Undergraduate Mathematics Day

University of Dayton

Saturday, November 11, 2017
## Program

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<td>Check In, Folder Pick-Up, Continental Breakfast</td>
<td>Science Center Auditorium Lobby and Atrium</td>
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<td>9:30 – 10:50</td>
<td>Welcome Dr. Jason Pierce Dean, College of Arts and Sciences, University of Dayton Introduction Peter Kawiecki President, University of Dayton's Chapter of Pi Mu Epsilon Invited Address: It's All Fun and Games Until Someone Becomes a Mathematician Allison Henrich, Seattle University</td>
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The 18th Annual Kenneth C. Schraut Memorial Lecture:
Breaking Driver’s License Codes
Dr. Joe Gallian
University of Minnesota Duluth

Abstract: Many states use complicated algorithms or formulas to assign driver’s license numbers but keep the method confidential. Just for the fun of it, I attempted to figure out how the states code their license numbers. In this talk I will discuss how I was able to break the codes for Minnesota, Michigan, New York and Missouri. The talk illustrates an important problem-solving technique used by scientists but is not emphasized in mathematics classes. It also teaches the lesson that sometimes things done just for the sake of curiosity can have applications.

Dr. Gallian received a Ph. D. from Notre Dame in 1971. He has been at the University of Minnesota Duluth since 1972. He is the author of the book “Contemporary Abstract Algebra” (9th edition) and coauthor of the book “For All Practical Purposes” (10th edition). His research interests include groups, graphs and combinatorics. He has published more than 100 articles and given over 500 invited lectures at colleges, universities and conferences. He has directed summer research programs for undergraduate students since 1977. He has received teaching awards from the Mathematical Association of America (MAA), the Carnegie Foundation and the University of Minnesota and is a past President of the MAA.
It’s All Fun and Games Until Someone Becomes a Mathematician

Dr. Allison Henrich
Seattle University

Abstract: As former MAA President Francis Su recently reminded us, PLAY is essential for human flourishing. Whether you are a poet or a scientist, a grandparent or a child, play can powerfully enrich your life. For mathematicians, play is essential for building intuition. For undergraduates, play can inspire a desire to get involved in mathematical research. The world of knots provides fertile ground for understanding these connections. Playing games on knot diagrams can give us intuition about knotty structures, while learning about the theory of knots can reveal the “magic” behind rope tricks and excite us to learn more.

Dr. Henrich is an Associate Professor at Seattle University who has a keen interest in studying knots from a mathematical perspective. She is passionate about undergraduate research, having worked with students on knot theory research in the Williams College SMALL Research Experiences for Undergraduates (REU) program, the University of Washington Math REU, and the Seattle University Mathematics Early Research (SUMER) REU program, of which she is a co-founder and director. In 2015, Allison won the Mathematical Association of America’s Henry L. Alder Award for Distinguished Teaching by a Beginning College or University Mathematics Faculty Member. In January, Allison and her coauthor, Inga Johnson, published an inquiry-based learning textbook entitled “An Interactive Introduction to Knot Theory”.

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### Contributed Paper Sessions

All rooms are in the Science Center

* denotes graduate student

** denotes high school student

Unless otherwise denoted, all contributed talks are presented by undergraduate students.

**Session: 11:15 a.m. - 12:10 p.m.**

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<td><strong>Hamiltonicity in k-partite Graphs</strong>&lt;br&gt;Bob Krueger&lt;br&gt;Miami University</td>
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<td><strong>Existence of Solutions of Boundary Value Problems at Resonance for Ordinary Differential Equations</strong>&lt;br&gt;Jabr Aljedani*&lt;br&gt;University of Dayton</td>
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Session: 3:15 p.m. - 4:10 p.m.
Abstracts

11:15 a.m. - 11:30 a.m.

Area Under an Interesting Metric
Matthew Forte
University of Dayton
Room 107

We explore a metric on $\mathbb{R}^2$ that is a variation of the discrete metric. While the discrete metric has values of 0 and 1, this metric adds a third possible value of 0.5. An intriguing aspect of this metric is that the areas of shapes change when the shapes are rotated. This presentation is based on a paper entitled An Interesting Metric Space by S.K. Hildebrand and Harold W. Milnes.

Generalized Catalan Objects
Emily Dautenhahn, Hannah Pieper
Oberlin College
Room 108

There are numerous sets of combinatorial objects that are counted by the Catalan numbers and many mathematicians have constructed bijections between these sets. The Catalan numbers can be generalized using parameters, which correspond to the Raney numbers. We present the results of our research on sets counted by generalized Catalan numbers, including combinatorial bijections between the sets to demonstrate that they have the same cardinality. This research was conducted as part of the 2017 REU program at Grand Valley State University.

A BGK-Type Model with Enforced Relaxation of Moments for Non-Continuum Flows
Truong Nguyen*
Wright State University
Room 119

A BGK-type model with velocity dependent collision frequency and enforced relaxation rates for selected moments is applied to simulation of one- and two-dimensional super sonic flows. Relaxation rates of the moments are estimated by evaluating the full Boltzmann collision integral several times during the simulation. The solutions show improvements in velocity and temperature profiles as compared to the classical ES-BGK model. However, enforcement of relaxation rates for high order moments increases stiffness of the model.

The Number of Fixed Points of AND-OR Networks with Chain Topology
Lauren Geiser
University of Dayton
Room 128

AND-OR networks are Boolean networks where each coordinate function is either the AND or OR logical operator. We study the number of fixed points of these Boolean networks in the case that they have a wiring diagram with chain topology. We find closed formulas for subclasses of these networks and recursive formulas in the general case. Our results allow for an effective computation of the number of fixed points in the case that the topology of the Boolean network is an open chain (finite or infinite) or a closed chain.

Investigation of Matrix Multiplication
Chloe Beckett
University of Dayton
Room 146

For $2 \times 2$ matrices $A$ and $B$, it is known that the associative property of multiplication and the distributive property of multiplication hold, however the commutative property does not always hold. That is, $AB = BA$ is not always true. This gives rise to questions about the commutative property when computing matrix multiplication. For which matrices $A$ does $AB = BA$ hold true for all $B$? Additionally, which pairs of matrices always commute? Solutions to the questions above and other similar questions will be discussed during the presentation.
11:15 a.m. - 11:30 a.m. (cont’d)

_existence of solutions of boundary value problems at resonance for ordinary differential equations_

Jabr Aljedani*
University of Dayton
Room 150

We consider a boundary value problem at resonance for second order ordinary differential equations. We employ a shift argument and construct a Green’s function and corresponding fixed point mapping. We show the fixed point mapping is completely continuous and employ the Schauder fixed point theorem to obtain sufficient conditions for existence of solutions of the boundary value problems at resonance.

Prime Factorization and Series
Junyu Lin
University of Dayton
Room 181

We know from integral calculus, that the harmonic series is divergent. That is, the sum of the reciprocals of the positive integers is equal to infinity. In this talk, I will show that, if we only sum the reciprocals of those numbers divisible by 2, 3 or 5, the resulting series is convergent and its sum can be obtained explicitly.
11:35 a.m. - 11:50 a.m.

**Closest Point Mapping and Dimension of Sets**  
Dylan Flaute  
University of Dayton  
**Room 107**

In this talk, we will present results connecting information about the closest point mapping to a set in $\mathbb{R}^2$ with the dimension of that set. The closest point mapping to a set in $\mathbb{R}^2$ is a map that associates an arbitrary point in space with its nearest point on the set. We prove that the maximum number of nonzero eigenvalues of the Jacobian matrix of the closest point mapping is the dimension of the set.

**Approximating the Traveling Salesperson Problem**  
Kathryn Posey  
University of Dayton  
**Room 108**

Given a set of cities, what order should we visit them in order to minimize the distance traveled? This question is the basis of the traveling salesman problem. Finding the shortest tour proves to be a difficult task, so we will consider approximation algorithms that quickly find a short tour, but possibly not the shortest tour. In this presentation, we demonstrate an approximation technique called simulated annealing. By optimizing a cost function with the use of randomization, this technique provides a way to approximate the solution to the traveling salesman problem.

**An Introduction to Optimal Control of Viscous Compressible Flows**  
Danielle Masse*  
Wright State University  
**Room 119**

Understanding and modeling the behavior of compressible flows is of great interest in many applications such as hypersonic aerodynamics. In many computational fluid studies, flow is modeled through or around a specific geometry and quantities of the resultant flow, such as the velocity or pressure field, are analyzed. For controlled fluid flow, a constraint is imposed so that characteristics of the simulated flow will approach some desired quantities. This constraint is imposed via a control which is introduced to the system of equations of fluid motion in order to influence the flow. The long-term goal of controlled fluid flow research is to develop and implement methods that will find an optimal control which minimizes a specific cost functional in a particular flow situation. In such implementations, rather than solve the controlled system of equations directly an equivalent set of adjoint equations can be used to avoid computation of multiple flow solutions. This talk will review the key concepts of fluid dynamics in order to define the equations of compressible, viscous fluid motion and then a review of some calculus of variations concepts and a derivation of the adjoint equations will follow.

**Steady State Patterns in Differential Equation with AND Gates**  
Zeyu Wang  
University of Dayton  
**Room 128**

We propose a combinatorial approach to find the stable steady states of ODE models of gene regulatory networks constructed with AND gates. Our approach consists in Booleanizing the system of differential equations to obtain a system of Boolean equations. Then, tools ranging from exhaustive search to graph theory can be used to solve such Boolean equations, which in turn predict the possible steady state patterns of the original ODE.
11:35 a.m. - 11:50 a.m. (cont’d)

*A Chicken-Rabbit Problem and Beyond*
Jianqiao Mao
Miami University
Room 146

In this talk, I will revisit an elementary algebra problem, the so-called chicken-rabbit problem, which maybe well-known to high school students. I will provide two solutions to this problem, one is standard in linear algebra, the other involves only arithmetic. We will discuss the comparison between these two solutions, and some generalizations of this problem. At the end I will also make a connection with the concept of Groebner basis.

*Extreme Points and Taylor’s Theorem of Functions with Caputo Fractional Order Derivatives*
Saleh Almuthaybiri*
University of Dayton
Room 150

In this talk, we introduce and modify the work of the Al-Refai (EJQTDE, 2012) to address extreme points of functions satisfying a Caputo fractional differential inequalities of order $1 < \alpha < 2$. Then, we offer a motivated proof of a version Taylor’s theorem with remainder for Caputo fractional derivatives of the same order.

*Euler’s Phi Function*
Amelia Pompilio
University of Dayton
Room 181

In this talk I will be presenting the proof of the multiplicity of Euler’s phi function, $\phi$. This function counts the number of positive integers up to some number $n$ that are relatively prime to $n$. Two numbers are relatively prime if their only common divisor is one. For example, $\phi(8)$ is 4 because there are 4 numbers less than 8 that are relatively prime to 8, and they are 1, 3, 5 and 7. This example is easy because the numbers involved are small, however what is $\phi(9216)$? The multiplicity of Euler’s function makes computing $\phi(n)$, for any natural number $n$, much faster.
11:55 a.m. - 12:10 p.m.

Volumes of Solids of Revolution Using Double Integrals
Brian Blakely
University of Dayton
Room 107

We present an approach for computing volumes of solids of revolution using double integrals. We show that for horizontal or vertical axes of rotation the method gives the shell or disk method depending on the order of integration. We finish with some examples using this method and highlight its advantages.

Hamiltonicity in \( k \)-partite Graphs
Bob Krueger
Miami University
Room 108

One major question of graph theory is which graphs have Hamiltonian Cycles, cycles that traverse every vertex of the graph exactly once. In particular, many people have investigated what conditions imply this property of Hamiltonicity. Dirac showed that if the minimum degree (the number of edges coming from a vertex) of a graph is at least half the number of vertices, then the graph contains a Hamiltonian cycle. Similar degree conditions have been created for balanced \( k \)-partite graphs (where the vertices are divided into \( k \) disjoint equally sized parts). We extend these results to not-necessarily balanced \( k \)-partite graphs. In the talk I will give an overview and history of the problem (suitable for an audience without much graph theory experience), some insight into the generalization, and if time permits an outline of our proof.

Basics of Numerical Methods for Inviscid Fluid Flow
Ian Holloway*
Wright State University
Room 119

Inviscid fluid flow is distinctly different from viscous flow in that it allows the possibility that shockwaves can occur. Since derivatives no longer have meaning in the presence of these discontinuities, shockwaves require special analytical and numerical treatment. The purpose of this talk is to outline the difficulties caused by the presence of shockwaves, and to present the basics of numerical methods which have been designed to appropriately handle them.

Controlling Dynamical Systems
Dylan Denner
Ohio University
Room 128

The desire to build systems that automate specific tasks can be traced back to Ctesibius of Alexandria (270 BC) with his addition of closed-loop feedback to existing water clocks. Today, control systems theory is a vast field with applications in engineering, economics, medicine, biology and ecology. Control systems engineering is the branch of engineering that focuses on dynamical systems and design of control models such that the system exhibits an optimal or desired behavior. This talk will highlight some of the key concepts in both dynamical systems and control systems theory. We will then model a linear time-invariant system and investigate how it is possible to use closed-loop state feedback to design the dynamics of the system.

Fractals
Keely Shorter
Columbus State Community College
Room 146

A study of fractals and how they relate to the physical world we live in. Connecting the studies of art and mathematics, fractals are everywhere. They are the language that we use to process unmeasurable complexities into understandable algorithms and codes. Whether it is measuring Britain’s coastline or predicting genetic coding, fractals are the key to unraveling seemingly disordered patterns in our otherwise ordered universe.
11:55 a.m. - 12:10 p.m. (cont’d)

Newton’s Law of Cooling and a Modified Newton’s Method  
Aidan Murphy  
University of Dayton  
Room 150

We study a modified Newton’s model that was developed for the purpose of studying cooling bodies at crime scenes. We compare this method to Newton’s law of cooling and we then analyze the output graphically to validate the use of the modified method.

Representations of Real Numbers Using a Finite Sum of Elements From an Open Set  
Lewis Dominguez  
Indiana University of Pennsylvania  
Room 181

In February 2017, a number theoretic problem was posed in Mathematics Magazine by Souvik Dey, a master’s student in India. The problem asked whether it was possible to represent a real number by a finite sum of elements in an open subset of the real numbers. Specifically, the open subset must contain one positive and one negative number. This talk will showcase a solution to this problem.
Algebraic sequences have uses in many engineering applications. For example, specialized sequences are critical for radar and communication systems. Here we investigate computational techniques for increased efficiency in the search to find ternary sequences with desirable properties. Specifically, we are interested in finding sequences whose periodic and aperiodic autocorrelation functions are small in magnitude. The techniques implemented include optimization of existing code structures and parallel computing.

**A Proof of the “Magicness” of the Siam Construction of a Magic Square**
Joshua Arroyo
Rose-Hulman Institute of Technology
Room 108

A magic square is an $n \times n$ array filled with $n^2$ distinct positive integers $1, 2, \ldots, n^2$ such that the sum of the integers in each row, column, and the main diagonal is the same. A Latin square is an $n \times n$ array consisting of $n$ distinct symbols such that each symbol appears exactly once in each row and column of the square. Many articles dealing with the construction of magic squares introduce the Siam method as a “simple” construction for magic squares. Rarely, however, does the article actually prove that the construction yields a magic square. In this talk, we describe how to decompose a magic square constructed by the Siam method into two orthogonal Latin squares, which in turn, leads us to a proof that the Siam construction produces a magic square.

**Alcoholism; A Mathematical Model with Media Awareness Campaigns**
Erik Ander*
Vanderbilt University
Room 119

In this paper, we study how media awareness campaigns influence the spread and persistence of drinking behavior in a community. We present a compartmental population model accompanied by an additional differential equation to describe the dynamics of media awareness campaigns. The population is subdivided into light or moderate drinkers, $S(t)$, heavy (problem) drinkers, $A(t)$, and recovered individuals, $R(t)$. The media campaigns, $M(t)$, are assumed to mitigate the effects of problem drinking and to encourage recovery from heavy drinking. Our model indicates a basic reproductive number, $R_0$, where there exists an asymptotically stable drinking-free equilibrium if $R_0 < 1$ and a unique endemic state, which appears to be stable when $R_0 > 1$. Results suggest that two factors influence the spread of problem drinking: the relative strength of interaction between heavy and moderate drinkers, and the average overall time spent in the problem drinking environment. We conclude that the existence of sufficient media awareness programs and effective treatment options does not eliminate heavy drinking culture in the community, rather, they mitigate the effects.

**Forecasting Rain Using Logistic and Time Series Regression Analysis**
Amal Alsomali*
University of Dayton
Room 128

Prediction and forecasting using logistic regression have exploded during recent years. Logistic regression modeling now used in almost all kind of knowledge. Rainfall is an important event in the climate system. Whether it rains or not has a big impact on several life areas such as nature, agriculture and animal life. Thus, we need to be able to predict rainfall. In this paper, we show how to use logistic regression for predicting rainfall. Ten years of daily rainfall data used to build the model. Two extra years of observed daily rainfall data used as a validation of the model. Our finding shows that logistic regression model can predict the rainfall very efficiently.
The purpose of our project was to display how our personal risk preferences affect our investment decisions, if we invested in two assets: one risky asset (stock) and one risk-free asset (bank account). We considered the problem in both the discrete and continuous case. In particular, the stock price follows a multinomial tree in the discrete case; and follows a Geometric Brownian motion in the continuous case. We then found the expected value of the stocks at varying times. By setting what we expect our bank account to be at those times equal to these expected values, we solved for the interest rates, at which investing on either asset are equivalent. We then incorporated risk aversion in the power utility function. Using different levels of risk aversion, we again solved for the interest rate at which investing on either asset are equivalent. By comparing the first interest rate with the interest rate that incorporated the risk aversion, we saw how this risk aversion affects our investment decisions.

Derivation of the Closed-Form Particular Solutions for Laplace Operator Using Oscillatory Radial Basis Functions
Alexander Sube
Ohio Northern University
Room 150

Particular solutions for the differential operator using radial basis functions (RBFs) are essential for the implementation of several particular solutions based RBFs method to numerically solve the partial differential equations (PDEs). In this talk, we introduce the derivation of the closed form particular solutions for the Laplace operator using a new class of oscillatory RBFs.
An Interesting Proof by Leonhard Euler
Qijing Pan
University of Dayton
Room 107

How can something be both infinite and finite? We will look at the life of Leonhard Euler and then turn our attention to his proof that infinite sum \[ 1 + \frac{1}{4} + \frac{1}{9} + \frac{1}{16} + \frac{1}{25} + \cdots + \frac{1}{k^2} + \cdots \] equals to \( \pi^2/6 \).

Magic Polygons and Their Properties
Victoria Jakicic
Indiana University of Pennsylvania
Room 108

Magic squares are square arrays, where the sum of each row, each column, and both main diagonals is the same. The concept of a magic square with 3 rows and 3 columns is generalized to encompass regular polygons. The magic polygons have the same sum on each edge, as well as each diagonal. Construction of these magic polygons, as well as their existence, will be discussed.

Functional Cortical Thickness as a Predictor of Placebo Response
Klirk Bhasavanich*
Wright State University
Room 119

An 8-week longitudinal study for treatment of Major Depressive Disorder (MDD) was conducted under a NIH grant from NYU. The goal of the study is to find a way to incorporate cortical thickness functional predictors into predictive models to aid in determining optimal treatment selection for individuals. More specifically, we would like to use cortical thickness data to predict Hamilton Rating Scale for Depression (HRSD). The treatment group were administered a drug called Sertaline and the control group were given a placebo. The outcome measure is the improvement in HRSD from baseline. One approach to developing a treatment decision rule is to use a regression model based on a Nadaraya-Watson type estimator. This is a nonparametric regression using normalized kernels. The cortical thicknesses are available on a fine mesh of coordinate points on a unit sphere for each individual. These cortical thickness values are mapped to two unit spheres (right and left hemisphere) with 163,842 values per sphere per individual. We would like to regard the cortical thicknesses as functions on the unit sphere. This talk will include my preliminary results modeling the dataset using this Nadaraya-Watson regression and future work.

An Analysis of Consumer Expenditures and the Great Recession
Robert Garrett
Miami University
Room 128

The Great Recession (2007-2009) created a well-established decline in the U.S. economy. This impact is typically measured with broad summative values, such as Gross Domestic Product and the national unemployment rate. The U.S. Bureau of Labor Statistics Consumer Expenditure data provides a more focused look into the demographics, financial situations and expenditures of U.S. Citizens. We aim to study the effects of the Great Recession on individual economic behavior. First, we visualize notable changes in consumer habits before and after the recession and compare the results to Macroeconomic trends. We then analyze the budgeting habits of US Consumer Units to identify useful information for modeling. Finally, we utilize the CE data to build a predictive model to estimate the continued effects of the Recession on Consumer Units.
3:35 p.m. - 3:50 p.m. (cont’d)

Option Pricing in Discrete Time: A General Theory
Peter Kawiecki
University of Dayton
Room 146

This project provides an understanding of basic pricing theory of derivative options from a financial mathematics perspective, based on discrete time and stochastic processes with a finite number of potential binomial tree paths. In particular, we explore topics in probability with an emphasis on expected values, finance with a focus on interest theory, and general intuition of solving algebraic expressions as applied to real world problems. We also explore and give background on European style options, American style options, and some other forms such as a “lookback” option. In discussion, not only we understand their differences and how they relate, but also work to accurately price them based on potential future valuations.

Stability In Nonlinear Infinite Delay Volterra Intro-Differential Systems
Sarah Alshammari*
University of Dayton
Room 150

We employ Lyapunov functionals to the system with infinite delay Volterra Integro-differential equations and obtain conditions for the stability of the zero solution. In addition, we will furnish an example as application.
3:55 p.m. - 4:10 p.m.

**Investigation into Homogeneous Functions**
Laura Gaines**, Brigid Griffin**, Madeline Karolak**
Kettering Fairmont High School
Room 107

This talk will define homogeneous functions giving examples and non-examples. It will also discuss applications to Euler’s Theorem.

**Packing the Plane**
Matthew Gerstbrein
University of Pittsburgh
Room 108

Given a convex two-dimensional shape, how might we pack the plane with non-overlapping images of this shape? There are plenty of ways, but one specific manner of doing so is finding the densest packing of this shape available. We may refer to this as a shape’s optimal lattice packing. An interesting question in discrete geometry is to then consider which shape has the worst optimal lattice packing. The Reinhardt Conjecture hypothesizes the solution as the smoothed octagon, where the corners of the octagon are replaced by hyperbolic arcs of maximum curvature. Identifying this curvature as maximal, we can reinterpret the Reinhardt Conjecture as a problem in optimal control theory, where the optimal packing density of a given shape is referred to as the ‘cost’. While a technique to the solution of the Reinhardt Conjecture will not be discussed here, a naturally related question will be. Specifically, given a particular shape’s optimal lattice packing, can we find another shape which has a lower cost (that is, it has a worse optimal packing)? In particular, the cost of the (unit) circle is well known to be \( \pi/\sqrt{12} \), so might we be able to explicitly construct a shape whose cost is strictly less than this? Here, I will present a potential method of construction of such a shape, utilizing concepts presented in The Reinhardt Conjecture as an Optimal Control Problem, authored by Thomas Hales, by reinterpreting the problem in the context of the hyperbolic geometry of the upper-half plane.

**A Mathematical Model to Evaluate Iodide Concentration Dynamics and Its Effect on Neurological Development**
Marina Mancuso
University of Dayton
Room 119

In this study, a biologically based dose-response model representing iodide concentrations circulating through lactating dam and nursing pup body compartments is modified to model a dam and fetus scenario. Iodide plays an essential role in developing thyroxine (T4) and triiodothyronine (T3) hormones. These hormones are secreted by the hypothalamic pituitary thyroid axis and are suggested to impact fetal neurodevelopment. This model analyzes the dynamics of iodide interacting between a dam and fetus. Optimizing parameters and sensitivity analysis allow increased understanding of the factors that influence the development of T3 and T4 hormones due to iodide deficiencies. Further research will evaluate the impact of iodide deficiencies in fetal neurodevelopment.

**Baseball: Defense or No?**
Jacob Stemmerich
Bethany College
Room 128

A series of defensive statistics, provided by FanGraphs, compares the average baseball player to a specific player. Each statistic it provides is scaled by the number of runs saved. This collection of numbers attempts to demonstrate the amount of runs a player saves in several different ways. With that being said, an overall measurement of an individual’s defensive contributions using all of the mentioned statistics has yet to be established. Wins above replacement, WAR, brings together multiple statistics to put a value to an individual as to how they contribute to a team’s record. This progress report will break down these defensive statistics, and test how to bring them together to find one brand new statistic similar to WAR. What will the statistic read? How should it be weighted? Can this improve WAR? The discussion will go over the questions listed and an open discussion on what potential problems could occur.
3:55 p.m. - 4:10 p.m. (cont’d)

*Introduction of Binomial Tree Model and Option Pricing*
Ying Ding*
University of Dayton
Room 146

In this presentation, I will talk about binomial tree model and option pricing. Options are widely used by investors in the financial market. The values of options depend on the underlying stock prices. Pricing options is an interesting and challenging problem. I will start with an introduction of options, then to explain how a multi-period binomial tree model can be used to calculate the prices of options written on a single stock. The binomial asset-pricing model provides a powerful tool to option pricing. Lastly, I will briefly talk about how to use the tree model to price options on two assets, which is the topic of my current research project.

*The Mathematics of Existence*
Paul Scheeler
University of Dayton
Room 150

A prominent criticism of metaphysics is that it is a set of mere philosophical conjectures and is essentially irrelevant, for it has been superceded by science in our quest for truth. For much of history, this claim has enjoyed some measure of validity; however, at the turn of the millennium, a new, mathematically rigorous theory, constructed from the ground up with tautologies, appeared. This novel theory describes reality as a self-contained, self-processing language identical to its universe on the syntactic level. This presentation breaks down the highly technical mathematical language into understandable terms and expounds on its profound implications. It is based on the work of Christopher M. Langan found in his papers: *The Cognitive-Theoretic Model of the Universe* and *An Introduction to Mathematical Metaphysics.*
Biography of Kenneth C. Schraut

Kenneth Charles Schraut was a professor of mathematics at the University of Dayton for over 50 years. He was born in Hillsboro, Illinois, on May 19, 1913. At the University of Illinois, where he graduated with a bachelor's degree in mathematics in 1936, he was a member of the honorary fraternity Phi Nu Epsilon. He earned both a master's degree (1938) and a Ph.D. (1940) from the University of Cincinnati.

Dr. Schraut was a visiting instructor at the University of Notre Dame in the summer of 1940 before coming to UD in the fall. He taught full-time at UD from 1940-1978 and continued teaching part-time from 1978-1993. Dr. Schraut was chairman of the Mathematics Department from 1954-1970 and founded a summer institute for high school mathematics teachers on campus. He taught math classes to business and pre-medical students, along with algebra, trigonometry, calculus, and advanced engineering mathematics. Dr. Schraut established the UD chapter of Pi Mu Epsilon (National Mathematics Honor Society) and was an advisor for pre-medicine students.

Dr. Schraut maintained strong relations with many alums and he was famous for his newsy Christmas letters. To this day, the Department of Mathematics maintains that spirit with the annual Newsletter. Dr. Schraut initiated the Biennial Alumni Career Seminar, both to maintain strong connections with alums and to connect the current student body with the alums. Again, the department maintains that spirit and in 2016, hosts the 27th Biennial Alumni Career Seminar.

His memory is honored at UD through a dedicated classroom, the Kenneth C. Schraut Memorial Lecture (an endowed lecture series), the Kenneth C. Schraut Memorial Scholarship, and the Schraut Research Award.

Among his most notable accomplishments was his pioneering work with what became the University of Dayton Research Institute. In 1949, Dr. Schraut and his top 10 math students received a $10,200 contract from Wright-Patterson Air Force Base (WPAFB) to analyze or "reduce" aircraft flight load data. This project, which became known as Project
Globe, was followed by a second data reduction contract for $25,000. From 1951-1952, Dr. Schraut directed the expansion of research efforts at UD. In 1952, he began Project Delta, recruiting full-time professional researchers for nuclear weapons effects research. From these beginnings, sponsored research at UD grew to $1 million by 1956 and on September 1 of that year, UD Research Institute was formally established.

Dr. Schraut's civic and professional activities included the American Math Society; the Math Association of America; the American Society for Engineering Education, for which he was chairman of the Math Division; the American Association of University Professors; the Metropolitan Dayton Honors Society; and the National Science Foundation Summer Institute, which he directed in 1959 and 1961-1967.

For his contributions to the University, Dr. Schraut received the first distinguished service professor award in 1972 and the Lackner Award in 1987. On May 9, 1992, the University of Dayton held an event to celebrate his career of over 50 years. Dr. Schraut died on October 29, 1997 at the age of 84.
Slate of Schraut Lecturers

- 2000: **Joe Diestel**, Kent State University  
  *Sums and Series in Vector Spaces*
  *Geometry in Two and Three Dimensions*
- 2002: **Paul Campbell**, Beloit College  
  *How to Keep Up With Mathematics*
- 2003: **Robert Lewand**, Goucher College  
  *How Not to Get Lost While on a Random Walk*
- 2004: **Jane Pendergast**, University of Iowa  
  *Beyond Reasonable Doubt: The Role of Statistics in Health Research*
- 2005: **Patrick Flinn**, National Security Agency  
  *Gröbner bases: A Natural Extension of Gaussian Reduction and the Euclidean Algorithm*
- 2006: **Greg Campbell**, Federal Drug Administration  
  *The Role of Biostatistics in Medical Devices: Making a Difference in People’s Lives Everyday*
- 2007: **William Dunham**, Muhlenberg College  
  *An Euler Trifecta*
- 2008: **Robert Bolz**, Lockheed Martin Corporation  
  *Leadership Founded in Habits of Inquiry and Reflection*
- 2009: **Thomas Santner**, The Ohio State University  
  *These Aren’t Your Mothers and Fathers Experiments*
- 2010: **Eugene Steuerle**, The Urban Institute  
  *Every Time I Turn Around There’s Dr. Schraut or You Can’t Take Mathematics out of a U.D. Mathematics Major*
• 2011: **Jeffrey Diller**, University of Notre Dame
  *Imaginary Numbers, Unsolvable Equations, and Newton’s Method*

• 2012: **Lilian Wu**, IBM Technology Strategy and Innovation
  *Creating Macroscopes with Technology and Analytics: New Possibilities in Our Lives – The Important Role of Tomorrow’s Mathematics Professionals*

• 2013: **Thomas Bohman**, Carnegie Mellon University
  *Randomness and Pseudorandomness in Combinatorics*

• 2014: **Rafe Donahue**, BioMimetic Therapeutics, Inc
  *Data Stories and Pictures: Discovering Lessons and Principles for Statistics and Life*

• 2015: **Chikako Mese**, Johns Hopkins University
  *Riemannian Geometry*

• 2016: **David Diller**, CMDbioscience
  *A Role for Mathematics in Understanding and Curing Disease?*

• 2017: **Joe Gallian**, University of Minnesota Duluth
  *Breaking Driver’s License Codes*