COLLOQUIUM Summer 2015

Sherry Liu

Department of Mathematics

The Solution Matching by Liapunov Theory of BVPs with Odd Gaps in Boundary Conditions for $n-$ th Order Differential Equations

Wednesday, July 15, EMCS 203, 2:30–3:30 pm.

Abstract. We are concerned with the existence and uniqueness of solutions to boundary value problems on an interval [a,c] for the n-th order ordinary differential equation $y^{(n)} = f(x, y, y', ..., y^{(n-1)})$, by matching solutions on [a,b] with solutions on [b,c] to extend the interval of existence for solutions. In this paper, we consider a general case where the gap in boundary conditions at b is odd. Different from the literature, we use Liapunov theory to deal with the case.

This talk may be appropriate for graduate students with an interest in ordinary differential equations and their applications.

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Michelle Rigler, Director

Disability Resource Center

423-425-4008

Michelle-Rigler@utc.edu

COLLOQUIUM Summer 2015

Sankha S. Basu

Department of Mathematics

The Pennsylvania State University, University Park

Logic and Foundations of Mathematics, Intuitionism, and Computability

Friday, July 17, EMCS 422, 2:00–3:00 pm.

Abstract. I will give a very brief introduction to the study of mathematical logic and foundations of mathematics. Following this, I will discuss two specific areas in this field, viz., intuitionistic logic and computability theory. Intuitionistic logic or intuitionism is a constructive approach to mathematics, where certain principles of classical logic, such as the principle of excluded middle, are not accepted. This was introduced by Brouwer in the early 1900s. Computability theory arose from another constructivist school in the 1930s. This was based on the informal concept of algorithms or effective procedures. One of the corner stones of this area of research was Alan Turing's paper in 1936, where he proposed an interesting conceptual characterization of algorithms and also showed the existence of algorithmically unsolvable problems in mathematics, via the famous halting problem. Turing also introduced, in one of his later papers, the concept of relative computability and degrees of unsolvability. Finally, I will discuss my recent joint work with Stephen Simpson that connects the above mentioned constructivist schools in a model for intuitionistic higher-order logic based on the degrees of unsolvability.

This talk may be appropriate for graduate students who are interested in Logic.

COLLOQUIUM Fall 2015

Sarah Nelson *

Ph.D. candidate

Department of Mathematics

University of Kentucky,

Lexington, KY

Musings about Polytopes: Who, What, When, Where and Why

Friday, September 11, EMCS 422, 2:00–2:50 pm.

Abstract. A polytope is the convex hull of n points in space. Mathematicians have studied polytopes for many years. For example, ancient Greeks and Egyptians seemed to have known about the platonic solids and Plato classified them. Combinatorialists today still explore properties of polytopes. In this talk, we will explore some history and interesting properties of polytopes. Further, we will discuss some places where polytopes show up and a few reasons why we still study them.

This talk will be appropriate for undergraduate and graduate students.

* Sarah Nelson graduated from UTC with a B.S., Applied Mathematics and Secondary Mathematics, in 2011.

COLLOQUIUM Fall 2015

Roy Liu

Department of Mathematics

University of Tennessee at Chattanooga

Chattanooga, TN

Friday, September 18, EMCS 422, 2:05-3:00 pm.

Some New Matrix Inequalities and Their Extensions to Lie Groups

Abstract. There is a natural and deep connection between the theory of matrices and the theory of Lie groups. On one hand, closed subgroups of the general linear group are Lie groups, which makes it possible to extend matrix results to abstract Lie groups. On the other hand, a realization of abstract Lie group results in closed linear groups provides deeper understanding of matrix results. The extensions and realizations rely on the abundant structures of (semi-simple) Lie groups. They are the various Lie group decompositions, namely, Cartan decomposition, KAK decomposition, Iwasawa decomposition, Jordan decomposition, etc., which correspond respectively in matrix theory polar decomposition, singular value decomposition, QR decomposition, (complete multiplicative) Jordan decomposition, etc. In many cases, inequalities on trace, eigenvalues and singular values can be reformulated in terms of majorization or log majorization. With the help of Lie group decompositions, Bertram Kostant derived a notion of majorization in Lie groups (which can also be expressed in representation theory), whose realization in closed linear groups is exactly the usual log majorization. This makes is possible to extend matrix inequalities to Lie groups in terms of majorization. In this talk, the speaker will introduce some newly obtained results in this spirit.

This talk may be appropriate for students who have a background of group theory or matrix theory.

COLLOQUIUM Fall 2015

Ivan V. Andronov

Department of Computational Physics

St. Petersburg State University

St. Petersburg, Russia

Friday, October 9, EMCS 422, 2:05-3:00 pm.

High-frequency Diffraction by a Strongly Elongated Body

Abstract. The asymptotic approach to the problem of high-frequency diffraction by elongated bodies is discussed in this work. The classical expansion is shown to require the frequencies to be too high for it to be applicable. Attempts to improve the approximating properties of the asymptotic methods are discussed. It is shown that effective approximations appear under the supposition that the squared transverse dimension of the body is proportional to its longitudinal size measured in wavelengths. This is referred to herein as the case of strongly elongated body and is examined in detail. It is assumed that the body has a rotational symmetry and can be well approximated by a spheroid. The cases of axial incidence and that of incidence at a grazing angle to the axis are considered. Both the asymptotics of the induced currents on the surface and of the far field amplitude are developed. Comparison with numerical results for a set of test problems shows that the leading terms of the new asymptotics provide good approximation in a uniform manner with respect to the rate of elongation. Some effects typical for scattering by elongated bodies are discussed.

This talk may be appropriate for all Math students who are interested in Applied Mathematics, as well as Physicists and Engineers. For the classical results, see the books F. Molinet, I.V. Andronov, D. Bouche, ''Asymptotic & Hybrid Methods in Electromagnetics" The IEE, London, 2005, 249 p. and V. M. Babich and N. Kirpichnikova, ''The boundary-layer method in diffraction problems" Springer-Verlag, Berlin Heidelberg, New York 1979, 140p. The new results are in the papers and on the Forum: Andronov I.V., Mittra R. Asymptotic theory of diffraction by elongated bodies from V. A. Fock to present //Forum for Electromagnetic Research Methods and Application Technologies (FERMAT) 2014, vol. 2, pp. 116. http://www.e-fermat.org/files/articles/1534c0c13a2ce7.pdf

COLLOQUIUM Fall 2015

G.R. Baker

Department of Mathematics

Ohio State University

Columbus, Ohio

Friday, October 23, EMCS 422, 2:05-3:00 pm.

An Effort to Coordinate Conceptual Development

in Math and Physics Educationfor Engineering Students

Abstract. Despite great strides in teaching pedagogy in the sciences and engineering, demonstrable long-term success in student performance is difficult to find. It is possible that much of the difficulty in making substantial improvements in science and engineering education lies in the deteriorating skills of students in the use of mathematics. To some it seems that math and physics education, the core to a start in engineering education, has pursued studies to improve how the content is taught at the neglect of what content is taught. There is a pressing need for students to learn and understanding how to use mathematics in physics and engineering. From my experience in teaching ODE to engineering students, it is quite clear that students see their mathematical education as simply a vast collection of specific procedures, a view encouraged by math teachers, probably unintentionally. They have little ability to express ideas that arise in physics and engineering in mathematical terms, and then use math problem-solving skills to understand the consequences. The question raised here is whether better coordination of the content in first-year math and physics courses could improve student ability to use math in subsequent engineering courses. If this is so, then the mathematical content used in the physics course and how it is used must be documented before changes in the content in the math course can be planned. At the same time, the physics course could be changed to better illustrate and emphasize important mathematics concepts, helping students to appreciate what they need to know mathematically. This paper presents a first attempt to document the mathematical content in a typical first-year physics course.

This talk may be appropriate for all Math students who are interested in Math Education.

The author suggests the following references for those who are interested in the topic.

1. E. Bingolbali, J. Monaghan, & T. Roper. (2007). Engineering students conceptions of the derivative and some implications for their mathematical education, International Journal of Mathematical Education in Science and technology, 38, pp.763-777.
2. E. Bingolbali & J. Monaghan. (2008). Concept image revisited, Education Studies in Mathematics, 68, pp.19-35.
3. E. Bingolbali & M. Ozmantar. (2009). Factors shaping mathematics lecturers service teaching in different departments, International Journal of Mathematical Education in Science and Technology, 40, pp.597-617.
4. J. Brown, A. Collins & P. Duguid. (1989). Situated cognition and the culture of learning, Educational Researcher, 18, p.32.
5. B. Moore. (1999). Situated cognition versus traditional cognitive theories of learning, Education, 119, pp.161-171.
6. J. Anderson, L. Reder & H. Simon. (1996). Situated learning and education, Educational Researcher, 25, pp.5-11.

COLLOQUIUM Fall 2015

Roger Nichols

Department of Mathematics

University of Tennessee at Chattanooga

Chattanooga, TN

Friday, October 30, EMCS 422, 2:00-3:00 pm.

Inverse Uniqueness Results for Rank One Perturbations

and the Krein Spectral Shift Function

Abstract. Although the Krein spectral shift function is over a half-century-old, it continues to be an interesting and powerful tool for obtaining new results in the perturbation theory of linear operators. In this general audience talk, we review fundamental concepts from spectral theory such as compact linear operators, Schattenvon Neumann trace ideals, infinite determinants, traces, and the spectral theorem for unbounded self-adjoint operators. We discuss the spectral shift function in abstract terms and then study its application to the theory of rank one perturbations, where new inverse uniqueness results are obtained for perturbations in terms of the underlying spectral shift functions.

This talk is appropriate for any student with an interest in analysis. Those with an interest in this subject may find the following references useful:
B. Simon, Trace Ideals and Their Applications, Mathematical Surveys and Monographs, Vol. 120, 2nd ed., Amer. Math. Soc., Providence, RI, 2005.
J. Weidmann, Linear Operators in Hilbert Space, Graduate Texts in Mathematics, Vol. 68, Springer, New York, 1980.
D. R. Yafaev, Mathematical Scattering Theory. General Theory, Amer. Math. Soc., Providence, RI, 1992.
D. R. Yafaev, Perturbation determinants, the spectral shift function, trace identities, and all that, Funct. Anal. Appl. 41, 217236 (2007).

COLLOQUIUM Fall 2015

Lili Ju

University of South Carolina

Department of Mathematics

Columbia, South Carolina

Centroidal Voronoi Tessellations: Theory, Algorithms and Applications
Friday, November 6, EMCS 422, 2:00–3:00 pm.

Abstract. Centroidal Voronoi tessellation (CVTs) are special Voronoi tessellations having the property that the generators of the Voronoi tessellations are also the centers of mass, with respect to a given density function, of the corresponding Voronoi cells. The CVT methodologies produce high-quality point distributions in volumes/surfaces or within sets of discrete data. CVTs enjoy an optimization characterization so that they turn out to be very useful in many scientific and engineering applications such as quantization and data analysis, image processing, mesh generation, geometric modeling, resource optimization, network design and control, cell biology and physics, model reduction, numerical partial differential equations and so on. This talk will give a brief review on the theory, algorithms and applications of CVTs.

The presentation is of interest to all graduate and undergraduate students.

The following references may be helpful if you are interested in the topic:
1. Q. Du, V. Faber and M. Gunzburger, Centroidal Voronoi Tessellations: Applications and Algorithms, SIAM Review, Vol. 41, pp, 637-676,1999.

http://epubs.siam.org/doi/abs/10.1137/S0036144599352836

2. Q. Du, M. Gunzburger and L. Ju, Advances in Studies and Applications of Centroidal Voronoi Tessellations, Numerical Mathematics: Theory, Methods and Applications, Vol. 3, pp. 199-142, 2010. http://www.global-sci.org/nmtma/ (Open Access article)

COLLOQUIUM Fall 2015

Sankha Basu

Department of Mathematics

University of Tennessee at Chattanooga

Chattanooga, TN

Friday, November 13, EMCS 422, 2:00-3:00 pm.

The Realizability Interpretation of Intuitionistic Arithmetic

Abstract. Kleene, in his 1945 paper "On the interpretation of intuitionistic number theory", introduced the notion of recursive realizability. The notion of realizability provides a connection between intuitionism and the theory of recursive functions. Since then, over the last 70 years, this has developed into a major subject of interest, and has infiltrated many other realms of the study of logic and foundations. In this talk, I will introduce and discuss the above notion of recursive realizability and also talk about some recent thoughts on extending my current research in this direction.

This talk is appropriate for the graduate and undergraduate students with an interest in Logic.

COLLOQUIUM Fall 2015

Yichuan Zhao

Georgia State University

Department of Mathematics

Atlanta, GA

Smoothed Jackknife Empirical Likelihood Inference for ROC Curves with Missing Data

Wednesday, November 18, EMCS 232, 1:00–2:00 pm.

Abstract. In this paper, we apply smoothed jackknife empirical likelihood (JEL) method to construct confidence intervals for the receiver operating characteristic (ROC) curve with missing data. After using hot deck imputation, we generate pseudo-jackknife sample to develop jackknife empirical likelihood. Comparing to traditional empirical likelihood method, the smoothed JEL has a great advantage in saving computational cost. Under mild conditions, the smoothed jackknife empirical likelihood ratio converges to a scaled chi-square distribution. Furthermore, simulation studies in terms of coverage probability and average length of confidence intervals demonstrate this proposed method has the good performance in small sample sizes. A real data set is used to illustrate our proposed JEL method. This is joint work with Dr. Hanfang Yang.

The presentation is of interest to all graduate and undergraduate students.

The following references may be helpful if you are interested in the topic:

H. Yang and Y. Zhao. Jackknife empirical likelihood confidence intervals for ROC curves with missing data, Journal of Multivariate Analysis, 140, 123 - 138, 2015.
https://www.researchgate.net/publication/276299020 Smoothed jackknife empirical likelihood inference for ROC curves with missing data

COLLOQUIUM Fall 2015

Lingju Kong

Department of Mathematics

University of Tennessee at Chattanooga

Chattanooga, TN

Friday, November 20, EMCS 422, 2:00-3:00 pm.

On Homoclinic Solutions for a Higher Order Difference Equation

Abstract. Nonlinear difference equations of order greater than one are of paramount importance in applications. Such equations appear naturally as discrete analogue and as numerical solutions of differential equations and delay differential equations which model various diverse phenomena in statistics, computing, electrical circuit analysis, dynamical systems, economics, and biology. Because of their applications, the existence of solutions of such equations has been investigated by many researchers in recent years. In this paper, we study a higher order difference equation defined on the set of integers with p-Laplacian and containing both advance and retardation. By using the critical point theory, sufficient conditions are obtained for the existence of infinitely many homoclinic solutions of the equation. The proof is based on the fountain theorem in combination with the variational technique. In particular, considerable effort has been made in the paper to construct a variational framework for the problem under study. Some known results in the literature are extended and complemented.

This talk is appropriate for anyone who is interested in differential and difference equations.

The talk is based on some recent work and the full text of the paper can be accessed via the link: http://www.sciencedirect.com/science/article/pii/S001935771500066X

COLLOQUIUM Spring 2016

Sumith Gunasekera

Department of Mathematics

University of Tennessee at Chattanooga

Chattanooga, TN

Friday, February 5, EMCS 422, 2:00-3:00 pm.

Bayesian Inference for the Offered Optical Network Unit Load

Abstract. In this presentation, Bayesian inference for the Offered Optical Network Unit Load (OOL) based on various priors such as non-informative, gamma, power function, and gamma-power function priors is considered. Pareto distributed ON-and OFF-periods generated by the ON/OFF sources at an Optical Network Unit (ONU) in an Ethernet Passive Optical Network (EPON) system are assumed for the implementation in this research. A simulation study and a real-data-based illustrative example are given to demonstrate the advantages of the proposed Bayesian method over the large-sample method.

This talk is appropriate for Graduate Students and the other interested parties with an interest in Bayesian Analysis, Data Networking, and rigorous Computation & Simulations Statistics.

The talk is based on some recent work and the full text of the paper can be accessed via the links: http://dx.doi.org/10.1080/03610926.2014.892136 or
http://www.tandfonline.com/doi/abs/10.1080/03610926.2014.892136.

COLLOQUIUM Spring 2016

Zhilin Li

Center For Research in Scientific Computation & Mathematics

North Carolina State University

Raleigh, NC

Monday, February 8, EMCS 216, 2:00-3:00 pm.

Modeling, Analysis, & Simulations of Free Boundary/Moving Interface Problems

Abstract. Free boundary/moving interface problems are challenging both theoretically and numerically. In this general talk, I will introduce some application examples and corresponding differential equations models. The applications include Stefan problems of unstable crystal growth, drop spreading, and multi-phase flows. Then I will give a brief review of numerical methods for solving those challenging problems, particularly Cartesian grid methods such as Peskin's Immersed Boundary (IB) method, the Immersed Interface Method (IIM), Augmented IIM, and Immersed finite element method (IFEM) developed by myself.

Another major component in solving free boundary/moving interface problems is how to evolve the interface. In our approach, both the front tracking and the level set methods are used. The level set method is simple and robust and can handle topological changes for any dimensions. I am going to discuss some issues about how to combine the level set method with IIM to achieve high order accuracy.

This presentation is suitable for upper level undergraduate and beginning graduate students.

The talk is based on some recent work, e.g.

1. The Immersed Interface Method – Numerical Solutions of PDEs Involving Interfaces and Irregular Domains, Zhilin Li and Kazufumi Ito, SIAM Frontiers in Applied mathematics, 33, Philadelphia, 2006, ISBN: 0-89871-609-8.
2. The immersed boundary method. Acta Numerica 11, 479-517, C. Peskin
3. The immersed interface method for elliptic equations with discontinuous coefficients and singular sources, SIAM J. Numer. Anal. 31:1019–1044, 1994, Z. Li and R. J. LeVeque

COLLOQUIUM Spring 2016

Junping Shi

Department of Mathematics

College of William and Mary

Williamsburg, VA

Friday, February 19, EMCS 422, 2:00-3:00 pm.

Pattern formation and bifurcations in reaction-diffusion-advection ecological models

Abstract. Spatial-temporal patterns appear often in historical ecosystem data, and the cause of the patterns can be attributed to various internal or external forces. We demonstrate that in spatial ecological models, spatial-temporal patterns can arise as a result of self-organization of the ecosystem. By using bifurcation theory, we show that the spatial-temporal patterns are generated with the effect of diffusion, advection, chemotaxis or time delay.

This presentation is suitable for upper level undergraduate and beginning graduate students.

The talk is based on some recent work, e.g.
DISCR. & and CONTIN. DYNAMICAL SYSTEMS SER. B (18), No. 10, 2013, pp. 2597-2625, PATTERN FORMATION OF THE ATTRACTION-REPULSION KELLER-SEGEL SYSTEM;
J. MATH. BIOL. (68) (2014) pp. 14791520, SPATIOTEMPORAL MUTUALISTIC MODEL of MISTLETOOES and BIRDS.

COLLOQUIUM Spring 2016

Andrew Ledoan

Department of Mathematics

University of Tennessee at Chattanooga

Chattanooga, TN

Friday, March 11, EMCS , 2:00-3:00 pm.

Complex Coefficients and Complex Zeros of a Class of Random Sums

Abstract. A fundamental topic in classical mathematics is the behavior and properties of quadratic and cubic functions with deterministic coefficients, such as real zeros, maxima, minima and tangencies. In many disciplines and in real life applications, the coefficients are random variables. They carry some physical implications and are subject to random error. Although there is a significant amount of research on the ensemble average of zeros of stationary normal processes, little is known in the nonstationary case, where random polynomials arise as special cases in the spectral theory of random matrices. In this talk I will present some recent work on the ensemble average of zeros in a measurable subset of the complex plane for a class of random polynomials, whose coefficients are independent standard normal random variables and whose terms consist of analytic functions that are real-valued on the real number line. This work is part of my technical report for the forthcoming Fifteenth International Conference in Approximation Theory.

This talk is suitable for upper level undergraduate and beginning graduate students. It is based on the following references:

1. Random Polynomials, A. T. Bharucha-Reid and M. Sambandham, Academic Press, 1986
2. Probability for Analysts, Karl R. Stromberg, Chapman & Hall, 1994
3. Complex Coefficients and Complex Zeros of a Class of Random Sums, A. Ledoan (in preparation)

COLLOQUIUM Spring 2016

Cuilan (Lani) Gao

Department of Mathematics

University of Tennessee at Chattanooga

Chattanooga, TN

Friday, April 8, EMCS 422, 2:00-3:00 pm.

Classification of Cancer Types using Neural Networks

and Cross-Species Genomic Data

Abstract. Microarray based gene expression profiling has been emerged as an efficient technique for cancer classification, as well as for diagnosis, prognosis, and treatment purposes. The aim of this study is to develop a method of detecting the closest animal model of human cancer types based on the gene expression profiling of human and mouse using artificial neural networks(ANNs). First we trained the neural network using gene expression profiling of mouse for classification of four distinct types of Medulloblastoma (a type of brain cancer). Then mapping procedure between animal and human genes is performed to match the orthologous genes (genes in different species that originated from a single gene of the last common ancestor) between human and mouse. After that we apply the ANN model to human expression data to detect the cancer types of 106 human tumor samples. To test ability of the ANN model, a cross validation using human gene expression data is performed. The classification result by ANN model is also compared to other typical statistical method such as ANOVA, logistic regression and the performance of these methods will be discussed. This study demonstrates the potential application of cancer classifications thus it will lead to improvements in early cancer diagnosis and in giving effective chemotherapy treatment

The presentation is of interest to all undergraduate and graduate students.

The following reference may be helpful if you are interest in the topic.

1. Daisuke Kawauchi, Giles Robinson, Cuilan Gao, etc. A mouse model of the most aggressive subgroup of human medulloblastoma, Cancer Cell. 2012 Feb 14; 21(2): 168180 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3285412/

2. Behrouz Shamsaei and Cuilan Gao. On the Evaluation of the Most Accurate Pediatric Medulloblastoma Animal Model, 2015 JSM proceedings American Statistical Association.

COLLOQUIUM Spring 2016

Farrah Sadre-Marandi

Postdoctoral Researcher

Mathematical Biosciences Institute

The Ohio State University

http://farrahsadremarandi.weebly.com/

Structure and Assembly of the HIV-1 Capsid: A Mathematical Approach

Friday, April 22, EMCS 422, 2:00-3:00 pm.

Abstract. HIV-1 (human immunodeficiency virus type 1) is a retrovirus that causes the acquired immunodeficiency syndrome (AIDS). This infectious disease has high mortality rates, encouraging HIV-1 to be an active research area for multi-disciplines. Group-specific antigen (Gag) polyprotein precursor is the major structural component of HIV-1 and the CA domain proteins join together to create the peculiar structure of HIV-1 virion core, called the capsid.

The capsid acts as a protective shell for the genetic material (DNA or RNA). These arrangements of proteins follow a fullerene-like structure composed of hexamers and exactly 12 pentamers, by Eulers theorem. First, in order to gain insight into the distinctive structure of the HIV conical capsid, we develop and analyze 3D models by geometric folding along a hexagonal lattice of three main viral capsid types: icosahedral, tubular, and conical. New modeling results demonstrate a good agreement with published HIV-1 data.

Lastly, we will describe and analyze a dynamical systems model for modeling HIV-1 capsid nucleation, one of two known stages for viral capsid assembly. Sensitivity and elasticity analysis of CA multimer concentrations to the association and dissociation rates will be examined. Results further reveal the importance of CA dimers during the nucleation stage.

This presentation will be of interest for undergraduate and graduate students with some knowledge of Virology, Geometry, and/or Dynamical Systems.
(b) Work will be presented from the following two papers:

F. Sadre-Marandi, J. Liu, S. Tavener, C. Chen, Generating vectors for the lattice structures of tubular and conical viral capsids, Mol. Based Math. Biol., 2 (2014), pp.128140.
F. Sadre-Marandi, Y. Liu, J. Liu, S. Tavener, X. Zou, Modeling HIV-1 capsid nucleation by dynamical systems, Math. Biosci., 270(2015), pp.95–105.