Publications

Dr. Talitha M. Washington *Modified September 2017*

Doctoral Thesis

Mathematical Model of a Protein-Protein Interaction Network
The University of Connecticut (2001).
http://proquest.umi.com/pqdweb?did=728955001&sid=19&Fmt=2&clientId=48996&RQT=309&VName=PQD

> Multicellular organisms have a complex signaling system that allows for efficient intercellular crosstalk. This requires that each cell has a mechanism to read and understand the information coming from other cells. In this paper, we analyze a theoretical model of protein-protein interaction with respect to cell signalling.

Refereed Publications

Publications in Press.

Mathematical Model of a Protein-Protein Interaction Network
Nonlinear Studies, 10 (2003), no. 3, 201-220.
http://nonlinearstudies.com/index.php/nonlinear/article/view/148

> A spatial-temporal model of theoretical protein-protein interactions is developed to analyze the behavior of a network of proteins that exist in two states: active and inactive. After given an initial protein concentration, the proteins activate and inactivate proteins in the network. After the proteins interact with each other, the concentrations of the proteins reach a unique steady state. This model mathematically explains how a network of proteins generates a specific protein concentration.

A Mathematical Model for LH Release in Response to Continuous and Pulsatile Exposure of Gonadotrophs to GnRH
With J. Joseph Blum, Michael C. Reed, and P. Michael Conn. Theoretical Biology and Medical Modeling, 1 (2004), no. 9, pgs. 1-17.
http://www.tbiomed.com/content/1/1/9

> In a previous study, a model was developed to investigate the release of luteinizing hormone (LH) from pituitary cells in response to a short pulse of gonadotropin-releasing hormone (GnRH). The model included: binding of GnRH to its receptor (R), dimerization and internalization of the hormone receptor complex, interaction with a G protein, production of inositol 1,4,5-trisphosphate (IP3), release of calcium from the endoplasmic reticulum (ER), entrance of calcium into the cytosol via voltage gated membrane channels, pumping of calcium out of the cytosol via membrane and ER pumps, and release of LH. The extended model, presented in this paper, also includes the following physiologically important phenomena: desensitization of calcium channels; internalization of the dimerized receptors and recycling of some of the internalized receptors; an increase in G_q concentration near the plasma membrane in response to receptor dimerization; and basal rates of synthesis and degradation of the receptors. With suitable choices of the parameters, good agreement with a variety of experimental data of the LH release pattern in response to pulses of various durations, repetition rates, and concentrations of GnRH were obtained. The mathematical model allows us to assess the effects of internalization and desensitization on the shapes

and time courses of LH response curves.

Mathematical Modeling of the Chemical Vapor Infiltration Process
With Andrew D. Jones, Pierre Ngnepieba, and Derrick K. Rollins. Proceedings of the International Conference on Carbon (2007).

> The Chemical Vapor Infiltration (CVI) process produces high performance ceramic composite materials. This process involves running a gas into a pyrolysis chamber at high temperatures to cause desired reactions within preforms of various shapes and chemical compositions. Achieving the desired pore filling in the least amount of time requires modeling and subsequent optimization of the reaction parameters such as temperature, pressure, and initial porosity of the preform. In this paper we present a model that describes gas transport phenomena, reaction kinetics and pore filling. With very few assumptions, the model predicts the concentration of gas molecules and the void in the preform. The proposed mathematical model yields a straight forward numerical algorithm that accurately simulates the process.

Evansville Honors the First Black Ph.D. in Mathematics and His Family
The Notices of the American Mathematical Society, 55 (2008), no. 5, pgs. 588-589.
`http://www.ams.org/notices/200805/tx080500588p.pdf`

> Elbert Frank Cox is the first black to earn a doctorate in mathematics. In 2007, I coordinated the installation of a plaque at the 600 Block of Cherry Street in Evansville, Indiana that gives honor to Johnson Duncan Cox and his son, Elbert Frank Cox. I joined the Evansville-Vanderburgh School Corporation, University of Evansville, University of Southern Indiana, and Ivy Tech Community College to support the plaque. This is an effort that I led out of my personal obligation to remember our past as I am the second African American from Evansville to earn a doctorate in mathematics.

A Tasty Combination: Multivariable Calculus and Differential Forms
With Edray Herber Goins. The Pentagon, 69 (2009), no. 1, pgs. 11-28.
`http://pentagon.kappamuepsilon.org/pentagon/Vol_69_Num_1_Fall_2009.pdf`

> Differential Calculus is a staple of the college mathematics major's diet. Eventually one becomes tired of the same routine, and wishes for a more diverse meal. The college math major may seek to generalize applications of the derivative that involves functions of more than one variable, and thus enjoy a course on Multivariate Calculus. We serve this article as a culinary guide to differentiating and integrating functions of more than one variable using differential forms which are the basis for de Rham Cohomology.

Sphere-of-Influence Graphs
With Edray Herber Goins. Wolfram Demonstrations Project (2010).
`http://demonstrations.wolfram.com/SphereOfInfluenceGraphs/`

> Let S be a set of vertices chosen from a grid. Given a vertex V in S, let $N(V)$ be the closest neighbor to V in S. Draw a circle with center V and radius $|V - N(V)|$, then draw an edge between two vertices U and V if their circles intersect in more than one point. This gives the "sphere-of-influence" graph for the given set of vertices. This demonstration provides a graphical representation of such graphs.

A Note on Fixed Points of Iterations of Real-Valued Functions
International Journal of Pure and Applied Mathematics, 61 (2010), no. 3, pgs. 297-300.
`http://www.ijpam.eu/contents/2010-61-3/5/5.pdf`

> In this paper we consider the fixed points of both real- and complex-valued continuous functions. We provide clarification of a result by Mohammad K. Azarian. In particular, we discuss how the fixed points of a given function f are related to the fixed points of its iterates
>
> $$f^n(x) = \underbrace{f(f(\ldots f(x)\ldots))}_{n\times}$$
>
> where $n \geq 1$.

Building Better Scientists Through Cross-disciplinary Collaboration in Synthetic Biology: A Meeting Report from the Genome Consortium for Active Teaching Workshop 2010.
With Michael J. Wolyniak, Consuelo J. Alvarez, Vidya Chandrasekaran, Theresa M. Grana, Andrea Holgado, Christopher J. Jones, Robert W. Morris, Anil L. Pereira, Joyce Stamm, and Yixin Yang. CBE-Life Sciences Education, 9 (2010), no. 4, pgs. 399-404.
`http://www.lifescied.org/cgi/content/full/9/4/399`

> Synthetic biology is the application of engineering and mathematical principles to develop novel biological devices and circuits. It is a newly emerging field in which costs are relatively low and the value of student input can be high. It rewards tackling the sort of interdisciplinary problems that are increasingly important for students' professional futures but are often difficult to undertake from traditional disciplinary towers. This paper summarizes GCAT Workshop 2010, and presents an introduction to synthetic biology for those who want to explore this exciting new field.

A Note on an NSFD Scheme for a Mathematical Model of Respiratory Virus Transmission
With Ronald E. Mickens. Journal of Difference Equations and Applications, 18 (2012), no. 3, pgs. 525-529.
`http://www.tandfonline.com/doi/abs/10.1080/10236198.2010.515590#preview`

> We construct a nonstandard finite difference (NSFD) scheme for an SIRS mathematical model of respiratory virus transmission. This discretization is in full compliance with the NSFD methodology as formulated by R. E. Mickens. By use of an exact conservation law satisfied by the SIRS differential equations, we are able to determine the corresponding denominator function for the discrete first-order time derivatives. Further, the scheme is shown to satisfy a positivity condition for its solutions for all values of the time step-size.

The Area of the Surface Generated by Revolving a Graph About Any Line
With Edray Herber Goins. PRIMUS, Vol. 23, Iss. 2 (2013), pgs. 121-132.
`http://www.tandfonline.com/doi/abs/10.1080/10511970.2012.702708`

> We discuss a general formula for the area of the surface that is generated by a graph $[t_0, t_1] \to \mathbb{R}^2$ sending $t \mapsto \big(x(t),\, y(t)\big)$ revolved around a general line $L:\ A\,x + B\,y = C$. As a corollary, we obtain a formula for the area of the surface formed by revolving $y = f(x)$ around the line $y = m\,x + k$.

A Note on Exact Finite Difference Schemes for the Differential Equations Satisfied by the Jacobi Cosine and Sine Functions

With Ronald E. Mickens. Journal of Difference Equations and Applications, Vol. 19, Iss. 2 (2013), pgs. 1042-1047.
`http://dx.doi.org/10.1080/10236198.2012.754020`

> We construct the exact finite difference equation discretizations for the nonlinear differential equations whose solutions are the Jacobi cosine and sine functions. Our derivations clarify and extend previous work done on this topic.

NSFD Representations for Polynomial Terms Appearing in the Potential Functions of 1-Dimensional Conservative Systems

Computers & Mathematics with Applications, Vol. 66, Iss. 11 (2013), pgs. 2251-2258.
`http://www.sciencedirect.com/science/article/pii/S0898122113003921`

> We provide a methodology for the construction of nonstandard finite difference (NSFD) schemes for 1-dim conservative dynamical systems. Such systems are used to model a broad range of nonlinear oscillators. To obtain the desired representations, we imposed conditions following from the constraints of parity invariance and the conservation of energy. A further, practical computational requirement is that these schemes be explicit and linear in the dependent variable evaluated at the upper discrete-time level. The current work extends previous studies by Mickens et al. Finally, we present an example of a non-polynomial potential and indicate how it can be treated within the NSFD method.

NSFD Discretizations of Interacting Population Models Satisfying Conservation Laws

With Ronald E. Mickens. Computers & Mathematics with Applications, Vol. 66, Iss. 11 (2013), pgs. 2307-2316.
`http://www.sciencedirect.com/science/article/pii/S0898122113003866`

> We consider the roles conservation laws can play in providing restrictions on the construction of finite difference discretizations of interacting population systems, modeled by coupled ordinary differential equations. Our analysis is formulated within the nonstandard finite difference (NSFD) methodology of Mickens. A major feature of this paper is the recognition that several distinct types of conservation laws exist. Using a number of well-known population models, we illustrate the details of our procedures by constructing appropriate NSFD discretizations. The relevance of these results to various issues associated with the numerical integration of the original population system differential equations is also presented, especially the role of positivity of the solutions.

On the Generalized Climbing Stairs Problem

With Edray Herber Goins. Ars Combinatoria, Vol. 117 (2014), pgs. 183-190.
`http://arxiv.org/abs/0909.5459`

> Let $\mathcal{S}$ be a subset of the positive integers and M be a positive integer. Mohammad K. Azarian, inspired by work of Tony Colledge, considered the number of ways to climb a staircase containing n stairs using "step-sizes" $s \in \mathcal{S}$ and multiplicities at most M. In this exposition, we find a solution via generating functions, i.e., an expression that counts the number of partitions of $n = \sum_{s\in\mathcal{S}} m_s s$ satisfying $0 \leq m_s \leq M$. We use this to answer a series of questions posed by Azarian and we conclude by posing an open problem.

A Note on the Exact Discretization for a Cauchy-Euler ODE: Application to the Black-Scholes Equation
With Ronald E. Mickens and Justin Munyakazi. Journal of Difference Equations and Applications, Vol. 21, Iss. 7 (2015), pgs. 547-552.
`http://www.tandfonline.com/doi/full/10.1080/10236198.2015.1034118`

> We construct the exact finite difference representation for a second-order, linear, Cauchy-Euler ordinary differential equation. This result is then used to construct new non-standard finite difference schemes for the Black-Scholes partial differential equation.

Curriculum Guidelines for Undergraduate Programs in Data Science
With Richard D. De Veaux, Mahesh Agarwal, Maia Averett, Benjamin S. Baumer, Andrew Bray, Thomas C. Bressoud, Lance Bryant, Lei Z. Cheng, Amanda Francis, Robert Gould, Albert Y. Kim, Matt Kretchmar, Qin Lu, Ann Moskol, Deborah Nolan, Roberto Pelayo, Sean Raleigh, Ricky J. Sethi, Mutiara Sondjaja, Neelesh Tiruviluamala, Paul X. Uhlig, Curtis L. Wesley, David White, and Ping Ye. Annual Review of Statistics and Its Application, Vol. 4 (2017), pp. 2.1-2.16.
`https://www.amstat.org/asa/files/pdfs/EDU-DataScienceGuidelines.pdf`

> The Park City Math Institute 2016 Summer Undergraduate Faculty Program met for the purpose of composing guidelines for undergraduate programs in data science. The group consisted of 25 undergraduate faculty from a variety of institutions in the United States, primarily from the disciplines of mathematics, statistics, and computer science. This paper presents guidelines to provide some structure for institutions planning for or revising a major in data science.

Book Chapters.

Use of Exact Difference Schemes to Construct NSFD Discretizations of Differential Equations
With Ronald E. Mickens. Chapter in book "Exact Finite-Difference Schemes", Eds. Sergey Lemeshevsky, Plotr Matus, and Dmitriy Poliakov. Berlin, Boston: De Gruyter. 2016, pgs. 144-164.
`https://www.degruyter.com/view/product/475741`

> The main purpose of the chapter is to provide a brief summary of some of the results coming from the application of nonstandard finite difference (NSFD) methodology to the discretization of both ordinary and partial differential equations.

Submitted Publications.

Nonstandard Finite Difference Scheme for a Tacoma Narrows Bridge Model
With Oluwaseye Adekanye. Submitted July 2017.

Supervised Undergraduate Students.

Improving the Mathematical Model of the Tacoma Narrows Bridge
Brian Fillenwarth. Rose-Hulman Undergraduate Math Journal, 8 (2007), no. 2.
`http://www.rose-hulman.edu/mathjournal/archives/2007/vol8-n2/paper7/v8n2-7pd.pdf`

In this paper, we investigate the mathematical model for the torsional rotation of the Tacoma Narrows Bridge derived by P.J. McKenna. Through modifying this model and programming various cases of these modifications using MATLAB, we explore how the Tacoma Narrows Bridge would respond to different loading conditions that may have occurred the day the bridge collapsed. From this we are able to gain a better understanding of how the bridge actually behaved prior to its collapse, and can see possible reasons for the ultimate collapse.

Other

Editorship.

From 2010 to 2012, I was the Editor of the National Association of Mathematicians (NAM). NAM is a professional organization that serves under-represented minorities in the mathematical sciences. The following editions of the *Newsletter* can be found at http://nam-newsletter.org.

Young Gifted and Black
NAM Newsletter, 41 (2010), no. 1, 12 pages.

Education, Empower and Create New Frontiers
NAM Newsletter, 41 (2010), no. 2, 12 pages.

Strength in Numbers
NAM Newsletter, 41 (2010), no. 3, 20 pages.

Black, Brown and Beige Together
NAM Newsletter, 41 (2010), no. 4, 20 pages.

The Next Generation of Scholars
NAM Newsletter, 42 (2011), no. 1, 12 pages.

Mathematical Inspiration
NAM Newsletter, 42 (2011), no. 2, 12 pages.

It's Math
NAM Newsletter, 42 (2011), no. 3, 16 pages.

We Math So Hard
NAM Newsletter, 42 (2011), no. 4, 20 pages.

Mathematical Light
NAM Newsletter, 43 (2012), no. 1, 16 pages.

Spring Forward
NAM Newsletter, 46 (2015), no. 1, 12 pages.

Mathematical Legacies
NAM Newsletter, 46 (2015), no. 3, 16 pages.

Football Scores in the Math Zone
NAM Newsletter, 47 (2016), no. 2, 12 pages.

We Square Up
NAM Newsletter, 47 (2016), no. 3, 16 pages.

Living Our Math Like It's Golden
NAM Newsletter, 48 (2017), no. 1, 16 pages.

Topology of Diversity
NAM Newsletter, 48 (2017), no. 2, 12 pages.

Non-technical Publications.

Activities outside the university include writing non-technical articles. These include educational and social topics of interest to the broader community.

AWM Visits to Capitol Hill
With Karen Saxe. AWM Newsletter, Vol. 46, No. 4 (2016), pp. 8-9.
`https://drive.google.com/file/d/0B2rXxbFqvn3ZTzRTSEw2dDBUT0xiRktUREdYbWhLb3ZkbkJ3/view`

Evansville Man Led Inspiring Life as Math Pioneer
Evansville Courier & Press, April 18 (2006), A7.
`http://www.courierpress.com/news/2006/apr/18/evansville-man-led-inspiring-life-as-math/`

Low Dropout Rate Helps Us All
Evansville Courier & Press, July 17 (2006), A9.
`http://faculty.evansville.edu/tw65/low-dropout-rate-helps-us-all_July_17_2006.pdf`

Cyclists Do More Than Spin Wheels
Evansville Courier & Press, July 29 (2008), A6.
`http://www.courierpress.com/news/2008/jul/29/cyclists-do-more-than-spin-wheels/`

New Definition of 'American' Has Arisen
Evansville Courier & Press, November 9 (2008), A15.
`http://www.courierpress.com/news/2008/nov/09/new-definition-of-american-has-arisen/`