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3.4.5 Number of research papers per teacher in the Journals notified on UGC website during the last five years (15)

3.4.5.1: Number of research papers in the Journals notified on UGC website during the last five years

Department/Section: Academic Department: Mathematics

Title of paper	Name of the author/s	Department of the teacher	Name of journal	Year of publication	ISSN number	Link to the recognition in UGC enlistment of the Journal
Further Results on Erdos - Faber - Lovasz Conjecture	S. M. Hegde, Suresh Dara	Mathematics	AKCE International Journal of Graphs and Combinatorics	2019	0972-8600	https://ugc.ac.in/journallist/ugc_admin_journal_report.aspx?eid=MzE3OQ==
A Nonlinear Mathematical Model Investigating the Sustainability of an Urban System in the Presence of Haphazard Urban Development and Excessive Pollution	Kumari Jyotsna and Abhinav Tandon	Mathematics	Natural Resource Modelling	2018	Online ISSN:1939-7445	https://www.ugc.ac.in/journallist/subjectwisejournallist.aspx?tid=TmF0dXJhbCBSZXNvdXJjZSBNb2RlbGxpbmc=&did=Q3VycmVudCBUaXRzZXM=

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Modelling the Impact of Migrated Population on Human-to-Human transmission of Ebola Virus Disease	Abhinav Tandon and Sankha Banerjee	Mathematics	International Journal of Modeling, Simulation and Scientific Computing	2018	ISSN (print) 17939623 ISSN (online): 17939615	https://www.ugc.ac.in/journallist/subjectwisejournalist.aspx?tid=SW50ZXJuYXRpb25hbCBKb3VybmFsIG9mIE1vZGVsaW5nLCBTaW11bGF0aW9uLCBhbmQgU2NpZW50aWZpYyBDb21wdXRpbmc=&&did=Q3VycmVudCBhbmQgQ2Vhc2VkIFRpdGxlcw==
A Mathematical Model to Investigate the Impact of Overgrowing Population Induced Mining on Forest Resources	Abhinav Tandon, Kumari Jyotsna and Susanto Dey	Mathematics	Environment, Development and Sustainability	2018	ISSN (print) 1387585X ISSN (online): 15732975	https://www.ugc.ac.in/journallist/subjectwisejournalist.aspx?tid=RW52aXJvbm1lbmQsIERldmVsb3BtZW50IGFuZCBTdXN0YWluYWJpbGl0eQ==&did=Q3VycmVudCBUaXRzZXM=
A Mathematical Model to Study the Impact of Mining Activities and Pollution on Forest Resources and Wildlife Population	Kumari Jyotsna and Abhinav Tandon	Mathematics	Journal of Biological Systems	2017	ISSN (print): 0218-3390 ISSN (online): 1793-6470	https://www.ugc.ac.in/journallist/subjectwisejournalist.aspx?tid=am91cm5hbCBvZiBiaW9sb2dpY2FsIHh5c3RlbnRlcw==&did=Q3VycmVudCBUaXRzZXM=

A Mathematical Model Studying the Survival of Forest Resource Dependent Wildlife Population in the Presence of Population Pressure Induced Mining Activities	Kumari Jyotsna and Abhinav Tandon	Mathematics	Natural Resource Modelling	2017	Online ISSN:1939-7445	https://www.ugc.ac.in/journallist/subjectwisejournalist.aspx?tid=TmF0dXJhbCBSZXNvdXJjZSBnb2RlbGxpbmc=&did=Q3VydmVudCBUaXRzZXM=
Modeling the effects of Environmental Intensified by Urbanisation on Human Population	Abhinav Tandon and Kumari Jyotsna	Mathematics	International Journal of Modeling, Simulation and Scientific Computing	2016	ISSN (print) 17939623 ISSN (online): 17939615	https://www.ugc.ac.in/journallist/subjectwisejournalist.aspx?tid=SW50ZXJuYXRpb25hbCBKb3VybmFsIG9mIE1vZGVsaW5nLCBTaW11bGF0aW9uLCBhbmQgU2NpZW50aWZpYyBDb21wdXRpbmc=&did=Q3VydmVudCBhbmQgQ2Vhc2VkIFRpdGxlcw==
An Efficient Algorithm for Solving Coupled Lane-Emden Boundary Value Problems in Catalytic Diffusion Reactions: The Homotopy Analysis Method	R. Singh, A. M. Wazwaz	Mathematics	<i>MATCH Communications in Mathematical and in Computer Chemistry</i>	2019	0340-6253	https://www.ugc.ac.in/journallist/ugc_admin_journal_report.aspx?eid=MzkzNw=
Haar wavelet collocation method for Lane-Emden equations with Dirichlet, Neumann and Neumann-Robin boundary conditions	R. Singh, H. Garg, V. Guleria	Mathematics	Journal of Computational and Applied Mathematics	2019	0377-0427	https://www.ugc.ac.in/journallist/ugc_admin_journal_report.aspx?eid=Njg3MA=

Steady-State Concentrations of Carbon Dioxide Absorbed into Phenyl Glycidyl Ether: An Optimal Homotopy Analysis Method	R. Singh, A. M. Wazwaz	Mathematics	<i>MATCH Communications in Mathematical and in Computer Chemistry</i>	2019	0340-6253	https://www.ugc.ac.in/journallist/ugc_admin_journal_report.aspx?eid=MzkzNw=
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Optimal homotopy analysis method for the non-isothermal reaction-diffusion model equations in a spherical catalyst,	R. Singh	Mathematics	Journal of Mathematical Chemistry	2018	1572-8897	https://www.ugc.ac.in/journallist/ugc_admin_journal_report.aspx?eid=MjQ0Nzg=
Optimal Homotopy Analysis Method for Oxygen Diffusion in a Spherical Cell with Nonlinear Oxygen Uptake Kinetics	R. Singh, A. M. Wazwaz	Mathematics	<i>MATCH Communications in Mathematical and in Computer Chemistry</i>	2018	0340-6253	https://www.ugc.ac.in/journallist/ugc_admin_journal_report.aspx?eid=MzkzNw=
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Stability of solutions of an equation governing dynamics of a renewable resources subject to Additive Allee effects	S. Padhi and Smita Pati	Mathematics	Applied Mathematics and Computation	2014	ISSN:00963	https://www.ugc.ac.in/journalist/ugc_admin_journal_report.aspx?eid=MTU5NzU=
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Propagation of Love Wave in Sandy Layer Under Initial Stress Above Anisotropic Porous Half-Space Under Gravity	A. P. Ghorai and Jayantika Pal	Mathematics	Transport in Porous Media	2015	1693913	https://www.ugc.ac.in/journalist/subjectwisejournalist.aspx?tid=VHJhbnNwb3J0IGlulFBvcml91cyBNZWRpYQ==&did=Q3VycmVudCBUaXRzZXM=

Head of the Department

S. Padhi
11.12.2019

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A new cipher system using semi-natural composition in Indian raga

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Abstract

Cryptographic algorithms are the basic of care-free transactions over the Internet today. Confidential information of a government or private agency or department is secured through the use of Cryptography. From doing secure communication to transferring information of national importance, Cryptographic algorithms play the sole role in hiding the confidentiality. Musical attributes such as notes of which the music is composed are not constant and vary from composition to composition. Same tune played by different composers shows a variation in the sequence of notes used along with other attributes of a musical composition such as duration of each note and the frequency at which each note is played. Such a variation can be employed for the purpose of encrypting the message. In this paper, we have incorporated the use of Hindustani (North Indian) musical notes to encrypt messages. We have used a semi-natural composition process to generate note sequences of Indian music which can then be used as a tool for message hiding. This at first place ensures that the message is hidden from the intruder and second it gives a new random sequence of notes every time same message is sent. So the very purpose of a Cryptographic algorithm is served. The encrypted message in the form of musical notes is then sent to the intended recipient in the form of a musical composition which helps in defying the intruder of sensing any confidential information that is being sent over the communication channel.

Keywords Cryptography · Indian raga · Semi-natural composition

1 Introduction

Cryptography is basically a mathematical model used for hiding confidential information. With the advancement of Internet technologies and reliance of more or less everyone on the use of Internet in the day to day life, it has become of utmost importance to hide the confidential information shared over the Internet in a form that cannot be read by an intruder. Three basic types of Cryptography are well known to everyone interested in this field and do not need a

mention here. But for a starter, the three types are Symmetric Key Cryptography, Asymmetric Key Cryptography and Message Digest. The first type deals with a single key for the purpose of both encryption and decryption, while the second type does the same with the use of two keys one public and other private only to the intended recipient. Message digest uses a hash function for securing the information.

To elaborate further, a Cryptographic algorithm either works by encrypting a sequence of message character by character or block by block. The first type called as stream ciphers encrypts a message in the form of a stream of characters. The well-known RSA algorithm is an example of stream ciphers. The second class of algorithm takes on a message of fine-tuned block size and encrypts it. AES, Blowfish and DES are some examples of block ciphers. In case of block ciphers, a mode of operation is required in order to encrypt a message of size less or greater than that of the block size.

Music has been long utilized in one form or other for the purpose of securing messages. Music is a prodigious area, and generated note sequences through some algorithms can be utilized for the purpose of message hiding. Hindustani

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Long-Term Statistical Characteristics of Air Pollutants in a Traffic-Congested Area of Ranchi, India

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Soubhik Chakraborty³ · Swapan Konar¹

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Abstract In this paper, we present an analysis of the air quality in a traffic-congested area in Ranchi, the proposed smart city as identified by the government of India. The main purpose of this study is to analyze the concentration of pollutants over a long period and to find the best possible way for its prediction. We have selected four air pollutants, particularly RSPM, SPM, SO₂ and NO_x, analyzed their distribution and compared with the National Ambient Air Quality standards over the period 2005–2015. The obtained data have been processed with two different methods and probability model as well as multiple regression models has been established for the prediction purpose. Since pollutants data are in continuous form, we have employed Easyfit software to find out the distribution pattern. Johnson SB, Error, Burr (4P) and Cauchy distributions were found to be the appropriate representatives of the RSPM, SPM, SO₂ and NO_x concentration patterns, respectively. Inverse cumulative density function has been used to predict the future concentration of particulate matters. With the help of SPSS 17 software, the impacts of the meteorological conditions on the variation of major pollutants have been examined by identifying the correlation between each pollutant and meteorological parameters and among the pollutants themselves.

Keywords Probability density function · Probability of exceedance · MLE · Inverse CDF · ANOVA

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Using Statistical Modeling, Rate of Change of Pitch and Inter-Onset Interval to Distinguish Between Restful and Restless Ragas

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Abstract Given that the strength of statistics lies in modelling, we are motivated to do a comparative statistical study between two types of ragas, one being aesthetically known to be restful and the other restless in nature. We first try to distinguish these two types through statistical modeling. To substantiate our findings, two more statistical features are considered in the paper to separate the two categories of ragas, namely the rate of change of pitch and inter-onset interval. The experimental results are encouraging.

Keywords Raga · {Restful, restless} nature · Rate of pitch change · Inter Onset interval · Statistical modeling

Mathematics Subject Classification 62P99

1 Introduction

The strength of statistics lies in modelling. Although statistical models are not unbiased, we can at least make the data unbiased and the mathematical theorems (such as the principle of least squares used to determine the smoothing factor in a simple exponential smoothing model) are free from bias which support these models. Statis-

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RESEARCH PAPER

MULTIPLE POSITIVE SOLUTIONS FOR A BOUNDARY
VALUE PROBLEM WITH NONLINEAR
NONLOCAL RIEMANN-STIELTJES INTEGRAL
BOUNDARY CONDITIONS

Seshadev Padhi ¹, John R. Graef ², Smita Pati ³

Abstract

In this paper, we study the existence of positive solutions to the fractional boundary value problem

$$D_{0+}^{\alpha}x(t) + q(t)f(t, x(t)) = 0, \quad 0 < t < 1,$$

together with the boundary conditions

$$x(0) = x'(0) = \dots = x^{(n-2)}(0) = 0, \quad D_{0+}^{\beta}x(1) = \int_0^1 h(s, x(s)) dA(s),$$

where $n > 2$, $n - 1 < \alpha \leq n$, $\beta \in [1, \alpha - 1]$, and D_{0+}^{α} and D_{0+}^{β} are the standard Riemann-Liouville fractional derivatives of order α and β , respectively. We consider two different cases: $f, h : [0, 1] \times \mathbb{R} \rightarrow \mathbb{R}$, and $f, h : [0, 1] \times [0, \infty) \rightarrow [0, \infty)$. In the first case, we prove the existence and uniqueness of the solutions of the above problem, and in the second case, we obtain sufficient conditions for the existence of positive solutions of the above problem. We apply a number of different techniques to obtain our results including Schauder's fixed point theorem, the Leray-Schauder alternative, Krasnosel'skii's cone expansion and compression theorem, and the Avery-Peterson fixed point theorem. The generality of the Riemann-Stieltjes boundary condition includes many problems studied in the literature. Examples are included to illustrate our findings.

Positive solutions of first order boundary value problems with nonlinear nonlocal boundary conditions

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Abstract: We consider the existence of positive solutions of the nonlinear first order problem with a nonlinear nonlocal boundary condition given by

$$x'(t) = r(t)x(t) + \sum_{i=1}^m f_i(t, x(t)), \quad t \in [0, 1]$$

$$\lambda x(0) = x(1) + \sum_{j=1}^n \Lambda_j(\tau_j, x(\tau_j)), \quad \tau_j \in [0, 1],$$

where $r : [0, 1] \rightarrow [0, \infty)$ is continuous, the nonlocal points satisfy $0 \leq \tau_1 < \tau_2 < \dots < \tau_n \leq 1$, the nonlinear functions f_i and Λ_j are continuous mappings from $[0, 1] \times [0, \infty) \rightarrow [0, \infty)$ for $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$ respectively, and $\lambda > 1$ is a positive parameter. The Leray–Schauder theorem and Leggett–Williams fixed point theorem were used to prove our results.

Key words: Positive solutions, Leray–Schauder fixed point theorem, nonlinear boundary conditions

1. Introduction

Consider the first order boundary value problem (BVP) with nonlinear nonlocal boundary condition

$$x'(t) = r(t)x(t) + \sum_{i=1}^m f_i(t, x(t)), \quad t \in [0, 1] \tag{1.1}$$

$$\lambda x(0) = x(1) + \sum_{j=1}^n \Lambda_j(\tau_j, x(\tau_j)), \quad \tau_j \in [0, 1], \tag{1.2}$$

where $r : [0, 1] \rightarrow [0, \infty)$ is continuous, $f_i : [0, 1] \times [0, \infty) \rightarrow [0, \infty)$, $i = 1, 2, \dots, m$, and the nonlocal points $\Lambda_j : [0, 1] \times [0, \infty) \rightarrow [0, \infty)$, $j = 1, 2, \dots, n$ are continuous with $0 \leq \tau_1 < \tau_2 < \dots < \tau_n \leq 1$, the nonlinear functions Λ_j satisfy

$$0 \leq \Lambda_j(t, x) \leq x \Psi_j(t, x), \quad t \in [0, 1], \quad x \in [0, \infty) \tag{1.3}$$

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Positive Solutions of a Fractional Differential Equation
with Nonlinear Riemann-Stieltjes
Type Boundary Conditions

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Abstract

In this paper, we apply fixed point index theory to study the existence of positive solutions of the fractional boundary value problem

$$D_{0+}^{\alpha}x(t) + q(t)f(t, x(t)) = 0, 0 < t < 1,$$

together with the boundary conditions

$$x(0) = x'(0) = \dots = x^{(n-2)}(0) = 0, D_{0+}^{\beta}x(1) = \int_0^1 h(s, x(s)) dA(s),$$

where $n > 2$, $n - 1 < \alpha \leq n$, $\beta \in [1, \alpha - 1]$ and D_{0+}^{α} and D_{0+}^{β} are the standard Riemann-Liouville fractional derivatives of order α and β , respectively.

AMS Subject Classification: 34B08, 34B18, 34B15, 34B10

Key words: Fractional differential equation, fixed points, positive solutions, Riemann-Liouville derivative

* Corresponding author

POSITIVE SOLUTIONS OF BOUNDARY VALUE PROBLEMS WITH NONLINEAR NONLOCAL BOUNDARY CONDITIONS

Seshadev Padhi, Smita Pati, and D.K. Hota

Communicated by Alexander Domoshnitsky

Abstract. We consider the existence of at least three positive solutions of a nonlinear first order problem with a nonlinear nonlocal boundary condition given by

$$x'(t) = r(t)x(t) + \sum_{i=1}^m f_i(t, x(t)), \quad t \in [0, 1],$$
$$\lambda x(0) = x(1) + \sum_{j=1}^n \Lambda_j(\tau_j, x(\tau_j)), \quad \tau_j \in [0, 1],$$

where $r : [0, 1] \rightarrow [0, \infty)$ is continuous; the nonlocal points satisfy $0 \leq \tau_1 < \tau_2 < \dots < \tau_n \leq 1$, the nonlinear function f_i and τ_j are continuous mappings from $[0, 1] \times [0, \infty) \rightarrow [0, \infty)$ for $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$ respectively, and $\lambda > 0$ is a positive parameter.

Keywords: positive solutions, Leggett-Williams fixed point theorem, nonlinear boundary conditions.

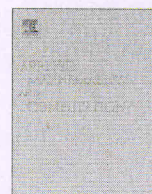
Mathematics Subject Classification: 34B08, 34B18, 34B15, 34B10.

1. INTRODUCTION

Consider the first order boundary value problem with a nonlinear nonlocal boundary condition

$$x'(t) = r(t)x(t) + \sum_{i=1}^m f_i(t, x(t)), \quad t \in [0, 1], \quad (1.1)$$

$$\lambda x(0) = x(1) + \sum_{j=1}^n \Lambda_j(\tau_j, x(\tau_j)), \quad \tau_j \in [0, 1], \quad (1.2)$$



Stability of solutions of an equation governing dynamics of a renewable resource subject to additive Allee effect [☆]



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ARTICLE INFO

Keywords:

Additive Allee effect
Upper–lower solutions
Periodic solutions
Asymptotic stability

ABSTRACT

In this paper, by using the upper and lower solution method, we have studied the existence and asymptotic behaviour of periodic solutions of the equation

$$\frac{dx}{dt} = x \left(1 - \frac{x}{K(t)} - \frac{\eta(t)}{1 + m(t)x} \right),$$

which is the model of a renewable resource subject to additive Allee effect.

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1. Introduction

Consider the following differential equation representing the dynamics of a renewable resource subjected to additive Allee effect

$$\frac{dy}{dz} = ry \left(1 - \frac{y}{K} - \frac{\gamma}{1 + wy} \right), \quad (1.1)$$

where the positive constants r, K respectively, represent intrinsic growth rate and carrying capacity of the resource, γ and w indicate the severity of Allee effect that has been modelled by Aguirre et al. in [1,2].

The Allee effect is an ecological concept with roots that go back at least to 1920 [8]. Any ecological mechanism that can lead to a positive relationship between a component of individual fitness and either the number or density of conspecifics can be termed as a mechanism of Allee effect [13,16] or depensation [6,10] or negative competition effect [19]. Several mechanisms generating Allee effects have been suggested by Berec et al. [3] and Courchamp [8] in the literature.

In this study, our focus is on additive Allee effect, which refers to the reduction of species due to an extra mortality rate influenced by factors such as satiation of a predator [4,8–10], anti-predator behaviour like group defence against predator and inhibition [11,17], or the necessity of finding a mate for reproduction [4,10] etc. One may find two interesting derivations in [18] for the term representing additive Allee effect, which are developed in the context of search for a mate and impact of a satiating generalist predator.

Many ecosystems experience fluctuations in biological and environmental factors which effect the birth rates, mortality rates, carrying capacities and other vital factors of the species in the ecosystems. Despite this fact, the amount of analysis which has been carried out on autonomous growth models far exceeds what has been done on models in which the param-

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INTERNATIONAL PUBLICATIONS USA

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Positive Periodic Solutions of Nicholson's Blowflies Model with Harvesting

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Abstract

In this paper, sufficient conditions are given for the existence of at least three positive T -periodic solutions of the Nicholson's Blowflies model with a harvesting term

$$x'(t) = -a(t)x(t) + p(t)x^m(t - \tau(t))e^{-\gamma(t)x^n(t - \tau(t))} - H(t, x(t)),$$

using the Leggett-Williams multiple fixed point theorem. Here, $a, p, \tau, \gamma \in C(R, R^+)$ are T -periodic functions, and $T > 0$ is a constant.

AMS (MOS) Subject Classification: 34K40, 34C10, 34C25

Key words: Positive Periodic solution; Nicholson's Blowflies Model; Functional Differential Equation

1 Introduction

This paper deals with the existence of at least three positive periodic solutions of the non-linear functional differential equation

$$x'(t) = -a(t)x(t) + p(t)x^m(t - \tau(t))e^{-\gamma(t)x^n(t - \tau(t))} - H(t, x(t)), \quad (1)$$

where $a, p, \tau, \gamma \in C(R, R^+)$ are T -periodic functions, $H \in C(R \times R^+, R^+)$ and is periodic with respect to the first variable, $m > 1$ and $n > 0$ are reals and $T > 0$ is a constant. From the periodicity of $\tau(t)$, it follows that $\lim_{t \rightarrow \infty} (t - \tau(t)) = \infty$.

Gurney et al. [5] proposed a mathematical model

$$x'(t) = -ax(t) + px(t - \tau)e^{-\gamma x(t - \tau)}$$

INTERNATIONAL PUBLICATIONS (USA)

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Existence and Nonexistence of Multiple Positive Periodic Solutions of First Order Differential Equations with Unbounded Green's Kernel

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Communicated by the Editors

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Abstract

The authors obtain sufficient conditions for the existence and nonexistence of at least two positive periodic solutions of a class of first order differential equations of the form

$$x'(t) = a(t)g(x(t))x(t) - \lambda b(t)f(x(h(t)))$$

that have an unbounded Green's kernel.

AMS (MOS) Subject Classification: 34C25, 34K13

Key words: Existence, nonexistence, positive periodic solution, unbounded Green's kernel.

1 Introduction

This paper is concerned with the existence of positive T -periodic solutions of a class of differential equations of the form

$$x'(t) = a(t)g(x(t))x(t) - \lambda b(t)f(x(h(t))), \quad (1)$$

INTERNATIONAL PUBLICATIONS (USA)

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Periodic Solutions of a Single Species Renewable Resources Under Periodic Habitat Fluctuations with Harvesting and Allee Effects

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Abstract

The authors study the existence of at least two positive periodic solutions of the dynamics of a single species renewable resource under periodic habitat fluctuation with harvesting and Allee effects. They focus on two cases: 1. proving existence of two positive periodic solutions of a differential equation that has an unbounded Green's kernel, and 2. applying these results to find the existence of two positive periodic solutions of a model with Allee effects and harvesting. The results obtained are new and improve some existing results.

Mathematical Modeling and Analysis of Torsional Surface Waves in a Transverse Isotropic Elastic Solid Semi-Infinite Medium with Varying Rigidity and Density under a Rigid Layer

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Abstract

In this paper, mathematical modeling of the propagation of torsional surface waves in a transverse isotropic elastic medium with varying rigidity and density under a rigid layer has been considered. The equation of motion has been formulated in the elastic medium using suitable boundary conditions. The frequency equation containing Whittaker's function for phase velocity due to torsional surface waves has been derived. The effect of rigid layer in the propagation of torsional surface waves in a transverse isotropic elastic medium with varying rigidity and density has been discussed. The numerical results have been shown graphically. It is observed that the influence of transverse and longitudinal rigidity and density of the medium have a remarkable effect on the propagation of the torsional surface waves. Frequency equations have also been derived for some particular cases, which are in perfect agreement with some standard results.

Keywords

Torsional Surface Waves, Transverse Isotropic Elastic Medium, Phase Velocity

1. Introduction

Surface waves in elastic medium have been well recognized in the study of earthquake waves, seismology, geo-

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Modeling of Surface Waves in a Fluid Saturated Poro-Elastic Medium under Initial Stress Using Time-Space Domain Higher Order Finite Difference Method

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ABSTRACT

In this present context, mathematical modeling of the propagation of surface waves in a fluid saturated poro-elastic medium under the influence of initial stress has been considered using time dependent higher order finite difference method (FDM). We have proved that the accuracy of this finite-difference scheme is $2M$ when we use 2nd order time domain finite-difference and $2M$ -th order space domain finite-difference. It also has been shown that the dispersion curves of Love waves are less dispersed for higher order FDM than of lower order FDM. The effect of initial stress, porosity and anisotropy of the layer in the propagation of Love waves has been studied here. The numerical results have been shown graphically. As a particular case, the phase velocity in a non porous elastic solid layer derived in this paper is in perfect agreement with that of Liu *et al.* (2009).

Keywords: Love Waves; Fluid Saturated Initially Stressed Porous Layer; Time-Space Domain; Finite Difference Scheme; Accuracy; Dispersion Analysis; Phase Velocity

1. Introduction

The simulation of surface waves propagating in a fluid saturated poro-elastic media is of great importance to seismologists due to its possible applications in geophysical prospecting, reservoir engineering and survey techniques for understanding the cause and estimation of damage due to natural and manmade hazards. Also the difficulty in exploring natural resources is gradually increasing as the nature of the reservoir is more complex and heterogeneous than it was assumed in past and the characterization of the subsurface materials as fluid saturated porous media is more realistic. It is also more accurate to consider soil as two phase composite materials, granular solid and pore fluid. The size of pores is assumed to be small and macroscopically speaking, their average distribution is uniform.

Since poro-elastic theory was developed by Biot [1-3] many efforts have been made in using experimental and numerical methods to characterize elastic wave propagation in porous, liquid-saturated solids. Quite a good amount of information about the effect of initial stress on propagation of surface waves is available in the literature of many authors namely, A. M. Abd-Alla [4], S. Gupta

[5], Shishir Gupta [6]. In these papers they have followed the conventional analytical method to solve these problems. But recently the finite difference method appears as an important tool for numerical simulations of partial differential equations and has been used widely in simulating elastic waves. Due to easy and straightforward approach, robustness, requiring small memory and computation time, the Finite Difference Methods are the most popular methods for seismic modeling. Also wave equation modeling in the time domain is popular because of its easy implementation and accuracy, compared to frequency domain modeling. In time-domain modeling, higher-order differencing operators are used to reduce the required spatial sampling. Virieux [7,8] have used velocity-stress finite difference method for the propagation of P-SV wave and SH wave in heterogeneous media. To improve the accuracy and stability of finite difference scheme, many authors have used and developed different types of difference schemes. Levander [9] applied 4th order approximation in space to the P-SV scheme. Hayashi and Burns [10] developed finite difference scheme with variable grids. R. W. Graves [11] discussed the simulation of seismic wave propagation in 3D elastic me-

Comparison and Analysis of Surface Waves Propagation in Initially Stressed Dry Sandy Layer Using Conventional and Time Dependent Finite Difference Scheme

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Abstract

In this reported manuscript, a mathematical modeling of propagation of surface waves in dry sandy layer under initial stress is presented. The equation of motion for the surface wave has been formulated following Biot, using suitably chosen boundary conditions. The dispersion equation of phase velocity of this proposed layer has been derived using conventional method of separation of variables and also by using time dependent finite difference method of approximation. The study reveals that initial stress and the sandiness on the layer play important roles on the propagation of surface waves. It is observed that with the increase of initial stress parameter, the phase velocity of the surface wave decreases, whereas it increases for the increase in the value of the sandy parameter. The phase velocity curve has been displays for different time-steps. Comparison between the methods (conventional and time dependent finite difference scheme) has been studied and presented graphically to show the effects of these above mentioned parameters and it has been shown that in every case the dispersion of phase velocity curves are less dispersed in time dependent finite difference method than in conventional method.

Keywords: Surface Waves, Dry Sandy Layer, Initial Stress, Time-Space Domain, Finite Difference Method, Dispersion Analysis and Phase Velocity.

INTRODUCTION

Mathematical modeling plays an important role about how we use the language of mathematics to express, communicate and think about the real world. A model may help to explain a system and to study the effects of different component and to make predictions about behavior. Geologic modeling in the applied science of creating computerized representations of portions of the earth's crust based on geophysical and geological observations made on or below the earth surface.

There are two basic types of elastic waves or seismic waves generated by an earthquake which is caused by sudden release of energy in the earth's crust; these are body waves and surface waves. These wave causes shaking, damaging in various ways. Traveling through the interior of the earth, body waves arrive before the surface waves and are of higher frequency than surface waves. In addition to the body waves, mentioned above, there are surface waves which are of a lower frequency than body waves. Although they arrive after body waves then also they are almost entirely responsible for

any type of damage and destruction associates with earthquakes. The surface waves propagating in different media is of great importance to seismologists due to its possible applications in geophysical prospecting, survey techniques and reservoir engineering for understanding the cause and estimation of damage due to natural and manmade hazards. These waves provide seismologists most direct and rich information regarding the structure of earth's interior. Surface wave which appear to travel along the earth's surface consist approximately of harmonic waves of varying amplitudes and of progressively diminishing periods. There are mainly two types of surface waves as Love waves and Rayleigh waves. The existence of Rayleigh waves was predicted by Lord Rayleigh, in 1885 and most of the shaking felt from an earthquake is due to these waves. Love waves are surface waves that cause circular shearing of the ground, the particle motion during the passage of these waves is purely horizontal and normal to the direction of wave propagation and have the largest amplitude creating most of the damage and destruction associate with earthquakes. In 1911, A. E. H. Love, a British mathematician created a mathematical model of these waves when there is a layered structure.

The layer of the soil in the earth is supposed to be more sandy than elastic. A dry sandy mantle may be defined as a layer consists of sandy particles retaining no moistures or water vapours. Weiskopf has discussed the mechanics of dry sandy soil [30] and it reveals that due to the slippage of granular

particles in a dry sandy soil, $\frac{E}{\mu} > 2(1 + \sigma)$ where E is the

Young's modulus of elasticity, μ is the rigidity and σ is the Poisson's ratio. Weiskopf suggested that the relationship $\frac{E}{\mu} = 2\eta(1 + \sigma)$ could be appropriate for the dry sandy soil,

where $\eta > 1$ is termed as sandy parameter and $\eta = 1$ corresponds to an elastic solid. Due to the factors like external pressure, slow process creep, difference in temperature, manufacturing processes etc. the media stay under high stress, known as initial stress for which the layers of the earth exhibit anisotropy, i.e.; deviates from the directionally regular elastic behavior of an isotropic material. So it is more worthy to study the propagation of surface waves in an initially stressed dry sandy layer.

Much information about the propagation of seismic waves is available in the well-known book by Ewing et al. [1]. Following Biot's theory [2, 3] of Mechanics of Incremental

Propagation of Love Wave in Sandy Layer Under Initial Stress Above Anisotropic Porous Half-Space Under Gravity

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Abstract In the present work, a mathematical modeling of propagation of Love waves in dry sandy layer under initial stress above anisotropic porous half-space under gravity is reported. The equation of motion for the Love wave has been formulated following Biot, using suitably chosen boundary conditions at the interface of sandy layer and porous half-space under gravity. The dispersion equation of phase velocity of this proposed multilayer ground structure has been derived following the Whittaker function and its derivative, which is further expanded asymptotically, retaining the terms up to only the second degree for large argument due to small values of Biot's gravity parameter (varying from 0 to 1). The study reveals that the gravity and porosity of the porous half-space play important roles on the propagation of Love waves. It is observed that with the increase in gravitation parameter and porosity of the half-space, the phase velocity of the Love wave decreases, whereas the velocity of the waves increases for the increase in the value of the sandy parameter. The effects of these above-mentioned medium parameters for isotropic and anisotropic cases are studied on the propagation of Love waves, and their numerical results have been presented graphically.

Keywords Sandy layer · Love waves · Porosity · Gravity · Whittaker function

1 Introduction

In recent times, everybody across the world acutely concerns about the safety of the environment of our planet and the mathematics related to the “system Earth” finds itself challenged by new problems nearly every day. Some of these problems are related to the earth's response

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Research Article

Selection of Vendor Based on Intuitionistic Fuzzy Analytical Hierarchy Process

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Business environment is characterized by greater domestic and international competitive position in the global market. Vendors play a key role in achieving the so-called corporate competition. It is not easy however to identify good vendors because evaluation is based on multiple criteria. In practice, for VSP most of the input information about the criteria is not known precisely. Intuitionistic fuzzy set is an extension of the classical fuzzy set theory (FST), which is a suitable way to deal with impreciseness. In other words, the application of intuitionistic fuzzy sets instead of fuzzy sets means the introduction of another degree of freedom called nonmembership function into the set description. In this paper, we proposed a triangular intuitionistic fuzzy number based approach for the vendor selection problem using analytical hierarchy process. The crisp data of the vendors is represented in the form of triangular intuitionistic fuzzy numbers. By applying AHP which involves decomposition, pairwise comparison, and deriving priorities for the various levels of the hierarchy, an overall crisp priority is obtained for ranking the best vendor. A numerical example illustrates our method. Lastly a sensitivity analysis is performed to find the most critical criterion on the basis of which vendor is selected.

1. Introduction

In most industries the cost of raw materials and component parts constitutes the main cost of a product, such that in some cases it can account for up to 70% (Ghobadian and Stainer [1]). In high technology firms, purchased materials and services represent up to 80% of total product cost (Weber et al. [2]). Thus the purchasing department can play a key role in an organization's efficiency and effectiveness since the department has a direct effect on cost reduction, profitability, and flexibility of a company by selecting the right suppliers which significantly reduces the purchasing costs and improves corporate competitiveness (Ghodsypour and O'Brien [3]). The objective of supplier selection is to identify suitable supplier on the basis of comparison of suppliers using a common set of criteria and measures.

The first study on vendor selection was carried by Dickson [4] who identified 23 important evaluation criteria for supplier selection. Later Weber et al. reviewed, classified, and addressed the supplier selection problem and

De Boer et al. [5] identified four stages for supplier selection including definition of the problem, formulation of criteria, qualification, and final selection, respectively. A number of methodologies have been proposed for solving vendor selection problem. Some adopted models specifically account for the imprecision of the rating mechanism. We will consider analytical hierarchy process for vendor selection problem. Narsimhan [6] used an analytical hierarchy process to select vendors for general industrial purchasing. Ghodsypour and O'Brien [7] combined AHP and LP in order to take into account tangible and intangible criteria and to optimize order allocation among suppliers. Yahya and Kingsman [8] used Saaty's analytic hierarchy process method into vendor rating system for a government sponsored entrepreneur development programme by describing a case study. Tam and Tummala [9] presented a real case study to select the best vendor for telecommunication systems by formulating analytic hierarchy process (AHP) based approach. It is seen that this approach is flexible and less time consuming. Zhang et al. [10] formulated AHP based model and presented a case

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Fuzzy Approach to Decision Support System Design for Inventory Control and Management

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Abstract: The ubiquitous nature of inventory and its reliance on a reliable decision support system (DSS) is crucial for ensuring continuous availability of goods. The DSS needs to be designed in a manner that enables it to highlight its present status. Further, the DSS should be able to provide indications about subtle and large-scale variations that are likely to occur in the supply chain within the context of the decision-making framework and inventory management. However, while dealing with the parameters of the system, it is observed that its operations and mechanisms are surrounded by uncertain, imprecise, and vague environments. Fuzzy-based approaches are best suited for such situations; however, these require assistance from learning systems like artificial neural network (ANN) to facilitate automated decision support. When ANN and fuzzy are combined, the fuzzy neural system and the neuro-fuzzy system (NFS) are formulated. The model of the DSS reported here is based on a framework commonly known as adaptive neuro-fuzzy inference system (ANFIS), which is a version of NFS. The configured model has the advantages of both the ANN and fuzzy systems, and has been tested for the design of a DSS for use as part of inventory control. In this work, we report the design of an ANFIS-based DSS configured to work as DSS for inventory management. The system accepts demand as input and generates procurement, ordering, and holding cost to control production and supply. The system deals with a certain profitability rating required to quantify the changes in the input and is combined with the day-to-day inventory records and demand-available cycle. The effectiveness of the system has been checked in terms of number and types of membership used, accuracy generated, and computational efficiency accounted by the computation cycles required.

Keywords: Inventory control, DSS framework, ANFIS, decision making.

1 Introduction

Inventory management and control are crucial elements in all segments of the economy. The traditional models of inventory design are built on crisp parameters where decision support is between two extremes. However, practical situations of inventory control demand that there be flexibility to handle uncertain situations. Most of these situations are closely entwined with the demand-supply chain on the one hand and control of the cost of production on the other. The various elements associated with how much to order are normally concerned with inventory costs and lot-sizing models. The inventory cost covers ordering, procurement, holding, and shortage. Inventory models are utilized to minimize operational costs and facilitate certain give-and-take approaches related to investment and customer satisfaction. A decision support system (DSS) may be used to achieve such objectives. The term DSS was first coined by P. G. W. Keen, a British academician who defined DSS as a computerized mechanism along with its analytical tools and manager's judgment for smooth handling of decision-dependent situations like inventory control, as mentioned in Ref. [1]. Aengchuan et al. defined a DSS to be "a computer based information system that combines models and data

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The optimal modified variational iteration method for the Lane-Emden equations with Neumann and Robin boundary conditions

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Abstract. An effective analytical technique is proposed for the solution of the Lane-Emden equations. The proposed technique is based on the variational iteration method (VIM) and the convergence control parameter h . In order to avoid solving a sequence of nonlinear algebraic or complicated integrals for the derivation of unknown constant, the boundary conditions are used before designing the recursive scheme for solution. The series solutions are found which converges rapidly to the exact solution. Convergence analysis and error bounds are discussed. Accuracy, applicability of the method is examined by solving three singular problems: i) nonlinear Poisson-Boltzmann equation, ii) distribution of heat sources in the human head, iii) second-kind Lane-Emden equation.

1 Introduction

Many problems of physical and engineering sciences are modeled by singular boundary value problems (SBVPs). Due to the presence of singularity, these problems pose difficulties in obtaining their solutions, and various methods have been proposed to overcome these difficulties. Heat conduction in human head [1], oxygen diffusion in spherical cell [2,3] and thermal explosion in rectangular slab [4] are modeled by the SBVPs. Therefore accurate numerical methods are required to solve such type of problems. Consider the following nonlinear SBVPs [5–8]:

$$\left. \begin{aligned} u'' + \frac{\alpha}{x} u' &= f(x, u), \quad 0 < x < 1, \\ u'(0) &= 0, \quad a u(1) + b u'(1) = c, \end{aligned} \right\} \quad (1)$$

where a, b, c are any finite real parameters. There is extensive literature available for both analytical methods [6–9] and numerical methods [10–13] for solving SBVPs of the form (1). The VIM and its modified versions have been employed in [14,15]. In [14], Wazwaz showed that the VIM gives good approximations only when the problem is linear or weakly nonlinear with nonlinearity of the form u^n, uu' . However, the VIM suffers when the nonlinearity is of the form $e^u, \ln(u), \sin u, \sinh u$. This may be one of the major drawback of the VIM for solving difficult nonlinear problems.

In this paper, we present a modification of the VIM to overcome the difficulties occurred in the VIM for solving (1). The proposed method provides a direct recursive scheme for solving SBVPs.

2 The VIM

The idea of the VIM and its applicability to various kinds of differential equations are given in [16,17]. Accordingly to the VIM, the correction functional for SBVPs (1) is constructed as

$$u_{n+1} = u_n + \int_0^x \lambda \left(u_n''(\xi) + \frac{\alpha}{\xi} u_n'(\xi) - f(\xi, \tilde{u}_n(\xi)) \right) d\xi, \quad (2)$$

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Optimal homotopy analysis method for the non-isothermal reaction–diffusion model equations in a spherical catalyst

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Abstract We consider the Lane–Emden boundary value problems which appear in chemical applications, biochemical applications, and scientific disciplines. The Lane–Emden problem is transformed into an equivalent integral equation. The optimal homotopy analysis method is used to solve two specific models. The first problem models reaction–diffusion equation in a spherical catalyst, while the second problem models the reaction–diffusion process in a spherical biocatalyst. We obtain reliable analytical solutions of the concentrations and the effectiveness factors. Numerical results and graphs show the reliability and efficiency applicability of the employed method.

Keywords Lane–Emden equation · Spherical catalyst · Spherical biocatalyst · Optimal homotopy analysis method · Michaelis–Menten kinetics · Singular boundary value problems

Abbreviations

C_A	Concentration of reactant A inside the catalytic pellet
C_{AS}	Concentration of reactant A at the surface of catalytic pellet
D	Effective diffusivity inside the catalytic pellet
E	Activation energy
ΔH	Heat of reaction
k_{ref}	Reference reaction constant
K	Effective thermal conductivity inside the catalytic pellet

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Optimal Homotopy Analysis Method for Oxygen Diffusion in a Spherical Cell with Nonlinear Oxygen Uptake Kinetics

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Abstract

We investigate the diffusion of oxygen in a spherical cell including nonlinear uptake kinetics. We study the Lane-Emden boundary value problem, with Michaelis-Menten kinetics, to model the dimensionless oxygen concentration. Due to the presence of singularity, this problem poses difficulties in obtaining its solutions. To overcome the singular behavior at the spherical origin of the cell, Lane-Emden equation is transformed into an equivalent Fredholm integral equation. The optimal homotopy analysis method (OHAM) is applied to solve the Lane-Emden integral form for studying the concentration of oxygen within the spherical cell. To speed up the calculations, the discrete averaged residual error is used to obtain optimal value of the adjustable parameter c_0 to control the convergence of solution. Unlike, Adomian decomposition method (ADM) [1], the proposed method contains an adjustable parameter c_0 to control the convergence of series solutions.

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Convergence of an Iteration of Fifth-Order Using Weaker Conditions on First Order Fréchet Derivative in Banach Spaces

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The convergence analysis both local under weaker Argyros-type conditions and semilocal under ω -condition is established using first order Fréchet derivative for an iteration of fifth order in Banach spaces. This avoids derivatives of higher orders which are either difficult to compute or do not exist at times. The Lipchitz and the Hölder conditions are particular cases of the ω -condition. Examples can be constructed for which the Lipchitz

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Analytical approach for computation of exact and analytic approximate solutions to the system of Lane-Emden-Fowler type equations arising in astrophysics

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Abstract. In this paper, we study the system of Lane-Emden-Fowler type equations which model many phenomena in mathematical physics and astrophysics. The equivalent Volterra integral forms of system of Lane-Emden-Fowler equations is considered. A reliable algorithm based on the optimal homotopy analysis method is employed for the exact and analytic approximate solutions to the Volterra integral forms of the system of equations. Convergence and error analysis of the proposed method are also discussed. The analytical results show that the present method gives a reliable algorithm for the approximate series solutions and the exact solutions of these systems.

1 Introduction

In the fields of mathematical physics and astrophysics there exist many problems which are modelled by the linear and nonlinear second-order singular differential equation of the form [1, 2]:

$$w''(x) + \frac{k}{x}w'(x) + f(x, w(x)) = h(x), \quad k > 0. \quad (1)$$

Equation (1) is known as the Lane-Emden-Fowler type equation. It was named after the name of the astrophysicists Lane [3] and Emden [4]. The Lane-Emden-Fowler equation has been used in modelling several phenomena in astrophysics and mathematical physics [5, 6]. Equation (1) with $f(x, w(x)) = w^m$, $h(x) = 0$ and $k = 2$, we get

$$w''(x) + \frac{2}{x}w'(x) + w^m(x) = 0. \quad (2)$$

This equation models many phenomena in mathematical physics and its closed form solution is only known for index $m = 0, 1, 5$ (see [7]). Equation (1) with $f(x, w(x)) = e^w$, $h(x) = 0$ and $k = 2$, we have

$$w''(x) + \frac{2}{x}w'(x) + e^{w(x)} = 0, \quad (3)$$

this model equation was used to model the isothermal gas spheres [8, 9]. Equation (1) with $f(x, w) = \frac{\theta w}{w + \kappa}$, $h(x) = 0$ and $k = 2$, we get

$$w''(x) + \frac{2}{x}w'(x) - \frac{\theta w(x)}{w(x) + \kappa} = 0. \quad (4)$$

The above model arises in the study of steady-state oxygen diffusion in a spherical cell with Michaelis-Menten uptake kinetics [10]. A similar model,

$$w''(x) + \frac{2}{x}w'(x) + e^{-w(x)} = 0, \quad (5)$$

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Numerical solutions of fourth-order Volterra integro-differential equations by the Green's function and decomposition method

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Abstract We propose a reliable technique based on Adomian decomposition method (ADM) for the numerical solution of fourth-order boundary value problems for Volterra integro-differential equations. We use Green's function technique to convert boundary value problem into the integral equation before establishing the recursive scheme for the solution components of a specific solution. The advantage of the proposed technique over the standard ADM or modified ADM is that it provides not only better numerical results but also avoids solving a sequence of transcendental equations for unknown constant. Approximations of the solutions are obtained in the form of series. Convergence and error analysis is also discussed. The accuracy and generality of the proposed scheme are demonstrated by solving some numerical examples.

Keywords Integro-differential equations · Boundary value problems · Adomian decomposition method · Green's function · Approximations

Mathematics Subject Classification 34B15 · 34B27 · 34B05 · 65L10 · 65L80

Introduction

Consider the following class of fourth-order BVPs for Volterra IDEs [1–5]

$$y^{(iv)}(x) = g(x) + \int_0^x K(x,t)f(y(t))dt, \quad x \in [0, b], \quad (1)$$

with the boundary conditions

$$y(0) = \alpha_1, \quad y'(0) = \alpha_2, \quad y(b) = \alpha_3, \quad y'(b) = \alpha_4, \quad (2)$$

where $\alpha_i, i = 1, 2, 3, 4$ are any finite real constants, $g(x) \in C[0, b]$, and $K(x, t) \in C([0, b] \times [0, b])$. The IDEs are often involved in the mathematical formulation of physical and engineering phenomena [4–6]. In general, the IDEs with given boundary conditions are difficult to solve analytically. Therefore, these problems must be solved by various approximation and numerical methods. The existence and uniqueness of solutions for such problems can be found in [1].

There is considerable literature on the numerical-approximate treatment of the BVPs for IDEs, for example, the compact finite difference method [7], monotone iterative methods [7, 8], spline collocation method [9], the method of upper and lower solution [10], Haar wavelets [11], and pseudo-spectral method [12]. Though, these numerical techniques have many advantages, a huge amount of computational work is involved that combines some root-finding techniques to obtain an accurate numerical solution especially for nonlinear problems.

Recently, some newly developed semi-numerical methods have also been applied to solve BVPs for IDEs such as, ADM [3], homotopy perturbation method (HPM) [4], and homotopy analysis method (HAM) [13]. In [5], the


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A modified homotopy perturbation method for singular time dependent Emden–Fowler equations with boundary conditions

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Abstract In this paper, we propose a new modification of the homotopy perturbation method (HPM) for solving nonlinear and singular time-dependent Emden–Fowler-types equations with the Neumann and Dirichlet boundary conditions. We first transform the singular problem into an equivalent integral equation, and we then apply the HPM to obtain approximate series solution. This new modified HPM will be used without unknown constants while computing the successive solution components, and we also avoid solving a sequence of transcendental equations for the determination of the unknown constants. Moreover, the proposed technique is reliable enough to overcome the difficulty of the singular point at $x = 0$. Four illustrative examples are examined to demonstrate the accuracy and applicability of the proposed method.

Keywords Emden–fowler equations · Heat-type equations · Wave-type equations · Singular behavior · Homotopy perturbation method

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Numerical Solution of the Time Dependent Emden-Fowler Equations with Boundary Conditions using Modified Decomposition Method

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Abstract: We propose a new modification to Adomian decomposition method for numerical treatment of the time-dependent Emden-Fowler-types equations with the Neumann and Dirichlet boundary conditions. In new modified method, we use all the boundary conditions to derive an integral equation before establishing the recursive scheme. The new modified decomposition method (MDM) will be used without unknown constants while computing the successive solution components. Unlike the recursive schemes that result from using the ADM, the new MDM avoids solving a sequence of nonlinear algebraic or transcendental equations for the derivation of unknown constants. Moreover, the proposed technique is reliable enough to overcome the difficulty of the singular point at $x = 0$. Five illustrative examples are examined to demonstrate the accuracy and applicability of the proposed method.

Keywords: Emden-Fowler Equations, Heat-type equations, Wave-type equations, Adomian decomposition method, Adomian Polynomials, Singular Behavior

1 Introduction

It is well known that the time-dependent Emden-Fowler equations can describe either heat diffusion or wave type equation. Many problems in the literature of the diffusion of heat perpendicular to the surfaces of parallel planes are modeled by the heat equation:

$$\frac{\partial^2 u(x,t)}{\partial x^2} + \frac{\alpha}{x} \frac{\partial u(x,t)}{\partial x} + af(x,t)g(u) + h(x,t) = \frac{\partial u(x,t)}{\partial t}, \quad 0 < x < l. \quad (1)$$

Here, $f(x,t)g(u) + h(x,t)$ is the nonlinear heat source, $u(x,t)$ is the temperature, and t is the dimensionless time variable. For the steady-state case, and for $h(x,t) = 0$, Eq. (1) is the Emden-Fowler equation [1] given by

$$u_{xx} + \frac{\alpha}{x} u_x + af(x)g(u) = 0. \quad (2)$$

For $f(x) = 1$ and $g(u) = u^n$, this equation is known as the standard Lane-Emden equation of the first kind, whereas the second kind is obtained when $g(u) = e^u$. It is

well-known that the Lane-Emden equation is used in modelling a thermal explosion in either an infinite cylinder ($\alpha = 1$) or a sphere ($\alpha = 2$), where α is the shape factor of the equation. In [2], Harley and Momoniat studied this problem, where approximate first integrals were obtained and employed to study the qualitative features of the solutions. For more information on recently works on Lane-Emden equations, see details [2, 3, 4, 5].

However, the time-dependent Emden-Fowler equation of the wave type, with singular behavior, is of the form:

$$\frac{\partial^2 u(x,t)}{\partial x^2} + \frac{\alpha}{x} \frac{\partial u(x,t)}{\partial x} + af(x,t)g(u) + h(x,t) = \frac{\partial^2 u(x,t)}{\partial t^2}, \quad 0 < x < l. \quad (3)$$

Here, $f(x,t)g(u) + h(x,t)$ is the nonlinear source, t is the dimensionless time variable, and $u(x,t)$ is the displacement of the wave at the position x and at time t .

In this work, we will concern ourselves on studying the heat type and the wave type of the Emden-Fowler-types equations (1) and (3) with the

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An efficient semi-numerical technique for solving nonlinear singular boundary value problems arising in various physical models

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An efficient semi-numerical method is proposed for solving nonlinear singular boundary value problems (BVPs) arising in various physical models. We proposed a modification of the Adomian decomposition method (ADM). The technique depends on transforming the BVPs to Fredholm integral equations before establishing the recursive scheme for the solution components of a specific solution. The major advantage of the proposed method over the classical ADM or modified ADM is that it provides not only better numerical results but also avoids unnecessary computation for determining the unknown parameters. Moreover, the proposed technique overcomes the singularity issue at the origin $x = 0$. Furthermore, the convergence analysis of the proposed method is established. Two singular examples are examined to demonstrate the accuracy, applicability, and generality of the proposed method.

Keywords: singular boundary value problems; Adomian decomposition method; approximations; Emden–Fowler equation; Green’s function

2010 AMS Subject Classifications: 34B05; 34B15; 34B16; 34B18; 34B27

1. Introduction

We consider the singular boundary value problem (BVP) arising in various physical models*

$$-(p(x)y'(x))' = p(x)f(x, y(x)), \quad x \in (0, 1), \quad (1)$$


with the boundary conditions

$$y(0) = \alpha_1 \quad \text{or} \quad \lim_{x \rightarrow 0^+} p(x)y'(x) = 0, \quad \beta_1 y(1) + \gamma_1 y'(1) = \eta_1, \quad (2)$$

where α_1 , $\beta_1 > 0$, γ_1 , and η_1 are any finite real constants. The condition $p(0) = 0$ characterizes that the differential equation (1) is singular. We assume that (i) $\int_0^1 (1/p) \int_x^1 p \, dx \, dx < \infty$ when $y(0) = \alpha_1$ and (ii) $\int_0^1 (1/p) \int_0^x p \, dx \, dx < \infty$ when $\lim_{x \rightarrow 0^+} p(x)y'(x) = 0$. The problems of the form (1)–(2) arise very frequently in applied mathematics, engineering, physics, chemistry such as in chemical reactions, atomic calculations, gas dynamics, nuclear physics, heat and mass

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An algorithm based on the variational iteration technique for the Bratu-type and the Lane–Emden problems

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Abstract In this paper, a new algorithm for the numerical solution of the Bratu-type and the Lane–Emden problems with boundary conditions is presented. The proposed algorithm is based on the variational iteration method (VIM), where all the boundary conditions are used before designing the recursive scheme for the approximate solutions of considered boundary value problems. Unlike the VIM, the proposed algorithm avoids solving a sequence of nonlinear algebraic or (transcendental) equations for the undetermined coefficients. Convergence and error analysis of the proposed method is also given. Illustrative examples, of two different models, are examined to demonstrate the accuracy, applicability, and generality of the proposed method.

Keywords Boundary value problems · Variational iteration method · Bratu’s problem · Lane–Emden problem · Approximations

Mathematics Subject Classification 34B15 · 34B27 · 34B05 · 65L10 · 65L80

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An Efficient Algorithm for Solving Coupled Lane–Emden Boundary Value Problems in Catalytic Diffusion Reactions: The Homotopy Analysis Method

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Abstract

In this paper, we use the homotopy analysis method (HAM) with Green's function [1] for solving the coupled Lane–Emden boundary value problems which appear in catalytic diffusion reactions. Due to the presence of singularity, these problems pose difficulties in obtaining their solutions. To overcome the singular behavior at the origin, the coupled Lane–Emden boundary value problems are transformed into an equivalent Fredholm integral equations. The integral forms of the Lane–Emden equations are then solved by the HAM. Unlike, Adomian decomposition method (ADM), the HAM contains an adjustable parameters to control the convergence of solution. For speed up the calculations, the discrete averaged residual error is used to obtain optimal value of the adjustable parameter c_0 to control the convergence of solution. The numerical results show that the HAM gives reliable algorithm for analytic approximate solutions of these systems. The error analysis of the sequence of the analytic approximate solutions has been performed by computing the residual error functions and the maximal residual error parameters, which demonstrate an approximate exponential rate of convergence.

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Steady-State Concentrations of Carbon Dioxide Absorbed into Phenyl Glycidyl Ether: An Optimal Homotopy Analysis Method

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Abstract

In this work, we extend our work in [1] for solving the *nonlinear coupled boundary value problems* that relates the concentrations of carbon dioxide CO₂ and phenyl glycidyl ether in solution. We first transform the coupled boundary value problems into an equivalent integral equations. We then apply the optimal homotopy analysis method for obtaining approximations to the solutions. The present method gives a rapidly convergent, easily computable, and readily verifiable sequence of analytic approximate solutions that is suitable for numerical parametric simulations. For speed up the calculations, we use the discrete averaged residual error to obtain optimal value of the adjustable parameters. The numerical results show that the optimal homotopy analysis method gives reliable algorithm for analytic approximate solutions of these systems. The error analysis of the sequence of the analytic approximate solutions has been performed by computing the residual error functions and the maximal residual error parameters, which demonstrate an approximate exponential rate of convergence.

1 Introduction

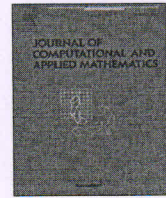
In practical life, there are many phenomena in chemistry, mechanics, biology, physics, chemical engineering and fluid dynamics can be represented by either linear or nonlinear

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Haar wavelet collocation method for Lane–Emden equations with Dirichlet, Neumann and Neumann–Robin boundary conditions

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ABSTRACT

In this paper, we present a numerically stable algorithm based on the Haar wavelet collocation method (hwcm) for numerical solution of a class of Lane–Emden equation with Dirichlet, Neumann and Neumann–Robin type boundary conditions, arising in various physical models. The Haar wavelet collocation method uses simple box functions and hence the formulation of the numerical algorithm is straightforward. Unlike other methods, the hwcm can be applied easily and accurately to the Neumann type boundary conditions. The advantage of the Haar wavelet method is its efficiency and simple applicability for a variety of boundary conditions. The Haar wavelet collocation method is utilized to reduce the Lane–Emden equation with boundary conditions to a system of algebraic equations, then the Newton's method is employed for numerical solutions. Nine examples of the Lane–Emden equation with various types of boundary conditions are provided to demonstrate the accuracy and efficiency of the hwcm. The numerical results are compared with the results obtained by other techniques and the exact solution.

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1. Introduction

In astrophysics, the Lane–Emden equation is a dimensionless form of Poisson's equation for the gravitational potential of a Newtonian self-gravitating, spherically symmetric, polytropic fluid. The Lane–Emden equation [1–4] of shape factor α reads

$$y''(x) + \frac{\alpha}{x}y'(x) + f(x, y(x)) = 0, \quad x \in (0, 1). \quad (1.1)$$

In this paper, the Haar wavelet collocation method is presented for solving the Lane–Emden equation (1.1) with Dirichlet, Neumann, and Neumann–Robin boundary conditions as:

$$y(0) = \alpha_1, \quad y(1) = \beta_1, \quad (1.2)$$

$$y'(0) = \alpha_2, \quad y'(1) = \beta_2, \quad (1.3)$$

$$y'(0) = 0, \quad \alpha_3 y(1) + \beta_3 y'(1) = \gamma_3, \quad (1.4)$$

where $\alpha_i, \beta_i, i = 1, 2, 3$ and γ_3 are real constants. We assume the following conditions on $f(x, y)$:

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A mathematical model to investigate the impact of overgrowing population-induced mining on forest resources

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Abstract Here, we develop a mathematical model which investigates the impact of growing population and rampant mining on forest resources, present in an urban region. In order to demonstrate the effect imposed by the overgrowing population on the environment, population pressure is incorporated in the model, which augments mining activities in the given region. The obtained model is studied qualitatively using stability theory of differential equations, while it is quantitatively analyzed through numerical simulation. The results of the model reveal that a whopping increase in unchecked mining activities, induced through excessive population growth, leads to declination of forest resources in a region. Therefore, sustainable mining is suggested through control measures imposed by the government on mining activities.

Keywords Forest resources · Population pressure · Mining · Qualitative analysis · Stability · Quantitative analysis

1 Introduction

Mining industry is an important segment of any country's economy and plays a significant role in the economic development of any country. While generating employment, mining also produces huge profits to the companies that own it (Das 2013; Mckinsey and Company, Inc 2014). In fact, Indian mining industry is a major mineral producer globally (Corporate Catalyst India 2013) and it is a big source of revenue for the government (India Brand Equity Foundation (IBEF) 2015). In India, Jharkhand is a mining state blessed with the natural gift of immense mineral resources, where, with advancement of technology,

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Modeling the effects of environmental pollution intensified by urbanization on human population

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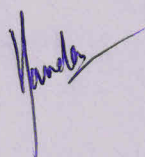
Published 10 March 2016

A mathematical model is presented here to investigate the effects of environmental pollution, intensified by urbanization, on the density of human population. Here, urbanization is assumed to grow with constant rate and also, induced through growing population and the corresponding population pressure. The model analysis, qualitatively and numerically, show that though the growth of population or population pressure is responsible for the growing urbanization, but for very large increase of urbanization, the population may not survive in the long run due to environmental pollution driven by urbanization.

Keywords: Pollution; population; urbanization; population pressure; stability; numerical analysis.

1. Introduction

All the major problems that confront the environment today in some critical way related to population growth and therefore population growth is one of the serious global problems. According to UN report,¹ the current world population is anticipated to increase from 7.2 billion to 9.6 billion by 2050. This rapid population growth emerges the need for the expansion of human activities, destruction of forests, establishment of industries, etc. and ultimately, leads to expansion of cities. The general demographic processes by which cities are expanding are referred as urbanization.² Population often requires urbanization for both cultural and economic development, because urbanization is the integral part of economic development.³ It brings lots of challenges, like urban settlement of growing population, high population density, increasing industrialization, high rise buildings and increased vehicular movement. Uncontrolled urbanization can lead to several kinds of negative consequences⁴ and environmental degradation is one of them. Due



Modeling the impact of migrated population on human-to-human transmission of Ebola virus disease

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A nonlinear SEIR mathematical model is developed to investigate the impact of migrated population, infected with Ebola virus, on human-to-human transmission of Ebola Virus Disease (EVD) in a disease-free area. In view of the dynamics of Ebola virus disease, here, the infected class is supposed to be divided into subclasses, viz. primary and secondary infected. The proposed model is analyzed qualitatively using the stability theory of differential equations and quantitatively using numerical simulation. The obtained results, qualitatively and quantitatively, suggest that migration and contact rates play an important role in controlling the spreading of disease. Critical values for migration and contact rates are evaluated and it is revealed that if these rates go beyond their critical values, it leads to delay in the stabilization of the system. It is also found that primary reproductive number increases with increase in migration rate. Besides this, the approximate time required to attain stability of the disease model system is also determined. The model analysis recommends quarantining the noninfected from the secondary infected in order to control the spreading out of disease.

Keywords: Mathematical model; primary infected; secondary infected; migration; Ebola virus; qualitative analysis; quantitative analysis.


1. Introduction

Rapidly increasing population and excessive environment degradation contribute a lot to world disease problems. However, the spread of infectious diseases like AIDS, tuberculosis, swine flu, etc. is also affected due to migration and urbanization. Increasing population densities and migration ease the transmission of infections and vulnerability to diseases. Recently, Ebola virus disease outbreak in West Africa

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A nonlinear mathematical model investigating the sustainability of an urban system in the presence of haphazard urban development and excessive pollution

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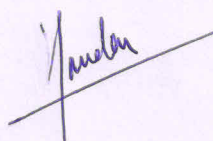
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Abstract

The study investigates the sustainability of an urban system in the presence of haphazard urban development taking place in cities, through the use of nonlinear model system of differential equations. Here, the urban system comprises of urban forests and population, along with different development activities and associated pollution. In addition to equilibrium points and their stabilities, the qualitative behavior of the model system is also being established by determining the uniform persistence. However, quantitative behavior is being predicted through numerical solutions of the model system. The obtained behaviors demonstrate that unplanned development and its associated excessive pollution can disturb the stability of the urban system. It is also being revealed that overexploitation of forest resources by population and devastation of forest resources, as well as of population, through pollutants concentration may also pose a serious threat for a sustainable urban system in the long time.

Recommendations for Resource Managers

- The sustainability of an urban system in the presence of haphazard development activities and excessive pollution is a matter of great concern as it may lead to extinction of urban forests as well as of urban population.



A MATHEMATICAL MODEL TO STUDY THE IMPACT OF MINING ACTIVITIES AND POLLUTION ON FOREST RESOURCES AND WILDLIFE POPULATION

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In this paper, we develop a nonlinear mathematical model that investigates the impact of mining activities and pollution on forest resources and wildlife population. It is assumed that concentration of pollutants grows in the environment at a constant rate and also augments due to different mining activities prevailing in the forest area. The model is formulated in terms of differential equations and analyzed using elements of stability theory and numerical simulation. The obtained results depict that both forest resources as well as wildlife population get very much affected, either directly or indirectly, due to mining activities and environmental pollution. It is being concluded that, in order to save forests, an ecological balance is required to be maintained among forest resources, forest-dependent wildlife population, mining activities and environmental pollution.

Keywords: Forest Resources; Wildlife Population; Mining Activities; Pollution; Stability; Simulation.


1. Introduction

Minerals constitute the backbone of economic growth of any nation and India has long been recognized as a nation enriched with this gift of nature. India ranks fourth in mineral production and mining sector contributes about 2% to India's GDP as per the report provided by FICCI.¹ Mining is a profitable activity which promotes the development of a nation, but could lead to deforestation and environment degradation. Today, uncontrolled mining for iron ore, both legal and illegal, is destroying not just the forests, but also the wildlife. In the process of mining, fine particles of ores spread as a uniform layer of dust on every available surface in these areas. The state of Jharkhand in India, which is endowed with diverse mineral resources and vast forest cover area, is also facing significant impact of mining

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A mathematical model studying the survival of forest resource-dependent wildlife population in the presence of population pressure-induced mining activities

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Abstract

Keeping human-wildlife conflicts in mind, that are taking place as a result of shrinking forest area due to overgrowing human population and consequently, due to augmentation of mining projects in the forest region, here, a nonlinear mathematical model is developed. The model is formulated under the assumption that continuously growing human population and its increasing demands impose population pressure on the environment, which results into augmentation of mining activities in the forest region. The model is analyzed qualitatively for boundedness, existence, and stability of equilibrium points, along with permanence of the model system. Quantitative analysis is also being performed by evaluating the numerical solutions of the model and analyzing them through graphical illustrations. The model analysis demonstrates that in order to have permanent model system, the growth of forest resources should be large as compared to their utilization for wildlife and human population.

KEYWORDS

forest resources, Holling type-II, human population, mining activities, permanence, stability, wildlife population



RESEARCH ARTICLE

Universally composable issuer-free adaptive oblivious transfer with access policy

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ABSTRACT

In today's Internet world, *security*, *privacy* and *efficiency* are three prime concerns in designing any cryptographic protocol. *Adaptive oblivious transfer with access policy* (AOT-AP) is widely used in oblivious search of privacy preserving databases in which each message is associated with an access policy and only authorized receivers can access the databases. All the existing AOT-AP protocols assume a trusted third party called issuer apart from a sender and multiple receivers and are secure under the restriction that the issuer never colludes with a collection of receivers. We propose the *first issuer-free* AOT-AP in *universal composable* (UC) framework. Our issuer-free AOT-AP is UC secure under standard assumptions assuming malicious adversary in static corruption model. More interestingly, our scheme exhibits significant improvements over the existing schemes. Copyright © 2015 John Wiley & Sons, Ltd.

KEYWORDS

Oblivious transfer; access policy; attribute based encryption; universal composable framework; non-interactive zero knowledge proofs

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1. INTRODUCTION

Internet users do not want to disclose their personal data, while adaptive oblivious search of large databases such as medical database, patent database, DNA database, and so on; at the same time, they want their interactions to be secure. Although users believe that small information do not reveal too much about them, but a malicious attacker can aggregate the collected information and identify the user. During the accession of large databases, following properties should be addressed to achieve secure and private interactions between a sender, who holds a database of N messages, and a receiver, who wants to get k of these messages.

- Only authorized receiver can access the database.
- The sender does not learn anything about the receiver's personal information.
- The sender does not know about the contents accessed by the receiver.

Adaptive oblivious transfer with access policy (AOT-AP) is a solution to such type of privacy and security problems. It executes between a sender, an issuer, and multiple receivers. The sender, who holds a database of N

messages, publishes encrypted database of N ciphertexts under their respective access policies. An authorized receiver, who carries an attribute set w , obtains attribute secret key ASK corresponding to w by interacting with the issuer and decrypts the desired ciphertext correctly using ASK if w satisfies the access policy associated with the message.

Rabin [1] introduced the basic 1-out-of-2 OT (OT_1^2) protocol in which a receiver gets exactly one of the two messages of its choice. The OT_1^2 was generalized to 1-out-of- N OT (OT_1^N) by Even *et al.* [2] and Brassard *et al.* [3]. Using projective hash framework of Cramer and Shoup [4], Tauman [5] presented an efficient OT_1^2 . Because of frequent use of OT protocols in the construction of secure multiparty protocols, researchers subsequently extended OT_1^N to *non-adaptive* k -out-of- N OT (OT_k^N) protocol and *adaptive* $k \times 1$ -out-of- N OT ($OT_{k \times 1}^N$) protocol. In OT_k^N , a receiver simultaneously gets any k messages out of N messages of its choice, whereas in $OT_{k \times 1}^N$, a receiver obtains one message at a time and learns all the k messages in adaptive manner. Naor and Pinkas [6] designed the *first* OT_k^N and $OT_{k \times 1}^N$ protocols. In literature, there is a wide range of OT protocols [7–11]. The security of the aforementioned OT protocols were proven in simulation-based model in which simulator uses adversarial rewinding

RESEARCH ARTICLE

Efficient oblivious transfer with adaptive queries in UC framework[†]

Vandana Guleria* and Ratna Dutta

Department of Mathematics, Indian Institute of Technology Kharagpur, Kharagpur -721302, India

ABSTRACT

We propose two efficient universally composable *adaptive k-out-of-N* ($OT_{k \times 1}^N$) protocols, secure in the presence of malicious adversary in static corruption model under the Decision Linear and q -Strong Diffie–Hellman assumptions. Our second scheme additionally requires the hardness of Decision Bilinear Diffie–Hellman problem. Non-interactive Groth–Sahai proofs are employed for the verification of pairing product equations. More interestingly, our first scheme facilitates the receiver to verify the correctness of messages recovered. The proposed protocols exhibit significant computational and communication efficiency compared with existing similar schemes in the literature. Copyright © 2016 John Wiley & Sons, Ltd.

KEYWORDS

oblivious transfer; universally composable security; Groth–Sahai proofs

***Correspondence**Vandana Guleria, Department of Mathematics, Indian Institute of Technology Kharagpur, Kharagpur - 721302, India.
E-mail: vandana.math@gmail.com**1. INTRODUCTION**

Oblivious transfer (OT) is a widely used primitive in cryptography. It is a useful ingredient in the construction of secure two-party and multiparty computation [1] in which the parties jointly compute a function in a secure manner. The OT protocol is a two-party protocol where at the beginning of the protocol one party, the sender, has input, and at the end of the protocol, the other party, the receiver, learns some information of the input in such a way that sender does not know which information is learnt by the receiver. Efficiency is a major concern in designing OT protocols, which includes the number of rounds, computation, and communication overheads. The computation overhead is measured by counting the number of pairing and exponentiation operations, which are the most expensive operations as compared with addition and multiplication. The communication overhead is calculated by counting the number of elements transferred from one party to another and vice-versa. Security is another crucial factor. The OT protocols are broadly classified as follows.

- (i) *1-out-of-2* OT (OT_1^2) protocol is a two-party protocol, where a sender with two messages m_0, m_1

interacts with a receiver with input $\sigma \in \{0, 1\}$ in such a way that the receiver learns exactly one message m_σ and the sender learns nothing at all.

- (ii) *1-out-of-N* OT (OT_1^N) protocol is a generalization of OT_1^2 where a sender has N messages m_1, m_2, \dots, m_N , and a receiver with input $\sigma \in \{1, 2, \dots, N\}$ learns 1 out of the N messages, that is, m_σ .
- (iii) In *non-adaptive k-out-of-N* OT (OT_k^N) protocol, a sender has N messages m_1, m_2, \dots, m_N , and a receiver learns exactly k out of N messages in a non-adaptive manner. The receiver simultaneously learns any k out of the N messages.
- (iv) In *adaptive k × 1-out-of-N* OT ($OT_{k \times 1}^N$) protocol, a receiver learns k out of the N messages in an adaptive manner. The $OT_{k \times 1}^N$ consists of one *initialization phase* in which the sender encrypts the messages m_1, m_2, \dots, m_N , and k *transfer phases* in each of which the receiver interacts with the sender and recovers 1 of the k messages $m_{\sigma_1}, m_{\sigma_2}, \dots, m_{\sigma_k}$, $\sigma_j \in \{1, 2, \dots, N\}$, of its choice, where $j = 1, 2, \dots, k$. In adaptive setting, the receiver may learn $m_{\sigma_{j-1}}$ before deciding on σ_j .

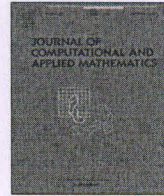
We can summarize the four aforementioned OT protocols into only two types OT protocols— OT_k^N and $OT_{k \times 1}^N$.

[†] The preliminary version of the paper is published in ISPEC'14



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Haar wavelet collocation method for Lane–Emden equations with Dirichlet, Neumann and Neumann–Robin boundary conditions

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1. Introduction

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$$y(0) = \alpha_1, \quad y(1) = \beta_1, \quad (1.2)$$

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$$y'(0) = 0, \quad \alpha_3 y(1) + \beta_3 y'(1) = \gamma_3, \quad (1.4)$$


where $\alpha_i, \beta_i, i = 1, 2, 3$ and γ_3 are real constants. We assume the following conditions on $f(x, y)$:

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	 http://dx.doi.org/10.5755/j01.itc.48.1.17270	

An Authentication Framework for Roaming Service in Global Mobility Networks

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In global mobility networks (GLOMONET), to provide secure and privacy-preserving communication among authorized mobile users in roaming services is not an easy task. To achieve authorized communication, mutual authentication is performed among legal users in GLOMONET. Therefore, security as well as privacy should be addressed in designing the security protocols for GLOMONET. In recent years, most of the research work is focused on one-way authentication and does not have desirable security attributes. In this paper, we discuss the development of authentication protocol for GLOMONET. To address security and privacy issues in authorized communication, we proposed a provably secure authentication protocol for GLOMONET. To identify the resistance against known attacks, we have analyzed the scheme against all known attacks. The comparative study on the security and performance with the related results manifests that the proposed scheme addresses the security and privacy challenges and avails comparable performance.

KEYWORDS: Global mobility networks, authentication, anonymity, untraceability, security.

DART algorithm for constrained optimisation with applications in suspension design

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Abstract: We propose a new hybrid algorithm with application of suspension designs problem. The algorithm is based on divide-and-rule technique (DART) governed by artificial bee colony (ABC) algorithm. A divide phase splits the search region into subregions of smaller size and a ruling phase allows bees to rule over the selected subregion and look for a new region with best food source. The DART process is recursively applied to discover higher fitness subregion producing the optimal solution to the problem. Moreover, a new search strategy has been implemented to bias the bees towards feasible solution. A suspension problem has been formulated as a nonlinear constrained optimisation problem where the weighted sum of sprung mass jerks and their deflections are minimised under technological constraints. By the proposed algorithm the optimal passive suspension parameters have been obtained from the half car model to minimise the level of vibration and enhance passengers comfort. Moreover, the results obtained by model simulations with existing and optimised suspension parameters are compared.

Keywords: suspension; half car; optimisation; bee colony algorithm; ISO 2631 standards.

Reference to this paper should be made as follows: Jabeen, S.D., Mukherjee, R.N. and Saha, J. (2019) 'DART algorithm for constrained optimisation with applications in suspension design', *Int. J. Heavy Vehicle Systems*, Vol. 26, No. 2, pp.136–157.



Multi-section-Oriented Robust Algorithm for Unconstrained Global Optimization

Syeda Darakhshan Jabeen^{1,2}

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Abstract

We develop a new hybrid method called multi-section-oriented artificial bee colony MSO-ABC algorithm, to solve complex unconstrained optimization problems. The method initially decomposes the search region into finite collection of subregions in which the best interval value of the objective function is found using ABC algorithm. ABC algorithm uses chaotic maps to express parameter adaption to improve the search performance and escape from local optima. Then, interval ranking rule defined with respect to the optimistic decision makers' point of view is applied to find most promising subregion containing best objective value for further division and non-promising region(s) are discarded. The technique narrows the search region by recursive decomposition and enhances computational effort toward better solution. The process is repeated reducing the search space consecutively. The global/ close to global values are obtained in the form of an interval with negligible width. Validity of MSO-ABC is tested on benchmark functions followed by the non-parametric tests viz., Friedman and Wilcoxon rank test for assessing statistical significance of the proposed method against other well-established optimization methods.

Keywords Interval analysis · Heuristic · Global optimization · Artificial bee colony algorithm · Unconstrained optimization

1 Introduction

Optimization problems arise naturally to any problems involving decision making, whether in engineering or economics. Most of these problems are multimodal, non-differentiable, nonlinear and non-convex objective function with domain non-convex in nature. So, it is very challenging to find the global solution of these problems. To solve such type of complex optimization problems, one may apply the faster search techniques like; traditional gradient based iterative methods. However, these methods have some difficulties, like, these methods are dependent on the initial guess, converge to the nearest local optima from the initial guess and require the derivative information of the objective function or constraints. To address these issues researchers are motivated toward developing intelligent optimization algorithms based on behavior of social creatures like; ants, bees, birds, fishes, etc. called ant colony opti-

mization (ACO) [1], artificial bee colony (ABC) algorithm [2], particle swarm optimization (PSO) [3], and artificial fish swarm algorithm (AFSA) [4]. All these swarm intelligence-based algorithms are probabilistic algorithms and require common controlling parameters like population size, number of generations, elite size, etc. Besides common control parameters, different algorithms require their own algorithm-specific control parameters. For example, PSO uses inertia weight, social and cognitive parameters; ABC uses the number of onlooker bees, employed bees, scout bees and limit. Similarly, the other algorithms such as ACO, AFSA etc. need the tuning of respective algorithm-specific parameters. The proper tuning of the algorithm-specific parameters is a very crucial factor which affects the performance of the above-mentioned algorithms. The improper tuning of algorithm-specific parameters either increases the computational effort or yields the local optimal solution. Considering this fact, to improve the computation efficiency, the precision of the final solutions and avoid premature convergence, researchers, usually enhance the performance of their algorithms by the integration of new and efficient techniques that improve the search mechanism or merge other algorithms or local search methods with their algorithm to form hybrid algorithms. For example, author in [5] introduced a

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SPLIT AND DISCARD STRATEGY: A NEW APPROACH FOR CONSTRAINED GLOBAL OPTIMIZATION

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In this paper we develop a new hybrid algorithm incorporating the penalty function technique for solving nonlinear constrained optimization problems. The principle is based on converting the constrained optimization problem into an unconstrained optimization problem by the penalty function technique. Then, we have proposed a new penalty technique, called Big-M penalty that is different from the existing ones. Accordingly, a hybrid algorithm has been developed based on Split and Discard Strategy (SDS) and advanced real coded genetic algorithm (ARCGA), with tournament selection, multiparent whole arithmetical crossover, double mutation (boundary and whole nonuniform mutation) and elitism. In SDS technique, the entire search space is divided into two equal subregions. Then the one containing the feasible solution with better fitness value is selected. This process is repeated until the accepted subregion reduces to a very small region with negligible edges. Finally, to test the performance of the proposed method along with three different penalty function techniques, it is applied to several well-known benchmark test problems available in the literature.

Keywords: Global optimization; genetic algorithm; hybrid genetic algorithm; penalty function; constrained optimization.

1. Introduction

As most of the practical problems are constrained optimization problems, determining their solution strategies is a crucial task to the researchers. In order to solve those optimization problems, different methods like classical search and optimization methods, heuristic methods have been developed. Among the classical search and optimization methods, the gradient-based methods are very popular. However, these methods have some limitations. This is mainly due to inherent solution mechanisms of these techniques. Solution strategies of the classical optimization methods are generally dependent on the type of optimization problem considered. In most of the

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Valuation of American passport option using a three-time level scheme

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1 Abstract

2 An American passport option whose contingent claim is dependent on the balance of a trading
3 account can be valued by solving a Hamilton–Jacobi–Bellman equation with free boundary. [1]
4 Here, we present the pricing problem for American passport option, as a sequence of linear
5 complementarity problems, using the three-time level finite difference scheme, which typ- [2]
6 ically is suitable for non-smooth payoffs and also applicable in case of large temporal grid
7 size. The option price is obtained through this scheme for the non-symmetric case (when the
8 risk-free rate is different from the cost of carry). It is observed that the numerical approach pre-
9 sented, results in solving the pricing problem using lesser number of grid points as compared
10 to numerical approaches for this problem used previously while maintaining the accuracy of [3]
11 the prices obtained.

12 **Keywords** American passport option · Linear complementarity problems · Three-time level
13 scheme

14 1 Introduction

15 We consider the problem of pricing passport option, with the contingent claim being depen-
16 dent on the balance of a trading account, driven by the price $S(t)$, of a traded asset Hyer et al.
17 (1997), Andersen et al. (1998), Topper (2003) and follows the process,

$$18 \quad dS(t) = (\mu - \gamma)S(t)dt + \sigma S(t)dW(t).$$

19 Here μ , γ , σ and $W(t)$ denote the drift, cost of carry, volatility and Wiener process, respec-
20 tively, in a risk-neutral world (with the risk-neutral probability measure \mathbb{P}^*), where the drift is
21 identical to the risk-free rate of return, r . The continuous accumulated gain process Andersen
22 et al. (1998) is given by

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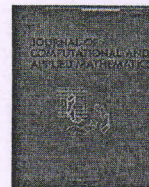
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Pricing and estimates of Greeks for passport option: A three time level approach



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ABSTRACT

We consider the problem of pricing the European type passport option (contingent on the balance on a trading account), for which, a closed form solution exists in the symmetric case, when the riskfree rate is identical to the cost of carry. However, in absence of an explicit solution for the nonsymmetric case, we need to resort to numerical methods in order to solve the corresponding valuation partial differential equation (PDE), in addition to evaluating the first and second derivative, since the optimal holding strategy is dependent on the Greeks, Delta and Gamma, respectively. It has been observed that classical schemes like the two time level Crank Nicholson scheme, is not particularly appropriate for the passport option pricing problem, unless a large number of appropriate time steps are used. This can be attributed to the nonsmooth initial data resulting in small oscillatory errors in the solution. In this article, we address these issues by resorting to the three time level finite difference scheme which can be implemented with larger time steps, without compromising on the accuracy of the price and the Greeks, namely, Delta, Gamma and Theta. We derive these Greeks for the passport option in the symmetric case. The key result is the improvement in the evaluation of the price of the option as well as estimation of these Greeks, with significantly better results being observed near zero accumulated gain, by using the three time level scheme as compared to the Crank Nicholson scheme in the symmetric case. Finally, the three time level scheme is extended to estimate the price and the Greeks in the nonsymmetric case.

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1. Introduction

Hyer et al. [1] introduced passport option, that allows the holder to adopt a trading strategy involving securities, while being compensated for the losses resulting from the adoption of such a strategy. Further, the authors [1] derived a partial differential equation (PDE) for the valuation of passport option, using results from stochastic control theory, and obtained the analytic solution in the symmetric case, where the riskfree rate is identical to the cost of carry. Andersen et al. [2] also derived the analytic solution for the symmetric case through *Laplace transform* and presented the numerical results for the nonsymmetric and discrete case, as well as the American option. The absence of a closed form solution in the nonsymmetric case has resulted in the adoption of numerical approaches to this valuation problem. Chan [3] studied the American passport option as a linear complimentary problem and solved the system resulting from the Crank Nicholson scheme, making use of the complimentary solver PATH [4]. A finite element approach was used by Topper [5] to obtain the approximate solution to the problem in addition to computing the hedge parameters. Ahn et al. studied passport options with discrete

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Valuation of American passport option using a three-time level scheme

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Abstract

An American passport option whose contingent claim is dependent on the balance of a trading account can be valued by solving a Hamilton–Jacobi–Bellman equation with free boundary. Here, we present the pricing problem for American passport option, as a sequence of linear complementarity problems, using the three-time level finite difference scheme, which typically is suitable for non-smooth payoffs and also applicable in case of large temporal grid size. The option price is obtained through this scheme for the non-symmetric case (when the risk-free rate is different from the cost of carry). It is observed that the numerical approach presented, results in solving the pricing problem using lesser number of grid points as compared to numerical approaches for this problem used previously while maintaining the accuracy of the prices obtained.

Keywords American passport option · Linear complementarity problems · Three-time level scheme

1 Introduction

We consider the problem of pricing passport option, with the contingent claim being dependent on the balance of a trading account, driven by the price $S(t)$, of a traded asset Hyer et al. (1997), Andersen et al. (1998), Topper (2003) and follows the process,

$$dS(t) = (\mu - \gamma)S(t)dt + \sigma S(t)dW(t).$$

Here μ , γ , σ and $W(t)$ denote the drift, cost of carry, volatility and Wiener process, respectively, in a risk-neutral world (with the risk-neutral probability measure \mathbb{P}^*), where the drift is identical to the risk-free rate of return, r . The continuous accumulated gain process Andersen et al. (1998) is given by

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Further results on Erdős–Faber–Lovász conjecture

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Abstract

In 1972, Erdős–Faber–Lovász (EFL) conjectured that, if \mathbf{H} is a linear hypergraph consisting of n edges of cardinality n , then it is possible to color the vertices with n colors so that no two vertices with the same color are in the same edge. In 1978, Deza, Erdős and Frankl had given an equivalent version of the same for graphs: Let $G = \bigcup_{i=1}^n A_i$ denote a graph with n complete graphs A_1, A_2, \dots, A_n , each having exactly n vertices and have the property that every pair of complete graphs has at most one common vertex, then the chromatic number of G is n .

The clique degree $d^K(v)$ of a vertex v in G is given by $d^K(v) = |\{A_i : v \in V(A_i), 1 \leq i \leq n\}|$. In this paper we give a method for assigning colors to the graphs satisfying the hypothesis of the Erdős–Faber–Lovász conjecture and every A_i ($1 \leq i \leq n$) has at most $\frac{n}{2}$ vertices of clique degree greater than one using Symmetric latin Squares and clique degrees of the vertices of G .

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Keywords: Chromatic number; Erdős–Faber–Lovász conjecture; Symmetric latin square

1. Introduction

One of the famous conjectures in graph theory is Erdős–Faber–Lovász conjecture. It states that, if \mathbf{H} is a linear hypergraph consisting of n edges of cardinality n , then it is possible to color the vertices of \mathbf{H} with n colors so that no two vertices with the same color are in the same edge [1]. Erdős, in 1975, offered 50 USD [2,3] and in 1981, offered 500 USD [3,4] for the proof or disproof of the conjecture.

Vance Faber quoted: “In 1972, Paul Erdős, László Lovász and I got together at a tea party in Colorado. This was a continuation of the discussions we had a few weeks before in Columbus, Ohio, at a conference on hypergraphs. We talked about various conjectures for linear hypergraphs analogous to Vizing’s theorem for graphs. Finding tight bounds in general seemed difficult, so we created an elementary conjecture that we thought that it would be easy to prove. We called this the n sets problem: given n sets, no two of which meet more than once and each with n elements, color the elements with n colors so that each set contains all the colors. In fact, we agreed to meet the next day to write down the solution. Thirty-Eight years later, this problem is still unsolved in general”.

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A method to solve linear programming problem with interval type-2 fuzzy parameters

Pradip Kundu¹ · Saibal Majumder² · Samarjit Kar³ · Manoranjan Maiti⁴

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Abstract In this paper, we propose a method to solve linear programming network problems with constraints using interval type-2 fuzzy variables. The method is developed using generalized credibility measure, and lower and upper membership functions of an interval type-2 fuzzy variable. This method has been applied to solve a solid transportation problem with availabilities and demands of a product, and conveyance capacities, which are represented by trapezoidal interval type-2 fuzzy variables. Moreover, we have also shown that different types of problems with objective function having interval type-2 fuzzy parameters can be solved using the proposed method. Apart from a solid transportation problem, we demonstrate its applicability by solving two different network problems: (i) a shortest path problem and (ii) a min-

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Uncertain multi-objective multi-item fixed charge solid transportation problem with budget constraint

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Abstract

Modeling of real-world problems requires data as input parameter which include information represented in the state of indeterminacy. To deal with such indeterminacy, use of uncertainty theory (Liu in Uncertainty theory, Springer, Berlin, 2007) has become an important tool for modeling real-life decision-making problems. This study presents a profit maximization and time minimization scheme which considers the existence of possible indeterminacy by designing an uncertain multi-objective multi-item fixed charge solid transportation problem with budget constraint (UMMFSTPwB) at each destination. Here, items are purchased at different source points with different prices and are accordingly transported to different destinations using different types of vehicles. The items are sold to the customers at different selling prices. In the proposed model, unit transportation costs, fixed charges, transportation times, supplies at origins, demands at destinations, conveyance capacities and budget at destinations are assumed to be uncertain variables. To model the proposed UMMFSTPwB, we have developed three different models: (1) expected value model, (2) chance-constrained model and (3) dependent chance-constrained model using uncertain programming techniques. These models are formulated under the framework of uncertainty theory. Subsequently, the equivalent deterministic transformations of these models are formulated and are solved using three different methods: (1) linear weighted method, (2) global criterion method and (3) fuzzy programming method. Finally, numerical examples are presented to illustrate the models.

Keywords Multi-objective solid transportation problem · Profit maximization · Fixed charge · Budget constraint · Uncertain programming

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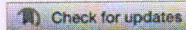
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1 Introduction

The notion of classical transportation problem (TP) is to determine an optimal solution (transportation plan) such that the transportation cost is minimized. The noteworthy work of Hitchcock (1941) introduced the term transportation problem, by modeling it as a conventional optimization problem with two dimensional properties, i.e., supply and demand. However, apart from supply and demand constraints, in real-world scenarios, often we need to consider the mode of transportation (e.g., goods train, cargo flights and trucks), types of goods, etc. Under such circumstances, a TP is extended to a solid transportation problem (STP), where apart from source and destination constraints, an additional constraint, related to the modes of transportation (convenience) or types of goods, is considered. Schell (1955) first extended the classical TP to solid transportation problem (STP). Later, Bhatia et al. (1976) minimized the shipping time of an STP. Afterward, Jiménez and Verdegay (1999), in their work, dealt



Reliability study of proportional odds family of discrete distributions

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ABSTRACT

The proportional odds model gives a method of generating new family of distributions by adding a parameter, called tilt parameter, to expand an existing family of distributions. The new family of distributions so obtained is known as Marshall–Olkin family of distributions or Marshall–Olkin extended distributions. In this paper, we consider Marshall–Olkin family of distributions in discrete case with fixed tilt parameter. We study different ageing properties, as well as different stochastic orderings of this family of distributions. All the results of this paper are supported by several examples.

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KEYWORDS

Marshall–Olkin extended distribution; stochastic ageing; stochastic orders.

MATHEMATICS SUBJECT CLASSIFICATION

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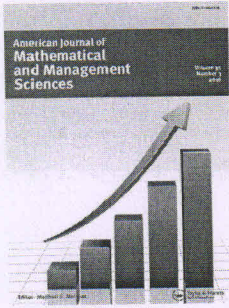
1. Introduction

Since the work of Bennett (1983) and Pettitt (1984) on the proportional odds (PO) model in the survival analysis context, it has been used by many researchers. The assumption of constant hazard ratio is unreasonable in many practical cases as discussed by Bennett (1983), Kirmani and Gupta (2001) and Rossini and Tsiatis (1996). The PO model has been used by Bennett (1983) to demonstrate the effectiveness of a cure, when the mortality rate of a group having some disease approaches that of a (disease-free) control group as time progresses. After Bennett's (1983) work, the PO model has found many practical applications, see, for instance, Collett (2003), Dinse and Lagakos (1983), Pettitt (1984), and Rossini and Tsiatis (1996). Let X and Y be two random variables with distribution functions $F(\cdot)$, $G(\cdot)$, survival functions $\bar{F}(\cdot)$, $\bar{G}(\cdot)$, probability density functions $f(\cdot)$, $g(\cdot)$ and hazard rate functions $r_X(\cdot) = f(\cdot)/\bar{F}(\cdot)$ and $r_Y(\cdot) = g(\cdot)/\bar{G}(\cdot)$, respectively. Let the odds functions of X and Y be given, respectively, by $\theta_X(t) = \bar{F}(t)/F(t)$ and $\theta_Y(t) = \bar{G}(t)/G(t)$. The random variables X and Y are said to satisfy PO model with proportionality constant α if $\theta_Y(t) = \alpha\theta_X(t)$. For more discussion on PO models one may refer to Kirmani and Gupta (2001). It is observed that, in terms of survival functions, the PO model can be represented as

$$\bar{G}(t) = \frac{\alpha\bar{F}(t)}{1 - \alpha\bar{F}(t)} \quad (1.1)$$

where $\bar{\alpha} = 1 - \alpha$, $0 < \alpha < \infty$. From the above representation we have

$$\frac{r_Y(t)}{r_X(t)} = \frac{1}{1 - \alpha\bar{F}(t)} = \frac{G(t)}{F(t)}$$



Some Reliability Properties of Transformed-Transformer Family of Distributions

Nil Kamal Hazra, Pradip Kundu & Asok K. Nanda

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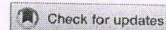
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On inertial proximal algorithm for split variational inclusion problems

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ABSTRACT

In this paper, a hybrid proximal algorithm with inertial effect is introduced to solve a split variational inclusion problem in real Hilbert spaces. Under mild conditions on the parameters, we establish weak convergence results for the proposed algorithm. Unlike the earlier iterative methods, we do not impose any conditions on the sequence generated by the proposed algorithm. Also, we extend our results to find a common solution of a split variational inclusion problem and a fixed-point problem. Finally, some numerical examples are given to discuss the convergence and superiority of the proposed iterative methods.

ARTICLE HISTORY

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KEYWORDS

Split variational inclusion problem; inertial method; weak convergence; resolvent mapping; fixed-point problem

1. Introduction

Let H_1 and H_2 be two real Hilbert spaces with inner product $\langle \cdot, \cdot \rangle$ and norm $\| \cdot \|$. In an excellent paper [1], Moudafi proposed the split variational inclusion problem in the following way:

$$(SVIP) \text{ find } x^* \in H_1 \text{ such that } 0_{H_1} \in B_1(x^*) \text{ and } 0_{H_2} \in B_2(Ax^*), \quad (1)$$

where $B_1 : H_1 \rightarrow 2^{H_1}$, $B_2 : H_2 \rightarrow 2^{H_2}$ are two set-valued maximal monotone mappings and $A : H_1 \rightarrow H_2$ is a bounded linear operator. Here, 0_{H_1} and 0_{H_2} denote the zero elements of the Hilbert spaces H_1 and H_2 , respectively. For simplicity, we use the notation 0 . Split zero problem, split equilibrium problem, split variational inequality problem and split feasibility problem [2–19] are the special cases of the (SVIP) (1). These problems have been studied and employed in practice as a model in intensity-modulated radiation therapy treatment planning, in modelling of inverse problem [20,21], and in many real-life problems such as sensor networks in computerized tomography and data compression [4,22]. In 2011, Byrne et al. [23] stated the following convergence theorem to study split variational inclusion problem (1).

Theorem 1.1 ([23]): *Let H_1 and H_2 be two real Hilbert spaces, $A : H_1 \rightarrow H_2$ be a bounded linear operator, and A^* denotes the adjoint of A . Let $B_1 : H_1 \rightarrow 2^{H_1}$ and $B_2 : H_2 \rightarrow 2^{H_2}$ be two set-valued maximal monotone operators, $\beta_n > 0$ and $\gamma \in (0, 2/\|A\|^2)$. Let Ω denotes the solution set of (SVIP), and suppose that $\Omega \neq \emptyset$. Let the sequence $\{x_n\}$ be defined by*

$$x_{n+1} = J_{\beta_n}^{B_1} [x_n - \gamma A^* (I - J_{\beta_n}^{B_2}) Ax_n], \quad n \in \mathbb{N}.$$

Then, $\{x_n\}$ converges weakly to a solution $x^* \in \Omega$.

Later, Chuang [24] introduced the following strong convergence theorem in the context of (SVIP).

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A modified iterative method for capturing a common solution of split generalized equilibrium problem and fixed point problem

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Abstract A new iterative method is proposed based on hybrid viscosity approximation method and hybrid steepest-descent method to approximate a common solution of a split generalized equilibrium problem and a fixed point problem of a finite collection of nonexpansive mappings. We prove that the sequences generated by the iterative scheme converges strongly to a common solution of the above said problems. Applications and numerical results are also given to illustrate the effectiveness and superiority of the proposed algorithm.

Keywords Nonexpansive mapping · Averaged mapping · Split generalized equilibrium problem · Strong convergence · Variational inequality problem · Fixed point problem

Mathematics Subject Classification 47H10 · 49J40

1 Introduction

Throughout the paper, unless otherwise stated, let H_1 and H_2 be two real Hilbert spaces with inner product $\langle \cdot, \cdot \rangle$ and norm $\| \cdot \|$. Let C and Q be two nonempty closed and convex subset of H_1 and H_2 , respectively. Let the symbols \rightharpoonup and \rightarrow denote weak and strong convergence, respectively.

A mapping $f : H_1 \rightarrow H_1$ is said to be ρ -Lipschitzian if there exists a constant $\rho \geq 0$ such that

$$\|f(x) - f(y)\| \leq \rho \|x - y\|, \quad \forall x, y \in H_1.$$

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A hybrid viscosity iterative method with averaged mappings for split equilibrium problems and fixed point problems

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Abstract In this paper, with the help of averaged mappings, we introduce and study a hybrid iterative method to approximate a common solution of a split equilibrium problem and a fixed point problem of a finite collection of nonexpansive mappings. We prove that the sequences generated by the iterative scheme strongly converges to a common solution of the above-said problems. We give some numerical examples to ensure that our iterative scheme is more efficient than the methods of Plubtieng and Punpaeng (J. Math Anal. Appl. **336**(1), 455–469, 2007), Liu (Nonlinear Anal. **71**(10), 4852–4861, 2009) and Wen and Chen (Fixed Point Theory Appl. **2012**(1), 1–15, 2012). The results presented in this paper are the extension and improvement of the recent results in the literature.

Keywords Nonexpansive mapping · Averaged mapping · Split equilibrium problem · Strong convergence · Variational inequality problem · Fixed point problem

Mathematics Subject Classification (2010) 47H10 · 49J40

1 Introduction

Throughout the paper, unless otherwise stated, let H_1 and H_2 be two real Hilbert spaces with inner product $\langle \cdot, \cdot \rangle$ and norm $\| \cdot \|$. Let C and Q be nonempty closed and

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A Modified Iterative Method for a Finite Collection of Non-self Mappings and a Family of Variational Inequality Problems

Prashanta Majee and Chandal Nahak

Abstract. This paper deals with an iterative algorithm with the help of averaged mappings for the common solution of a fixed point problem of a finite collection of k -strictly pseudocontractive *non-self* mappings and a system of variational inequality problems in the setting of a real Hilbert space. Under some suitable conditions, the sequence generated by the proposed algorithm converges strongly to the common solution of the above said problems. Also, a numerical example is given to establish the superiority of the proposed algorithm over some existing methods.

Mathematics Subject Classification. Primary 47H10; Secondary 49J40.

Keywords. Variational inequality problem, k -strictly pseudocontractive mapping, averaged mapping, fixed point problem.

1. Introduction

Let H be a Hilbert space with inner product $\langle \cdot, \cdot \rangle$ and norm $\| \cdot \|$. Let C be a nonempty closed convex subset of H and P_C be the metric projection of H onto C . A *non-self*-mapping $T : C \mapsto H$ is said to be k -strictly pseudocontractive mapping if there exists a constant $k \in [0, 1)$ such that

$$\|Tx - Ty\|^2 \leq \|x - y\|^2 + k\|(I - T)x - (I - T)y\|^2, \quad \forall x, y \in C.$$

If $k = 0$, then T is said to be nonexpansive *non-self* mapping. For the mapping T , fixed point problem is to find $x \in C$ such that $Tx = x$. Let $Fix(T)$ denote the set of all fixed points of T .

A mapping $f : H \mapsto H$ is said to be ρ -Lipschitzian if there exists a constant $\rho > 0$ such that

$$\|f(x) - f(y)\| \leq \rho\|x - y\|, \quad \forall x, y \in H.$$

An operator $A : H \rightarrow H$ is said to be strongly positive if there exists a constant $\delta > 0$ such that

A hybrid viscosity iterative method with averaged mappings for split equilibrium problems and fixed point problems

P. Majee¹ · C. Nahak¹

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Abstract In this paper, with the help of averaged mappings, we introduce and study a hybrid iterative method to approximate a common solution of a split equilibrium problem and a fixed point problem of a finite collection of nonexpansive mappings. We prove that the sequences generated by the iterative scheme strongly converges to a common solution of the above-said problems. We give some numerical examples to ensure that our iterative scheme is more efficient than the methods of Plubtieng and Punpaeng (J. Math Anal. Appl. **336**(1), 455–469, 2007), Liu (Nonlinear Anal. **71**(10), 4852–4861, 2009) and Wen and Chen (Fixed Point Theory Appl. **2012**(1), 1–15, 2012). The results presented in this paper are the extension and improvement of the recent results in the literature.

Keywords Nonexpansive mapping · Averaged mapping · Split equilibrium problem · Strong convergence · Variational inequality problem · Fixed point problem

Mathematics Subject Classification (2010) 47H10 · 49J40

1 Introduction

Throughout the paper, unless otherwise stated, let H_1 and H_2 be two real Hilbert spaces with inner product $\langle \cdot, \cdot \rangle$ and norm $\| \cdot \|$. Let C and Q be nonempty closed and

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A modified iterative method for split problem of variational inclusions and fixed point problems

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Abstract In this paper, we study a new split problem of variational inclusions and fixed point problems. With the help of averaged mappings, we introduce a new iterative method to solve the stated split problem. Strong convergence results are obtained under mild conditions. Also, we present some preliminary numerical examples to demonstrate the convergence and efficiency of our proposed algorithms.

Keywords Nonexpansive mapping · Averaged mapping · Split variational inclusion problem · Split feasibility problem · Fixed point problem

Mathematics Subject Classification 47H10 · 49J40

1 Introduction

Let H_1 and H_2 be two real Hilbert spaces with inner product $\langle \cdot, \cdot \rangle$ and norm $\| \cdot \|$. Let C and Q be two nonempty closed and convex subset of H_1 and H_2 , respectively. A mapping $T: H_1 \rightarrow H_1$ is said to be nonexpansive if $\|Tx - Ty\| \leq \|x - y\|$, $\forall x, y \in H_1$. The set of all fixed points of T is defined as $\text{Fix}(T) = \{x \in H_1 : Tx = x\}$.

Split feasibility problem was first introduced by Censor and Elfving (1994) in the finite dimensional space, which could be formulated as follows: find $x \in H_1$ such that

$$x \in C \text{ and } Ax \in Q, \quad (1)$$

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Inertial algorithms for a system of equilibrium problems and fixed point problems

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Abstract In this paper, we introduce two new algorithms (one parallel and another sequential) with inertial effect for approximating a common solution of a system of equilibrium problems and fixed point problems. Under suitable conditions, we establish weak convergence results for the proposed algorithms. Finally, we give a numerical example to demonstrate the convergence and performance of the proposed algorithms.

Keywords Nonexpansive mapping · Averaged mapping · Equilibrium problem · Fixed point problem · Inertial method

Mathematics Subject Classification 47H10 · 90C33 · 47J20

1 Introduction

Let H be a Hilbert space and C be a nonempty closed and convex subset of H . For a bifunction $F : C \times C \rightarrow \mathbb{R}$, an equilibrium problem is defined by

$$\text{find } x \in C \text{ such that } F(x, y) \geq 0, \text{ for all } y \in C. \quad (1)$$

The solution set of the equilibrium problem is denoted by $EP(F, C)$. Numerous problems in physics, economics, game theory, optimization, etc., for instances, variational inequality problem, optimization problem, Nash equilibrium problem, saddle point problem, fixed point problem are special cases of the equilibrium problem (1) (see [12, 17] and the references therein).

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Extended new generalized mixed vector variational-like inequalities in reflexive Banach spaces

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Abstract In this paper, we introduce and study an extended new generalized mixed vector variational-like inequality (ENGMVLI) problem in real reflexive Banach spaces. This problem is more general than many existing equilibrium problems and variational inequalities available in the literature. We prove the existence results of (ENGMVLI) by utilizing the KKM lemma and Nadlar's results with relaxed semi- α -monotone mappings. Also, by using the Brouwer's fixed point theorem, we prove the existence of solutions for (ENGMVLI) without using the monotonicity concept. Finally, we give an example to justify the validity of our results.

Keywords Extended new generalized mixed vector variational-like inequalities · Relaxed semi- α -monotonicity · Fan-KKM theorem · Nadler's result · Brouwer's fixed point theorem

1 Introduction

Vector variational inequality (in short, VVI) problem is the vector valued version of variational inequality (VI) problem. In 1980, Giannessi [10] introduced this problem in the finite dimensional space setting. Subsequently this problem was generalized to infinite dimensional spaces in [18, 19]. This problem has shown to be a powerful

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Modeling of Dengue with Impact of Asymptomatic Infection and ADE Factor

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Abstract

In this paper, a nonlinear vector-host model has been proposed and analyzed for the two dengue serotypes incorporating ADE effect. The model considers that the asymptomatic infected people are more responsible for secondary infection than that of symptomatic ones and differentiates between them. The existence and stability analysis have been performed for various equilibrium states. Basic reproduction number is found to be directly proportional to ADE parameter. This means that increasing ADE parameter increases the basic reproduction number which not only enhances the severity of serotype-1 free state but also destabilizes the disease-free state. Numerical simulation has been carried out for the stability of endemic state and found to be locally stable for choice of initial conditions in its neighborhood. The persistence of disease in periodic form is also obtained for a suitable choice of data. Sensitivity analysis has been performed with respect to transmission parameters involved in basic reproduction number.

Keywords Dengue · Asymptomatic infection · ADE effect · Secondary infection · Stability · Periodicity

Introduction

Dengue is a mosquito-borne viral disease spread by *Aedes aegypti* and *Aedes albopictus* mosquitoes. It is mostly observed in tropical, subtropical and temperate areas of the world. Dengue has four closely related viruses or serotypes: DEN I, DEN II, DEN III and DEN IV. Infection with one serotype provides life-long immunity towards it but only temporary cross immunity for heterologous serotypes. Due to short life span, no recovery/immunity is considered in mosquitoes. When a person is infected by a serotype, it is called the primary infection. The symptoms of primary infection such as headaches, bone or joint pain, muscular pain, pain behind the eyes, rashes etc. have been observed in patients. When a person is reinfected by a different serotype, the secondary infection occurs and more severe complications of dengue infections are observed. In some cases this secondary infection takes the form of dengue hemorrhagic fever (DHF) or most severe dengue shock syndrome

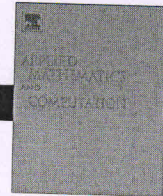
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The effects of awareness and vector control on two strains dengue dynamics



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ABSTRACT

The aim of this paper is to study the effects of awareness and mosquito control on dengue epidemic. A non-linear host-vector model has been developed to study the dynamics of primary and secondary infection in the presence of two serotypes of dengue virus. The existence and local stability of equilibrium points have been discussed. The global stability of disease-free equilibrium point has been established. The thresholds for both the serotypes have been computed. The mosquito control and awareness parameters decrease the threshold and thereby enhancing the stability of disease-free state.

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1. Introduction

Dengue fever has caught the attention of all over the world and has become the disease of important international health concern. According to the one estimate of WHO report, 2.5 billion of people are living in dengue risk area and 50 to 100 million cases of dengue occur every year [1]. During 1779–1780, the first dengue epidemic was reported from Africa, Asia and North America simultaneously. This shows the presence of mosquitoes and dengue virus for more than 200 years [2]. Dengue fever is a mosquito-borne infectious disease. The mosquitoes live mostly in the tropical and subtropical regions of the world. The *Aedes aegypti* and *Aedes albopictus* female mosquitoes are the prominent carriers of dengue virus of *Flaviviridae* family. When susceptible mosquito bites an infected person, it gets infected. The infected mosquitoes transfer infection on biting susceptible persons. The symptoms of the disease is characterized by high fever, frontal headache, pain behind the eyes, joint pains, nausea, vomiting etc. [3,4].


Dengue virus is having four serotypes denoted by DEN I, DEN II, DEN III and DEN IV. A person living in an endemic area can have as many as four dengue infections during his lifetime, one with each serotype. Infection by any dengue serotype produces lifelong immunity to the recovered individual with respect to the particular, but only temporal cross immunity to the other serotypes. The mosquitoes remain infected through its life time. The spectrum of dengue disease ranges from dengue fever (DF) to more severe dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS). The people usually recover from DF in three to seven days. Only those who experience secondary infection with an heterologous dengue serotype present DHF/DSS. In general children and older adults usually suffer from dengue fever. Most commonly children under the age of 15 and in some cases senior adults are the victims of DHF/DSS [2,4].

Some investigators have modeled the dynamics of single serotype of dengue virus [5,6]. They have analyzed the model for stability of disease-free and endemic states. Different approaches have been used for the global stability of endemic state. To study the effects of secondary infection, some investigators have incorporated the vector-host dynamics in presence of

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Stage-Structured Transmission Model Incorporating Secondary Dengue Infection

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Abstract In this paper, a non-linear stage-structured model has been formulated to study the effects of primary/secondary dengue infection on children and adults. It is assumed that a proportion of susceptible children have been previously infected by a serotype asymptotically. After recovery from asymptomatic infection, the immunity is developed for the particular serotype but they remain susceptible to heterologous serotypes. These children may get secondary infection when exposed to a different serotype. The model has two equilibrium states. Global/local stability of equilibrium states have been discussed. The stability of disease-free state changes at $R_0 = 1$. Applying the center manifold theory, the existence of forward bifurcation is possible. This concludes that the primary/secondary infection in children as well as in adults population could be eradicated for $R_0 < 1$. Numerical results are used to explore the global behavior of disease-free/endemic state for choice of arbitrary initial conditions.

Keywords Dengue · Age-structure · Center manifold · Secondary infection · Forward/backward bifurcation

Introduction

Dengue is a mosquito-borne viral disease found mostly in tropical, subtropical and temperate areas of Africa, Southeast Asia and Latin America for the last 200 years. The common symptoms of dengue fever are: headache, bone or joint pain, muscular pain, pain behind the eyes, rashes etc. The more severe complications of dengue infection occur when person is having secondary infection. In some cases this secondary infection takes the form of DHF (dengue hemorrhagic fever) or most severe DSS (Dengue shock syndrome). Clinical manifestations of DHF are: severe abdominal pain or persistent vomiting, red spots or patches

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A NETWORK MODEL FOR CONTROL OF DENGUE EPIDEMIC USING STERILE INSECT TECHNIQUE

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(Communicated by Andrei Korobeinikov)

ABSTRACT. In this paper, a network model has been proposed to control dengue disease transmission considering host-vector dynamics in n patches. The control of mosquitoes is performed by SIT. In SIT, the male insects are sterilized in the laboratory and released into the environment to control the number of offsprings. The basic reproduction number has been computed. The existence and stability of various states have been discussed. The bifurcation diagram has been plotted to show the existence and stability regions of disease-free and endemic states for an isolated patch. The critical level of sterile male mosquitoes has been obtained for the control of disease. The basic reproduction number for n patch network model has been computed. It is evident from numerical simulations that SIT control in one patch may control the disease in the network having two/three patches with suitable coupling among them.

1. Introduction. Dengue is a vector-borne disease spread by the female mosquitoes *Aedes aegypti* and *Aedes albopictus*. The mosquitoes *Aedes aegypti* were originated from Africa but have now been spread in tropical, subtropical and temperate regions of the world. The fast growth in human population, uncontrolled urbanization and inadequate waste management systems have led to abundance of mosquito breeding sites [6]. These are the main causes which bring this global distribution of mosquitoes and consequently spread of the mosquito-borne diseases. Before 1970, dengue was reported from only nine countries, now it has been widespread in the areas of North America, South America, Africa and Southeast Asia

2010 *Mathematics Subject Classification.* Primary: 97M10, 37C75.

Key words and phrases. Dengue, network model, basic reproduction number, stability, sterile insect technique.

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***-Ricci Soliton within the frame-work of Sasakian and (κ, μ) -contact manifold**

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We prove that if a Sasakian metric is a *-Ricci Soliton, then it is either positive Sasakian, or null-Sasakian. Next, we prove that if a complete Sasakian metric is an almost gradient *-Ricci Soliton, then it is positive-Sasakian and isometric to a unit sphere S^{2n+1} . Finally, we classify nontrivial *-Ricci Solitons on non-Sasakian (κ, μ) -contact manifolds.

Keywords: *-Ricci Soliton; almost gradient *-Ricci soliton; Sasakian manifold; η -Einstein manifold; (κ, μ) -contact manifold.

Mathematics Subject Classification 2010: 53C15, 53C25, 53D10

1. Introduction

A Riemannian metric g , defined on a smooth manifold M^n of dimension n is said to be a Ricci soliton if there exists a vector field V and a constant λ such that

$$\frac{1}{2} \mathcal{L}_V g + \text{Ric} = \lambda g, \quad (1)$$

where \mathcal{L}_V denotes the Lie-derivative in the direction of V and Ric is the Ricci tensor of g . This is considered as a generalization of Einstein metric [1] and often arises as a fixed point of Hamilton's Ricci flow: $\frac{\partial}{\partial t} g(t) = -2 \text{Ric}(g(t))$, where $g(t)$ is a one-parameter family of metrics on M (see [11]).

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The Fischer–Marsden conjecture and contact geometry

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Abstract In this paper, we consider the Fischer–Marsden conjecture within the frame-work of K -contact manifolds and (κ, μ) -contact manifolds. First, we prove that a complete K -contact metric satisfying $\mathcal{L}_g^*(\lambda) = 0$ is Einstein and is isometric to a unit sphere S^{2n+1} . Next, we prove that if a non-Sasakian (κ, μ) -contact metric satisfies $\mathcal{L}_g^*(\lambda) = 0$, then M^3 is flat, and for $n > 1$, M^{2n+1} is locally isometric to the product of a Euclidean space E^{n+1} and a sphere $S^n(4)$ of constant curvature $+4$.

Keywords The Fischer–Marsden equation · K -contact manifold · (κ, μ) -Contact manifold · Einstein manifold · Sasakian manifold

Mathematics Subject Classification 53C25 · 53C20 · 53C15

1 Introduction

Let (M^n, g) be a compact orientable manifold and g be a Riemannian metric on M . We denote by \mathcal{M} the set of all Riemannian metrics on (M^n, g) of unit volume. It is well known that the scalar curvature r is a non-linear function of the metric g . The linearization $\mathcal{L}_g(g^*)$ is given by

$$\mathcal{L}_g(g^*) = -\Delta_g(\text{tr}_g g^*) + \text{div}(\text{div}(g^*)) - g(g^*, \text{Ric}_g),$$

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Certain almost Kenmotsu metrics satisfying the Miao–Tam equation

By AMALENDU GHOSH (Hooghly) and DHRITI SUNDAR PATRA (Ranchi)

Abstract. In this paper, we consider the Miao–Tam equation within the framework of Kenmotsu and almost Kenmotsu manifolds. These classes have a nice connection with the warped product of real line and almost Hermitian (Kähler) manifolds. Here, we prove that a Kenmotsu metric satisfying the Miao–Tam equation is Einstein. Next, we study the Miao–Tam equation on almost Kenmotsu manifolds satisfying some nullity conditions. To this end, we construct some examples of almost Kenmotsu manifolds that satisfy the Miao–Tam equation.

1. Introduction

A classical problem in differential geometry is to find Riemannian metrics on a given compact manifold M^n that provide constant scalar curvature. In this sense, it is crucial to study the critical points of the total scalar curvature functional through variational approach. Einstein and Hilbert proved that the critical points of the total scalar curvature functional $S : \mathcal{M} \rightarrow \mathbb{R}$ defined by

$$S(g) = \int_M r_g dv_g,$$

on a compact orientable Riemannian manifold (M^n, g) restricted to the set of all Riemannian metrics \mathcal{M} (where \mathcal{M} denotes the set of all Riemannian metrics

Mathematics Subject Classification: 53C25, 53C20, 53C15.

Key words and phrases: the Miao–Tam equation, almost Kenmotsu manifold, Kenmotsu manifold, Einstein manifold, nullity distributions.

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THE k -ALMOST RICCI SOLITONS AND CONTACT GEOMETRY

AMALENDU GHOSH AND DHRITI SUNDAR PATRA

ABSTRACT. The aim of this article is to study the k -almost Ricci soliton and k -almost gradient Ricci soliton on contact metric manifold. First, we prove that if a compact K -contact metric is a k -almost gradient Ricci soliton, then it is isometric to a unit sphere S^{2n+1} . Next, we extend this result on a compact k -almost Ricci soliton when the flow vector field X is contact. Finally, we study some special types of k -almost Ricci solitons where the potential vector field X is point wise collinear with the Reeb vector field ξ of the contact metric structure.

1. Introduction

A Riemannian manifold (M^n, g) is said to be a Ricci soliton if there exists a vector field X on M^n and a constant λ satisfying the equation $S + \frac{1}{2}\mathcal{L}_X g = \lambda g$, where $\mathcal{L}_X g$ denotes the Lie-derivative of g along the vector field X on M^n and S is the Ricci tensor of g . In general, X and λ are known as the potential vector field and the soliton constant, respectively. Ricci solitons are the fixed points of Hamilton's Ricci flow: $\frac{\partial}{\partial t} g(t) = -2S(g(t))$ (where $g(t)$ a one-parameter family of metrics on M^n) viewed as a dynamical system on the space of Riemannian metrics modulo diffeomorphisms and scalings (cf. [12]). Recently, the notion of Ricci soliton was generalized by Pigoli-Rigoli-Rimoldi-Setti [16] to almost Ricci soliton by allowing the soliton constant λ to be a smooth function.

Recently, Wang-Gomes-Xia [18] extended the notion of almost Ricci soliton to k -almost Ricci soliton which is defined as:

Definition 1.1. A complete Riemannian manifold (M^n, g) is said to be a k -almost Ricci soliton, denoted by (M^n, g, X, k, λ) , if there exists a smooth vector field X on M^n , a soliton function $\lambda \in C^\infty(M^n)$ and a positive real valued function k on M^n such that

$$(1.1) \quad S + \frac{k}{2}\mathcal{L}_X g = \lambda g.$$

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2010 *Mathematics Subject Classification.* 53C25, 53C20, 53C15.

Key words and phrases. contact metric manifold, k -almost Ricci soliton, k -almost gradient Ricci soliton, K -contact manifold, Sasakian manifold, Einstein manifold.