA.  
*Title: Development of a Machine Learning Approach to Identify Veterans Carrying the V142I Variant in the US Veterans Administration Healthcare Network.*
5. **Thomas Fehlmann**, Senior Researcher, Euro Project Office AG, Switzerland.  
**Eberhard Kranich**, Senior Researcher, Euro Project Office AG, Switzerland.  
*Title: How to Teach Literacy to Artificial Neural Networks.*

**10:30-12:00 Session 6**

**Moderator: Viktorija Taroudaki**, Associate Professor, Eastern Washington University, USA.

1. **Aleksandra Kostic**, Full Professor, University of Sarajevo, Bosnia and Herzegovina.  
**Valentina Timotic**, Assistant Professor, University of Sarajevo, Bosnia and Herzegovina.  
**Izet Horman**, Full Professor, University of Sarajevo, Bosnia and Herzegovina.  
*Title: Improving Variational Characterization Interval Bounds to Gyroscopic Problems.*
2. **Carmelo Raffaele Cartiere**, Head of Research and Development, Division of Quantitative Physics and Systems Engineering, Kellogg College, University of Oxford, UK.  
*Title: An Analytical Study of Diophantine Equations of Pythagorean Form.*

3. **Michael Hecht**, Visiting Professor / Research Group Leader, CASUS / HZDR, Germany.  
*Title: Fast Multivariate Newton Interpolation for Downward Closed Polynomial Spaces.*
4. **Karl Javorszky**, Retired, Austria.  
*Title: Update on  $a+b=c$ .*

**12:00-13:30 Session 7**

**Moderator: Karl Javorszky**, Retired, Austria.

1. **Philip Slobodsky**, Director, Halomda Educational Software, Israel.  
**Mariana Durcheva**, Lecturer, Sami Shamoon College of Engineering, Israel.  
**Leonid Kugel**, Lecturer, Kaye College of Education, Israel.  
*Title: If you Can't Beat It, Join It! Teaching and Learning Mathematics with ChatGPT and Key Prompts to Stimulate Self-Learning.*
2. **Yenting Lai**, PhD Student, Chung Hua University, Taiwan.  
**Erh-Tsung Chin**, Professor, Chung Hua University, Taiwan.  
*Title: A Case Study of Rural Teachers Developing Bilingual Mathematics Teaching through a Teacher Professional Learning Community.*
3. **Weng Sung-Huan**, PhD Candidate, Chung Hua University, Taiwan.  
**Erh-Tsung Chin**, Professor, Chung Hua University, Taiwan.  
*Title: The Development of Ethno-mathematics Teaching Activity Design Based on Bunun (a Taiwan Indigenous Tribe) Traditional Weaving.*
4. **Chia-Hao Tsai**, PhD Candidate, Chung Hua University, Taiwan.  
**Erh-Tsung Chin**, Professor, Chung Hua University, Taiwan.  
*Title: A Study on the Feasibility of Establishing a Teacher Professional Learning Network through the Implementation of On-line Public Lesson Mode.*

**13:30-14:30 Lunch**

**14:30-16:30 Session 8**

**Moderator: Seren Yashar**, AI Governance Lead, Independent, Greece.

1. **Catalin Silviu Nutu**, Associate Professor, Constanta Maritime University, Romania.  
*Title: Decrypting Evolutionary Fractals using Intelligence Models based on the CSN Matrix.*
2. **Sahika Gokmen**, Associate Professor, Ankara Hacı Bayram Veli University, Türkiye.  
*Title: An Early-Warning System Against Violence for Woman: Türkiye Example.*
3. **Mariana Durcheva**, Lecturer, Sami Shamoon College of Engineering, Israel.  
*Title: Tropical Cryptography – The State of The Art and Future Prospects.*
4. **Nemanja Milenkovic**, Assistant Professor, University of Belgrade, Serbia.  
*Title: A Novel Approach in Multivariate Outlier Detection.*
5. **Babhrubahan Bose**, Research Assistant, Indian Institute of Science, Bengaluru, India.  
*Title: Pointwise Symmetry of Birkhoff-James Orthogonality and Geometry of  $\mathbb{B}(\ell_n^\infty, \ell_m^1)$*

**17:00-20:00 Session 9**

**Old and New-An Educational Urban Walk**

The urban walk ticket is not included as part of your registration fee. It includes transportation costs and the cost to enter the Parthenon and the other monuments on the Acropolis Hill. The urban walk tour includes the broader area of Athens. Among other sites, it includes: Zappion, Syntagma Square, Temple of Olympian Zeus, Ancient Roman Agora and on Acropolis Hill: the Propylaea, the Temple of Athena Nike, the Erechtheion, and the Parthenon. The program of the tour may be adjusted, if there is a need beyond our control. This is a private event organized by ATINER exclusively for the conference participants.

**20:30-22:00**

**Dinner**

**Wednesday 3 July 2024**  
**An Educational Visit to Selected Islands**  
**or Mycenae Visit**

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**Thursday 4 July 2024**  
**Visiting the Oracle of Delphi**

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**Friday 5 July 2024**  
**Visiting the Ancient Corinth and Cape Sounion**



**Mahsa Allahbakhshi**

Assistant Professor, Pontificia Universidad Católica de Chile, Chile

## **Pedagogical Innovation to Enhance Mathematical Learning and Cross-Disciplinary Skills in Incoming Mathematics Faculty Students**

This paper explores the implementation of active and self-regulated learning strategies within a workshop-course designed for first semester Bachelor of Mathematics students and those in Secondary education math teacher students at the Pontificia Universidad Católica de Chile. The course integrates three mandatory theoretical courses, with the aim of equipping university students with essential academic and interpersonal skills. The paper details various active learning strategies identified in literature and discusses the integration of selected approaches that collectively create a conducive learning environment. These strategies are focused on enhancing mathematical knowledge, as well as fostering communication and collaboration skills among students.

A significant aspect of this educational approach is the emphasis on high-quality and rigorous pedagogical standards. Such standards have been instrumental in increasing student motivation and their capacity to address complex mathematical challenges. This approach not only facilitates a seamless transition into university academics but also ensures the development of critical skills like communication and mathematical reasoning. Additionally, the course design pays particular attention to deepening the students' understanding of the cognitive, emotional, and social factors that influence their learning, interactions, and teamwork abilities in mathematical contexts.

To realize these educational objectives, the paper describes a comprehensive framework used in both the design and implementation of the course's strategies. This includes the development of instructional guides for students and teaching-assistants, the creation of collaborative pedagogical activities, and the production of multimedia content for asynchronous learning. The evaluation of this educational model involved a range of methods, including individual interviews, focus groups, and self-assessment questionnaires. A notable feature of the evaluation was the analysis of video recordings from classroom sessions, which provided insights into the active collaboration and dynamic interactions among student groups.

The paper emphasizes that the adoption of an integrated approach has been crucial in meeting the course objectives. This methodology has

not only helped in achieving the desired learning outcomes but also contributed to the ongoing improvement and refinement of the educational process. The results and insights from this study offer valuable contributions to the field of mathematics education, particularly in the context of transition to higher education, and highlight the effectiveness of active learning strategies in enhancing student engagement and learning outcomes.

**Fawzi Benmessaoud**

AI Program Director, Indiana University - Purdue University  
Indianapolis, USA

&

**Mohamed Habib Agrebi**

Researcher, Indiana University - Purdue University Indianapolis, USA

## **FazBoard: An AI-Educational Hybrid Intelligent Teaching & Learning System**

FazBoard, an avant-garde educational platform, seamlessly integrates artificial intelligence with contemporary educational methodologies to foster a dynamic, adaptive, and collaborative learning ecosystem. The platform's linchpin comprises two components: an agile digital canvas that simulates interactive teaching and learning spaces, and an AI Assistant, incarnated as a digital humanoid, available round-the-clock for responsive academic support. The digital canvas is designed to cultivate an immersive and versatile environment, emulating the interactions of traditional classrooms without the constraints of time or location. The AI Assistant excels in providing instantaneous responses to queries, aggregating valuable learning analytics, and streamlining administrative tasks - all of which contribute to curriculum refinement and enhanced pedagogical efficacy. Furthermore, FazBoard is aimed at bolstering student engagement by creating an inclusive learning milieu, through adaptive learning strategies that cater to the diverse educational needs of its users. This paper delves into the architecture, functionalities, and far-reaching applications of FazBoard, heralding it as a quintessential model of integrating AI into education, thereby shaping the trajectory of 21st-century educational practices.

**Babhrubahan Bose**

Research Assistant, Indian Institute of Science, Bengaluru, India

## **Pointwise Symmetry of Birkhoff-James Orthogonality and Geometry of $\mathbb{B}(\ell_n^\infty, \ell_m^1)$**

We study the relationship between the point-wise symmetry of Birkhoff-James orthogonality and the geometry of the space of operators  $\mathbb{B}(\ell_n^\infty, \ell_m^1)$ . We show that any non-zero left-symmetric point in this space is a smooth point. We also show that for  $n \geq 4$ , any unit norm right-symmetric point of this space is an extreme point of the closed unit ball. This marks the first step towards characterizing the extreme points of these unit balls and finding the Grothendieck constants  $G(m, n)$  using Birkhoff-James orthogonality techniques.

**Gordon Brooks**

Professor, Ohio University, USA

&

**Nina Adjanin**

Assistant Professor, Northwest Missouri State University, USA

## **Using Human-Friendly Scheffé Comparisons to Explore Group Differences in One-way ANOVA**

Applied researchers are familiar with multiple comparison procedures (MCPs) used to explore group mean comparisons following a statistically significant one-way ANOVA or main effect in factorial ANOVA. Commonly used MCPs include pairwise comparison techniques like Tukey-Kramer and Games-Howell. Relatively few researchers use the Scheffé method because it is well-known to lack the statistical power of other MCPs for the pairwise post hoc comparisons that most researchers use – and most statistics programs provide.

The Scheffé MCP has lower power because it adjusts for all possible comparisons: all pairwise and non-pairwise comparisons. However, only Scheffé MCP guarantees the congruence to find a statistically significant comparison whenever the omnibus or main-effect ANOVA is statistically significant – and conversely, not find one when ANOVA is not significant. That is, a maximum Scheffé comparison can be calculated that provides the set of contrast coefficients for the means that maximally differentiates some combination of groups on the dependent variable. This maximum comparison has the same statistical significance as the omnibus Fisher  $F$  ANOVA and is usually a non-pairwise (also called complex) comparison.

Unfortunately, coefficient weights from this maximum Scheffé comparison are often uninterpretable or meaningless from a practical or theoretical perspective. Therefore, Barcikowski (personal communication, 2000) suggested a method by which a researcher can identify the maximum “human-friendly” comparison that serves to approximate the Scheffé maximum comparison with coefficients that are reasonably interpretable. That is, Barcikowski’s approach identifies and tests all possible comparisons that use “reasonable” ways to compare complex combinations of groups. For example, one acceptable reasonable comparison would be the Helmert-type contrast that compares a control group with the average of multiple treatment groups. Similarly, another example would be the comparison of the average of two control groups with the average of two treatment groups. Barcikowski’s method will identify the maximum comparison from among all

possible reasonable Scheffé-like comparisons and will also identify all statistically significant complex comparisons that have interpretable coefficients.

We believe researchers may be missing potentially useful exploratory information by not examining the maximum Scheffé or Barcikowski comparisons. Our primary purpose in the presentation is to demonstrate the use of the new R Shiny web app to obtain (a) the Scheffé maximum comparison, (b) the maximum Barcikowski “human-friendly” comparison, as well as all the statistically significant Barcikowski comparisons, and (c) the relatively unknown Brown-Forsythe adjustment to the Scheffé MCP for when the equal variances assumption is not met. We will also share some of our research that supports the use of Barcikowski contrasts, especially examples from a review of recent education literature that might have benefited from use of the Scheffé maximum comparisons and Barcikowski comparisons.

**Carmelo Raffaele Cartiere**

Head of Research and Development, Division of Quantitative Physics  
and Systems Engineering, Kellogg College, University of Oxford, UK

**An Analytical Study of Diophantine Equations of  
Pythagorean Form**

In XVII century, presumably between 1637 and 1638, in a marginal note of Diophantus' "Arithmetica", Pierre de Fermat claimed that Diophantine equations of the Pythagorean form (or,  $x^n + y^n = z^n$ ) have no integer solutions for  $n > 2$ , and  $x, y, z > 0$ . Of this statement, however, Fermat never provided a proof. Only after more than 350 years, in 1994, Prof. Andrew J. Wiles was finally successful in demonstrating it. However, Wiles' proof adopts such advanced calculus techniques that they could never have been in the background of Fermat's knowledge.

In this work, our aim is to establish an analytical method to attempt a proof of Fermat's Last Theorem using solely elementary calculus techniques. Our methodology unfolds as a step-by-step process, mathematically robust, transparent, and comprehensible to a broader audience, ultimately leading to the rigorous confirmation of Fermat's Last Theorem.

**Dimitris Christodoulou**

Teaching Professor (Retired), University of Massachusetts Lowell, USA

## **Euclid Absent from the Standard Model of Particle Physics**

It takes no more than Euclid's geometric means between the known quarks to derive empirically some 16 of the 19 free parameters of the Standard Model of particle physics. Quantum chromodynamics, supersymmetry, and their exotic variants are simply unable to accomplish such a feat. After a brief historical introduction of cosmological units (and ratios and rates), I will derive these 16 parameters from the quark geometric means that pervade our universe, the fine-structure constant, and Koide's constant. Then, I will close with the "dreadful" consequences.



**Mariana Durcheva**

Lecturer, Sami Shamoon College of Engineering, Israel

## **Tropical Cryptography - The State of The Art and Future Prospects**

H.S. Vandiver is credited with introducing the concept of semirings in 1934, although earlier examples of implicitly defined semirings can be traced back to research in ring ideal theory. Nevertheless, semirings remained unnoticed by mathematicians for a long time. It was not until 1961, when Marcel Schützenberger presented the concept of a weighted machine, that interest in semirings experienced a revival.

A *semiring* can be considered as the general algebra  $(S, +, \cdot)$  with two binary associative operations: "+" and "\cdot", such that the distributive law connects the semigroups  $(S, +)$  and  $(S, \cdot)$ . We will use the term *semiring* in a narrower sense, namely to refer to cases where addition is commutative. Usually, a semiring is called *idempotent* if  $a + a = a$  for all  $a \in S$ .

Tropical algebra, originally proposed by Cuninghame-Green in the 1960s, introduced an innovative approach by replacing the field of real number  $\mathbb{R}$  with the semifield  $\mathbb{R}_{\max}$ . The term *idempotent analysis* was later coined by Viktor Maslov in 1985. This theory offers a new perspective to transform many non-linear problems in the real number domain into linear ones using this new arithmetic. Since 1995, the field of tropical algebra has seen significant growth with numerous discoveries and diverse applications in areas such as control theory and optimization; phylogenetics; modeling cellular protein production; railroad planning...

D. Grigoriev and V. Shpilrain were the first to demonstrate the use of tropical semirings in public key cryptography in 2013. Since then, numerous tropical schemes have been proposed, incorporating various idempotent semirings. The most commonly used idempotent semirings for cryptographic purposes are: *min-plus semiring* (where the additional operation is min, a multiplicative - usual addition) and *max-plus semiring* (where the additional operation is max, a multiplicative - usual addition), while there are also schemes utilizing *max-time semiring* (the addition is max, the multiplication is usual multiplication) and *min-time semiring* (the addition is min, the multiplication is usual multiplication).

The main mathematical problems which provide the security of these schemes are: **the tropical discrete logarithm problem (tropical DLP); the tropical semigroup action problem (tropical SAP); the tropical semidirect product; the problem of solving a two-sided linear**

**system in tropical semiring; factorization of tropical polynomial and finding the GCD of two tropical polynomials; the tropical matrix power function problem (tropical MPF).**

In this work, we provide a review of existing tropical schemes, discuss the difficulty of the underlying problems, examine existing attacks on these schemes, and explore the future prospects and directions for cryptography based on tropical semirings.

**Thomas Fehlmann**

Senior Researcher, Euro Project Office AG, Switzerland  
&

**Eberhard Kranich**

Senior Researcher, Euro Project Office AG, Switzerland

## **How to Teach Literacy to Artificial Neural Networks**

Kausalai Wijekumar, a professor at Texas A&M University, USA, and his team gave a talk at the 26<sup>th</sup> Annual International Conference on Education, 20-23 May 2024, collocated with Computer Science, on how to teach children to gain literacy by reading. This turned out to be an excellent tutorial on how to make an artificial neural network intelligent.

Our organization is currently building a collection of designs for AI-enabled intelligent systems with self-learning capabilities. Using Wijekumar's work as inspiration, this talk will explain how such autonomous learning works, and present the state of the collection project. Unlike traditional deep learning, our collection of intelligent system designs can fine-tune themselves without the help of knowledge engineers who prepare an appropriate training set.

But what does literacy mean in AI? Generative AI, especially Large Language Models (LLM), use statistical relevance to build responses to prompts. Literacy in education means understanding cause and effect from a text and why one observation follows another. It has to do with the real world and some understanding of how the grounding behaves and works. This kind of learning can be achieved with intelligent systems that combine AI engines with traditional programming, or in terms of the graph model of combinatorial logic: Observations and Concepts with Lambda Concepts.

In conclusion, it is very helpful to listen to other disciplines for making AI intelligent. Such a list of AI engineers includes, but is not limited to, education and teaching to children and humans.

**Sahika Gokmen**

Associate Professor, Ankara Hacı Bayram Veli University, Türkiye

**Sibel Atan**

Ankara Hacı Bayram Veli University, Türkiye

**Rukiye Dagalp**

Ankara Hacı Bayram Veli University, Türkiye

&

**Murat Atan**

Ankara Hacı Bayram Veli University, Türkiye

## **An Early-Warning System against Violence for Woman: Türkiye Example**

In this research, we want to suggest an early warning system for violence against woman in Türkiye. The violence against woman has been an important topic of scientific literature for many countries. WHO and the similar organizations take into consideration this issue as it affects the social form of the society both on today and in the future. In the literature, it is possible to encounter with lots of factors that affect the violence against woman by intimate partner; partner's behavioral attitudes, economic factors, education level, family structure, living area etc. Even each country has own a protection system for woman who faces with violence. It has been realized from the related literature that an early warning system has not been researched yet. However, having this kind of an early warning system may help to reach woman under risk even they do not realize the situation and/or organize education programs for woman under certain circumstances. In this case, it is believed that this research may increase the benefit of education and/or protection applications as it focuses on the woman under specific conditions through an early warning system. For this motivation, firstly the factors effect violence against woman is investigated by the statistical tools and secondly is defined an early warning system depending on the related tools in this research.

**Michael Hecht**

Visiting Professor/Research Group Leader, CASUS/HZDR, Germany

## **Fast Multivariate Newton Interpolation for Downward Closed Polynomial Spaces**

We introduce a fast Newton interpolation algorithm of runtime complexity  $O(Nn)$ , where  $N$  denotes the dimension of the underlying downward closed polynomial space and  $n$  its  $l_p$ -degree,  $p > 1$ . We demonstrate the algorithm to reach the optimal geometric approximation rate for analytic Bos-Levenberg-Trefethen functions in the hypercube, in which case the Euclidean degree,  $p=2$ , turns out to be the pivotal choice for resisting the curse of dimensionality. The spectral differentiation matrices in Newton basis are sparse, which enables realizing fast pseudo-spectral methods on flat spaces, polygonal domains, and regular manifolds. In particular, we discuss applications for high-dimensional PDEs and reaction diffusion systems on surfaces.

**Karl Javorszky**  
Retired, Austria

## Update on $a+b=c$

Basic research brought up a possible solution to many current questions regarding the nature of interdependencies observed in biology and during research into AI. We use a Pythagorean approach to deictic logic and demonstrate the existence of typical patterns and of families of patterns on an etalon collection of 136 pairs of natural numbers  $(a,b)$ ,  $a \leq b \leq 16$ .

The etalon collection of 136 pairs of  $(a,b)$  is placed in a habitat that is subject to periodic changes. We sort, resort, and order the logical primitives according to their diverse aspects. For sorting, we use the concept known as permutations. For grouping, we make use of the cyclic properties of permutations. We find an upper limit for the number of group relations that are concurrently possible on an assembly to be  $n? = \exp(\ln(\text{partition}(n))^2)$ . The relations  $n! / n?$  are fundamental. We further use a metric **liaisons** relating to the properties of groups (cycles) the element belongs to.

The work is an instruction manual on how to build the databases out of which the results are read out. The pairs of natural numbers organize themselves into paths within self-made geometries. The basic patterns that simple logical elements show when being reordered are archaic building material for logic. The terms of place and material become data in a data depository that is an element. Above this mother matrix of facts (which element is where when) there is a matrix of order, relations, and predictions. The accounting image of the inventory and the factual state of the inventory are two slightly deviating sets of data, which maintain a common currency of predictability resp. degree of certainty. The mutual expectations - predictions are an inbuilt feature of the symbols set and picture the rationally explainable world within the Eddington delineation. Its rules can be learnt by means of the data set we suggest the reader builds on their own computer.

I hope this Conference is the right forum to present a numeric invention to. The versatile tool provides translation coefficients between interpretations of numbers as space designators and as quality, matter and chronicity designators. The laboratory phase is over. The inventor now seeks to meet people interested in the production of a prototype of a tool that will prove to be extremely practical for generations to come.

18<sup>th</sup> Annual International Conference on Statistics: Teaching, Theory & Applications,  
1-4 July 2024, Athens, Greece: Abstract Book

See: [Update on  \$a + b = c\$  - Article \(Preprint v1\) by Karl Javorszky | Qeios.](#)

**Aleksandra Kostic**

Full Professor, University of Sarajevo, Bosnia and Herzegovina

**Valentina Timotic**

Assistant Professor, University of East Sarajevo, Bosnia and  
Herzegovina

&

**Izet Horman**

Full Professor, University of Sarajevo, Bosnia and Herzegovina

## **Improving Variational Characterization Interval Bounds to Gyroscopic Problems**

A quadratic matrix polynomial  $Q(\lambda) = \lambda^2 I + \lambda B + C$ ,  $B = B^H$ ,  $\det B \neq 0$ ,  $C = C^H > 0$  is gyroscopically stabilized if for some  $k > 0$  it holds that  $|B| > kl + k^{-1}C$ , where  $|B|$  denotes the positive square root of  $B^2$ . The eigenvalues of the quadratic matrix polynomial are divided into four disjoint intervals: in the first interval there are negative eigenvalues of positive type, in the second interval there are positive eigenvalues of positive type, in the third interval there are negative eigenvalues of negative type and in the fourth interval there are positive eigenvalues of negative type. Therefore, this problem is suitable for the application of the variational characterization method for determining the eigenvalues. The borders of these four intervals are unknown. In this paper we will improve the borders of these intervals, to which we apply the variational characterization. We will consider the application of Sylvester's law of inertia to this type of problem.



**Yenting Lai**

PhD Student, Chung Hua University, Taiwan

&

**Erh-Tsung Chin**

Professor, Chung Hua University, Taiwan

## **A Case Study of Rural Teachers Developing Bilingual Mathematics Teaching through a Teacher Professional Learning Community**

Taiwan aims to become a bilingual country by 2030, advocating not only for Mandarin Chinese but also integrating English as an official language. In primary education, mathematics holds paramount significance, serving not just as foundational knowledge for more advanced subjects but also as a subject deeply intertwined with daily life. Hence, this study primarily investigates how educators in rural settings develop a Professional Learning Community (PLC) for bilingual mathematics curricula, exploring their journey, encountered challenges, and adaptive strategies. To collect data, the study utilises instruments such as interviews, curriculum documents, and classroom observations.

The establishment of a PLC among rural educators aligns with government-driven initiatives. The case study involves three mathematics teachers and a native English teacher. The PLC activities encompass scheduling meetings, collaborative curriculum preparations, classroom observations, and post-lesson discussions. The instructional framework focuses on a second-grade bilingual mathematics curriculum, collectively exploring content planning and the timing and methods of integrating English in classroom settings. However, this instructional initiative encounters various challenges. While designing the bilingual mathematics curriculum, challenges have emerged due to the scarcity of vetted bilingual materials meeting national standards, compelling teachers to engage in continual discussions regarding material validity and students' learning considerations. Additionally, the inconvenience of transportation in rural areas hinders the invitation of experts to schools for educator capacity building, limiting access to external teaching resources. Furthermore, teachers within the PLC face time constraints from overwhelming administrative duties, causing difficulties in joint curriculum preparation. Moreover, the differences in expertise between the three mathematics teachers and the English teacher led to initial divergences in PLC discussions. Nevertheless, the PLC navigate these challenges by collecting diverse resources from

within and outside the school for curriculum development and implementation, subsequently refining the curriculum. The geographic constraints are mitigated by utilizing online communication tools (e.g., Google Meet) to invite experts to provide insights and guidance to teachers. The unified efforts of the PLC members aim at educational advancement, actively overcoming these challenges.

The research findings illustrate the collaborative efforts of rural educators in enhancing bilingual mathematics education through PLCs. Overall, this study not only underscores the pivotal role of PLCs in educational reform and teaching quality enhancement but also offers specific strategies for rural educators to address challenges in developing bilingual mathematics. These insights contribute to further research and practical applications in related domains.

In summary, this study highlights the endeavours of rural educators through PLC collaboration to enhance bilingual mathematics education, providing concrete strategies to tackle challenges while emphasizing the critical role of PLCs in educational reform and teaching quality enhancement, from the perspective of mathematics education researchers.

**Liang-Ching Lin**

Professor, National Cheng Kung University, Taiwan

## **LIMOS - LightGBM Interval Merton's One-period-portfolio Selection**

The modern portfolio theory can assist us in allocating wealth to risky and risk-free assets reasonably by using some statistical methods. In this study, we will focus on evolving Merton's portfolio problem. Instead of the conventional parameter estimations based on only the closing prices, we include the opening, high, low, and closing prices to enlarge the database as much as possible to make the parameter estimations much more accurate. Furthermore, we consider a weighted arithmetic mean of estimations obtained from different lengths of training datasets to stabilize the estimators in which the weights are evaluated by using the least squared method. In addition, we use the LightGBM to predict the transaction directions and include not only the prices as tradition but also many statistics to be the features. In real data analysis, we demonstrate the usefulness of combining the methods above by showing the portfolio profits of selecting 10 stocks in 2018 and 2019. The results particularly show the superiority of the proposed strategy over the conventional method: the profits are almost positive and have around 32% to 72% annually.

**Mihail Mateev**

Chief Assistant Professor, UACEG – Sofia, Bulgaria

## **Implementing Image Analysis with Azure AI Vision and Open AI for Predictive Analysis**

One of the most used predictive analytics applications involves extracting necessary metadata from images and videos to evaluate the condition of real-world systems and recommend measures to sustain these systems.

Microsoft's Azure AI Vision service offers access to sophisticated algorithms that analyze images and generate insights based on the visual aspects of interest to the user. Additionally, Azure OpenAI Service has introduced an image analysis feature that leverages large language models (LLMs) to comprehend the content of images.

GPT-4 Turbo with Vision, developed by OpenAI, is a significant multimodal model (LMM) capable of interpreting images and providing text-based answers to queries regarding those images, combining capabilities in both natural language processing and visual comprehension.

This research proposes an efficient approach to implementing image analysis and automated metadata generation for images. The article compares Azure AI Vision and GPT-4 Turbo with Vision, exploring how these technologies can be utilized together for enhanced predictive analysis.

**Nemanja Milenković**

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**Aleksandar Doković**

Associate Professor, University of Belgrade, Serbia

&

**Zoran Radojičić**

Professor, University of Belgrade, Serbia

## **A Novel Approach in Multivariate Outlier Detection**

Detecting outliers in the multidimensional space is as important as detecting them in a single dimension. The term "outlier" refers to the observation which is in some way inconsistent with the rest of the observations in a data set. Outliers can lead to incorrect calculation of sample parameters, and thus to poor estimation of population parameters. Definitions of outliers are numerous. The most commonly cited definition is that it is "an observation that deviates so much from other observations as to arouse suspicion that it was generated by a different mechanism. Multivariate outliers are most commonly detected using the Mahalanobis distance. In this research, the statistical I-distance method is thoroughly explained, applied and compared with Mahalanobis distance, since they have similar nature and calculation process. I-distance method, as a metric in an n-dimensional space, has been originally devised in order to rank countries according to their level of development, based on several indicators. There are many improvements of this method that led to its widespread use, such as multivariate outlier detection. This research is conducted on 30 point guards in the NBA league and the values of nine indicators were measured in order to detect players with specific set of skills.

**Nadya Morozova**

Researcher, CNRS, Institute Gustave-Roussy, France

## **Developmental Graphs Comparison Strategy for Analysis of Pattern Formation and Phylogeny**

We apply mathematical formalization of a development in living organisms as a graph and next apply graphs comparison strategy for the analysis of some intriguing phenomena of the process of embryogenesis.

Namely, in most taxa of plant and animal kingdoms the first steps of embryogenesis and the final morphology of an organism are strongly determined. But surprisingly, the determination of these patterns does not correlate from phylogenetic point of view, namely, different unrelated big taxons can have the same type of development in early embryogenesis, while there can be different types of early embryogenesis inside one big taxon. Here we provide an insight into the problem of possible interrelation between these two phenomena.

First, we propose a strategy of construction developmental graphs (trees) formalizing a process of embryogenesis. Second, we suggested an algorithm of trees comparison, developed specifically for this type of labeled graphs, which allows calculating a distance between two developmental trees, and thus clustering them into groups. Next the analysis of correspondence between the obtained clusters and the inception of morphological features in a given clustered group of organisms can elucidate the interrelation between developmental trends and formation of morphological structures.

We illustrate the suggested methodology on the analysis of 30 examined plant species belonging to different taxa of various ranks. The analysis of obtained clusters of developmental trees allowed predicting those cells in early embryos which are responsible for the inception of morphological structures of these species.

**Catalin Silviu Nutu**

Associate Professor, Constanta Maritime University, Romania

## **Decrypting Evolutionary Fractals using Intelligence Models based on the CSN Matrix**

This paper is expanding on a previous paper of the author [1], by providing an alternative intelligence model to complete the present models of A.I. This new intelligence model is based on the CSN Matrix presented in this referenced paper [1].

This CSN Matrix can be used, on one hand, to decrypt evolutionary fractals having unknown rules, and on the other, it can be used to simulate the way in which random creative processes occur. The CSN Matrix simulates better how brain behaves, because when making scientific discoveries, often times, existing information is not processed as in classical A.I models, which are mostly deterministic, but it is processed aleatory by brain, in random processes, as in the model based on the CSN Matrix.

Decryption of these evolutionary fractals may be the key of understanding of human brain functioning and of human intelligence. The first step, however, is the decryption of evolutionary fractals related to more simple lifeforms, and only then, after the decryption at this first step, the decryption of the human intelligence may be addressed.

The model presented in this paper can either be used as an entirely independent intelligence model to simulate human intelligence random creative processes, but it also can be used to create enhanced intelligence models.

### *Research Question*

Evolutionary fractals are defined as fractals evolving from a certain shape into another one, by changing shapes because of moving through different fractal rules, or in this particular case, from a life form into another, from an initial state of the life form into a final state of life, by passing through a multitude of phases and transformations. More exactly it means a structure based on and constructed using a set of many fractals, each one having its own fractal rule.

Evolutionary fractals may be deemed as structures in which is embedded the Intelligence of Nature.

The first step toward decrypting the Intelligence of Nature is the decryption of these evolutionary fractals.

Understanding human brain processes may imply decryption of the evolutionary fractals, after previously decrypting more simple evolutionary fractals encountered in Nature.



**Ivonne Pallares-Vega**

Professor, Autonomous University of the State of Morelos, Mexico

## **Some Thoughts on Teaching Set Theory**

The Zermelo-Fraenkel axioms for set theory are the ones presented in most textbooks on this subject. There is another, less well-known axiomatization of the concept of set. From a purely logical point of view, the chief difference between these two approaches consists in what each one takes as the basic, undefined concept. The traditional approach takes this to be the membership relation, whereas the other one takes as its basic concept that of map, mapping or function. From a philosophical point of view, much has been said about the advantages and disadvantages of one approach over the other. In this talk, I discuss some issues raised almost exclusively by philosophers of mathematics, but from an educational point of view, thus raising the question of what we should teach when we teach set theory.

**Carlos Rojas**

Assistant Professor, Pontificia Universidad Católica de Chile, Chile

## **The Academic Portfolio as an Assessment Purpose-Driven Tool in the Training of Primary School Teachers in Mathematics**

This paper aims to outline the implementation methodology of the academic portfolio as an assessment tool in Algebra and Number Systems I and Algebra and Number System II courses. These courses are part of the elementary teacher students' curriculum in mathematics during their program formation's final year at Pontificia Universidad Católica de Chile.

The use of portfolios has emerged as a necessity for designing an effective strategy to bridge the observed gap between course content and the required learning outcomes that the students must achieve with their future students when they become teachers. This gap is particularly significant in both courses due to the level of abstraction and mathematical formalism required, primarily because of the topics covered, including number systems, logic, and axiomatic set theory.

The description of the model's implementation begins with an in-depth look at the initial phase of student-teacher negotiation, which is aimed at establishing a learning contract. In this phase, both parties collaboratively determine the essential elements to be included in the portfolio. Following this, the course rules are meticulously reviewed. This is succeeded by a comprehensive explanation of the class content, learning objectives, and the materials to be utilized, along with the grading rubrics. These components are strategically designed to continually highlight to the students the relevance of their learning in the context of their future roles as teachers. A pivotal aspect of this model is the role of the teacher as a facilitator, who is responsible for effectively conveying this purpose-driven approach to the students.

Preliminary findings suggest that this approach not only bridges the gap between theoretical content and practical learning outcomes but also fosters a deeper engagement with complex mathematical concepts. This methodology, therefore, holds promise not only for improving the efficacy of mathematics education in teacher training programs but also for contributing to the broader goal of elevating the quality of mathematics teaching at the elementary level. Future research could explore the scalability of this approach and its adaptability to other areas of mathematical education, potentially improving the way we assess and facilitate learning in complex subject areas.

Unlike traditional assessment instruments, which often increase students' negative perceptions of this gap, the implementation methodology and portfolio described in this paper provide a more effective approach. This method also empowers students to become protagonists of their own learning process, keep records of their work and improve their academic self-efficacy.

In conclusion, the implementation of academic portfolios in Algebra and Number Systems courses has demonstrated significant potential in enhancing the learning experience of elementary teacher students.

**Philip Slobodsky**

Director, Halomda Educational Software, Israel

**Mariana Durcheva**

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&

**Leonid Kugel**

Lecturer, Kaye College of Education, Israel

## **If you can't Beat It, Join It! Teaching and Learning Mathematics with ChatGPT and Key Prompts to Stimulate Self-Learning**

In this paper, we demonstrate the use of ChatGPT for teaching and learning mathematics, despite the frequent occurrence of miscalculations. The increasing popularity of ChatGPT among students, on the one hand, and the challenge of incorporating mathematical expressions into prompts, on the other, led us to develop an editor for mathematical expressions in a format compatible with ChatGPT syntax. This innovation enables students to interact with the bot effectively.

The only tool to communicate with ChatGPT is a prompt. In case students are interested in asking for help in math problems from class assignments, they just need to type queries in the ChatGPT message box, while writing mathematical expressions in LaTeX format. To facilitate this, the Chat-Mat module of the Halomda platform features a tool for editing and transferring expressions to ChatGPT.

To address the issue of false answers generated by ChatGPT and the pedagogical concerns regarding the automatically generated solutions, we integrated ChatGPT with new tools. These include Math Prompt Editor, Algebraic Calculator, Graph Plotter, and a list of Key Prompts, transforming the toolkit into a comprehensive Chat-Mat™ unit. This integration allows students to interact with ChatGPT and verify its responses.

The central pedagogical principle behind Chat-Mat can be formulated in the following assertion: student's mastery of any mathematical subject is proportional to the time dedicated to studying it. Accordingly, the provision of diverse activities correlates with enhanced academic achievement.

Following this principle, we offer students a math prompts editor and streamline their access to ChatGPT's message box adjacent to the Halomda's editing window. We anticipate that students, upon attempting to solve exercises, may encounter difficulties due to possible miscalculations. To foster deeper engagement, we encourage them to

validate solutions using the Graph Plotter and Algebraic Calculator provided by the platform. These tools offer visual and algebraic representations, respectively, of correct solutions, although without the explanatory of ChatGPT.

In addition to direct problem-solving, we provide supplementary tools for students to pose various questions to the AI bot. These prompts aim to enrich their understanding of the subject matter, enhance problem-solving skills, and ultimately improve exam performance.

To aid students in formulating effective prompts, each problem in the Learn and Train sections of the Halomda system includes a list of recommended "Key Prompts." These prompts encompass three categories, reflecting didactic ideas for student engagement, including:

1. Solving equations, integrals; calculating derivatives, simplifying expressions, etc., relevant to the topic.
2. Recalling definitions, theorems, proofs related to the topic.
3. General questions on history, applications, "tricky" questions (paradoxes, etc.).

By furnishing students with suggested prompts, we cultivate the ability to compose their own questions and also enrich their learning experience with additional contextual information.

Sets of Key Prompts have been integrated into various tasks in mathematics and physics, such as "Complex functions," "Limits and derivatives," "Statistics," "Quantum mechanics" and other.

Currently, a study on the utilization of Key Prompts and other Chat-Mat tools by mathematics students is underway across several colleges in Israel, with results expected to be published soon.

**Jian Song**

Professor, OWL University of Applied Sciences and Arts, Germany

## **Application of Statistics in Evaluation of State of Health and Lifetime of Electrical and Electronic Components**

For electrical and autonomous vehicles, the importance of reliable electrical and electronic components cannot be overstated. With an increasing number of electrical and electronic components being used in vehicles, ensuring their state of health and reliability is crucial for both comfort and safety. One of the key indicators of state of health and reliability is the lifetime of electronic components. Statistics play a very important role in the estimation and evaluation of the reliability, state of health and lifetime of electrical and electronic components. An electrical connector is one of the crucial electrical and electronic components. In this paper, various data-driven statistical methods and probability distributions for the reliability and lifetime prognosis of electrical connectors are introduced.

Since electrical connectors, along with all other electrical and electronic components used in electrical and autonomous vehicles, are reliable components with a very long lifetime, classical lifetime tests are time- and labor-intensive. To address this challenge, a data-driven method has been proposed that predicts the lifetime of electrical connectors using statistical analysis of electrical contact resistance data collected from short-term tests. Both distribution-based methods with different distributions and a distribution-free method are used for the analysis. Additionally, a sensitivity analysis is performed to investigate the influence of the selection of different time durations on the prognosis of lifetime. The results of the sensitivity analysis using percentiles of contact resistance are compared with probability distribution-based methods. The predictions from this method have been compared to actual results obtained from long-term tests. A strong correlation has been observed between the predicted contact resistance development with short-term data and the number of failures in later stages of testing. Thus, apart from predicting the lifetime of connectors, this method can also be applied for failure prognosis in real-time operations.

**Codruta Stoica**

Professor, Aurel Vlaicu University of Arad, Romania

## **On Evolution Cocycles Associated to Control Systems**

The aim of this paper is to highlight new trends and current developments in the study of evolution cocycles associated to control systems.

Over the last years, several concepts of the control theory, as stability, stabilizability, detectability, controllability or observability were refined. The differential equations that generally relate the inputs and outputs of a control system can be asymptotically addressed by means of evolution cocycles.

Therefore, the properties of stabilizability and detectability of a control system are strongly linked with the stable behaviour of the associated evolution cocycle. But these properties are not sufficient to assure the exponential stability of the cocycle.

The theory of evolution cocycles and of skew-evolution semiflows allows a straightforward operator-theoretic analysis of internal stability as determined by classical frequency-domain and input-output operators, even for nonautonomous Banach-space systems.

In particular, the stability is shown to be equivalent to input-output stability for stabilizable and detectable systems. The various concepts of stability and the related results that we emphasize in this paper for evolution cocycles extend some classic notions of the stability theory.

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**Erh-Tsung Chin**

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&

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## **The Development of Ethno-mathematics Teaching Activity Design Based on Bunun (a Taiwan Indigenous Tribe) Traditional Weaving**

The purpose of this study is to explore the mathematics knowledge contained in the traditional woven fabrics of the indigenous tribe, Bunun, in Taiwan, and then apply it to design indigenous culture-based mathematics teaching activities for the Bunun students in order to assist the maintenance and recovery of tribal culture. The research subjects are an elderly couple from Bunun whilst the wife is an expert in traditional weaving. Through the help of indigenous language experts and Bunun cultural experts, the collected materials including video files, interview records and artefacts are interpreted and analysed. Then, based on the geometrical patterns from the Bunun traditional woven fabrics, the mathematics teaching activities are designed and taught in the local junior high school.

Some reflections after conducting this ethno-mathematics research are as follows: (1) it is important to obtain the tribal acknowledgement first; (2) researchers need to gain some understanding of the difference between the tribal culture and mainstream culture; (3) hands-on inquiry activities are especially crucial for the indigenous students' mathematics learning; (4) ethno-mathematics teaching activities may enhance indigenous students' cultural acknowledgement.



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**Michael Winer**

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&

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EHE Distinguished Professor of Mathematics Education, Ohio State  
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## **Using an Online Dynamic Geometry Curriculum to Gain Insights into Preservice Elementary Teachers' Learning of the Properties of Quadrilaterals**

Research has found that many elementary teachers in the United States are lacking the deep conceptual understanding necessary to adequately teach mathematics to their students in a meaningful way. Consequently, teacher educators must help elementary preservice teachers (PTs) use accessible research-based curricula that will better prepare them to conceptually understand the mathematics they teach. One curriculum that tries to address this, is the Individualized Dynamic Geometry Instruction (iDGi). iDGi is a National Science Foundation funded online interactive Dynamic Geometry learning system based on several elementary learning progressions. It was created to develop elementary students' conceptual learning of geometry topics (length, area, isometries, quadrilaterals, and triangles) through a series of learning progression sequenced instructional modules. In this study, we extend iDGi use from elementary students to PTs enrolled in a Mathematics for Elementary Teachers university course to investigate how iDGi instruction affected their learning about the geometry topics they are frequently asked to teach. For this paper, we focus on PTs' learning of prototypical defining properties of quadrilaterals. These properties express in formal geometric terms the most visually salient spatial characteristics that students use in identifying different types of quadrilaterals and interrelationships between quadrilaterals. As an example, the prototypical defining properties of a rectangle are opposite sides that are congruent and parallel, and four right angles. Instructors assigned specific iDGi quadrilateral modules for PTs to complete prior to quadrilateral concepts addressed in class to encourage PTs to develop their own initial conceptions. During the classroom quadrilaterals unit, a typical class had PTs working collaboratively on an activity that was designed to be used alongside the assigned iDGi modules. Each class activity was followed by a whole

class discussion in which PTs revealed their findings from the activity and the instructor assessed and advanced PTs' reasoning through questions and scaffolding techniques. Data was collected over 5 years with multiple Mathematics for Elementary Teacher's classes that used iDG<sub>i</sub> with instruction. There were four instructors who taught these courses using iDG<sub>i</sub>, with whom each course was taught using an inquiry-based teaching method and using the same lesson plans. Data collection also occurred prior, during, and after the COVID-19 pandemic, therefore, data is from both in-person courses and courses that were taught synchronously on Zoom. To measure learning from iDG<sub>i</sub>, we used one-sample matched pairs and two-sample t-tests by having 541 PTs take the same online multiple-choice test to check their understanding before using iDG<sub>i</sub> (pre-test) and after (post-test). We used a significance level of  $\alpha=0.05$ . The results showed that there was not enough evidence to suggest that the instructor, quarter, or method of instruction (i.e. Zoom or in-person instruction) made a difference in the scores, but the increase in the scores after the use of iDG<sub>i</sub> curriculum was statistically significant—evidence supporting the hypothesis that the use of iDG<sub>i</sub> was beneficial.

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**Development of a Machine Learning Approach to Identify  
Veterans Carrying the V142I Variant in the US Veterans  
Administration Healthcare Network**

**Background:** Hereditary amyloidosis (haTTR) is a severely underdiagnosed debilitating disease that is due to a variant in the TTR

gene (c.424G>A p.Val142Ile, also referred to as V122I), which is found in 3-4% of individuals of African ancestry (AA). Penetrance approximates 100% with increasing age. Early diagnosis is key to successful therapy but is hampered by the initial heterogenous and nonspecific presentation of the disease, slow progression, and failure of healthcare providers recognize symptoms and appropriately work up patients. Our goal was to create an AI tool that uses features from the electronic health record to identify individuals likely to carry the V142I variant, and thus at risk for hATTR, among the U.S. Veterans Administration's (VA) AA population.

**Methods:** We developed an analytic cohort in the Million Veterans Program cohort (MVP) among Veterans who were genetically similar to self-reported non-Hispanic Black (NHB) Veterans and who underwent genome-wide genotyping. The V142I variant was imputed based on the 1000 genomes project reference panel. For every Veteran who carried the V142I variant we selected 5 age, sex, and race/ancestry matched non-carriers to serve as controls. We removed subjects with < 10 clinical visits, age < 50 years, and presence of other known TTR variants. Clinical data comprising clinical procedures, diagnoses, medications, laboratory results, and specific clinical features derived by natural language processing of text notes was extracted from the VA electronic medical record and one-hot encoded. We used logistic regression to estimate effect sizes and standard errors for the association of each feature with V122I carrier status and then calculated z-scores for each feature by dividing the effect estimate by its standard error. For each individual we then computed a composite score based on the sum of the z-score for each feature multiplied by its respective indicator variable for each feature.

**Results:** Among all MVP participants genetically similar to self-described NHB Veterans (123K), 3,861 (3.1%) carried the V142I variant. After matching the analytic cohort comprised 19,892 individuals. The mean age was 58.3 years and 17,630 (88.6%) were male. Among the 1000 highest risk individuals identified by cumulative z-score, 293 carried the V142I variant. This was significantly (binomial test  $p < 0.001$ ) more than the 187 that would be expected to carry the variant by chance based on the composition of the analytic cohort.

**Conclusions:** V142I carrier status can be predicted based on clinical features from the electronic health record. The ability to identify these individuals at risk for hATTR based on their existing clinical information in their medical records and refer them for clinical genetic testing is a new strategy for early detection of hATTR risk and will likely deliver earlier access to proven therapies for individuals with this

condition. We are currently deploying an alternative analytic strategy (Bayes Network analysis) in the analytic cohort. Once completed, we will attempt to validate the prediction model by applying it to all NHB patients in the nation-wide VA healthcare network to identify potentially at-risk Veterans and perform clinical genetic validation testing in the 2000 Veterans at highest risk.

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## **Adjusting the Balance between Alpha and Beta Risks in NN Classifiers**

Classification tasks involve assigning the correct label to a given data. Typically, there are only two classes, such as fraud/not fraud for security purposes, breakdown/not breakdown for reliability studies, or sick/not sick for medical purposes as examples. It is important to note that two types of errors can occur, but they do not have equal impact. Misclassifying a fraud as non-fraudulent has a much greater impact than the opposite. In statistical studies, hypothesis testing involves two hypotheses:  $H_0$  and its opposite,  $H_1$ . This approach can result in two types of error: Type I error (alpha), which is the risk of falsely rejecting hypothesis  $H_0$ , and Type II error (beta), which is the risk of falsely accepting hypothesis  $H_0$ .

If the hypothesis  $H_0$  (or  $H_1$ ) corresponds to the data belonging to class 0 (or class 1), for example, where class 0 represents 'not sick' and class 1 represents 'sick', then the alpha risk corresponds to the false alarm rate and the beta risk corresponds to the non-detection rate, which are commonly used in classification.

The two risks, alpha and beta, are linked; an increase in alpha risk results in a decrease in beta risk and vice versa. The principle of statistical studies is to select an acceptable alpha risk to construct the test, which enables risk management. In classification problems, the primary objective is to minimize the misclassification rate. The two risks may not be chosen but are instead imposed by the learning process. This is notably the case when using neural networks, particularly multilayer perceptron, to perform classification tasks. It is often the case that the two risks are not equal, which can be a drawback in many application purposes.

This paper aims to propose a modification of the learning algorithm for multilayer perceptron to manage the balancing between two risks. This modification is based on the use of a weighted criterion to minimize, taking into account that different error types have different

signs (negative errors correspond to Type I errors, while positive errors correspond to Type II errors).

The initial results on a simulated benchmark are promising, allowing for tuning of the alpha risk from 1% to 7%, resulting in a corresponding beta risk ranging from 39% to 17%. The statistical test with a confidence interval of 5% shows that these results do not degrade the misclassification rate.

Additionally, this paper presents results on a medical dataset. The patients are distributed into different categories ranging from healthy to ill patient by using a combination of different tuning of the alpha and beta risks, which allows for differentiation in patient treatment.

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## **A Study on the Feasibility of Establishing a Teacher Professional Learning Network through the Implementation of On-line Public Lesson Mode**

Numerous studies have shown that students' learning is closely related to the teaching expertise of the teacher. Therefore, the professional development of teachers is imperative. Influenced by lesson study, "public lesson" has become an essential process for the professional development of primary school teachers in Taiwan since 2019. However, due to the nature of its implementation, school types, the composition of professional learning community members, and the limitations of time and space, the effectiveness of teachers' professional growth has been limited. Consequently, it is necessary to establish a professional learning network for the implementation of public lessons.

This study aims to construct a professional learning network (PLN), leveraging the advantages of the internet to reduce constraints related to personnel, space, and time. Through the implementation of public mathematics lessons, the study seeks to facilitate dialogues among mathematics teachers, with the expectation of fostering the professional development of their mathematics teaching. Teachers' mathematical teaching knowledge is analysed through their dialogues, and the mathematics quality for instruction is examined via the analysis of their classroom teaching video records. Ultimately, the study presents recommendations for perspectives and models of teacher professional learning community activities on the internet, anticipating contributions to the professional growth of primary school mathematics teachers.



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### **Long-term Benefits of Blood Pressure Management on Memory Complaint Reduction: A Time Series Analysis in a 4-year Prospective Cohort in Hong Kong**

**Objective:** The blood pressure (BP) trend is shown to have seasonally fluctuated; and is affected by both personal physical and cognitive conditions. This study aimed to investigate the long-term benefits of a BP management programme with adjustment for year-round BP fluctuations among the elderly in Hong Kong.

**Methods:** Participants with ages above 55 years were recruited from elderly centres and were prospectively followed-up since September 2016. Personal health conditions were interviewed by social workers. Those with suboptimal BP records, follow-up nursing calls and social engagement activities were offered. Participants with over 80% of weekly BP records in at least 2 years of follow-up were included. The seasonal BP fluctuations and random noise of the BP trend were adjusted by time-series models. The BP trends were tested by the Mann-Kendall test, and the downward BP trend was defined as the optimal BP control for the hypertensive participants. The logistic regression models were used to investigate the potential factors for optimal BP control.

**Results:** A total of 1,151 participants with a mean age of 79 years were included in the study. Based on the trend testing, 662(58%) participants were classified as improved and stable BP trends defined as downward and consistent trends of BP records, and 489(42%) were classified as having deteriorated BP levels. The multivariate model showed that improved and stable BP trends were associated with baseline systolic BP levels, (OR 1.03, CI 1.02-1.04), cholesterol problems (OR 1.26, CI 0.98-1.63), and subjective memory complaints (OR 0.64, CI 0.47-0.85) (Table 1). Compared with daily junk food intake, eating less than once a week was good for BP management.

**Conclusion:** Seasonal blood pressure fluctuations always influence

the performance of blood pressure management programmes. Time-series modelling is possible to figure out the real trend of personal blood pressure records after adjustment for seasonal effects. This study demonstrates that the long-term benefits of our blood pressure management programme were limited by the elderly with memory complaints. When we are offering blood pressure management programme, special arrangement is required for the participants with mild cognitive impairment or even dementia.

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## **Identifying Sustainability Efforts in Company's Reports Using Text Mining and Machine Learning**

This study delves into the utilization of text mining to scrutinize social and environmental reports of companies, showcasing its effectiveness in evaluation. It explores various text mining techniques and practically applies decision tree, k-nearest neighbors, and naïve Bayes methods. The paper offers guidance on extracting pertinent terms related to four

CSR dimensions: Environment, Employee, Social responsibility, and Human rights. Results demonstrate the successful differentiation of text based on these dimensions, leveraging a CSR-relevant dictionary by Pencil and Malascue. Employing document classification techniques, the study constructs four models using distinct text mining approaches for comparative analysis. Through this research, the valuable role of text mining in assessing social and environmental disclosures is underscored, providing insights into optimizing these techniques for evaluations and emphasizing their potential to enhance understanding and decision-making in corporate social responsibility assessments.

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## **Ranking by Pairwise Comparison with Preference of Orders**

There is no doubt that rankings have become a significant part of the modern society. If you run business on a website, you want your website to be ranked number one. Research shows that customers are 40% likely to click on your site if you are ranked number one by Google, 30% likely to click if you are ranked second and 24% likely if you are ranked third. Hence, to be rank at the top is key for success of your business. If a student is applying for university admissions, rankings have become ever important in students' choice of the universities and in parents' perception about a university. Ranking also affects employers' perception on the quality of the education institutions, which further affect their decision on recruiting students. If you are a sports player sports, there is no need to mention the importance of being ranked on the top. However, ranking is no simple matter and different ranking methods may lead to different ranking results. The question raised is which ranking methods are fair and the best. In this paper, I will first provide a review of existing ranking methods and discuss their pros and cons. Then, several new ranking methods will be proposed as an attempt to improve the performance of the existing ranking methods. One advantage of our proposed ranking methods is that they can be applied to datasets with missing observations.

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## **CycleTTA: Continuous Cyclical Test Time Domain Adaptation**

Deep learning models have made significant strides in various fields, demonstrating exceptional capabilities in image recognition, natural language processing, and predictive analytics. However, these models often face challenges when there is a discrepancy between their training environments and the new, unseen data they encounter during testing. This gap, primarily due to models being optimized on specific datasets, necessitates a method to enhance their adaptability to new data domains during testing. Test time domain adaptation (TTA) addresses this need by optimizing pretrained models during the testing phase, but traditional TTA methods have limitations. They tend to overfit to specific test domains and often presume static target domains, which is not reflective of the dynamic and cyclical nature of real-world scenarios.

To overcome these challenges, this paper introduces the CycleTTA framework, an innovative approach designed for continuous cyclical test time domain adaptation. CycleTTA is tailored to address the dynamic nature of real-world data, enabling source-pretrained models to maintain robustness and effectiveness as the testing data undergoes changes. The key feature of our method is the implementation of matrix-wise perturbation noise in batch normalization statistics, a technique that allows for a more flexible adaptation process. This method enables the model to adjust to new data patterns without requiring additional parameters or extensive retraining.

To demonstrate the effectiveness of CycleTTA, we conducted experiments with advanced deep learning models such as WideResNet-28-10, WideResNet-40-2, and PreactResNet-18. These models were chosen for their efficiency in various tasks, and the results from our experiments were highly promising. We observed significant

improvements in the generalization capabilities of these models in continuous testing scenarios compared to traditional TTA methods.

The CycleTTA framework is particularly relevant in fields such as autonomous driving, where environmental conditions change rapidly; medical imaging, where patient data can vary significantly over time; and real-time surveillance systems, which must adapt to varying environmental factors like lighting and crowd densities. By effectively bridging the gap between training and testing phases, CycleTTA enhances the resilience and adaptability of deep learning models, making them more suited for dynamic and evolving real-world applications.

In conclusion, CycleTTA marks a substantial advancement in the field of domain adaptation. It provides a scalable, efficient, and adaptable solution for various applications, enhancing the capability of deep learning models to handle the complexities and dynamics of real-world data. This research opens new horizons in the application of AI, potentially leading to more robust and efficient systems capable of navigating the ever-changing landscape of real-world data environments.

## References

- Young TM, Gkounta O (2024) *Statistics: Teaching, Theory & Applications. Abstract Proceedings of the 18th Annual International Conference*. Athens: Athens Institute for Education and Research (ATINER).
- Young TM, Gkounta O (2023) *Statistics: Teaching, Theory & Applications. Abstract Proceedings of the 17th Annual International Conference*. Athens: Athens Institute for Education and Research (ATINER).
- Young TM, Gkounta O (2022) *Statistics: Teaching, Theory & Applications. Abstract Proceedings of the 16th Annual International Conference*. Athens: Athens Institute for Education and Research (ATINER).
- Papanikos GT (2021) *Statistics: Teaching, Theory & Applications. Abstract Proceedings of the 15th Annual International Conference*. Athens: Athens Institute for Education and Research (ATINER).
- Papanikos GT (2020) *Statistics: Teaching, Theory & Applications. Abstract Proceedings of the 14th Annual International Conference*. Athens: Athens Institute for Education and Research (ATINER).
- Papanikos GT (2019) *Mathematics & Statistics: Teaching, Theory & Applications. Abstract Proceedings of the 13th Annual International Conference*. Athens: Athens Institute for Education and Research (ATINER).
- Papanikos GT (2018) *Mathematics & Statistics: Teaching, Theory & Applications. Abstract Proceedings of the 12th Annual International Conference*. Athens: Athens Institute for Education and Research (ATINER).
- Papanikos GT (2017) *Statistics. Abstract Proceedings of the 11th Annual International Conference*. Athens: Athens Institute for Education and Research (ATINER).
- Papanikos GT (2016) *Statistics: Teaching, Theory & Applications. Abstract Proceedings of the 10th Annual International Conference*. Athens: Athens Institute for Education and Research (ATINER).
- Papanikos GT (2015) *Mathematics & Statistics: Education & Applications. Abstract Proceedings of the 9th Annual International Conference*. Athens: Athens Institute for Education and Research (ATINER).
- Papanikos GT (2014) *Mathematics & Statistics: Education & Applications. Abstract Proceedings of the 8th Annual International Conference*. Athens: Athens Institute for Education and Research (ATINER).
- Papanikos GT (2013) *Mathematics, Statistics & Mathematical Education. Abstract Proceedings of the 7th Annual International Conference*. Athens: Athens Institute for Education and Research (ATINER).
- Papanikos GT (2012) *Mathematics, Statistics & Mathematical Education. Abstract Proceedings of the 6th Annual International Conference*. Athens: Athens Institute for Education and Research (ATINER).
- Papanikos GT (2011) *Mathematics, Statistics & Mathematical Education. Abstract Proceedings of the 5th Annual International Conference*. Athens: Athens Institute for Education and Research (ATINER).
- Papanikos GT (2010) *Economics. Abstract Proceedings of the 4th Annual International Conference*. Athens: Athens Institute for Education and Research (ATINER).