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N. J. Malunguza, T. Nemaura and T. B. Gashirai (Eds.)

BOOK OF ABSTRACTS

Contents

1 Keynote Presentations

SAMSA Masamu Advanced Study Institute and the Collaborative Research Network

Overtoun Jenda
Department of Mathematics & Statistics, Auburn University, USA, jendaov@dms.auburn.edu

Abstract

The SAMSA Masamu (masamu means mathematics in Southern Africa) Program was established in 2010 with the primary goal of enhancing research in mathematical sciences within Southern Africa Mathematical Sciences Association (SAMSA) institutions through promotion of international research collaboration. Key components of the Masamu Program are (1) the Masamu Advanced Study Institute (MASI) and Workshop Series in Mathematical Sciences and (2) the Collaborative Research Network. Participants in the Collaborative Research Network take advantage of the annual SAMSA conferences, MASI, and Workshops to meet face to face, work on research problems, plan research activities for the following year, and present their research findings. Other Masamu components include Research Workshop, Career Development Workshop, and Department Chairs and Senior Research Scientists Workshop. The target audiences of the MASI are graduate and undergraduate students and early career faculty (rank less than associate professor), while the workshops are open to students, faculty, and other researchers in the mathematical sciences.
In this presentation, we will give an update on the Masamu Program and discuss how one can participate in the Collaborative Research Network.

Monetary utility functions with convex level sets.

F. Delbaen[1,2]
[1]Department of Mathematics ETH Zurich, Switzerland, delbaen@math.ethz.ch
[2]Institute of Mathematics University of Zurich

Abstract

Monetary utility functions are – except for the expected value – not of von Neumann-Morgenstern type. In case the utility function has convex level sets in the set of probability measures on the real line, we can give some characterisation that comes close to the vN-M form. For coherent utility functions this was solved by Johanna Ziegel. The utility function is either the essential infimum or is an expectile. The general concave case is less trivial but with under an extra weak compactness property Stephan Weber could characterise these utility functions. We can characterise these class of utility functions in its full generality. The proofs are based on a refinement of the techniques of Stephan Weber. Having convex level sets can be seen as a weakened form of the independence axiom in the vN-M theorem.
This is joint work with Bignozzi, Bellini and Ziegel.

Recent advances in spectral collocation based methods for solving PDEs with fluid mechanics applications

S. S. Motsa
School of Mathematics, Statistics and Computer Science,
University of KwaZulu-Natal, Private Bag X01,
Scottsville 3209, Pietermaritzburg, South Africa.
Email: sandilemotsa@gmail.com

Abstract

We consider the solution of partial differential equations (PDEs) by new approaches that combine interpolation polynomials and spectral collocation based methods. The proposed methods, called bivariate spectral collocation methods, are applied to highly coupled non-linear systems of PDEs that are commonly found in some fluid mechanics applications. The main aim of the talk is to describe the simple derivation of the solution algorithms and to highlight their superior performance in terms of accuracy, convergence speeds and general computational efficiency. The derivation of the solution schemes is based on decoupling and linearising the non-linear PDE system using relaxation or quasi-linearisation methods. The performance of the bivariate spectral collocation approach is benchmarked against that of popular methods that are used in solving the class of PDEs that have been used for numerical experimentation in this study.

SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS VIA THE FINITE VOLUME METHOD WITH APPLICATIONS TO COMPUTATIONAL FLUID DYNAMICS

E. Lungu
Department of Mathematics, University of Botswana, lunguliz@gmail.com

Abstract

We formulate a mathematical model for the transplacental transmission of p. falciparum malaria in pregnant mothers. First, we investigate conditions under which the infection is active in the mother but latent in the foetus and secondly, conditions under which the infection is active in both mother and foetus. We ask whether the infection can be present and active in the foetus but absent in the mother. It is known that when the mother receives treatment, the drug concentration that diffuses to the foetus is reduced to protect the foetus. What reduced drug concentrations are efficacious to clear the infection in the foetus?

Convergence theorems for a common point of solutions of fixed point, variational inequality and equilibrium problems

Habtu Zegeye Hailu
Department of Mathematics, University of Botswana, Pvt. Bag 00704, Gaborone, Botswana,
habtuzh@yahoo.com

Abstract

Let C be a nonempty, closed and convex subset of a real Hilbert space H. Let $T : C \to H$ be continuous pseudo-contractive mapping and $A : C \to H$ be L-Lipschitz monotone mapping with Lipschitz constant L. Let $f : C \times C \to \mathbb{R}$ be a bifunctions mapping. In this paper, it is our aim to introduce an iterative process which converges strongly to a common element of the fixed point set of a continuous pseudocontractive mapping, the solution set of a variational inequality for a Lipschitz monotone mapping and the solution set of an equilibrium problem under certain conditions. Moreover, a numerical example which supports our main result is presented. Our theorems extend and unify most of the results that have been proved for this important class of nonlinear operators.

Malliavin calculus and optimal control of stochastic Volterra equations, with applications to financial markets with memory

B. Øksendal
Department of Mathematics, University of Oslo, Norway, oksendal@math.uio.no

Abstract

Stochastic Volterra equations appear in many applications and models, ranging from population dynamics, economic investment theory, transport of a substance dispersing in a fluid and Newtonian motion of objects in a random environment. They can also be derived from stochastic differential equations with delay. More generally, they represent interesting models for stochastic systems with memory.
Solutions of stochastic Volterra equations are not Markov processes, and therefore classical methods, like dynamic programming, cannot be used to study such control problems. However, we shall see that by using Malliavin calculus it is possible to formulate a modified, functional type of maximum principle suitable for such systems. This principle also applies to situations where the controller has only partial information available to base her decisions upon. We present both a sufficient and a necessary maximum principle of this type, and then we use the results to study some specific examples. In particular, we solve an optimal portfolio problem in a financial market model with memory.
The talk is based on recent joint work with Nacira Agram, University Med Khider, Biskra, Algeria.

Nonparametric Max-Central Classification and Feature Selection

A. Abebe
Department of Mathematics & Statistics, Auburn University, USA, abebeas@auburn.edu

Abstract

In this talk, I will discuss some nonparametric max-central classifiers and related methods for selecting features that are relevant for discrimination. Such methods are useful for ultra-high dimensional data such as those derived from genetic sequencing studies. Monte Carlo simulation studies demonstrate that there are several situations where the proposed strategy provides lower misclassification error rates than classical approaches.

A systems approach to modelling substance abuse related problems

F. Nyabadza
Department of Mathematical Sciences, University of Stellenbosch, South Africa,
nyabadzaf@sun.ac.za

Abstract

A systems approach to reducing substance use and abuse problems is proposed. The approach proposed here arises from identify elements or functions within an actual system in which evaluation of treatment and prevention efforts can occur. Further, these functions can be used to stimulate accountability for reducing substance abuse problems and harm and to support the increased use of model based practices and policies. To effectively model substance abuse from a systems perspectives, we formulate conceptual models from which we develop mathematical models using the STELLA simulation software. The conceptual framework models are displays of sequences of steps that are used to define and address problems through implementing programs, practices or policies. We propose two examples: 1. reduction of alcohol related motor vehicle accidents and 2. community harm through methamphetamine abuse. Simulations are carried out using some hypothetically chosen values values to illustrate a systems approach to complex problems.

A continuous auction model with insiders and information release

Giulia Di Nunno, Jose Manuel Corcuera, Gergely Farkas, and Bernt Øksendal.
CMA and Department of Mathematics
University of Oslo.

Abstract

In a unified framework we study equilibrium in the presence of an insider having information on the signal of a firm value, which is naturally connected to the fundamental price of the firm related asset. The fundamental value itself is announced at some future random stopping time. We consider the two cases in which this release time of information is known and not known to the insider. We study the structure of the optimal insider's strategies in equilibrium and we discuss market efficiency in the two cases of insider's information. Some examples of explicit insider's strategy will be provided.

Covering and enveloping classes of morphisms

F. Ozbek
Department of Mathematical and Statistics, Auburn University, Allison Lab 109, United States,
fzo0005@auburn.edu

Abstract

A significant result of cotorsion theory proven by Eklof & Trlifaj is that if (F, C) is cogenerated by a set, then it is complete. Recently the cotorsion pairs of ideals (I, J), where I, J are subfunctors of Hom_R, have been of interest. In this talk we will look at a few results motivated by Eklof & Trlifaj argument for an ideal I when it is generated by a set. Moreover, we will show how identifying an ideal I with a certain class of objects in A_2 (category of all representations of 2-quiver by modules) can help us to obtain sufficient conditions for I to be a covering ideal.

A new technique to extend the power of Cauchy-Frobenius Theory

J. A. Ryan
Mzuzu University, Malawi, jar@mzuzu.org

Abstract

The Cauchy-Frobenius Theory is a famous counting theorem which states that if a group G acts on a set X, then the number of orbits in X under the action of G is the average number of fixed points fixed by an element of G. In this presentation we present a new technique which extends the power of this Theorem. We consider orbits which are nested within other orbits in the set X under the action of G and demonstrate the power of the Cauchy Frobenius Theorem when applied to a nesting series of orbits.

Mathematical Coding Theory: Perfect Codes and related structures

KT. Phelps
Department of Mathematics & Statistics, Auburn University, USA, phelpkt@auburn.edu

Abstract

Coding Theory initially arose in the 1940s and 50s in response to engineering problems with reliable communication and has grown in relevance with the tremendous growth of digital media. At the same time it has been the subject of more mathematical investigations which may have future practical implications. Perfect Codes are one of the more interesting areas of mathematical research which are also related to other important codes and related structures. We will discuss recent research directions in this area along with connections to other important related codes and structures.

Recent Developments in Functional Data Analysis

N. Billor
Department of Mathematics & Statistics, Auburn University, 36849 USA,
BILLONE@auburn.edu

Abstract

As advances in computer technology has been growing so fast data collection technology has been evolving in parallel. This triggered collecting and recording a huge amount of data containing more detailed information (such curves, images) about the underlying system than the traditional data (of which consists of point observations). Although having more detailed data, such as curves or images (called functional data) are sound, new challenges arise to extract meaningful information hidden from such dataset arising in a wide scope of scientific fields ranging from climatology to medicine, from seismology to chemometrics. Although the generating process can be a continuous function, the data are observed discretely in practice. Considering data as functions most accurately represents the true structure of the data. In addition the curse of dimensionality exists inherently in this type of data. Therefore standard multivariate data analysis methodologies are not suitable for functional data. The challenges with functional data lie in the infinite]dimensional nature of the data, implicit assumption of smoothness, and the extra variability in the time direction, among others. Although appropriate statistical methods started been developed along with the appearance of functional data by 1960s and 1970s slowly, development accelerated more in the 1980fs and 1990s, but in last 10 years development accelerated tremendously as functional data were more widely produced and recognized. In this talk, we will introduce functional data, provide recent developments in functional data analysis, and give some real life applications.

Developing mathematics in the Third World

N. Koblitz
University of Washington, Seattle, WA 98195 USA, koblitz@uw.edu

Abstract

This talk is on developing mathematics in the developing world. At first I will talk about women in mathematics from the perspective of the Kovalevskaia Fund and its goals. Then I will give some personal viewpoints concerning approaches to mathematical development in the Third World. Admittedly, some of these views have been informed by my experiences mainly in Asia (especially Vietnam) and Latin America, not so much in Africa; and some are controversial. It is hoped that the talk will arouse debate on the subject during the plenary.

Category: Mathematical development, Third World, Kovalevskaia Fund.

A Fourier analysis based approach of (stochastic) integration

Peter Imkeller[1]**, M. Gubinelli and N. Perkowski.**
[1]HU Berlin, imkeller@mathematik.hu-berlin.de

Abstract

In 1961, Ciesielski established a remarkable isomorphism of spaces of Holder continuous functions and Banach spaces of real valued sequences. The isomorphism can be established along Fourier type expansions of (rough) Holder continuous functions by means of the Haar-Schauder wavelet. We will use Schauder representations for a pathwise approach of the integral of one rough function with respect to another one, via Ciesielski's isomorphism. In a more general and analytical setting, this pathwise approach of rough path analysis can be understood in terms of Paley-Littlewood decompositions of distributions, and Bony paraproducts in Besov spaces. It allows a smooth approach of formal products of singular distributions, and consequently of BSDE with rough and multiplicative noise.

The Secure-Domination Ratio in Toroidal, Cylindrical, and Ordinary Grids

Johnson P.
Department of Mathematics & Statistics, Auburn University, USA, johnspd@auburn.edu

Abstract

A set of vertices in a graph G is secure in G if each attack on it by vertices outside the set can be thwarted by a judicious allocation of the defensive capabilities of the vertices in the set. (Definitions will be given!) A secure-dominating set in G is a set that is both secure and dominating in G; a connected secure-dominating set in G is a secure-dominating set in G which induces a connected subgraph of G. The [connected] secure-domination number of G is the number of vertices in a smallest [connected] secure-dominating set in G. These numbers and the sets that realize them are obviously valuable basic knowledge in all sorts of modern problems, especially when the graph is a subgraph of some sort of grid. In work that began at last year's SAMSA Conference it has been found that for all plane grids, almost all cylindrical grids, and most toroidal grids, the connected secure-domination number is the theoretical minimum, the ceiling of half the number of vertices in the graph. Further, it is clear that the "lim sup" of the ratio of the connected secure-domination number to the order of the graphs in each of the latter classes is $\frac{1}{2}$. The cases that remain open will be listed.

Modeling of Johne's Disease in Dairy Cattle

S. Lenhart
University of Tennesse, lenhart@math.utk.edu

Abstract

Johne's disease in dairy cattle is a chronic infectious disease in the intestines caused by the baciili, Mycobacterium avium ssp. paratuberculosis. We have modeled this disease with several approaches to illustrate different features. A system of difference equations represented an epidemiological situation in dairy farm to compare the effects of two types of diagnostic tests. Then an agent-based model at the farm level was developed to see the effects of stochasticity, Lastly, a PDE/ODE model illustrated a novel way to link a within-host model with an epidemiological model.

Intermittence and time fractional stochastic partial differential equations

E. Nane
Department of Mathematics and Statistics, Auburn University, USA, ezn0001@auburn.edu

Abstract

In this talk, I will consider time fractional stochastic heat type equations. The time fractional stochastic heat type equations might be used to model phenomenon with random effects with thermal memory. In this talk I discuss: (i) Existence an uniqueness of solutions and existence of a continuous version of the solution; (ii) absolute moments of the solutions of this equation grows exponentially; and (iii) the distances to the origin of the farthest high peaks of those moments grow exactly linearly with time. These results extend the results of Mohammud Foondun and Davar Khoshnevisan, (Intermittence and nonlinear parabolic stochastic partial differential equations, Electron. J. Probab. 14 (2009), no. 21, 548–568) and Conus and Khoshnevisan (On the existence and position of the farthest peaks of a family of stochastic heat and wave equations, Probab. Theory Related Fields 152 (2012), no. 3-4, 681–701) on the parabolic stochastic heat equations.

These results are our recent joint work with Jebessa B Mijena.

2 ALG: Abstract Algebra & Group Theory

Quasi-Implementation of Comparative Probability on von Neumann Algebras

Simba A Mutangadura
University of Pretoria, Lynnwood Drive, 0002 Pretoria, South Africa.
simba.mutangadura@up.ac.za

Abstract

Let $\mathcal{A}$ be a von Neumann algebra with identity $\mathbf{1}$ and let P, Q, and R be arbitrary projections in $\mathcal{P}(\mathcal{A})$. A comparative probability on $\mathcal{P}(\mathcal{A})$ is a linear pre-order $\preceq$ on $\mathcal{P}(\mathcal{A})$, the projections of $\mathcal{A}$, satisfying (a) $0 \preceq P$ for all $P \in \mathcal{P}(\mathcal{A})$ with $\mathbf{1} \npreceq 0$. (b) If P, Q, and R are such that $P \perp R$ and $Q \perp R$, then $P \preceq Q \Leftrightarrow P + R \preceq Q + R$. Uniform (weak operator) continuity of $\preceq$ is a necessary, and often sufficient, condition for $\preceq$ to be implemented by a state (normal state) ω on $\mathcal{A}$ via the association $P \preceq Q \Leftrightarrow \omega(P) \leq \omega(Q)$. In this article, we explore a new implementation condition for the case where $\mathcal{A}$ has no type I summand. The new condition is: "If $P \preceq Q$, then Q has a subprojection $Q' \in \mathcal{P}(\mathcal{A})$ for which $P \preceq Q'$ and $Q' \preceq P$." In the process, we define a weaker association of $\preceq$ with a state which we call quasi-implementation.

Keywords: comparative probability; von Neumann algebra; quasi-implementation; state

Category: **Operator Algebras**

Convergence theorems for a common point of solutions of fixed point, variational inequality and equilibrium problems

Habtu Zegeye Hailu[1]
[1]Department of Mathematics, University of Botswana, Pvt. Bag 00704
Gaborone, Botswana

Abstract

Let C be a nonempty, closed and convex subset of a real Hilbert space H. Let $T : C \to H$ be continuous pseudo-contractive mapping and $A : C \to H$ be L-Lipschitz monotone mapping with Lipschitz constant L. Let $f : C \times C \to \mathbb{R}$ be a bifunctions mapping. In this paper, it is our aim to introduce an iterative process which converges strongly to a common element of the fixed point set of a continuous pseudocontractive mapping, the solution set of a variational inequality for a Lipschitz monotone mapping and the solution set of an equilibrium problem under certain conditions. Moreover, a numerical example which supports our main result is presented. Our theorems extend and unify most of the results that have been proved for this important class of nonlinear operators.

Rational families of instantons

Prof. Dr. Alexander Schmitt
Freie Universitat Berlin, Institut fur Mathematik, Arnimallee 3, 14195 Berlin, Germany,
aschmitt@zedat.fu-berlin.de

Abstract

The notion of an instanton comes from mathematical physics. Mathematically, it is a self-dual connection on a principal bundle on a four-dimensional Riemannian manifold. The PenroseWard correspondence identifies instantons on the four-dimensional sphere S^4 with holomorphic instanton bundles on the three-dimensional complex projective space $\mathbf{P}^3$. This construction turned out to be a major motivation for studying vector bundles on complex projective spaces and similar algebraic varieties. In recent preprints, Jardim, Markushevich, Tikhomirov, and Verbitsky managed to settle fundamental open questions on geometric properties of moduli spaces of instanton bundles on P^3, namely smoothness, connectedness and rationality. The PenroseWard correspondence exists also on higher odd-dimensional complex projective spaces. For $n \geq 2$, the knowledge about moduli spaces of symplectic instanton bundles on $\mathbf{P}^{2n+1}$ is much less complete. Together with Laura Costa, Norbert Hoffmann, and Rosa Maria Miro-Roig, we made some progress in this area. In the talk, we will briefly review the classical theory of instanton bundles. Then, we will present the results obtained jointly with Costa, Hoffmann, and Miro-Roig on the geometry of moduli spaces of so-called t Hooft and RaoSkiti instanton bundles. The strongest results concern the rationality of certain moduli spaces. Note that such rationality results mean that, in principle, almost all instanton bundles in the families under consideration may be uniquely specified by a set of complex coordinates.

Quintic Goppa Codes Defined over F_{2^5} and F_{2^6}

Kondwani Magamba
Department of Mathematics and Statistics, Mzuzu University

Abstract

In this paper we consider the number of Quintic Irreducible Goppa codes defined over F_{2^5} and F_{2^6} and their extended versions. We first revisit the results we obtained on these codes using a computer search. We show that we can obtain the same results if we use the maps $\tau : \alpha \to \zeta\alpha^{q^i} + \xi$ to count Quintic Irreducible Goppa codes and
$\mu : \alpha \to \frac{\zeta_1\alpha^{q^i}+\xi_1}{\zeta_2\alpha^{q^i}+\xi_2}$ to count extended quintic irreducible Goppa codes where τ and μ are defined on $S(n, 5)$, the set of all elements in $F_{q^{5n}}$ of degree 5.

ON THE ZERO DIVISOR GRAPHS OF GALOIS RINGS

Owino Maurice Oduor
University of Kabianga, 2030-20200-Kericho (Kenya), morricearaka@yahoo.com

Abstract

A ring is Galois if its subset of all the zero divisors (including zero) forms a principal ideal. For each prime integer p and positive integers k and r, let $R_o = GR(p^{kr}, p^k)$ be a Galois ring of order p^{kr} and characteristic p^k. In this paper, we associate to each R_o, a zero divisor graph $\Gamma(R_o)$ and investigate some properties of the graph.

Keywords: Zero divisor graphs, Galois rings

Enumeration of Extended Irreducible Goppa Codes of Degree 6

Augustine I. Musukwa[1] **and John A. Ryan**[2]
Mzuzu University, Mathematics Department, P Bag 201, Luwinga, Mzuzu 2, Malawi.
augulela@yahoo.com[1], jar@mzuzu.org[2]

Abstract

Let n be a prime number greater than 3. We produce an upper bound on the number of inequivalent extended irreducible Goppa codes of degree 6 and length $2^n + 1$ over $\mathbb{F}_2$. **Keywords:** classical Goppa codes; irreducible Goppa codes; extended Goppa codes; equivalent codes.

Category: **Algebra**

3 BIO: Bio-mathematics & Bio-statistics

MODELLING THE DYNAMICS OF MOTHER-TO-CHILD TRANSMISSION OF HIV WITH TREATMENT

R. Kaondera-Shava[1] **and E. Lungu**[2]
[1] University of Botswana, P.O Box 0074,Gaborone, Botswana, roseshava@gmail.com
[2] University of Botswana, P.O Box 0074,Gaborone, Botswana, lunguliz@gmail.com

Abstract

Efforts to prevent mother-to-child transmission (PMTC) of HIV have gained momentum globally since the launch of ”Global plan towards the elimination of new HIV infection among children by 2015 and keeping their mothers alive”. There has been remarkable successes and considerable challenges with regards to PMTC of HIV infection. In developing countries, the observed reduction in HIV transmission raised the hopes of an ”AIDS-free generation”. However, reducing mother to child transmission (MTCT) of HIV in resource poor countries continues to be a major challenge. This research proposes and analyzes a mathematical model for the dynamics of HIV/AIDS with treatment and vertical transmission. The equilibrium points of the model system are found and their stability is investigated.

Keywords: dynamics of HIV; mother-to-child transmission; mathematical model.

Category: **Biomathematics.**

Optimal control of allocation of monetary resources in HIV-Infected Communities

Semu Mitiku Kassa[1]**, and Senelani D. Hove-Musekwa**[2]
[1] Addis Ababa University, Department of Mathematics,
P.O.Box 1176, Addis Ababa, ETHIOPIA, semu.mtk@gmail.com
[2]Department of Mathematics, National University of Science and Technology,
P.O.Box AC 939, Ascot, Bulawayo, ZIMBABWE,sdmusekwa@gmail.com

Abstract

The neoclassical model of economic growth is used to model the economic growth of a HIV-infected community with efforts in controlling the epidemic. An optimal control model with pure-state constraints is formulated and investigated. It is found that reduction of prevalence for the disease and economic growth agrees in a positive sense in the communities with high rate of population growth and low income.Moreover, the same control strategy will decrease the prevalence even if the capital is not growing for the case of high income communities. However, a disease control strategy with economic growth as its objective will not result in decrease in prevalence if the rate of population growth of the community is very low. Therefore, if the rate of the population growth of a community is nearly the replacement level, then the utility function for the selection of disease control strategies should not be an economic benefit.

Keywords: economic growth; dynamical systems; epidemiological models; HIV; optimal control; pure-state constrains

A Copula-based Approach to Differential Gene Expression Analysis

Linda Chaba[2],John Odhiambo[1], and Bernard Omolo[2]
[1]University of South Carolina – Upstate,Spartanburg, SC, U.S.A.
[2]CARMS, Strathmore University, Nairobi, Kenya

Abstract

Melanoma is a major public health concern in the developed world. Melanoma research has been enhanced by the introduction of microarray technology, whose main aim is to identify genes that are associated with outcomes of interest in melanoma biology and disease progression. Many statistical methods have been proposed for gene selection but so far none of them is regarded as the standard method. In addition, none of the proposed methods have applied copulas to identify genes that are associated with continuous outcomes. In this study, we developed a copula-based approach to identify genes that are associated with continuous outcomes in the systems biology of melanoma. To assess the statistical properties of the model, we evaluated the power, the false-rejection rate and the true-rejection rate using simulated gene expression data. The model was then applied to two melanoma datasets for validation. Comparison of the copula approach with the Bayesian and other parametric approaches was performed, based on the false discovery rate (FDR), the value of R-square and prognostic properties. It turned out that the copula model was more robust and better than the others in the selection of genes that were biologically and clinically significant.

Keywords: Copula; False discovery rate; Gene expression; Melanoma; Microarray.

Category: **Bio-mathematics & Bio-statistics**

Modeling Feral Hogs in Great Smoky Mountains National Park

Benjamin Levy[1], **Suzanne Lenhart**[2], **Charles Collins** [3], **Marguerite Madden** [4], **Joseph Corn** [5], **Rene Salinas** [6] , **Bill Stiver** [7]
[1,2,3]Department of Mathematics, University of Tennessee.
[4]University of Georgia, mmadden@uga.edu
[5]University of Georgia, jcorn@uga.edu
[6]Appalachian State University, salinasra@appstate.edu
[7]Great Smoky Mountains National Park, bill_ stiver@nps.gov

Abstract

Feral Hogs (Sus Scrofa) are an invasive species that have occupied the Great Smoky Mountains National Park since the early 1900s. Recent studies have revitalized interest in the pest and have produced useful data on vegetation, mast and harvest history. Using these data, a model with discrete time and space was formulated to represent the hog dynamics in the park. Management strategies, disease threats and habitat suitability of population was investigated.

Mathematical Modelling Seasonality: A Case of Wood Frog Population

Nofe Al-Asuoad[1], Roumen Anguelov[2], Keith Berven[3] and Meir Shillor[1]

[1] Department of Mathematics and Statistics
Oakland University, Rochester, MI 48309
nalasuoa@oakland.edu, shillor@oakland.edu

[2] Department of Mathematics and Applied Mathematics
University of Pretoria, Pretoria, South Africa
roumen.anguelov@up.ac.za

[3] Department of Biological Sciences
Oakland University, Rochester, MI 48309
berven@oakland.edu

Abstract

Seasonal changes are important factor in the survival of species and ecosystems particularly in the subtropical and temperate zones. Therefore accurate representation of seasonal effects in mathematical models is essential for their usefulness. In this paper we discuss the modelling of seasonality in a model of a wood frog population in a forest in Michigan. The wood frogs go trough three main stages of development. The first one is aquatic where they live as larvae in the water. The second one is terrestrial following a metamorphosis of the larvae into juvenile frogs not yet large enough to reproduce. The third stage is the one of mature egg laying frogs.

Due to the very well pronounced seasonality of the climate at this latitude the eggs are laid at more or less the same time and the juveniles emerge from the water more or less the same time. Hence, mathematically, these two events are modelled by impulses and the aquatic stage via an impulse differential equation. The transfer from juvenile stage to the adults depends mainly on the size of the frogs. The growth of the juveniles in size is not uniform across and may depend on external factors as well. It is modelled though an advection partial differential equation for the density distribution with respect to the size x at given time t. Considering that the annual survival probability is about 14%, the number of frogs reaching reproduction size by the eggs-laying time is crucial for the population. The resulting model is an impulsive ODE-PDE system. Numerical simulations compare favorably to data collected at the Department of Biological Sciences of Oakland University over a 23 year period, thus demonstrating the power of the proposed new approach to mathematical modelling of seasonality.

Analysis of combined Langerhans and CD4^+ T cells HIV infection: A model with treatment

Faraimunashe Chirove[1], Sutimin[2], Edy Soewono[2] and Nuning Nuraini[2]
[1]School of Mathematics, Statistics and Computer Science, University of KwaZulu-Natal, South Africa, *Chirovef@ukzn.ac.za*
[2]Department of Mathematics, Institut Teknologi Bandung, Indonesia.

Abstract

We develop a mathematical model that captures the combined infection of Langerhans cells and CD4^+ T cells, and their contribution to early HIV infection within the host. Mathematical analysis of the mathematical model revealed a threshold parameter denoted alternative reproduction ratio. The relationship between alternative reproduction ratio and the basic reproduction ratio showed that the predictions of results using the alternative reproduction ratio could be easily inferred to those of the basic reproduction ratio. The antagonistic roles of viral lysis and the viral degradation mechanisms was shown to slow down the growth of the virus. The efficacy of treatment strategies is modeled by periodic functions of pharmacokinetics concept.

Keywords: Langerhans cells; HIV; CD4^+ T cells; periodic treatment.

Category: **Biomathematics**

A mathematical model to study the impact of Irresponsible Infective immigrants and Vertical Transmission on the Dynamics of HIV/AIDS

Madubueze, C.E. Nwaokolo, M.A. and Gweryina, R.I.

Abstract

This paper examined the combined effects of inflow of irresponsible infective immigrants and vertical transmission in a varying population. A mathematical model for the problem was proposed and transformed into proportions in order to define the prevalence of infection. Using the next-generation method, the basic reproduction number R_0 was computed in terms of the parameters of the transformed model. The disease free equilibrium was obtained and found to be locally asymptotically stable when $R_0 < 1$ and unstable for $R_0 > 1$. By the method of the centre manifold theory, the existence of transcritical bifurcation was investigated. The study ascertained that backward bifurcation existed if certain conditions were met. Numerical simulation of the model was carried out to assess the effect of irresponsible HIV infective immigrants and vertical transmission in the spread of HIV/AIDS disease. The result showed that screening and counselling the irresponsible HIV infective immigrants will help to reduce the spread of HIV and prevent MTCT.

PROJECTIONS OF PHARMACOKINETIC PARAMETER ESTIMATES FROM MID-DOSE PLASMA CONCENTRATIONS IN INDIVIDUALS ON EFAVIRENZ:A NOVEL APPROACH

T Nemaura[1,2]
[1]Department of Clinical Pharmacology, College of Health Sciences, University of Zimbabwe, Harare, Zimbabwe.
[2]Department of Applied Mathematics, National University of Science and Technology, Bulawayo, Zimbabwe.

Abstract

This work seeks to project individual pharmacokinetic (PK) parameter estimates of efavirenz (a drug with a long half life) from mid-dose concentrations and covariates, assuming full mass transfer of the drug. Gender, weight and $CYP2B6,516G > T$ genetic data of 61 patients on efavirenz containing highly active antiretroviral therapy (HAART) was collated and analysed. Models were derived to guide dose adjustment in patients predicted to have unsafe drug exposure, and new modelling methods and interpretations are suggested to estimate PK parameters. A new measure related to the uptake of the drug is incorporated in modelling of transportation (cumulative uptake volume). The cumulative uptake-volume associated with the full absorption of $600mg$ of efavirenz was estimated to be 35.56L whereas the volume of distribution was found to be $39.68L$. A sufficient relationship was established between estimated absolute oral bioavailability (f) and mid-dose concentration (x) at steady state $f(x) = \frac{x^{1.121}}{x^{1.121}+3.135^{1.121}}, R^2 = 0.98$. Patients who carry the $CYP2B6G516TTT$ genotype are projected to have high efavirenz exposure. The estimated bioavailability in this population ranges from $(0.29; 0.86)$. Genotype, weight and gender based inference for dose adjustment proposition is evident for the drug efavirenz. The drug is projected to have been fully absorbed in $31h$ in this population.

Keywords:Efavirenz; cumulative uptake-volume; bioavailability; volume of distribution; area under curve (AUC), absorption rate.
Category: **Bio-Statistics**

On the efficiency of HIV transmission: Insights through discrete time HIV models

S.P. Showa[a], F. Nyabadza[b], G. Magombedze[c], S.D. Hove-Musekwa.[a]
a Department of Applied Mathematics, National University of Science and Technology, Box AC 939 Ascot, Bulawayo, Zimbabwe
b Department of Mathematical Sciences, University of Stellenbosch, P. Bag XI, Matieland, 7602, South Africa
c National Institute for Mathematical and Biological Synthesis, 1122 Volunteer Blvd, University of Tennessee, Knoxville, TN, USA

Abstract

The role of antibodies in HIV-1 infection is investigated using a discrete time mathematical model that considers cell-free and cell-associated transmission of the virus. Model analysis shows that the effect of each type of antibody is dependent on the stage of the infection. Neutralizing antibodies are efficient in controlling the viral levels in the early days after seroconversion and antibodies that coat HIV-1 infected cells and recruit effector cells to either kill the HIV-1 infected cells or inhibit viral replication are efficient when the infection becomes established. Model simulations show that antibodies that inhibit viral replication are more effective in controlling the infection than those that recruit Natural Killer T cells after infection establishment. The model was fitted to subjects of the Tsedimoso study conducted in Botswana and conclusions similar to elasticity analysis results were obtained. Model fitting results predicted that neutralizing antibodies are more efficient in controlling the viral levels than antibodies that coat HIV-1 infected cells and recruit effector cells to either kill the HIV-1 infected cells or inhibit viral replication in the early days after seroconversion.
Keywords Antibodies, HIV infection, antibody-dependent cell mediated virus inhibition, antibody-dependent cellular cytotoxicity.

Mathematical modelling the effects of vertical transmission, isolation and quarantine on the transmission dynamics of hand, foot and mouth disease.

Gashirai, T. B[1] **and Hove-Musekwa, S. D**[1]
[1]Department of Applied Mathematics, National University of Science and Technology, P.O. Box AC 939 Ascot, Bulawayo, Zimbabwe, byrongash7@gmail.com, sdhmusekwa@gmail.com

Abstract

A basic, deterministic, compartmental model for the transmission dynamics of hand, foot and mouth disease is designed and analyzed. The disease free equilibrium point is globally asymptotically stable for $R_0 < 1$. The endemic equilibrium point exists and is stable for $R_0 > 1$. An isolation and quarantine model is formulated and analyzed to assess the effect of isolating symptomatic and infectious individuals and quarantining carrier individuals who do not possess signs or symptoms. Analysis of the isolation and quarantine model suggest that vertical transmission increases the spread of hand, foot and mouth disease (HFMD) and that isolating symptomatic and infectious individuals can eradicate the disease.

Keywords: vertical transmission; isolation; quarantine; hand, foot and mouth disease.

Modelling of Mothers Access to Maternal Health Care Services in Namibia

Nghikongwa R.R.N[1], **Pazvakawambwa L.**[1,2]
[1]Department of Statistics and Population Studies, Private Bag 13301, 340 Mandume Ndemufayo Ave, Pionierspark, Windhoek, NAMIBIA , lpazvakawambwa@unam.na
[2]Department of Statistics and Population Studies, Private Bag 13301, 340 Mandume Ndemufayo Ave, Pionierspark, Windhoek, NAMIBIA , ruusanghikongwa@gmail.com

Abstract

A significant percentage of 23.4% of women only visit ANC after 6 months of pregnancy, which may lead to late detection of pregnancy. With reference to the MDG5, Namibia has the best availability of these health care services but yet there still remains a high Maternal Mortality Rate (MMR), where MMR in 1992 from the DHS showed a prevalence of 225 maternal deaths per 100 000 live birth, MMR in 2000 from the DHS showed a prevalence of 271 maternal deaths per 100 000 live births which increased to a prevalence of 449 maternal deaths per 100 000 live births from the 2006/07 DHS thus MMR keeps increasing. The third desired outcome of the Fourth National Development Plan states that by 2017, Namibians will have access to a quality health system in terms of prevention, cure and rehabilitation. The objective of the study was to identify factors that are attributable to a pregnant womens access to both ANC and PNC services and study sample consisted of all women in the childbearing age range which is 15-49 in Namibia that were pregnant during the last Demographic and Health Survey 2006/2007 in Namibia in 2006. Poisson regression and binary logistic regression models were employed to establish correlates of access to maternal health care in Namibia.

Keywords: Poisson regression; logistic; maternal healthcare; Access.

Category: **Statistics**

Mathematical Analysis of the model of HIV-HCV co-infection

Kgosimore M.
Department of Basic Sciences, Botswana college of Agriculture, Private Bag 0027, Gaborone, Botswana; kgosimor@gmail.com or mkgosi@bca.bw

Abstract

Human Immunodeficiency virus (HIV) accounts for 40-50 million infections globally, while Hepatitis C virus (HCV) an important cause of chronic liver disease, accounts for 150 million infections. The co-infection of HIV and HCV accounts for 8-10 million, making HIV-HCV co-infection a major public health problem. Notably, the two infections may be transmitted both horizontally and vertically. HIV infection accelerates liver disease progression in patients who are co-infected with Hepatitis C virus (HCV). HCV on the other hand, weakens the liver system thus compromising HIV treatment effectiveness.

This paper formulates and analyzes a theoretical model of HIV-HCV co-infection accounting for both horizontal and vertical transmission of both diseases. We determine the basic reproduction number R_0, of the model and apply it to discuss the existence and stability the model equilibria. Simple numerical simulations backed by simple sensitivity analysis are carried out to illustrate analytical results derived in the study as well as to identify the most influential factors on the transmission dynamics diseases.

Modelling HIV/HBV coinfection

Hasifa Nampala[1], **Livingstone S. Luboobi**[1], **Joseph Y.T Mugisha**[1], **Celestino Obua**[2]
[1]Department of Mathematics, Makerere University, Uganda
[2]Department of Pharmacology and Therapeutics, Makerere University, Uganda

Abstract

Alanine Aminotransferase (ALT) elevation which reflects hepatocellular injury is a current challenge in HIV infected people. One of the factors that enhances the risk of liver injury in HIV infected people is underlying diseases such as Hepatitis caused by Hepatitis B virus (HBV), which is the most common and fatal liver infection in the world. HIV/HBV coinfected patients stand a greater risk of liver damage because liver cells (hepatocytes) support all stages of HIV and HBV viral production.

In this study we used a mathematical model to identify the impact of the coinfection on the dynamics of the monoinfection. Simulations results show a strong correlation between the time of peak of ALT, HIV, healthy CD4+ cells, cytotoxic T lymphocytes (CTLs), healthy hepatocytes, HIV infected hepatocytes and HIV infected CD4+ cells. Based on the level of ALT, results also show that individuals co-infected with HIV and HBV have higher risk for liver disease than either infection alone. Simulation results further show that faster HIV progression lead to higher HBV viral load in HIV/HBV coinfection while HBV has no significant impact on HIV.

Optimal Control of Smoking Dynamics

Takaidza, I
Vaal University of Technology, P. Bag X 021, Vanderbijlpark 1900, South Africa,
isaactkdz@gmail.com

Abstract

Tobacco smoking remains a major public health menace globally as it inflicts significant mortality, morbidity and continues to cost billions of dollars in health-care. This paper provides a study for assessing the dynamics of smoking and its impact in a community by considering the model of Sharomi and Gumel, 2008. The population is sub-divided into nonsmokers, mild smokers, chain smokers, those who quit smoking either temporarily or permanently and the ill due to smoking. Theoretical analysis of this model reveals that the smoking-free equilibrium is globally asymptotically stable whenever the smokers generation number is than unity and unstable if this threshold is greater than unity. We then consider interventions by introducing time dependent controls and then consider the optimal control problem using Pontryagins maximum principle. We make use of arbitrary but reasonable parameter values to numerically analyse the resultant optimality system by considering various combinations of the interventions. Finally, we identify the cost effective combination.

Mathematical properties of an HIV model with heterosexuals and homosexuals

N. Malunguza[1], **S. D. Hove-Musekwa**[1] **and Z. Mukandavire**[2]
[1]Department of Applied Mathematics, National University of Science and Technology, Zimbabwe, nmalunguza@gmail.com
[2]Social and Mathematical Epidemiology Group, London School of Hygiene and Tropical Medicine, London, UK

Abstract

An HIV model to assess HIV transmission dynamics in African heterosexual communities sexually connected to men who have sex with men (MSM) by networks of bisexual men is formulated. Comprehensive analysis of the model to assess the effects of homosexuals on the intrinsic dynamics of the disease in African settings is carried out using robust computational techniques. We find that connectivity of the low risk heterosexual population to the high risk MSM population through bisexuals has the potential to increase HIV burden in the heterosexual population. Intervention measures implemented in the heterosexual population will fail to eradicate HIV if no targeted measures are implemented in the MSM population. Bisexuality is the source of bi-stability in our model and reduction of the *heterosexuality, homosexuality and bisexuality induced reproductive number*, $\mathcal{R}_h$ below unity is insufficient for disease eradication. The continuous generation of bisexuals ensures HIV overflow from the competing sub-populations and boundary equilibria are therefore non-existent. When bisexuality is removed from our model, eradication of HIV from the community is feasible whenever $\mathcal{R}_h < 1$. These results compel for the urgent identification and elimination of bisexuality drivers which will result in the decoupling of heterosexuals from MSM making them independent of each other's HIV dynamic processes.

Keywords: HIV/AIDS model, heterosexual, homosexual, bisexual, reproductive number.

Category: **Mathematical Biology**

In-HOST HIV IN AN ADULT PREGNANT WOMAN.

B.M. Lephodisa[1] **and E.M. Lungu**[2]
[1] lephodib@mopipi.ub.bw
[2] lunguliz@gmail.com.

Abstract

In this paper we propose and analyse a mathematical model, in the form of ordinary dierential equations governing the PASSAGE of HIV virus from the mother to the foetus during pregnancy. Mother to child trasmission of HIV has become a public health problem for much of Sub-Sahara Africa. Since the initiation of the highly active anti-retroviro therapy (HAART), it has been found that most of the babies from mothers on HIV treatment were born free of the HIV infection. We propose and analyse a mathematical model to show that the HIV prognosis for the unborn babies is improved and this treatment strategy can signicantly reduce future infection rates.

AN OPTIMIZATION MODEL FOR THE CONTROL OF CHOLERA

OchocheJ.M.
Federal University of Agriculture, Makurdi, Nigeria. jeffreycyborg@gmail.com

Abstract

Infectious diseases continue to be a leading cause of mortality globally. Cholera, once a global disease is now relegated to low and middle income countries thriving in communities with poor hygienic conditions and lack of access to portable water. Even when cholera does not kill it reduces the quality of life and retard economic growth causing undue panic and public concern. In Peru 1991, the estimated cost of cholera outbreak due to food trade embargoes and adverse e?ect on tourism is 770 million dollars. Developing countries cannot afford to spend such whooping sums on a preventable disease like cholera, it is therefore important that adequate attention be paid to the control of such diseases. Recent cholera outbreaks include Haiti (20102011), Nigeria (2010), Kenya (2010), Vietnam (2009), Zimbabwe (20082009) etc. In this paper, we presented a mathematical model for the optimal control of cholera. Seeking the best means of reducing the ?nal size of the epidemic, we introduced three time dependent controls namely, provision of clean water, social distancing and treatment. Using optimal control theory we develop an objective functional to minimize the number of infectives. The Pontryagins Maximum principle was used to convert the problem of minimization of the objective functional coupled with the state variable into a problem of minimizing point-wisely a Hamiltonian. The optimal control is obtained by solving the optimality system which was composed of four non- linear ODEs with initial conditions and four nonlinear adjoint ODEs with transversality conditions. The results were analysed and interpreted numerically using MATLAB. The optimal policies identi?ed could have a substantial e?ect in the control of cholera if imple- mented. We found that in the case of limited resources, a combination of social distancing and treatment is equally as good as all three policies. Further, a combination of provision of clean water and social distancing is also capable clearing the epidemic but takes more time. Keywords: Cholera; Numerical analysis; Objective functional; Optimization; Pontryagins maximum principle.

Keywords: Cholera; Numerical analysis; Objective functional; Optimization; Pontrya- gins maximum principle.

Modeling the Transmission Dynamics of Tuberculosis in Enclosed Spaces: The Case Study of Zomba Maximum Prison in Malawi.

M. Maliyoni[1], E. S. Mwanandiye[2] and L. K. Eneya[3]
[1,2,3]Mathematical Sciences Department, University of Malawi, Chancellor College
P. O. Box 280, Zomba, Malawi.
mmaliyoni@gmail.com; ericmwanandiye@gmail.com and leneya@cc.ac.mw

Abstract

Tuberculosis (TB) is an infectious airborne disease caused by Mycobacterium tuberculosis. The spread of TB is intensified in overcrowded environments like prison communities that results in high prevalence of the disease. TB, which is one of the leading causes of morbidity and mortality, remains a public health problem in Malawi. Modelling of tuberculosis has been attended to for decades but models that quantify risk of TB in enclosed spaces are scanty. The main objective of this work was to understand the prevalence, transmission and how can TB be controlled in enclosed spaces by formulating a mathematical model that addresses transmission of the disease in enclosed spaces, analysing its steady points, calculating R_0 or R_{eff} and investigating how various interventions affect prevalence and transmission of TB by simulations. We formulated a mathematical model that incorporates physical features namely volume and ventilation. Analysis of disease-free and endemic equilibrium points showed that the disease can be eliminated when $\frac{V}{S_0}$ is greater than a critical value calculated. Basic reproductive number, R_0 or R_{eff}, for the model was computed using the Next Generation Matrix (NGM) method and then numerical solution were found using Matlab. Results showed that $R_0 = 4.4692$ in absence of any intervention which confirms the effect of overcrowding on transmission of TB in enclosed space. However, there was a significant reduction in prevalence when all interventions are employed giving the lowest prevalence of all other combination where effective number R_eff was 0.0270. We conclude that despite treating TB cases in overcrowded settings like prisons, considering administering physical interventions can help in the fight against tuberculosis. We recommend that there should be physical interventions in addition to treating the infectious individuals in the fight against TB in enclosed space.

Keywords: Tuberculosis model; ventilation; volume; area.

4 CRY: Cryptography

CONSTRUCTING PAIRING - FRIENDLY ORDINARY ELLIPTIC CURVE WITH LOW EMBEDDING DEGREE

Patrick Sawerengera[1] **and Ezekiel Kachisa**[2]
[1]University of Malawi-Chancellor College, P.O.Box 280, Zomba, patsawerengera@gmail.com
[2]Malawi Institute of Education, P.O.Box 50, Zomba, ezekiel@live.ie

Abstract

Elliptic curves which are suitable for pairing-based protocols are known as pairing-friendly elliptic curves. These curves have small embedding degree with respect to a large prime order subgroup, as such are rare and thus require specific constructions. We propose a method of constructing pairing-friendly elliptic curves extending the method proposed by Brezing and Weng. In our strategy, instead of defining the size of the subgroup $r(x)$ as a cyclotomic polynomial as in Brezing and Weng method, we define the size of the subgroup $r(x)$ to be the minimal polynomial of the cyclotomic polynomial Φ_m and re-define the number field $K \equiv Q[x]/r(x)$. Using the new method, we constructed families of pairing-friendly ordinary elliptic curves with small $\rho-$values as best reported in literature for different embedding degree with CM discriminant $D = 1$ or $D = 3$.

Keywords: Elliptic curve; Embedding degree; Pairing-friendly.

Category: **Cryptography**

5 DIF: Differential Equations

On the separation theorem for a Dynkin stopping game

Cloud Makasu[1]
[1]Department of Mathematics and Applied Mathematics,
University of the Western Cape, Private Bag X17, Bellville 7535, South Africa,cmakasu@uwc.ac.za

Abstract

Under certain conditions, we prove a separation theorem for a Dynkin stopping game arising in the classical McDonald-Siegel optimal stopping problem.

Keywords: Dynkin stopping game; standard optimal stopping problem

Exact solutions and conservation laws of the Korteweg-de Vries Burgers equation with power law nonlinearity

Isaiah Elvis Mhlanga [1] **and Chaudry Masood Khalique**[2]
[1], 2International Institute for Symmetry Analysis and Mathematical Modelling, Department of Mathematical Sciences, North-West University, Mafikeng Campus, Private Bag X 2046, Mmabatho, Isaiah.Mhlanga@nwu.ac.za , Masood.Khalique@nwu.ac.za

Abstract

In this talk we present traveling wave solutions and conservation laws of the Korteweg-de Vries-Burgers equation with power law nonlinearity. This is a modified Korteweg-de Vries-Burgers equation for a wide class of nonlinear system in weak non-linearity and long wavelength approximation. Lie symmetry method along with the simplest equation method are used to obtain exact solutions and the direct method is used to construct the conservation laws.

Keywords: Korteweg-de Vries-Burgers.

Category: **Differential Equations**

32nd Conference of the Southern Africa Mathematical Sciences Association - SAMSA2013
November 25 - 29, 2013, Cape Town, South Africa
C. Makasu, F. Benyah, G. Muchatibaya, F. Nyabadza and T. Chinyoka (Eds.)

LIE GROUP ANALYSIS OF NON-LINEAR DIFFERENTIAL EQUATIONS: A SYSTEMATIC DETERMINATION OF ARBITRARY FUNCTIONS

Motlatsi Molati
Department of Mathematics and Computer Science, National University of Lesotho, P.O. Roma 180, LESOTHO, m.molati@gmail.com

Abstract

Non-linear differential equations are used to describe physical phenomena applicable in real life. However, many of these equations contain arbitrary functions which are usually assumed. The method of Lie group classification is a systematic approach which specifies the forms of the arbitrary functions. In this work various methods of group classification are presented.

Keywords: Non-linear differential equation; group classification.

On the conservation laws of a generalized Zakharov-Kuznetsov equation

Dimpho Millicent Mothibi and Masood Khalique
International Institute for Symmetry Analysis and Mathematical Modelling,
Department of Mathematical Sciences, North-West University, Mafikeng Campus,
Private Bag X 2046, Mmabatho 2735, South Africa,
Dimpho.Mothibi@nwu.ac.za
Masood.Khalique@nwu.ac.za

Abstract

In this talk we construct conservation laws of a generalized (2+1)-dimensional Zakharov-Kuznetsov equation. It is well-known that the Zakharov-Kuznetsov equation governs the behavior of weakly nonlinear ion acoustic waves in a plasma comprising cold ions and hot isothermal electrons in the presence of a uniform magnetic field.

Keywords: A generalized (2+1)-dimensional Zakharov-Kuznetsov equation; conservation laws.

Category: **Differential Equations**

Group invariant solutions for the unsteady MHD flow of a third grade fluid in a porous medium

Taha Aziz[1] **and Fazal. M. Mahomed**[2]
[1]Centre for Differential Equations, Continuum Mechanics and Applications, University of the Witwatersrand, Wits, South Africa
[2] School of Computational and Applied Mathematics, University of the Witwatersrand, Wits, South Africa

Abstract

This work describes the time-dependent flow of an incompressible non-Newtonian fluid over an infinite rigid plate. The flow is induced due to the arbitrary velocity $V(t)$ of the plate. The fluid occupies the porous half space $y > 0$ and is also electrically conducting in the presence of a constant applied magnetic field in the transverse direction to the flow. Analytical solutions of the governing nonlinear partial differential equation for the unidirectional flow of a third grade fluid are established using the symmetry approach. We construct three types of analytical solutions by employing the Lie symmetry method and the better solution from the physical point of view is shown to be the non-travelling wave solution. We also present numerical solutions of the governing PDE and the reduced ODE and compare with the analytical results. Finally, the influence of emerging parameters are studied through several graphs with emphasis on the study of the effects of the magnetic field and non-Newtonian fluid parameters.

A New General Approach to Vector Valued Stochastic Integration

Mangatiana A. Robdera
Department of Mathematics, University of Botswana, robdera@yahoo.com

Abstract

We use an extended theory of integral that generalizes the integration of vector valued functions with respect to non-negative, monotonic, countably subadditive set functions, in order to introduce a new approach to stochastic integral. With such an approach, we will explore the possible extension of the theory of stochastic integration to the more general setting of integrable processes taking values in normed vector spaces. We show that our approach makes applications possible to stochastic processes that are not necessarily square integrable, nor even measurable. Such an extension generally consolidates the typical and classical results obtained for the standard scalar case. A New General Approach to Vector Valued Stochastic Integration

A note on the integrability of a remarkable static Euler–Bernoulli beam equation

Aeeman Fatima and Fazal. M. Mahomed[1]
[1]Centre for Differential Equations, Continuum Mechanics and Applications, School of Computational and Applied Mathematics, University of the Witwatersrand, Wits, South Africa.

Abstract

It has recently been shown that the fourth-order static Euler–Bernoulli ordinary differential equation, where the elastic modulus and the area moment of inertia are constants and the applied load is a function of the normal displacement, in the maximal case has three symmetries. This corresponds to the negative fractional power law $y^{-\frac{5}{3}}$, and the equation has the nonsolvable algebra $sl(2, IR)$.We obtain new two- and three-parameter families of exact solutions when the equation has this symmetry algebra. This is studied via the symmetry classification of the three-parameter family of second-order ordinary differential equations that arises from the relationship among the Noether integrals. In addition, we present a complete symmetry classification of the second-order family of equations. Hence the admittance of $sl(2, IR)$ remarkably allows for a three-parameter family of exact solutions for the static beam equation with load a fractional power law $y^{-\frac{5}{3}}$.

SOLUTIONS AND CONSERVATION LAWS OF A COUPLED KORTEWEG-DE VRIES MODIFIED KORTEWEG-DE VRIES SYSTEM

Abdullahi Rashid Adem, Chaudry Masood Khalique
International Institute for Symmetry Analysis and Mathematical Modelling, Department of Mathematical Sciences, North-West University, Mafikeng Campus, Private Bag X 2046, Mmabatho 2735, Republic of South Africa
Abdullahi.Adem@nwu.ac.za; Masood.Khalique@nwu.ac.za

Abstract

Lie symmetry analysis is performed on a coupled Korteweg-de Vries modified Korteweg-de Vries (KdV-mKdV) system, which arises in the analysis of various problems in theoretical physics and many scientific applications. The similarity reductions and exact solutions are obtained. The solutions obtained include the solitary waves, cnoidal and snoidal waves. In addition, we derive the conservation laws of the coupled KdV-mKdV system.

Keywords: Lie symmetry analysis, Cnoidal waves, Snoidal waves, Conservation laws

Category: **Differential Equations**

6 EDU: Mathematics Education

PROBLEM SOLVING IN MATHEMATICS: TEACHER EDUCATORS' PERCEPTIONS AND STRATEGIES

Mercy Kazima[1] **and Arne Jakobsen**[2]
[1]University of Malawi, Malawi, mkazima@cc.ac.mw
[2]University of Stavanger, Norway, arne.jakobsen@uis.no

Abstract

Problem solving is an important part of learning mathematics because it enhances logical reasoning. Many curricula recognise this and have problem solving as one of the aims of teaching mathematics in primary schools. For example, Malawi and Zambia curricula both have 'to stimulate and encourage innovation, creativity and problem solving' (Ministry of Education, 2005; p. 4, Nalube, 2007). Despite having this aim stated in curricula, many primary school learners in Southern Africa, and particularly in Malawi and Zambia, do not reach problem solving level in mathematical achievement (Hungi, et. al, 2010). Refvik (2014) conducted a case study in a Malawi primary school and revealed that teachers perception of problem solving was related to mathematics problems situated in a daily and practical context, which is a limited view of problem solving. This prompted us to conduct a small study with mathematics teacher educators at one primary teacher education college in Malawi. Teacher educators were chosen because they prepare pre-service teachers to teach mathematics in schools. We collected data through a workshop for mathematics teacher educators where activities included completing a written questionnaire which explored what the teacher educators perceive as problem solving in mathematics; and a demonstration of how they conduct problem solving in their mathematics classes. In the paper we discuss our findings and their implications to mathematics teacher education.

This project is kindly funded by Norwegian Programme for Capacity Building in Higher Education and Research for Development (NORHED).

Keywords: Problem solving; Teacher education; Mathematical achievement; Malawi; Southern Africa.
Category: **Mathematics Education**

Mathematical knowledge for teaching geometric proof: learning from teachers' practices

Lisnet Mwadzaangati[1]
[1]Curriculum and Teaching Studies Department, Chancellor College, Malawi Email: lmwadzaangati@cc.ac.mw

Abstract

Mathematics is a compulsory subject in secondary school education in Malawi as it is one of the requirements for enrolling students into different higher institutions to study science courses. The aim of mathematics education courses in both undergraduate and post graduate programmes in Malawi is to improve teacher's knowledge for teaching mathematics. Although the number of colleges and universities offering secondary mathematics education courses has increased in Malawi, the quality of teaching has not improved to a greater extent. The capacity of teachers to teach geometric proof in particular is still inadequate. This is evidenced through students' consistent poor performance in geometry proof questions during national examinations for the past five years. The purpose of the study in progress, is to explore knowledge that teachers require in order to teach geometric proof well in Malawian context. The study has employed the Professional Knowledge for Secondary School Mathematics Teachers (PKSSMT) framework developed by Baumert & Kunter (2013) for methodology. Case study qualitative approach is being used to answer the following question; 1. How is secondary geometric proof conceptualised by secondary school teachers? 2. What is the nature of the problems that are selected and used to enhance students' geometric thinking? 3. How do teachers interpret student productions/solutions of geometric proofs? 4. How are geometry proof concepts represented and explained to secondary school students? The study is being done in phases. The first phase involved a base line survey to uncover the problem. Document analysis was conducted on Malawi national examination chief examiners' mathematics reports of both junior and senior secondary school for the past five years (2008 to 2013). The aim was to find out the branch of mathematics in which students performed poorly. The initial study showed that students had problems in understanding and applying geometry theorems. The second phase will involve administering of tests and conducting of interviews and lesson observations of mathematics teachers to explore mathematical knowledge necessary for teaching geometry proof. During the SAMSA 2014 conference, I will present a poster containing the results of the baseline survey. The poster will also contain the problem statement, purpose, conceptual framework and methodology of the main study.

An Investigation into Students' Misconceptions in Linear Equations in Public Secondary Schools of Malawi: The Case of the South Eastern Education Division

Florence Mamba[1]
[1]Faculty of Education, University of Malawi, P.O.Box 280, flothomo@gmail.com

Abstract

This research aimed at investigating Malawian Secondary School students' misconceptions exhibited when formulating and solving linear equations. In order to identify the misconceptions, research instruments such as student test, student interviews and teachers' questionnaire and document analysis were used. Data was analysed quantitatively using frequency counts and qualitatively by studying each student's problem solving performance and then identified common themes among all of the students' work. Results from the themes show that secondary school students, in the South Eastern Education Division of Malawi, have misconceptions about variables, equal sign, and graphs. In addition, the transposing misconception, the other inverse misconception, confusion between equation and expression, quadratic equation prototype, and the misconception about gradient were evident. The results indicate that misconceptions blocked further development of the students' algebraic procedures. It was also found out that students with misconceptions lack the ability to solve problems that require reversibility, flexibility, generalisation, and transfer of knowledge to unfamiliar situations. It is therefore, inferred that such students perceive algebraic symbols and equations as processes to be performed rather than treating them as objects in their own right. The fact that students could not give conceptual justifications of the procedures which they used to solve problems also reveals that the students possess procedural knowledge and that they lack conceptual knowledge. This implies that most students have not been successful in making the transition from arithmetic to algebra.

This study has important applications. The study indicates which misconceptions are associated with certain aspects of linear equations. Moreover, in light of these misconceptions, the study emphasises the need for the interrelations of various concepts such as numerical, operational and algebraic symbols and also the interrelation and complementary aspect of algebraic and graphical representations in an on-going back-and-forth process in the process of teaching and learning linear equations. The study also informs content developers, pre-service teacher training institutions, in-service teacher training programs and teachers to create more effective lessons and teaching and learning materials. Furthermore, the information about students' misconceptions will help in assisting students to confront their misconceptions and providing better understanding of the concept of linear equations. The most important thing is the cognitive conflict that is produced when the students consider conflicting ideas. Cognitive conflict is a highly effective means of inducting cognitive development.

INVESTIGATING THE ADOPTION AND INTEGRATION OF ICT IN THE TEACHING AND LEARNING OF MATHEMATICS

Mangwiro Magodora
Department of Mathematics & Physics, Bindura University, P. Bag 1020, Bindura, Zimbabwe.
mmagodora@gmail.com

Abstract

This paper investigates the perceptions of undergraduate and postgraduate in-service teachers towards adoption and integration of ICT in the teaching and learning of mathematics in Zimbabwe's schools. A total of 43 participants took part in the study. The data was collected using a 40-item questionnaire which contained 33 structured and 7 open-ended questionnaires. Focus group discussions were also undertaken in the study. The Statistical Package for Social Scientists (SPSS) was used to analyse the data. Chi-Square test and Analysis of Variance (ANOVA) were performed to test hypotheses of different treatment means. Some constructs were perceived to be very important while others were perceived to be not that important. The constructs which were consistently given high scores were; computer technology is easy to use, generates interest, improves confidence, gives quality lesson presentation, is motivating, enhances good career prospects, clarifies concepts, gives prestige and is pivotal for national development. Those constructs which were consistently ranked low included among others; ICT is addictive, time wasting and expensive. The study also shows that even though the majority of teachers perceived ICT in positive light, the teachers faced hurdles which militated against the adoption and integration of ICT in their teaching of mathematics. Prominent hurdles which were revealed include unreliability and unavailability of electricity and internet connectivity, inadequate infrastructure and lack of relevant training that is necessary in the full utilization and integration of ICT in their actual teaching practices. Lack of administrators' support and lack of access to computer laboratories were also cited as notable hindrances. Study findings also suggested that teachers' negative perceptions towards ICT could be attributed to fear of losing relevance, authority and influence as they strongly felt that increased ICT use would lead to redundancy. It is therefore recommended that when embracing ICT in the teaching and learning of mathematics, emphasis must be directed towards those constructs which were identified to be statistically significant in the study.

Keywords: Adoption, Integration, Chi-Square Test, Analysis of Variance, Statistically Significant.

Continua of biliteracy: Tension between formal and informal mathematical language

Chitera, N, Kasoka, D. N. and Thomo, E
University of Malawi.

Abstract

In this paper, we present a discussion on the type of mathematical discourse that is being produced in classrooms where the language of teaching and learning is local languages. We also further explore the tensions in the mathematical discourse being produced. The study sample was 4 mathematics teachers from a semi-urban primary school in Malawi. The methods of data collection included classroom observations, pre-observation focus group discussions and reflective interviews.

The results show that even though both students and teachers were able to communicate freely in local languages in the mathematics classroom, the mathematical discourse that was produced was distorted. This was mainly caused by lack of a well-developed mathematical discourse in local languages, which in turn took away the confidence of mathematics teachers in the classroom. As a result, the mathematics classrooms were characterized by teachers not being creative, use of word by word from books, focus more on procedural than conceptual understanding and thus teacher centeredness still dominated in these classrooms. Furthermore, it was found that there were tensions between the formal and informal mathematical language in local languages. These results in turn have promoted our understanding of the teaching and learning of mathematics when a local language is the language of learning and teaching. Therefore, we argue for a balanced approach when it comes to teaching and learning of mathematics rather than just focusing on the use of local languages in order to improve the teaching and learning of mathematics.

An Investigation into Students' Misconceptions in Linear Equations in Public Secondary Schools of Malawi: The Case of the South Eastern Education Division

Florence Mamba[1]
[1]Faculty of Education, University of Malawi, P.O.Box 280, flothomo@gmail.com

Abstract

This research aimed at investigating Malawian Secondary School students' misconceptions exhibited when formulating and solving linear equations. In order to identify the misconceptions, research instruments such as student test, student interviews and teachers' questionnaire and document analysis were used. Data was analysed quantitatively using frequency counts and qualitatively by studying each student's problem solving performance and then identified common themes among all of the students' work. Results from the themes show that secondary school students, in the South Eastern Education Division of Malawi, have misconceptions about variables, equal sign, and graphs. In addition, the transposing misconception, the other inverse misconception, confusion between equation and expression, quadratic equation prototype, and the misconception about gradient were evident. The results indicate that misconceptions blocked further development of the students' algebraic procedures. It was also found out that students with misconceptions lack the ability to solve problems that require reversibility, flexibility, generalisation, and transfer of knowledge to unfamiliar situations. It is therefore, inferred that such students perceive algebraic symbols and equations as processes to be performed rather than treating them as objects in their own right. The fact that students could not give conceptual justifications of the procedures which they used to solve problems also reveals that the students possess procedural knowledge and that they lack conceptual knowledge. This implies that most students have not been successful in making the transition from arithmetic to algebra.

This study has important applications. The study indicates which misconceptions are associated with certain aspects of linear equations. Moreover, in light of these misconceptions, the study emphasises the need for the interrelations of various concepts such as numerical, operational and algebraic symbols and also the interrelation and complementary aspect of algebraic and graphical representations in an on-going back-and-forth process in the process of teaching and learning linear equations. The study also informs content developers, pre-service teacher training institutions, in-service teacher training programs and teachers to create more effective lessons and teaching and learning materials. Furthermore, the information about students' misconceptions will help in assisting students to confront their misconceptions and providing better understanding of the concept of linear equations. The most important thing is the cognitive conflict that is produced when the students consider conflicting ideas. Cognitive conflict is a highly effective means of inducting cognitive development.

7 FIN: Mathematical & Mathematics of Finance

Optimal Dividend and Issuance of Equity Policies in the Presence of Transaction Costs and Interest

M. Mandiudza[1], **E.Chikodza**[1,2]
[1]Great Zimbabwe University,P.Bag 1235 Masvingo, mandiudzam@gmail.com
[2]Great Zimbabwe University, P.Bag 1235 Masvingo, eriyoti.chikodza@gmail.com

Abstract

We investigate the dividend and equity issuance problem in the presence of transaction costs and interest rate. We will extend the work of Lokka and Zervos by including the interest rate component into the model in order to make the model more realistic. The nature of the second order ordinary differential equation eventually turns out to be transformed to belong to the class of Kummer's confluent hypergeometric differential equations. The Kummer's confluent hypergeometric differential equation therefore plays a very vital role in this context. The aim is to maximise the expected discounted dividends pay-out until the time of bankruptcy. In order to model this problem, the stochastic control theory for diffusion will be used. The researcher will use the Hamilton-Jacobi-Bellman equation (HJB) dynamic principal to solve the problem.

Keywords: Equity issuance; Optimal dividend; Hamilton-Jacobi-Bellman equation; Confluent hypergeometric function.

Category:**Mathematics of Finance**

Construction of Nominal Yield Curve for Nairobi Securities Exchange: An improvement on Monotone Preserving r(t)t Interpolation Method

Lucy Muthoni[1]**, Prof. Silas Onyango**[2]
[1]Assistant Lecturer,Centre for applied Research in Mathematical Sciences (CARMS),Strathmore University,P.O Box: 4877-00506, Nairobi. Email: LMuthoni@strathmore.edu;
[2]Dean,School of Business and Public Management, KCA University, P.O Box: 56808-00200,Nairobi. Email:sonyango@kca.ac.ke

Abstract

There is no agreed-upon method used to construct yield curves at the Nairobi Securities Exchange. The existing practice is that each financial company uses in-house methods to construct the yield curves for their pricing and decision making. The most common yield curve used in the market is the one constructed by the Cannon Asset Managers Limited (CAM), a Kenyan company, in 2011. The choice of the interpolation function is extremely important when constructing a yield curve. CAM used linear interpolation on the logarithms of the interest rates as their interpolation function. Studies have shown that all variations of linear interpolations produce discontinuities in the forward rate curve.

The monotone convex interpolation method, introduced by Hagan and West (2006), improved on the shortcomings of linear and cubic interpolations by ensuring not only a positive and (mostly) continuous forward rate curve but also a strictly decreasing curve of discount factors. Unfortunately, the model not only depends heavily on an appropriate interpolation algorithm but also produces discontinuity of $f(t)$ under specific conditions.

The monotone preserving $r(t)t$ method improves on monotone convex method in that the knot points are estimated in manner which ensures positivity and continuity in $f(t)$ besides preserving the geometry of $r(t)t$.Unfortunately, monotone preserving method has the undesirable characteristic of not being differentiable at the knot-points. This paper suggests an improvement on monotone preserving $r(t)t$ interpolation method which ensures that the knot points of the curve are differentiable.

Keywords: Yield curves; Interpolation methods; Nairobi Securities Exchange.

Category:**Financial Mathematics**

Joint indifference pricing and game theoretical approach to pricing contingent claims in incomplete markets

Sure Mataramvura
University of Cape Town, South Africa, sure.mataramvura@uct.ac.za

Abstract

It is well known that if markets are incomplete then there is no unique price for a contingent claim. The set of prices admissible to buyers and sellers has been categorized in literature. The question of the best possible price is one of debate so far with much emphasis on choosing a suitable equivalent martingale measure used to price a given contingent claim. But market prices do not behave according to probability measures unfortunately, they depend on demand and supply and in some way the market agents at play. In this paper we discuss a combination of indifference pricing and game theory to come up with the a price which is dependent on the type of buyers and sellers on the market.

Pricing and simulation of catastrophe bonds

S. Lekoko, O. Baraedi, and E.R Offen[1]
[1]University of Botswana

Abstract

Classic insurance techniques may be inadequate when dealing with losses that comes from natural catastrophes due to a number of factors. Some of these factors being the dependencies that exist, inter alia, between sources of losses, the huge value of claims, problems with advance selection and moral hazards. As a result there emerged catastrophe bonds (catastrophe linked securities). In our study we price some of these bonds.

Key words: catastrophe bond, Monte Carlo simulation.

Consumer Loan Scoring and Capitalization Decisions in the context of Multiple Economic Scenarios

Kanshukan Rajaratnam [1], Peter Beling [2], and George Overstreet [3]

Abstract

A topic of interest in recent literature is incorporating forecasts of future economic conditions into acquisition decisions for consumer loan portfolios. The decision to accept or reject consumer loan applications and the respective regulatory decision must be made prior to the future economic outcome is known with certainty. Under the assumption that score performance is independent of the prevailing economic scenario, Rajaratnam et al. (2011) showed the set of efficient operating points in the expected profit expected market-share space are constructed using a combination of single-cutoff score and double-cutoff score strategies. In this work, we extend the work to the scenario where score performance is conditioned on the prevailing economic scenario. We construct the efficient frontier using simulation.

Optimal portifolio strategy with discounted stochastic cash inflows in a semimartingale setting.

O. Baraedi and E.R Offen[1]
[1]University of Botswana

Abstract

We examine optimal portfolio with discounted stochastic cash inflows. The cash inflows are invested into a market that is characterized by a stock and a cash account. It was assumed that the cash inflows are stochastic and the stock is modeled by a semimartingale. We derive the general formula for finding an optimal portfolio under this circumstance.

Key words: Semimartingale, cash flow, inflation.

Modelling Stock Market Volatility Using Long Memory Processes: The Case of Emerging Economies

Chipumuro M[1] **and Chikodza E**[1,2]
[1]Great Zimbabwe University, P.O Box 1235, Masvingo, amaimusara@yahoo.co.uk
[2]Great Zimbabwe University, P.O Box 1235, Masvingo, eriyoti.chikodza677@gmail.com

Abstract

Stock price dynamics in recent years have crippled many financial markets in emerging economies. This paper proposes an ARFIMA(p,d,q) model for long memory financial data series. Main focus is on the model's applicability to model exchange rates for an emerging economy at different time horizons (daily, weekly, monthly) taking into account the stylized facts about volatility. The fractional differencing operator d is estimated using the spectral regression method with special attention on the model's forecasting power compared with the classical ARIMA(p,d,q) model.

Keywords: ARFIMA model; Long-memory process; Volatility; Forecasting.

Category: **Mathematical Finance**

Extreme Risk, Value-at-Risk and Expected Shortfall: Empirical Evidence from Precious Metals

Knowledge Chinhamu[1], **Chun-Kai Huang**[2], **Delson Chikobvu**[3]
[1]School of Mathematics, Statistics and Computer Science, University of KwaZulu-Natal, Durban, South Africa; email: chinhamu@ukzn.ac.za
[2]Department of Statistical Sciences, University of Cape Town, South Africa; email: chun-kai.huang@uct.ac.za
[3]Department of Mathematical Statistics and Actuarial Science, University of The Free State, South Africa; email: chikobvu@ufs.ac.za

Abstract

Extreme value theory (EVT) has been widely applied in fields such as hydrology and insurance. It is a tool used to reflect on probabilities associated with extreme, and thus rare, events. EVT is useful in modeling the impact of crashes or situations of extreme stress on investor portfolios. It describes the behavior of maxima or minima in a time series, i.e., tails of a distribution. In this study, we propose the use of generalized Pareto distribution (GPD) to model extreme daily platinum, gold and silver log-returns. This method provides effective means of estimating tail risk measures such as Value-at-Risk (VaR) and Expected Shortfall (ES). This is confirmed by various backtesting procedures. In particular, we utilize the Kupiec unconditional coverage test and the Christoffersen conditional coverage test for VaR backtesting, while the Bootstrap test is used for ES backtesting.

Keywords: Platinum, Silver, Gold prices; generalized Pareto distribution; Value-at-Risk; Expected Shortfall; Kupiec; Christoffersen

OPTION PRICING WITH UNCERTAIN STOCHASTIC PROGRAMMING

J.Chirima[1], **E.Chikodza**[1,2]
[1]Great Zmbabwe University,P.Bag 1235 Masvingo, chirimaj@gmail.com
[2]Great Zimbabwe University, P.Bag 1235 Masvingo, eriyoti.chikodza@gmail.com

Abstract

This paper investigates the problem of option pricing where asset prices e.g stock prices have both randomness and uncertainty as forms of indeterminacy. The option pricing model of stock prices is extended from the problem of stochastic programming to the case of uncertain stochastic programming. We develop a hybrid programming model for option pricing. Stochastic programming with recourse mathematical model formulation is used in this paper. Stock price data is analysed to illustrate the results.

Keywords: Stochastic programming; randomness; uncertainty; indeterminacy.

Category:**Mathematics of Finance**

Measuring Gap Risk for Constant Proportion Portfolio Insurance Strategies in Uncertain Markets.

F Matenda[1], **E. Chikodza** [2] **and V. Gumbo**[3]
[1]Great Zimbabwe University, Department of Banking and Finance, P.Box 1235, Masvingo, Zimbabwe ,frmatenda@gmail.com
[2]Great Zimbabwe University, Depart of Mathematics and Computer Science, P.Box 1235, Masvingo, Zimbabwe, eriyoti.chikodza677@gmail.com
[3]National University of Science and Technology, Department of Finance, Bulawayo, Zimbabwe, victor.gumbo@nust.ac.zw; victor.gumbo@gmail.com

Abstract

Portfolio insurance is a critical component of portfolio management. Constant proportion portfolio insurance (CPPI) limits the downside risk of a portfolio when markets are bearish whilst maintaining its upside potential when markets are bullish. The by-products of CPPI strategies are known as negative gamma products. Currently, portfolio insurance is premised on stochastic finance theory which recognises randomness as the only important feature in asset pricing. However, recent research through uncertainty theory propounds that uncertainty is another form of indeterminacy which is important in asset pricing. In the classical Liu uncertain stock model, CPPI approaches are not exposed to gap risk. Gap risk is the possibility that the portfolio value may fall below the floor during the tenure of the investment. However, in reality the probability of gap risk for CPPI techniques is non-zero. This gives the platform for the quantification of gap risk for CPPI strategies in uncertain markets through various risk measures. We analyse the relationship between the participation rate, m, and the value of the insured portfolio. The importance of m in portfolio insurance is also examined.

Keywords: Portfolio insurance, negative gamma products, indeterminacy, gap risk, uncertain markets, participation rate
Category: **Mathematics of Finance**

Applications of white noise calculus to the computation of Greeks

Farai Julius Mhlanga
[1]Department of Mathematical Sciences, University of Zululand, Private Bag X1001, Kwa-Dlangezwa, South Africa

Abstract

We apply white noise calculus to the computation of Greeks for contingent claims priced in a general Lévy process model. The starting point is to obtain Greeks for contingent claims priced both in a pure diffusion model and in a pure jump model. The important tool used here is the Donsker delta function. More precisely, we show how the option price can be represented in terms of the Donsker delta function. Using this representation we prove how one can explicitly compute Greeks. In particular we give a proof for computing Δ.

Keywords: white noise; Greeks; Wick product; Donsker delta function.

Optimal Portfolio in the presence of stochastic income.

O. Doctor, E. R. Offen and E. M. Lungu
[1]University of Botswana

Abstract

We look at an optimal portfolio choice problem in the presence of the stochastic income in finite time horizon. Henderson (2004) solved a similar problem with investor's risk preferences following negative power utility. We extend this analysis to a class of von Neumann Morgenstern utility functions. We have shown that the correlation between stochastic income and stock price has a significant influence on the Merton portfolio.

Keywords: Optimal Portfolio; Utility function; Stochastic Income.

Valuation and optimal hedging of defaultable securities based on credit ratings using Reliability and Levy processes.

I. L. Moyo
National University of Science and Technology, P.O. Box AC 939, Ascot, Bulawayo, Zimbabwe.
isabel.zulu@nust.ac.zw, ilzulu82@gmail.com

Abstract

In this thesis, the credit risk problem is considered as a reliability problem. Nevertheless, due to the volatility of credit spreads which can switch from a low to a high level, after a downgrade of rating or during an uncertain economic conjuncture, the researcher will also anticipate on modeling the companys asset value by Markov modulated Levy processes so as to capture the changes in trends observed in credit spreads incorporating the jump component in the firms asset process. Solving a reliability problem consists of devising a system, usually a mechanical system that moves randomly between many possible states in time. Likewise, for the purpose of managing risks of a debt portfolio, it is also necessary to account for changes in the value of the portfolio due to changes in credit ratings of the components of the portfolio. Most firms issuing publicly traded debt are rated at least by one of the three major rating agencies, Moodys, Standard & Poors(S&P), and Fitch Ratings. It is also anticipated to find hedging strategies for the securities, and while this hedging problem has been addressed to some extent in the past by some researchers, their approach has been one of quite simplistic constraints and has been generally silent on the challenges presented by defaults, jumps, or diffusion. Although valuation models for defaultable securities date back to Merton (1974) and researchers have improved considerably on the basic Merton framework, problems remain. This fact was evidenced by the recent global financial crisis that stressed the importance of the study of the risk of default in any financial contract.
Keywords: Credit risk; Credit ratings; Reliability; Levy processes

VALUING VARIABLE ANNUITY GUARANTEES ON MULTIPLE ASSETS

José Da Fonseca[1] **and Jonathan Ziveyi**[2]
[1]Auckland University of Technology, Business School, Department of Finance, Private Bag 92006, 1142 Auckland, New Zealand. Phone: +64 9 9219999 extn 5063. Email: jose.dafonseca@aut.ac.nz
[2]UNSW Australia, UNSW Business School, Risk and Actuarial Studies, Sydney, NSW 2052, Australia. Phone: + 61 2 9385 8006. Email: j.ziveyi@unsw.edu.au

Guarantees embedded variable annuity contracts exhibit option-like payoff features and the pricing of such instruments naturally leads to risk neutral valuation techniques. This paper considers the pricing of two types of guarantees; namely, the Guaranteed Minimum Maturity Benefit and the Guaranteed Minimum Death Benefit riders written on several underlying assets whose dynamics evolve under the influence of affine stochastic volatility processes. Within the standard affine framework for the underlying mortality risk, stochastic volatility and correlation risk, we develop the key ingredients to perform pricing of such guarantees. The affine nature of the model implies that the corresponding characteristic function for the state variables is known in a closed form. We illustrate the methodology for two possible payoffs for the guarantees whose Fourier transforms are computed and combined with the characteristic functions so that resulting prices can be obtained through numerical integration. Using typical values for the parameters, an implementation of the model is provided and underlines the significant impact of the assets correlation structure on the guarantee prices.

Keywords: Mortality risk; Variable annuity; Stochastic volatility risk; Correlation risk; Multiple assets; European option.

A Comparison of Generalized Hyperbolic Distribution Models for Equity Returns

V. KONLACK SOCGNIA[1], D. WILCOX Author[2]
[1]School of CAM, University of the Witwatersrand, Private BagX3, Wits, 2050, South Africa, ksognia@gmail.com
[2]School of CAM, University of the Witwatersrand, Private BagX3, Wits, 2050, South Africa, diane.wilcox@wits.ac.za

Abstract

We discuss the calibration of the univariate and multivariate generalized hyperbolic distributions, as well as their hyperbolic, variance gamma, normal inverse Gaussian and generalized hyperbolic skew Student's t-distribution subclasses for the daily $\log$-returns of seven of the most liquid mining stocks listed on the Johannesburg Stocks Exchange. To estimate the model parameters from historic distributions, we use an expectation maximization based algorithm for the univariate case and a multi-cycle expectation conditional maximization estimation algorithm for the multivariate case. We assess the goodness of fit statistics using the log-likelihood, the Akaike information criterion and the Kolmogorov-Smirnov distance. Finally, we inspect the temporal stability of parameters and note implications as criteria for distinguishing between models.

To better understand the dependence structure of the stocks, we fit the MGHD and subclasses to both the stock returns, as well as to the two leading principal components derived from the price data. While the MGHD could fit both data subsets, we observed that the multivariate normality of the stock return residuals, computed by removing shared components, suggests that the departure from normality can be explained by the structure in the common factors.

Keywords: Generalized hyperbolic distributions, heavy-tailed returns, goodness of fit, principal component analysis.

The Impact of Dual Market Listing on the Evaluation of Executive Remuneration

K.I. Moalosi and E.M Lungu[1]
[1]Department of Mathematics, University of Botswana, Gaborone, Botswana E-mail addresses: kebarengc@gmail.com, lunguliz@gmail.com

Abstract

Financial, manufacturing and processing institutions face many problems among them attracting, motivating and retaining the right calibre of Chief Executive Officers (CEO). One of the major problems for these institutions relates to remuneration of their senior staff. In recent years, most institutions have resorted to stock based re- muneration as the mode of rewarding their CEO's in the hope of retaining their services and for them to continue bringing pro

tability and more importantly growth into the revenue of the company. We use a continuous time utility maximization model to find the remuneration package for the CEO whose company is dual listed (market 1 and 2). We show the remuneration package in two scenarios; the CEO invests only one in market; either in market 1 or 2, or invests in both markets.

Keywords:dual market listing, CEO, remuneration package.

8 FLU: Fluid Mechanics

SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS VIA THE FINITE VOLUME METHOD WITH APPLICATIONS TO COMPUTATIONAL FLUID DYNAMICS

Tiri Chinyoka[1,2,3]
[1]Department of Mathematics & Applied Mathematics, University of Cape Town, Rondebosch 7701, South Africa, tchinyok@vt.edu
[2]Center for Research in Computational & Applied Mechanics, University of Cape Town, Rondebosch 7701, South Africa, tchinyok@vt.edu
[3]Department of Chemical Engineering, University of California Santa Barbara, CA 93106-5080 USA

Abstract

This talk explores intuitive and robust numerical methods for the solution of the nonlinear systems of coupled partial differential equations governing the flow of complex fluids in complex geometries. In particular, we present the finite volume method as the most intuitive such numerical method, for a broad range of computational fluid dynamics applications, as compared to the finite difference and finite element methods.

We begin by explaining the fundamentals of the finite volume method using generic convection-diffusion type partial differential equations. Such equations are prototypical of generic transport equations in fluid flow. We illustrate and explain the several numerical issues that are symptomatic of the numerical methods for fluid dynamical problems. Such issues include:

(a) mesh skewness and related flux correction methods,

(b) numerical discretization of convective fluxes along mesh boundaries using either:

  (i) basic methods such as central differencing or upwind discretization, or

  (ii) more advance schemes such as quadratic upwind interpolation of convective kinematics or total variation diminishing schemes,

(c) consistent methods for pressure-velocity coupling,

(d) numerical stability and implementation of relevant remedies such as the discrete elastic viscous stress splitting schemes, etc.

We finally proceed to provide illustrative fluid dynamical examples in more complex geometries in order to demonstrate the versatility of the finite volume method.

Keywords: Numerical solutions; Computational fluid dynamics; Finite volume method; Complex fluids; Flow in complex geometries; Non-linear PDE's.

Category: **Fluid mechanics, Numerical methods, Computational Fluid Dynamics**

Transient growth in a diverging channel

Peter Yavizu Mhone
The Polytechnic, University of Malawi, P/Bag 303, Chichiri, Blantyre 3, Malawi,
pmhone@poly.ac.mw

Abstract

We consider temporal stability of three dimensional flow in a diverging channel. Instead of concentrating on an eigenvalue problem, we explore the equations in the form of an initial value problem. We confirm that large transient growth occurs when normal velocity forces normal vorticity.
Keywords: stability, initial value problem, transient growth;

Category: **Fluid Mechanics**

Effects of Double Stratification on Unsteady Hydromagnetic Thermal Boundary Layer of Nanofluid Past a Flat Surface

Winifred Nduku Mutuku
[1]Department of Mathematics & Applied Mathematics,Kenyatta University,
P.O. Box 43844-00100, Nairobi, Kenya, mutukuwinnie@gmail.com, Winifred.mutuku@ku.ac.za

Abstract

A similarity solution for the effects of double stratification on heat and mass transfer in an unsteady hydromagnetic boundary layer flow of a nanofluid past a flat surface is presented. The transport equations employed in the analysis include the effects of Brownian motion, thermophoresis, thermal stratification and solutal stratification. The non-linear partial differential equations governing the flow system together with their associated boundary conditions are transformed into a system of nonlinear ordinary differential equations using appropriate similarity variables. A numerical shooting technique with a fourth-order Runge-Kutta-Fehlberg integration scheme was used to solve the resulting boundary value problem. The effects of different pertinent parameters, namely; solutal and thermal stratification, Lewis number, thermophoresis, Brownian motion, magnetic field and unsteadiness on the fluid velocity, temperature, skin friction coefficient, the local Nusselt number and the local Sherwood number are graphically depicted and quantitatively discussed in detail taking into account the practical applications of the model problem.

Keywords: Double Stratification; Heat Transfer; Boundary Layer Flow; Unsteady; MHD; Nanofluid;
Category: **Fluid Mechanics**

Viscosity; variable thermal conductivity; Non-Darcian Flow; free convection; Dufour; Soret; porous flat surface.

Fadugba S. E. , Edogbanya O. H , Zelibe S. C [1,2,3]
[1]Department of Mathematical Sciences, Ekiti State University, Ado Ekiti, Nigeria emmasfad2006@yahoo.com [2]Department of Mathematics, Federal University, Lokoja, Kogi State, Nigeria helyna4christ@yahoo.com [3]Department of Mathematics, Delta State College of Physical Education, Mosogar, Nigeria szelibe@yahoo.com

Abstract

This paper presents Crank Nicolson method for solving parabolic partial differential equations. Crank Nicolson method is a finite difference method used for solving heat equation and similar partial differential equations. This method is of order two in space, implicit in time, unconditionally stable and has higher order of accuracy.

Keywords: Crank Nicolson Method, Finite Difference Method, Exact Solution, Parabolic Equation, Stability

IMPLICIT-EXPLICIT HIGHER-ORDER TIME INTEGRATION SCHEMES FOR COMPUTATIONS OF STRUCTURAL DYNAMICS WITH FLUID-STRUCTURE INTERACTION

First A. José C. Pedro[1], Second B. Mapundi K. Banda[1,2] and Third C. Precious Sibanda[2]
[1]Departamento de Matemática, Faculdade de Ciências da Universidade Agostinho Neto, Av. 4 de Fev. nr 71, 1. andar, Luanda, Angola, caluyna1@gmail.com
[1,2]Applied Mathematics Division, General Engineering Building (A415), University of Stellenbosch,Private Bag X1, Matieland 7602, South Africa, mkbanda@sun.ac.za
[2]School of Mathematics, Statistics and Computer Science, University of KwaZulu-Natal, Private Bag X01, Scottsville 3209, South Africa, sibandap@ukzn.ac.za

Abstract

In this paper higher order implicit Runge-Kutta schemes are applied to fluid-structure interaction (FSI) simulations. A staggered approach with a structural predictor is applied to a FSI problem. The equations governing the dynamics of the structure are integrated in time by the Explicit Single Diagonal Implicit Runge-Kutta (ESDIRK) schemes and the arbitrary high order finite volume scheme is taken as the fluid solver. The performance of the ESDIRK scheme of order of convergence three to five is tested. Comparative studies with other time integration schemes which have been successfully applied to FSI problems are undertaken. Comparisons to test the performance of the scheme are carried out and the influence of the structural predictors is analyzed through energy conservation.

Keywords: Fluid-structure interaction; ESDIRK; High order time integration; Structural predictor; Structural dynamics; staggered approach; Euler gas dynamics; piston problem.

Analysis of unsteady MHD reactive flow of non-Newtonian fluid through a porous saturated medium with asymmetric boundary conditions

Lazarus Rundora[1] **and Oluwole D Makinde**[2]
[1]Department of Mathematics, Vaal University of Technology, South Africa. [2]Faculty of Military Science, Stellenbosch University, South Africa.

Abstract

This paper aims to study thermal effects in an unsteady hydromagnetic flow of a pressure driven, reactive, variable viscosity, electrically conducting third-grade fluid through a porous saturated medium with asymmetrical convective boundary conditions. It is assumed that the chemical kinetics in the flow system is exothermic and that the asymmetric convective heat exchange with the surrounding medium at the surfaces follows Newton's law of cooling. The coupled nonlinear partial differential equations governing the flow and heat transfer are derived and solved numerically using a semi-implicit finite difference scheme. The flow and heat transfer characteristics are analysed graphically and discussed for different values of the parameters embedded in the system.

Keywords: Unsteady hydromagnetic flow, saturated porous medium, third grade fluid, variable viscosity, convective boundary conditions, finite difference method

Two phase peristaltic fluid transport in a permeable microvessel

P. Sibanda
School of Mathematics, Statistics and Computer Science
University of KwaZulu-Natal, Private Bag X01, Scottsville 3209
Pietermaritzburg, South Africa
e-mail: sibandap@ukzn.ac.za

Abstract

We present a mathematical model for the peristaltic transport of blood in a micro-vessel. The blood is treated as a two-phase fluid with a core region that is described by the Casson model and a porous peripheral glycocalyx layer that is described by the Brinkman extended Darcy model. The model assumes a stress-jump condition together with continuity of velocity and normal stress at the interface of the fluid and porous region. The shape of the interface between the fluid and porous regions is calculated using a transcendental equation derived from the conservation of mass in both the core and the peripheral regions. The study shows, *inter alia*, that a high blood flow rate introduces a trapping region in the peripheral layer while reflux occurs in the core region for increasing porosity and stress-jump constant, and a better pumping performance is obtained by reducing the Darcy number.

9 GRA: Graph Theory

Antipodal double covers of triangular graphs

Khumbo Kumwenda[1]
[1]Department of Mathematics, Mzuzu University, P/Bag 201, Mzuzu 2, Malawi,
khumbo@aims.ac.za

Abstract

A family of vertex-transitive graphs has been introduced in [2]. The graphs are embeddings of the strong product of triangular graphs and the complete graph K_2. Properties of linear codes from incidence matrices of the graphs have also been discussed. In related work [1], these appear to be the only codes known to have other minimum words in addition to constant multiples of rows of incidence matrices of the graphs. In this paper, we present a generalisation of the graphs. Particular focus is given to a family that is also an antipodal double cover of the triangular graphs.

Keywords: Triangular graphs, double cover, antipodal double cover.

Category: **Graphs and Codes**

MESSAGE PASSING DECODING OF CODES FROM COMPLETE GRAPHS

Francisco Chamera[1] **and Khumbo Kumwenda**[2]
[1]Kasungu Secondary School, P. O Box 316, Kasungu, Malawi. fchamera@gmail.com
[2]Mzuzu University, Private Bag 201, Luwinga. Mzuzu 2. Malawi. khumbo@aims.ac.za

Abstract

We describe iterative decoding of binary codes from incidence matrices of complete graphs. Parameters for these codes are well known. The codes are also known to be low density parity-check (LDPC). We determine cases where they are decodable by bit flipping (BF) and sum product (SP) decoding algorithms.

Let c be a codeword from the binary code from incidence matrix of a complete graph. Suppose c is sent through the binary symmetric channel (BSC) with parameter p. Let N and k be the length and dimension of the code respectively. We show that errors occurring in the first k positions are correctable by SP while those occurring in the last $N - k$ positions are correctable by BF. We also show that, where there is a decoding success, a valid codeword is obtained after performing a single iteration.

Keywords: Binary symmetric channel; Bit flipping; Complete graph; Incidence matrix; LDPC code; Linear code; Sum product; Tanner graph.

Applications of fluid mechanics to non-fluid systems: A brief review

P. K. Jain
Department of Physics, University of Botswana, Private Bag UB 00704, Gaborone, Botswana.
jainpk@mopipi.ub.bw

Abstract

Study of liquids and gases at rest or in motion comprise the most common and majority of applications of fluid mechanics. To a lesser extent principles of fluid mechanics have also been applied to non-fluid systems which can be modeled to mimic fluids. Examples of such systems include avalanche, land and debris slide, mudflow, hurricane, sand dune, airborne sand transport, microbial locomotion, and volcanic lava flow to name a few. Such systems are not commonly studied by fluid mechanists in natural sciences, i.e., mathematicians and physicists. This paper describes few applications of fluid mechanics to non-fluid systems in order to stimulate dialogue and discussion amongst pure fluid mechanists with a possibility of opening up new windows on fluid mechanics for research and teaching in natural sciences.
Keywords: Fluid mechanics, non-fluid systems, avalanche, landslide, mudflow, hurricane, sand dune.

Codes, graphs and designs from maximal subgroups of alternating groups A_n for n even

Nephtale B. Mumba[1], **Eric Mwambene**[1,2], **Washeila Fish**[1,3], **Bernardo Rodrigues**[2]
[1]Department of Mathematics and Applied Mathematics, University of the Western Cape, 7535 Bellville, South Africa, mumba2001n@yahoo.com
[1,2]Department of Mathematics and Applied Mathematics, University of the Western Cape, 7535 Bellville, South Africa, emwambene@uwc.ac.za
[1,3]Department of Mathematics and Applied Mathematics, University of the Western Cape, 7535 Bellville, South Africa, wfish@uwc.ac.za
[2] University of KwaZulu Natal, Pietermaritzburg 3209, South Africa, rodrigues@ukzn.ac.za

Abstract

For a set Ω of size $n = 2k \geq 6$ and $\Omega^{\{k\}}$ the subsets of Ω of size k, we look at the primitive action of the alternating group A_{2k} on $\Omega^{\{k\}}$. We examine the binary code from the adjacency matrix of the graph with vertex set $\Omega^{\{k\}}$, with adjacency defined by two vertices as k-sets being adjacent if they have one element in common. The relationship between the code and its dual from the graph-theoretical point is investigated. We also explore the sub-codes which have a role to play in the code constructed. Further we will also investigate the automorphism group of the entities constructed.

Keywords: Primitive action; alternating groups; binary codes; graphs; designs; adjacency matrix.

Category: Graph Theory

10 NUM: Numerical Algorithms & Numerical Methods

On The Stability and Convergence of the Time-Fractional Variable Order Telegraph Equation

Rodrigue Gnitchogna Batogna[1]
[1]University of Namibia, Department Of Mathematics Private Bag 13301, 340 Mandume Ndemufayo Windhoek Namibia , rgnitchogna@unam.na

Abstract

In this work, we have generalized the time-fractional telegraph equation using the concept of derivative of fractional variable order. The generalized equation is called time-fractional variable order telegraph equation. This new equation was solved numerically via the Crank-Nicholson scheme. Stability and convergence of the numerical solution were presented in details. Numerical simulations of the approximate solution of the time-fractional variable order telegraph equation were presented for different values of the steps number N.

Keywords: Telegraph equation; Fractional variable order derivative; Crank-Nicholson scheme; Stability convergence.

Category: **Derivatives and Integrals of Real Orders, Numerical methods.**

Strong Convergence Theorems for a Common Fixed Point of a Finite Family of Multivalued Mappings

Sebsibe Teferi Woldeamanuel[1], **Mengistu Goa Sangago**[2] **and Habtu Zegeye Hailu**[3]
[1]Department of Mathematics, College of Natural Sciences, Addis Ababa University, sebsibe.teferi@gmail.com
[2]Department of Mathematics, College of Natural Sciences, Addis Ababa University,P.O. Box 1176,mgoa2009@gmail.com
[3]Department of Mathematics, University of Botswana, P.O. Box 1176, Botswana, habtuzh@yahoo.com.

Abstract

Let K be a non-empty, closed and convex subset of a real Hilbert space H. Let $CB(K)$ be the collection of all nonempty, closed and bounded subsets of K. Let $T_i : K \to CB(K), i = 1, 2, \ldots, N$, be a finite family of Lipschitz hemicontractive-type mappings with Lipschitz constants $L_i, i = 1, 2, \ldots, N$, respectively. It is our purpose, in this paper, to introduce a Halpern type algorithm which converges strongly to a common fixed point of a finite family of Lipschitz hemicontractive-type multivalued mappings under certain mild conditions. There is no compactness assumption on either the domain set or on the mappings T_i considered.

Coupling finite volume and nonstandard finite difference schemes for a singularly perturbed Schrödinger equation

M. Chapwanya[1]
[1]Department of Mathematics & Applied Mathematics, University of Pretoria, Pretoria 0002, South Africa, Michael.Chapwanya@up.ac.za

Abstract

The Schrödinger equation is a model for many physical processes in quantum physics. It is a singularly perturbed differential equation where the presence of the small reduced Planck's constant makes the classical numerical methods very costly and inefficient. We design two new schemes. The first scheme is the nonstandard finite volume method, whereby the perturbation term is approximated by a nonstandard technique, the potential is approximated by its mean value on the cell and the complex dependent boundary conditions are handled by exact schemes. In the second scheme, the deficiency of classical schemes is resolved using a corrector obtained from singular perturbation analysis. Numerical simulations supporting the performance of the schemes are presented.

Geometric Modelling in Animated Movies

Mpfareleni R. Gavhi[1]
[1]African Institute for Mathematical Sciences,6 Melrose Road,Muizenberg 7945, South Africa,
rejoyce@aims.ac.za

Abstract

Subdivision is a method for generating smooth curves and surfaces. It has, over the last two decades, developed into a powerful tool in a variety of application areas, e.g., computer graphics and Computer Aided Geometric Design. Comparing subdivision with other possible modeling approaches for smooth curves and surfaces, subdivision is easy to implement and is computationally efficient. It is also a fundamental mathematical tool in wavelet analysis which has many proven successful applications such as image/video processing and computer vision. The underlying mathematical analysis of subdivision and wavelets is strongly related via the concept of refinable functions. In this talk, I will introduce subdivision for curves, and provide conditions on which subdivision convergence and regularity is guaranteed. Graphical illustrations will be provided.

Weight Distribution of Inequivalent Extended Irreducible Goppa Codes of Degree 4

Aaron D. Kaunda[1] **and John A. Ryan**[2]
[1,2] Mzuzu University, Mathematics Department, P/Bag 201, Luwinga, Mzuzu 2, Malawi.
kaundaaron@gmail.com[1], jar@mzuzu.org[2]

Abstract

Goppa codes are a very large class of codes and some have considered them to be near to random codes. They are easy to generate and posses an interesting algebraic structure. Furthermore they have a lot of good properties for research.

In this paper we examine the weight distribution of the inequivalent extended irreducible binary Goppa codes of length 33 and degree 4.

Keywords: Weight distribution; irreducible Goppa codes; extended Goppa codes; equivalent codes.

Category: **Algebra**

Application of a bivariate interpolated spectral relaxation method to higher order systems of nonlinear PDEs

Z. G. Makukula and S. S. Motsa
School of Mathematics, Statistics and Computer Science, University of KwaZulu-Natal, Private Bag X01, Scottsville 3209, Pietermaritzburg, South Africa.

Abstract

The application of a bivariate interpolated spectral relaxation method (BI-SRM) for solving nonlinear partial differential equations (PDEs) is extended to higher order and highly nonlinear systems of PDEs. The principal idea of the BI-SRM is to decouple a nonlinear system of equations into a linear system using ideas similar to the Gauss-Seidel method. The derivatives in both space and time are then discretized using spectral methods. The applicability and effectiveness of the BI-SRM are tested on a problem modeling the unsteady three-dimensional flow of an Oldroyd-B fluid with variable thermal conductivity and heat generation/absorption. To the best of our knowledge the problem has not been investigated before. Numerical simulations are carried out to generate results for some of the important flow properties such as the local skin friction. Numerical analysis of the error and convergence properties of the method are also discussed.

New Trends in Computer Keyboarding

Thokozani Vincent Chimkono
The Polytechnic, University of Malawi, P/Bag 303, Chichiri, Blantyre 3, Malawi,
tchimkono@poly.ac.mw

Abstract

Data processing by the use of computers is now an integral part of any public and private information processing. In both cases, efficiency is a key consideration during data entry, processing and outputting. This paper discusses new developments in data entry techniques when a computer-user is using a keyboard. It focuses on a relatively new field of Mathematics known as Link Theory and suggests how this theory can be applied in developing high efficiency keyboards.
Keywords: Link theory; computer keyboards;

Category: **Algebra**

Group classification of a generalized (2+1)-dimensional Klein-Gordon equation

Chaudry Masood Khalique
International Institute for Symmetry Analysis and Mathematical Modelling,
Department of Mathematical Sciences, North-West University, Mafikeng Campus, Private Bag X 2046, Mmabatho 2735, South Africa,
Masood.Khalique@nwu.ac.za

Abstract

In this talk we carry out Lie group classification of a generalized Klein-Gordon equation in (2+1) dimensions. We show that the equation admits a nine-dimensional equivalence Lie algebra. It is also shown that the principal Lie algebra is six-dimensional and has several possible extensions. Exact solutions are obtained for certain cases of the arbitrary parameter.

Keywords: A generalized (2+1)-dimensional Klein-Gordon equation; group classification, exact solutions.

Category: **Differential Equations**

Numerical analysis of unsteady MHD flow near a stagnation-point of two dimensional porous body with heat and mass transfer, thermal radiation and chemical reaction

S. Shateyi[1], **G.T Marewo**[2]
[1]University of Venda, Department of Mathematics, P Bag X5050,
Thohoyandou 0950, South Africa, stanford.shateyi@univen.ac.za
[2]University of Swaziland, Department of Mathematics, Private Bag 4,
Kwaluseni, Swaziland, gtmarewo@uniswa.sz

Abstract

Uniform fluid flow over bodies of various geometries has been considered by many researchers over the years due their numerous applications in industry and engineering. Due to complexity and non-linearity of the modeling governing equations exact equations are impossible. To that end, many researchers have employed different analytical and numerical methods. In recent years, the study of stagnation flow has gained tremendous research interest. Stagnation flow is the fluid motion near the stagnation point. The fluid pressure, the rates of heat and mass transfer are highest in the stagnation area. A flow can be stagnated by a solid wall or a free stagnation-point or a line can exist in the interior of the fluid domain.

The problem of unsteady MHD flow near a stagnation point of a two dimensional porous body with heat and mass transfer in the presence of thermal radiation and chemical reaction has been numerically investigated. Using similarity transformation, the governing time-dependent boundary layer equations for the momentum, heat and mass transfer were reduced to a set of ordinary differential equations. These set of ordinary equations were then solved using the spectral local linearization method together with the successive relaxation method. The study observed among other observations that the local Sherwood number increases with increasing values of the unsteadiness parameter and the Schmidt number. The fluid temperature was found to be significantly reduced by increasing values of the Prandtl number and the thermal radiation parameter. The velocity profiles were found to be reduced by increasing values of the chemical reaction and the Schmidt number as well as by the magnetic parameter.

Keywords: Numerical analysis; unsteady MHD flow; stagnation-point; thermal radiation;chemical reaction.

A unified comparative study of a class of four efficient iterative solvers for Stokes equations

Muzhinji[1] Email: kizmuzhinji@yahoo.co.uk, S Shateyi[2],[1 2]
University of Venda, Department of Mathematics,
P Bag X5050, Thohoyandou 0950, South Africa,
[3] University of KwaZulu-Natal, Department of Mathematics,
P Bag X01, Pietermaritzburg, Scottsville 3209, South Africa , [3]Email: motsas1@ukzn.ac.za
.

Abstract

his study numerically considers a class of four efficient iterative solvers for the linear indefinite system arising from the discretization of the Stokes equations. The numerical tests are based on the finite element approximation of 2-D domain using uniform rectangular meshes. The solution methods are based on the suitable choice of preconditioners and smoothers. These solvers are PMINRES and conjugate gradient, inexact Uzawa and multigrid as well as their combinations as smoothers and preconditioner approximations. We provide a unified comaparison of these solvers: PMINRES with standard multigrid, diagonal, Chebyshev preconditioner approximations, PCG in a non standard inner product with standard multigrid, standard PCG and Chebyshev preconditioner approximations, inexact Uzawa with standard multigrid and PCG preconditioners, and coupled multigrid solvers with Braess-Sarazin, inexact Uzawa, PMINRES and standard PCG smoothers. The comparison is made in terms of iterative counts and computational time. The results obtained indicate that though all the methods are robust in terms of changes in mesh size, the multigrid solver with the Braess-Sarazin smoother is more efficient since it requires fewer iterations and among the other methods, the inexact Uzawa solver with multigrid preconditioner is also robust and efficient, the preconditioned MINRES is slightly slower than the preconditioned conjugate gradient but it has an advantage that it is free of any iterative parameters estimates. We discritize the problem using stable Hood-Taylor $Q_2 - Q_1$ pair of finite rectangular elements and present results of the numerical experiments.

Keywords: Stokes problem, mixed finite element method, multigrid, preconditioner, non-standard inner product, preconditioned conjugate gradient method(PCG), inexact Uzawa, preconditioned minimum residual(PMINRES).

Development of a 2D Vertically Integrated Shallow Water Equation Model of Lake Victoria

David Ddumba Walakira, Seema Paul, Richard Wait, John Magero Mango, Juma Kasozi1 , Jesper Oppelstrup, Roger Thunvik[1]
[1]Makerere University, Department of Mathematics, Kampala, Uganda

Abstract

Lake Victoria is the largest tropical lake in the world and straddles the equator. The Coriolis ”force” causes moving objects on the surface of the Earth to be deflected clockwise in the Northern Hemisphere and counter-clockwise in the Southern Hemisphere. Both (weak) longitudinal and vertical Coriolis effects are evident at low latitude locations such as Lake Victoria. The 2-D nonlinear vertically integrated shallow water equations (SWE) with Coriolis force model will be developed using different schemes for Lake Victoria (LV). The SWE are chosen as a primary test problem for FVM modelling of lakes, rivers and other large, shallow bodies of water. The FVM, as a numerical tool, has been applied to capture not only the discontinuities, but also the seasonal physical variations in the shallow water flow of the second largest fresh water body in the world. First order, second order, and high resolution schemes on rectangular grids are often used for finite volume approximations of the SWE. The first order algorithms are the Lax-Friedrichs (LF) method and the Roe scheme based on the Godunov scheme with Riemann problems solved approximately by the Roe linearization technique. For second order methods, the Lax-Wendroff time discretization procedure for the discontinuous Galerkin method (LWDG) and Roe scheme are considered.

BEM for solving high frequency scattering problems for obstacles with no corners

M. Mokgolele[1]
[1]Department of Basic Science, Botswana College of Agriculture, Private Bag 0027, Gaborone, Botswana

Abstract

We consider scattering of a time-harmonic acoustic incident plane wave by a sound soft smooth object with Lipschitz boundary. The application of conventional (piecewise polynomial approximation space) boundary or finite element methods, have computational cost that grows linealy respect to the frequency of the incident wave. Recent research has been devoted in finding methods which does not loose robutness as frequency of the incident wave increases. Recently Arden, Chandler-Wilde and Langdon proposed a collocation method to solve a high frequency scattering by convex polygons. They use a boundary element method, and incorpating products of plane wave basis functions with piecewise polynomials supported on a graded mesh into approximation space. They demonstrated via numerical experiments the number of degrees of freedom required to achieve a prescribed level of accurancy grows only logarithmically with respect to frequency. Here we proposed a collocation method for high frequency scattering by smooth objects (objects with no corners, e.g. a circle). We applied same approximations as theirs, we demonstrate through numerical experiments the logarithmical grow of the solutions as frequency increases, with much reduced computational cost.

On the Robustness of PLS with Simple SIMPLS Modifications

Brad Schneid
Auburn University, USA, bps0002@auburn.edu

Abstract

Classical least-squares (LS) regression cannot handle cases where n¡¡p, and/or when the design matrix is highly collinear. Partial least squares (PLS) regression includes several non-traditional multivariate algorithms (e.g. NIPALS, SIMPLS) that deal with these problems via dimension-reduction. Unfortunately, PLS algorithms rely on estimates of location and scatter and are therefore sensitive to outliers and otherwise non-normally distributed data (e.g. wide tails, skewness). PLS algorithms can be robustified in at least several ways: 1) replacement of one or more LS solutions in NIPALS algorithm with robust alternatives, 2) replacement of the covariance matrix with a robust location and scatter matrix in the SIMPLS algorithm, and 3) various iterative reweighing schemes. Many of the currently implemented robust PLS alternatives rely on somewhat complex algorithms to create robustified covariance matrices and/or the trimming of outlying observations. In this study, we assess the robustness properties of a more simple approach: the replacement of covariance estimates with robust estimates based on Spearman's and Kendall's rank correlation estimates. We present results from a simulation comparing these simple PLS alternatives to standard PLS and robust alternatives currently available in Matlab or R.

11 OPT: Optimization

On Pointwise Minimization of Energy of Mixed Fluids

Levis Eneya (leneya@cc.ac.mw)[1]
[1]Department of Mathematical Sciences, Chancellor College, P.O. Box 280, Zomba, Malawi

Abstract

In this paper we minimize the energy of mixed fluids pointwise, using the method for computing the value of a polyconvex envelope at a given feed $A^0 \in \mathbb{R}^{m\times n}$ introduced in Eneya et al., 2013 and Bosse et al., 2013 as a generalizaion of the approaches for computing convex envelopes by MacKinnon et al., 1996 and MacKinnon and Mongeau, 1998. In our case n is the number of fluid components comprising the mixture, and $m \equiv 1$. The problem is formulated as a non-linear optimization task in $p(1 + mn)$ variables $(\Lambda, \mathcal{A}) \in \mathbb{R}^p \times (\mathbb{R}^{m\times n})^p$ subject to $(\tau + 1) \equiv binom(m + n, n)$ equality constraints, where p is the number of phases. We show improved results from using this approach as compared to results by Berner et al., 1999. As our method is dependent on the efficiency of the nonlinear solvers employed, at the end of the paper we propose a semi-local strategy as an improvement to the method.

Key words: mixed fluids, phase, polyconvex envelope, local optimization, global optimization
Key words: Optimization

OPTIMAL CONTROL OF MALARIA TRANSMISSION DYNAMICS WITH SEASONALITY IN RAINFALL

Bakare E.A.[1,2]
[1]Department of Mathematics,Federal University Oye Ekiti,Ekiti State, Nigeria,Km 3, Are Afao Road Oye-Ekiti, emmanuel.bakare@fuoye.edu.ng
[2]Department of Mathematics,University of Ibadan,Ibadan, Nigeria

Abstract

We formulate and analyzed rigorously a mathematical model that describes the dynamics of malaria transmission with seasonality by rainfall in the mosquito birth rate under the influence of multiple control strategies. We obtained the basic reproduction number and we introduce some combinations of control variables e.g educational campaign, insecticides treated bedNets, Spray of insecticides and treatment by drug use to control the dynamics of transmission of the disease. We carried out detailed general qualitative analysis and optimal control analysis of the malaria model. To achieve control of the disease, we formulated a control problem and derived the necessary conditions for optimal control of the disease using Pontryagin's Maximum Principle. it is shown that an optimal control exists for our model. We derived the optimality system . Finally, numerical simulations were obtained to describe our analytical results.

Keywords: *Optimal control*, Computational simulations, Disease Free Equilibrium, Pontryagin's Maximum Principle,stability theory.

Biomathematics

12 STA: Mathematical Statistics

Multivariate Exponentially Weighted Moving Average for Monitoring Coke Production

Mawonike R[1]
[1]Great Zimbabwe University, P.O Box 1235 Masvingo, rmawonike@yahoo.com

Abstract

Industrial processes are mainly monitored by multivariate statistical process control (MSPC) charts as the processes are multivariate in nature. Quality characteristics are more correlated than being independent to each. In this paper, the quality of bituminous coal is being monitored for the production of coke of appropriate strength. The general MEWMA control chart proposed by Lowry et al, (1992) is used amongst all MSPC because of its equal potential to detect small shift in the mean vector as its counterpart, the MCUSUM control chart. Five quality characteristics are monitored and the chart shows that the process is out - of - control. However, individual Exponentially Weighted Moving Average (EWMA) control charts are constructed to identify the characteristic(s) causing out - of - control signals. Finally, the identified out of control variables are eliminated and a revised MEWMA control chart is constructed (in control). The results show that an out of control MEWMA control chart can be made in control through elimination of out of control quality characteristics identified through running individual EWMA control charts. Through this research, it is advised to authorities to put much concentration on the ash and moisture content of the coal before the coking process.

Keywords: MEWMA control chart; EWMA control chart; in- control signal; out-of-control signal.

Category: **Statistical Process Control**

Multivariate Time Series Analysis of Tourist Arrivals in Zimbabwe Using Bootstrapped Vector Error Correction Method: A Case Study of Victoria Falls Rainforest.(2009-2013)

Tendai Makoni[1], **Precious Mdlongwa** [2] **and Tinashe P. Chinofunga**[3]
[1]Great Zimbabwe University, P O Box 1235 Masvingo, tpmakoni@gmail.com
[2]National University of Science and Technology, P O Box AC 940 Ascot Bulawayo, precious.mdlongwa@nust.ac.zw
[3]Great Zimbabwe University, P. O Box 1235 Masvingo, ptchinofunga@gmail.com

Abstract

Tourism is the most important economic activity in Victoria Falls Rainforest and tourist arrivals have increased since the introduction of multiple currency system in 2009. This paper utilized bootstrap method and vector error correction method to explain tourist arrival patterns and forecast tourist arrivals at Victoria Falls Rainforest. The procedure allowed one to extract the maximum amount of information contained in the series on tourist arrivals while at the same time include any other information relevant to forecasting arrivals. A 95% confidence interval 13734.606 to 17176.066 for tourist arrivals was constructed using bootstrapped data for means. A Vector Error Correction Model (VECM) was estimated due to cointegrating equations on bootstrapped data. The derived model consisted of lagged and differenced data of tourist arrivals, CPI and exchange rate. The models offered valuable insights into the stylized facts of tourism behavior and provided reliable forecasts. In terms of multivariate analysis, it was found that exchange rate (Z) and tourist arrival (X) for the entire period have a causal relationship.

Keywords: Tourist arrivals; Bootstrap; Cointegration; Granger causality.

Category: **Statistics**

A Multilevel Analysis of Survival Data on Ordinal Outcomes

Jesca M Batidzirai[1]
[1]University of KwaZulu-Natal

Abstract

In this study, multilevel regression modeling is described for the analysis of grouped-time survival data. This utilizes a technique of treating survival time as a set of dichotomous indicators of whether the event occurred for time periods up to the period of event or censor. Proportional odds model is written in terms of the logit link function. Probit and logistic link regression as well as proportional hazards of the multilevel model are presented. Further, numerical data application is considered for stressing the usefulness of the time to event data modelling.

Keywords: Survival analysis, Proportional hazards, Likelihood ratio test, Statistical power

Analysis of Recurrent Events Data: An Application to Flu Infection

Collins Ojwang' Odhiambo[1]
[1]Centre for Applied Research in Mathematical Sciences (CARMS)Strathmore University
(Nairobi, Kenya)

Abstract

Flu is one of known infections that is unpredictable and its severity tends to varies signif- icantly from one season to another depending on the type of flu viruses that are spreading, how much flu vaccine is made available, how many people get vaccinated, and how well the vaccine is matched to the correct flu viruses in question. In this paper we interrogate the best recurrent events model for analysis of recurrence of flu infection. Our analysis is motivated by data that was collected from a survey, conducted by KEMRI Wellcome Trust between December 2009 and June 2010, in Kilifi, Kenya where individuals were observed for over 6 months period. To assess this recurrence, we estimated the length of time an individual caught an RSV infection (Whichever occurs: respiratory syncytial virus types (RSV A and RSV B) and coronavirus types (NL63, OC43)), measured from the time the individual enrolled in the study. One of the key features of this dataset is existence of non-proportionality of hazards rates across recurrence. We systematically compare all existing recurrent models to fit this dataset with the aim of determining which models are appropriate. Results shows model fit 2 yields the best output. Further, applying a robust variance to fit the dataset for different models does not adequately account for within-subject correlation.
Keywords: Recurrent Events, Conditional model, covariates, Flu

MODELLING OF EXTREME MINIMUM RAINFALL USING GENERALISED EXTREME VALUE DISTRIBUTION FOR ZIMBABWE

Retius Chifurira[1], **Delson Chikobvu**[2]
[1]University of KwaZulu-Natal, Private Bag X54001 Durban 4000, South Africa,
chifurira@ukzn.ac.za
[2]University of the Free State, P.O Box 339 Bloemfontein 9300, South Africa,
chikobvu@ufs.ac.za

Abstract

In this paper mean annual rainfall for Zimbabwe is modelled using recorded data for the years 1901 to 2009. Extreme value theory (EVT) is used to estimate the probabilities of meteorological droughts. Droughts can be viewed as extreme events which go beyond/below normal occurrences such as exceptionally low mean annual rainfall. The duality between the distribution of the minima and maxima is exploited and used to fit the Generalised Extreme Value Distribution (GEVD) to the data and find probabilities of extreme low levels of mean annual rainfall. The Augmented Dickey Fuller (ADF) test confirms that rainfall data is stationary. The normal Q-Q plot indicates that rainfall data deviates from the normality at both ends of the tails of the distribution. Maximum Likelihood Estimation method is used to find the estimates the parameters of the GEVD. The Kolmogorov-Smirnov (K-S) and Anderson-Darling goodness of fit tests shows the GEVD of the Weibull class of distribution is a good fit to the minima mean annual rainfall. The mean return period estimate of a meteorological drought using the threshold value of mean annual rainfall of 473 mm is 8 years. This implies that if year , is a meteorological drought another is expected after 8 years.

Keywords: Extreme; Minimum; Generalized Extreme Value; Return level.

Category: **Statistics**

Application of chance constrained linear programming to urban water allocation: Case of Bulawayo.

Mwembe Desmond[1], **Chikanya Nathan**[2] **and Ndava Constantine Mupondo**[3]
National University of Science and Technology, Department of Statistics and Operations Research, P.O Box AC 939 Ascot Bulawayo, Zimbabwe.
[1]desmwembe@gmail.com.
[2]chikanyan@gmail.com.
[3]mupondocn@gmail.com.

Abstract

This research work formulates and implements a mathematical optimization program to assist the citys water branch with monthly water allocations among the five user sectors: Residential, Industrial, Commercial, Public Institutions and the Social Sector. The model developed is a chance constrained linear programming which provides monthly flows from each supply source and the flows allocated to each user sector by taking into account the costs of sourcing water from each supply source and the benefits from the allocation into each user sector. Model constraints include demands, limitations in the capacity of the various water sources and technical specifications that must be followed in the water allocation. Reservoir inflows into each of the five supply sources considered displayed a significant variability and appropriate probability distributions were fitted into each reservoirs inflows data for the period of 1970 to 2010, and the associated reservoir chance constraints included in the model. The model was run for the month of March and allocated 80% of the total allocated water to the industrial sector whilst the other four sectors shared the remaining 20%. It is recommended that the water rationing scheme is updated each month and water demand measurements introduced to limit water use to the amount allocated by the model.
Keywords: Chance; Constrained; Urban; Water.

Modelling daily Rand-Dollar Exchange Rate using an Artificial Neural Network (ANN) Model, Autoregressive Conditional Heteroscedasticity (ARCH) and the Generalized ARCH (GARCH) models.

F. K Mutasa[1]
[1]Department of Applied Mathematics, National University of Science and Technology, Zimbabwe, tariromutasa@gmail.com

Abstract

In this study, we examine the usefulness of the auto-regressive conditional heteroscedasticity (ARCH), generalized auto-regressive conditional heteroscedasticity (GARCH) models and the non-linear Artificial Neural Network (ANN) model in modelling and forecasting the South African rand to United States dollar exchange rates. The adoption of the multicurrency system in Zimbabwe since 2009 has resulted in the country's economy depending on these two major currencies and knowing the volatility patterns of these two currencies is of great importance to various stakeholders in the country. Models are constructed using 4 years daily time series data, from March 2009 to August 2013. These forecasting models are then tested with out-of-sample data over the period September 2013 to March 2014 to determine their forecasting accuracy. The ARCH and GARCH models are developed under 3 different distributions, the Normal, the Student-t and the Generalized Error distribution (GED). These models are validated under each distribution and the Student-t distribution is chosen due to its heteroscedasticity in residuals. The Artificial neural Network model is estimated using the Multilayer Perceptron (MLP) approach and the min-batch training procedure is selected. Data is partitioned and 80% is for training, 14.3% testing and 5.7% for validation. The models are compared using RMSE, MAPE and MAE. The ANN forecasts are more accurate than those of more traditional ARCH and GARCH models. We recommend that Artificial Neural Network (ANN) models should be used as a complement to standard time series forecasting methods, especially when the relation among variables presents significant non-linear behaviour.

Keywords: ARCH, GARCH, ANN.

Category: **Statistics**

Application of Nonlinear modeling of climate change to Southern Africa

Florance Matarise[1]
[1]Department of Statistics, University of Zimbabwe, Harare, Zimbabwe.

Abstract

A controversy rages on the best way to model climate change. Meteorologists, Physicists and Mathematicians have come up with interesting models for climate change. Daron and Stainforth(2013) recommend the use of low dimensional nonlinear systems and stress the importance of the initial condition. The claim by Rosenberg and Trenberth(2010) that global warming started 3 centuries ago around 1680 when the ”Little Ice Age” began to disappear is a very important observation that implies that in modeling climate change many factors need to be considered such as temperature, radiation, precipitation clouds, surface air, carbon dioxide, aerosols, convergence zones, extreme precipitation, soil moisture, the Indian Ocean, Atlantic Ocean and Pacific multi-decadal variability, Intertropical Convegence Zone(ITCZ), Biological processes and atmospheric blocking to name a few. We explore the best nonlinear models for Southern Africa.

13 TOP: Topology & Analysis

CR-Submersions of locally conformal cosymplectic manifolds

Ange Maloko Mavambou, Fortuné Massamba
School of Mathematics, Statistics and Computer Science
University of KwaZulu-Natal
Private Bag X01, Scottsville 3209
South Africa

Abstract

We introduce CR- Submersions of almost contact metric structures with specific attention to almost locally conformal (alc) cosymplectic structures. We particularly define submersions of alc cosymplectic manifolds onto almost contact metric manifolds, and then construct a commutative diagram between ambient manifolds and their submanifolds. This induces a diagram between bundles obtained by linear tangent maps.

Keywords: Almost contact structure,CR-submanifolds, Cosymplectic manifold, Submersion
.

Category: **Topology and Geometry, Algebra**

Strong Convergence Theorems for a Common Fixed Point of a Finite Family of Multivalued Mappings

Sebsibe Teferi Woldeamanuel[1], **Mengistu Goa Sangago**[2] **and Habtu Zegeye Hailu**[3]
[1]Department of Mathematics, College of Natural Sciences, Addis Ababa University, sebsibe.teferi@gmail.com
[2]Department of Mathematics, College of Natural Sciences, Addis Ababa University,P.O. Box 1176,mgoa2009@gmail.com
[3]Department of Mathematics, University of Botswana, P.O. Box 1176, Botswana, habtuzh@yahoo.com.

Abstract

Let K be a non-empty, closed and convex subset of a real Hilbert space H. Let $CB(K)$ be the collection of all nonempty, closed and bounded subsets of K. Let $T_i : K \to CB(K), i = 1, 2, \ldots, N$, be a finite family of Lipschitz hemicontractive-type mappings with Lipschitz constants $L_i, i = 1, 2, \ldots, N$, respectively. It is our purpose, in this paper, to introduce a Halpern type algorithm which converges strongly to a common fixed point of a finite family of Lipschitz hemicontractive-type multivalued mappings under certain mild conditions. There is no compactness assumption on either the domain set or on the mappings T_i considered.

On the history of tensor products from a functional analytic perspective

Johan Swart[1]
[1]Department of Mathematics and Applied mathematics, University of Pretoria, South Africa

Abstract

In this talk we trace back the historical roots of the concept of a tensor product of vector spaces, and the subsequent introduction of different topologies on the tensor product of various types of locally convex spaces.

We shall give particular attention to the following historical aspects:

- The role of Quantum Mechanics.
- The relation between tensor products and bilinaer mappings.
- The relation to tensor calculus.
- The role of the Schwartz kernel theorem, nuclear spaces and Grotehendieck's Memoir and Resumé
- The influence of among others D Hilbert, H Weyl, J Von Neumann, R Schatten, H Whitney and P Samuel.

Hochschild cohomology of homogeneous spaces

Oteng Maphane
University of Namibia, oteng@aims.ac.za

Abstract

A derivation θ is a k-linear map $\theta : A^n \to A^{n-k}$ such that $\theta(ab) = \theta(a)b + (-1)^{k|a|}a\theta(b)$; where $A = A^n_{n\geq 0}$ is a commutative graded algebra over a commutative ring k. Let $Der_k A$ denote the vector space of all derivations of degree k and $DerA = \oplus_k Der_k A$. If $A = (\wedge V, d)$ is a minimal Sullivan algebra, then there is a homomorphism $\phi : \wedge AL, d_0 \to C^*(A; A)$ which induces an isomorphism of graded Gerstenhaber algebras in homology, where $L = s^{-1}(\text{Der}A)$. The latter shows that the Hochschild cochain complex of A with coefficients in A can be computed in terms of derivations of A. In this talk we shall use this method to compute the loop space homology of Homogeneous spaces.

An Invariant Subspace Problem for nonlinear maps via summability properties on Banach spaces

John Emenyu
[1]Mbarara University of Science and Technology P. O. Box 1410 Mbarara - Uganda,
jemenyu@must.ac.ug

Abstract

In this paper, we first prove that every strongly 2-summing operator on a Banach space is nuclear if and only if it is factorable strongly 2-summing. This result then enables us to prove that if $1 \leq r \leq 2$ then every factorable strongly r-summing multilinear/polynomial operator on a Banach space has nontrivial invariant subspaces. On the other hand, we prove that if $2 < r < \infty$ then there is a multilinear operator corresponding to a power of a factorable strongly r-summing polynomial operator on a Banach space having nontrivial invariant subspaces. Moreover, as a corollary, we obtain a typical famous Lomonosov's hyperinvariant subspace theorem $[1]$ for r-summing linear operators on a Banach space; that is, if $1 \leq r < \infty$ then every absolutely r-summing linear operator on a Banach space has nontrivial invariant subspaces.

Keywords: Banach spaces; invariant subspaces; hyperinvariant subspaces; multilinear operators; polynomial operators; nuclear operators; summing operators; Stability; power boundedness.

Application of Banach Space Ideal Properties in Image Transmission over Wireless Network.

M.S. Wabomba
Coordinator, Section of Mathematics,
Chuka University, P.O. Box 109-60400, Chuka-Kenya,

Abstract

The Banach space operator ideals and nuclear maps have a large class of morphisms which behave as if they were part of a compact closed category, that is, they allow one to transfer variables between the domain and the codomain. We use the concept of nuclearity in functional analysis to establish application aspect of Banach space ideal properties in the transmission of image over wireless network based on the embedded system.
Key Words: A compact closed category, wireless network, embedded system.

Metric tree in T_0-quasi-metric spaces.

O. O. Otafudu
School of Mathematical and Physical Sciences
North-West University (Mafikeng campus), South Africa
olivier.olelaotafudu@nwu.ac.za

Abstract

In this talk, we discuss the concept of metric tree in a T_0-quasi-metric space. We show that large parts of the theory of metric trees do not use the symmetry of the metric and, under appropriate modifications, it still holds essentially unchanged for T_0-quasi-metrics.
Keywords: Chance; Constrained; Urban; Water.

ON CHEN-CONNECTED CONGRUENCES

Zechariah Mushaandja
Department of Mathematics and Statistics, Botswana International University of Science and Technology (BIUST), Private Bag 16, Palapye, Botswana
Email address: mushaandjaz@biust.ac.bw

Abstract

We show that connectedness of a congruence as an element of a congruence frame is not equivalent to connectedness of a congruence in the sense of Chen [1]. Hence, we introduce the term Chen-connected for the latter. Furthermore, we provide another proof of the fact that the preimage of a connected congruence under a frame homomorphism is connected [1].

Keywords: connectedness, congruence frame.

Category: **Topology**

References

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An algorithm for finding a common point of the solutions of fixed point and variational inequality problems in Banach spaces

Abebe R. Tufa and H. Zegeye[1]
[1]Department of Mathematics, University of Botswana, Pvt. Bag 00704
Gaborone, Botswana

Abstract

Let C be a nonempty, closed and convex subset of a 2-uniformly convex and uniformly smooth real Banach space E. Let $T : C \to C$ be relatively nonexpansive mapping and let $A_i : C \to E^*$ be L_i-Lipschitz monotone mappings, for $i = 1, 2$. In this paper, we introduce and study an iterative process for finding a common point of the fixed point set of a relatively nonexpansive mapping and the solution set of variational inequality problems for A_1 and A_2.Under some mild assumptions, we show that the proposed algorithm converges strongly to a point in $F(T) \cap VI(C, A_1) \cap VI(C, A_2)$. Our theorems improve and unify most of the results that have been proved for this important class of nonlinear operators.