ABSTRACTS OF TALKS PRESENTED TO THE INDIANA SECTION OF THE MAA

1. Introduction

The Fall 2014 meeting of the Indiana Section of the Mathematical Association of America is at Trine University, October 18. The abstracts appearing here are based on text electronically submitted by the presenters. Contributed talks are listed in alphabetical order by presenter.

2. Invited Talk

Presenter: Tim Comar, Benedictine University

Undergraduate Mathematical Biology: From the Classroom to Research

Mathematical Biology provides a wonderful avenue for undergraduate mathematics majors and quantitatively-inclined majors in the biological sciences to become actively involved with research projects. We describe how beginning mathematics courses, such as a year-long biocalculus sequence, can be used to introduce students to mathematical biology and the mathematical and computational tools needed to study biological problems from a quantitative perspective. We illustrate with several examples of course activities, typically using computational software and show how the level of sophistication increases through the course sequence. We then give examples of research results completed in collaboration with undergraduate students who have completed this course sequence. The research work we'll discuss comes from the areas of integrated pest management and the dynamics of gene regulatory networks.

3. Indiana Project NExT Panel Discussion

Strategies for Helping Students Transition to Proofs

Panelists:

- Jeff Leader, Rose-Hulman Institute of Technology
- Tiffany Kolba, Valparaiso University
- Katie Merkling, Valparaiso University undergraduate student
- Mary Porter, St. Mary's College.

Moderator: William Lindsey, IU Kokomo

4. Contributed Talks

Presenter: Adam Coffman, IPFW
MSC 2010: 26B20
Green's Theorem revisited
Green's Theorem is nearly two hundred years old, but in this expository talk, I will present some 20^{th} and 21^{st} century versions.

Presenter: Dennis Collins, University of Puerto Rico, Mayagüez (retired)
From Energy to Entropy to Emergy
By considering the mathematical properties of the Sackur-Tetrode equation, this paper shows how entropy cannot by itself describe order/disorder, just as energy by itself cannot describe the ability of a system to do work or how much "pep" it has, for which the new term "entropy" was created to tell how "tired" the energy is. The new property to describe "energy quality" was studied by H. T. Odum and coined "emergy" by David Scienceman.

Presenter: Dennis Collins, University of Puerto Rico, Mayagüez (retired)
Joint work with: Glenn Collins, Ohio State University alumnus
Math Magic Number Blocks and the wobble-square method of multiplication
The talk discusses a patent-pending set of play blocks with more closure properties which may be helpful to teach elementary or autistic students, as well as an alternate way of doing multiplication, partially presented at the 10^{th} International Mathematica Conference, 1998.

Presenter: Ramesh Karki, Indiana University East
MSC 2010: 35S11
The L^2-gradients & application to nonlinear pseudo-differential equations
As motivated by solving a nonlinear pseudo-differential equation, we are interested in a problem of finding critical points of an energy type functional defined on an infinite dimensional Hilbert space (namely L^2-Space). To set up such a problem, we first consider the L^2-gradient of such a functional as an element of $L^2(\Omega)$, where Ω is a bounded domain in $\mathbb{R}^d$, then consider the steepest descent (L^2-gradient descent) equation. Under suitable initial and periodic boundary conditions, we prove existence and uniqueness of semi-flow of this equation and discuss its equilibrium solutions, which are indeed critical points of the functional.

Presenter: Haseeb Kazi, Trine University

Fostering undergraduate research

Designing and leading active undergraduate research involves direct and indirect involvement of faculty, students, and possibly several other key individuals on campus and in the community. The focal point of our discussion will be identifying viable and effective ways of promoting undergraduate research in mathematics and mathematics education. The primary challenge would be taking an appropriate initiative without conflicting with the overall culture and mission of the institution, and the next would be meticulously leading this vision through the evolutionary process and persistence. Understanding that unique and universally agreed upon approaches might not exist and work in all situations; we will try to share some recommendations and examples that we have found useful.

Presenter: Tiffany Kolba, Valparaiso University

Teaching a writing-intensive mathematics course

Nationally, there has been a movement for writing across the curriculum in order to improve not only students' general writing skills, but also critical thinking in the disciplines. This talk will overview Valparaiso University's new writing across the curriculum guidelines and discuss tips and challenges for implementing a writing-intensive mathematics course. Examples will stem from a writing-intensive "math for liberal arts" course taught in Spring 2014 with generalization to other mathematics courses.

Presenter: Melissa Lindsey, Indiana Wesleyan University

Inverting the linear algebra classroom

In this talk I will discuss how I used a flipped classroom without videos to increase engagement and active learning in a linear algebra class. At a Project NExT workshop in August 2013, I heard David Pengelley of New Mexico State University talk about how he uses traditional textbooks in the classroom to promote active learning and avoid lecturing. The method involves breaking the traditional homework assignment up into three parts: reading the section, doing the easier problems, and doing the harder problems. Students complete the first two parts before class and the third part after class. During class, students discuss questions they have about the pre-class work. This method of flipping the clasroom intrigued me and I was eager to try it out. When I found out that I would be teaching Linear Algebra for the first time during the Spring 2014 semester, it was the perfect time to try this method. I will discuss what worked, what did not, and what I changed to meet the needs of my students.

Presenter: Steven Schonefeld, Trine University

Amorous bugs and pursuit problems

We first discuss the classical Four Bug Problem, in which bugs $B1$, $B2$, $B3$, $B4$ move in two dimensions so that:

$$\begin{aligned} B1 &\text{ follows } B2,\\ B2 &\text{ follows } B3,\\ B3 &\text{ follows } B4,\\ B4 &\text{ follows } B1. \end{aligned}$$

We develop differential equations for the coordinates of each bug. The solutions give the expected logarithmic spiral paths for the bugs. We discuss generalizations to different numbers of bugs and bugs flying in three dimensions.

Presenter: Lochana Siriwardena, University of Indianapolis

MSC 2010: 60G

Introduction to stochastic models in population dynamics

In this talk I will introduce the basics of stochastic modeling and some famous stochastic models used in population dynamics. I construct a general model using the infinitesimal mean and variance given by birth and death rate functions and analyze specific stochastic delay models and non-delay models generated using specific birth and death rates. Delay models are a result of allowing birth and death rates to depend on the population size at a prior time which would take the maturity time in to account. Drift terms are set up in the form of the logistic growth and delayed logistic growth functions. I discuss the existence and uniqueness of the global solution, non-negativeness of the solution, and boundary behavior. A new method is presented to analyze the boundary behavior of a class of discrete delay models.

Presenter: Feng Tian, Trine University

Joint work with: Palle Jorgenson, University of Iowa, and Steen Pedersen, Wright State University

MSC 2010: 47L60, 47A25, 47B25, 35F15

Spectral theory of multiple intervals

Motivated by scattering theory and quantum graphs, we present a model for spectral theory of families of selfadjoint operators acting in the L^2 space of a finite union of bounded intervals. As an application, we study Fuglede's spectral pair problem. Fuglede's conjecture (1974) states that a bounded Borel set in $\mathbb{R}^d$ with positive Lebesgue measure has an orthogonal Fourier basis iff the set tiles $\mathbb{R}^d$ by translations. It is known to be negative for $d \geq 3$, but the question is still open for $d = 1$ and 2. The case $d = 1$ is of special interest, and our interval configurations provides an affirmative answer in this restricted setting.

Presenter: Elizabeth Wolf, St. Mary's College
MSC 2010: 60, 92

Biological systems can be random: How to deal.

Randomness is inherent in many biological processes, from predator-prey models down to the biochemical reactions occurring within a single cell. We might therefore consider using a stochastic model — one that includes some form of randomness. Can such models behave significantly differently from deterministic models? How exactly does one use a stochastic model to say anything useful? We'll see a few examples that help answer the first question (with a resounding 'yes'!). We'll also take a look at a particular stochastic model (called a continuous time Markov chain), and see how, using Monte Carlo simulation, we can gain some insight into the biological systems we model.