

History, Education and/or Logic

A Generalization of Conic Sections

Tiffany Lundy

Stephen F. Austin State University

In this presentation we explore ideas related to the development of conic sections. Some typical conic sections are formed by studying the locus of points such that the sum or difference from the points to two fixed foci is constant. Here we explore the locus of points such that the product or quotient of the distance from the points to two fixed foci is constant. Time permitting we will discuss a related application.

A Finely Tuned Model

Sara Watson

Southwestern University

Tuning systems are vital to any form of music and affect how music is sung, played, and listened to. Our modern western tuning system has developed over the years and many systems have been created in hopes to find the most favorable sound. We will consider the differences in Pythagorean, Meantone, and Equal Temperament tuning systems by way of mathematical modeling.

"Ah-hA Method"

Jin Ha (Faculty)

Northeast Lakeview College

One of the most difficult topics for our math students is how to factor trinomials. When I learned how to factor trinomials in High School in South Korea, I was taught using "the guessing method". When I came to US, I was introduced with "the ac-method" ("factor by grouping method"). Then I saw something while I was teaching both methods in class that I could combine these two methods to make this process quicker and simpler. "Ah-hA" method!

Probability and Statistics

Recycling toward a Better Earth Through Math

Yvette Niyomugaba

Southwestern University

As the world population increases significantly quickly, recycling is one of the effective ways to conserve and save energy and natural resources. In addition, recycling reduces landfill use and the environmental damage from pollutants and greenhouse gas emissions. Plastic is one of the most consumed products worldwide and this research will focus on modeling plastic recycling and landfill usage in Bangladesh and the United States using mathematical procedures. We develop a Markov chain model in which state diagrams show the flow of plastic in a recycling system. Linear, exponential, and logistic functions are used to describe the amount of plastic at different stages: virgin plastic, landfill, and lost plastic. In addition, the relationships between landfill growth, population growth, and plastic consumption are modeled using various mathematical procedures.

School Meals: How Much is Too Much?

Zachary A. Anglin

Southwestern University

College meal plan prices can seem inscrutable, but is there a method to the madness? We will present a mathematical model using actual data from several liberal arts schools in the Southwest United States. Probable revenue from students, under both mandatory and non-mandatory plans, as well as from faculty, staff, and visitors will be predicted.

Math asks: "Water You Doing, Georgetown?"

Van (Zoe) Pham

Southwestern University

We will present an original model of water demand and its relation to temperature and rainfall in Georgetown, Texas. Data is obtained from a variety of sources. Our model will estimate the amount of water use for irrigation in this area.

Predictive Models for the Performing Arts

Mario Perez & Danica Martinez

University of the Incarnate Word

For a summer internship project, the researchers collaborated with ARTS San Antonio (SA ARTS), a non-profit performing arts organization, to generate a model to assist SA ARTS in achieving their goal of increasing their profitability and long term sustainability. It was decided that a predictive model should be created to increase the organization's cost effectiveness. Specifically, the model would predict the number of attendants for a particular type of performance. Three models were created to aid SA ARTS. Segregating by type of performance and creating appropriate models for those types of performances created models that had more predictive power than a singular model containing all the data because, it was discovered, certain types of performances behaved differently with the predictor variables. The first two models predicted the number of attendants for theatrical and musical performances and the third model predicted the occupancy percentage of venues that would host dance performances.

Love All: Mathematical Tennis

Andy Clarage

Southwestern University

A stochastic model of a tennis game, used to predict the outcome of sets and therefore matches, will be described. Monte Carlo simulation methods, implemented in Java, will be applied to the 2012 United States Open beginning at the quarterfinal stage to test the accuracy of the model.

Distractions Can Be a Real Pain

Ben Cardiff

Southwestern University

Today's society is full of phones, portable gaming systems, and other gadgets that steal our attention while driving, which may lead to serious injury or death. We will examine data of motor vehicle accidents caused by distracted drivers and predict the number of accidents that may occur in upcoming years, based on increasing device use.

Apparel Size Standards within the Fashion World

Jenny N. Gomez

University of the Incarnate Word

The intent of this experiment was to examine the theory of standardized clothing within the fashion industry. This research concentrated primarily on the apparel size standard for waist measurements of size 12 black-colored female skirts and size 32 black-colored male dress pants. Moreover, this study investigated factors Style, Fabric, and Store Category, which affected adherence to the apparel size standard developed in the study. Throughout the investigation additional interactions were discovered and included into the final statistical model. The final statistical model was

explored to examine the statistical significances these interactions had on the waist length. The apparel size standard developed within the study was also compared to apparel standards developed by the United States Department of Commerce. This study concluded that the waist length of size-twelve skirts sold within the San Antonio region, on average, matched the waist length established by the National Institute of Technology. However, the waist length of pants size thirty-two for men sold within the San Antonio region, on average are below the US size standard of 34 inches. The study indicated that the waist length of formal pants purchased at Designer/Bridge stores, casual pants purchased at Off-price/Discount and at Designer/Bridge stores, on average, are the same and are the widest. Business pants sold at Off-Price/Discount stores had the lowest average waist length. Therefore wide waist lengths are not exclusive to high price stores, nor are narrower waist pants exclusive to low-price stores. The waist length of business skirts purchased at Designer/Bridge stores and formal and business skirts purchased at Off-price/Discount stores, on average, are the widest.

Statistical Analysis to Validate the Dark Sky Laws

Geoffrey H. Schuette

Sul Ross State University

We will attempt to use statistical analysis to validate the Dark Sky Laws of the region around McDonald Observatory-Fort Davis, Texas. Data reduction methods are used to find the flux under the curves of the natural lines, oxygen and nitrogen, and man-made lines, sodium and mercury. Interpretations of the the results of data reduction are given and explored.

Estimators Under The Restriction of Stochastic Ordering

Yesenia Guzman and Javier Tapia

St. Mary's University

Stochastic ordering of probability distributions arises frequently in medical, engineering, and economics applications. While several nonparametric estimators for stochastically ordered distributions in the presence of censoring have been proposed in the literature, there does not seem to be one that is uniformly best. In this work, we examine the behavior of a new estimator and compare it to those that have been proposed in the literature through an extensive simulation study that considers various censoring scenarios.

Algebra and Geometry

Real Root Counting For Central Configurations

Wako Bungula

Texas Lutheran University

We use methods of algebraic geometry to count the number of real solutions of systems of polynomial equations in a given region of Euclidean space, such as the positive orthant consisting of points with all positive coordinates. These root-counting methods yield the exact number of positive real solutions and do not rely on sensitive numerical techniques. This real root-counting method is applicable and useful in some interesting areas such as celestial mechanics.

An Algorithmic Approach to Pentagonal Plane Tiling

John Hyde

The University of Texas at Tyler

It is known that there are 14 types of convex pentagons which tile the plane. It is not known, however, whether this list is complete. We have developed an algorithm which generates tiles whose Heesch numbers are nonzero with the intent of gaining insight into either completing the list or proving the list is complete already.

Thus far, the algorithm has produced examples of all 14 types as well as some examples of Heesch number one tiles, and it seems as though it is a promising approach toward a complete classification.

Topology and/or Knot Theory

The Tangle Model Applied To Site-Specific Gin Recombinase On Dna

Jennifer Lazarus

University of North Texas at Dallas

The tangle model was introduced by Knot Theorist Dewitt Sumners to analyze the actions of enzymes, called site-specific recombinases, on DNA. Site-specific recombinases act on DNA by implementing the change in crossover sites; which either occur as direct repeats or inverted repeats, in a process called recombination. The tangle model includes a system of equations that aid in describing the processive recombination of enzymes with DNA; which produces four products. Biological evidence suggests that the enzyme Gin recombinase acts on DNA by processive recombination. We explore the application of the tangle model to processive recombination using Gin recombinase.

Java Implementation of C. Ernst's Tangle Equations II

Jonathan k. Sullivan

University of North Texas at Dallas

Solutions to Tangle Equations are important equation in mathematics, bio-chemistry, molecular biology, and biophysics. The "knotting" of bio structures has even recently been attributed to competitive advantage in evolution. C. Ernst published a paper called Tangle Equations II. In this paper an algorithm is presented to find the O,P,R, given $N(O + P)$ and $N(O + R)$. In this paper I will discuss knot theory's place in study of life, the basics that build up to understanding and solving tangle equations, and present some results of my Java implementation of C. Ernst's "Tangle Equations II".

Algebra of Tangles for Classical and Virtual Knots

Elizabeth Reyes

University of North Texas at Dallas

In classical Knot Theory Reidemeister moves are one of the three ways to change projection of a knot that consequently changes the relationship between the crossings. Knots and links can be formed by taking the numerator closure of a tangle or a sum of tangles. In this paper we introduce the algebra of rational tangles on classical and virtual Reidemeister moves and present combinatorial approach to show its invariance for rational tangles.

Analysis, Calculus, and/or Differential Equations

Growth Patterns of Ethnic Groups in Bexar County with Modified Leslie Models

Judith Arriaza

University of the Incarnate Word

In the previous research study the Leslie model was established to predict the population growth of ethnic groups in Bexar County. Even though the model seemed to give satisfactory results, one of its limitations was that the matrix used in that model was static. The purpose of this study is to improve and modify the Leslie model with a dynamic matrix for better population projections. The Leslie model with a dynamic matrix seems appropriate for a human population since the birth rates and survival rates are changing from year to year. As the population grows, the demand for organization will be needed. Growth patterns affect all the daily aspects of life. This study will benefit businesses, households, politics, city development, and the people in Bexar county. It will help future planned services for the people; provide awareness and an idea to the government of the composition of ethnic groups.

This research will be a quantitative study. Mathematica was used as the main computational platform and for curve fitting tasks. A function template was chosen to model the birth and survival rates. The modeled functions were put into the Leslie matrix. For each of the ethnic groups a Leslie matrix was constructed. Population projections were made until 2020 and the results were compared to the census of 2000, 2010 and to the static Leslie matrix. Projections were also made up to 2020 in Bexar county. All of the results and projections for this study were illustrated in a bar, line and pie graphs.

In conclusion, using a dynamic matrix instead of a static matrix definitely makes a difference. The dynamic matrix model produced better results for total population projections and per age groups comparisons when compared to the static matrix model. The dynamic model also produced good match with real data for all group.

Area and Hausdorff Dimension of Convex Quadrilateral Fractals

Rebecca Vasquez and Michelle Okura

University of North Texas at Dallas

We will describe a class of self-similar fractals, which we define as "convex

quadrilateral fractals (CQF's)". Our goal is to discover the greatest possible contraction ratio, which satisfies the open set condition. We will then explore the greatest possible area and Hausdorff Dimension of CQF's.

Modeling the Spread of HIV

Yasmin Leon

Southwestern University

A mathematical model of HIV transmission will be presented. This model consists of differential equations and uses data acquired from the Center for Disease Control as well as the U.S. Census Bureau.

Look at Them Grow: A Mathematical Model of Cancer cell and T cell Populations

Nina Baccam

Southwestern University

We will present a mathematical model of the generation and spread of the cancer cells of chronic myelogenous leukemia (CML). The interaction of the cancer and host cells is modeled through a system of ordinary differential equations showing the rates of change with respect to time of three cell populations. The model aids in the understanding of the rapid generation of CML cells.

Genetic Diversity and Long-term Genotype Evolution

Melody Marie Packard

Northeast Lakeview College

Evolutionary biology is an area of great interest. Explaining biological diversity has been a longstanding problem. The focus of this project is modeling the genotype evolution process from simple genotypes to complicated genotypes through genetic concatenation of various geno-lengths. I used Matlab to model a differential equation that represents the changes in species population densities over time, considering the mutation and fitness of the species plus non-linear environmental factors.

Modeling the Relationship Between Visceral Leishmaniasis Incidence and the Proportion of Post-Kala-Azar Dermal Leishmaniasis Cases Treated into Remission

Ryan Landrith

University of Texas at Arlington

Visceral Leishmaniasis (VL) is a fatal disease caused by species of the Leishmania protozoan parasite. VL infection results in the death of thousands and illness of hundreds of thousands every year in countries including India and Sudan. Post-kala-azar Dermal Leishmaniasis (PKDL) is a cutaneous manifestation of Leishmaniasis following the treatment of VL and serves as a reservoir for the transmission of VL. This study focuses on the relationship between VL incidence during a given period and the proportion of PKDL cases treated into remission during the same period using a dynamical system to model VL and PKDL infection dynamics over a fixed period of time under the assumption that the infection has reached an endemic state. Here the proportion of PKDL cases treated is defined as the ratio of cumulative number of PKDL cases treated to the incidences of PKDL over the time period. This study indicates that with the current treatments available and considering achievable levels of treatment the impact of treating new PKDL cases on incidences of Visceral Leishmaniasis cases does not diminish at higher proportions of new cases treated, however the ability to treat new cases is precipitously inhibited at high proportions.

Math Bites: Predator-Prey Models of Various Species

David Scott Ryan

Southwestern University

The relationship between predator-prey species, such as wolf and deer, can have a monumental impact on the local community. We will present predator-prey models based on intrinsic growth rates.

Gompertz Function and Tumor Growth

Rhyzl Guimbatan

El Centro College

Mathematical modelers have focused for more than five decades on rigorous description and quantitative understanding of tumor growth kinetics. The goal of this presentation is to develop and present a coherent and integrated interpretation of the Gompertz model describing tumor growth. A summary of the pertinent deterministic models of tumor growth kinetics is presented with special emphasis on model scrutiny against experimental data.

Public Health Policy and Managing Bioterrorism

Annalisa Moore

University of the Incarnate Word

The possibility of bioterrorism and experiencing a bioterrorist attack has been steadily increasing throughout history. The use of diseases and infectious agents as weaponry dates back to hundreds and hundreds of years ago. Recently biological advancements and research have made the mutation of infectious agents possible and life threatening. This research uses mathematical modeling to simulate the effects of possible bioterrorist agents on a closed population. By using variations of an SIR model, this research simulates several possible epidemic scenarios caused by a bioterrorism attack with the smallpox virus, as well as the avian and bird influenzas. The parameters of the model were manipulated to demonstrate the effects of various public health policies on minimizing the impact of those attacks. The results convey that public health policies are more effective when both preventative and responsive measures are implemented.

A Positive Nonstandard Finite Difference Scheme for a Model of Competition in a Chemostat

Ian Martines(Faculty)

St. Mary's University

In this presentation we construct a nonstandard finite difference (NSFD) scheme for a mathematical model of nutrient competition in the chemostat. Using a conservative property found in the chemostat model we are able to develop a numerical scheme which preserves both the conservative property and the positivity of approximate solutions regardless of time step-size.