SCHEDULE FOR 38TH ANNUAL MATHEMATICS SYMPOSIUM
WESTERN KENTUCKY UNIVERSITY
NOVEMBER 9-NOVEMBER 10, 2018

***Gatton Academy Student, **Undergraduate Student, ***Graduate Student**

FRIDAY, NOVEMBER 9, 2018

Registration and refreshments begin at 3 PM on 1st floor of Ogden Hall

Welcome (Friday 3:25-3:30 PM, Ogden Auditorium)
Bruce Kessler, Head of the Department of Mathematics
Cheryl Stevens, Dean of Ogden College of Science & Engineering

Keynote Talk (Friday 3:30-4:20 PM, Ogden Auditorium)

How to always win at beanbag toss (if you're a robot)
--or--
Why you already know calculus, and how a little more can change your life
Friday 3:30-4:20 PM, Ogden Auditorium
Jason Cantarella, University of Georgia

Abstract: Suppose you have to make a free throw in basketball, toss a coin into a wishing well, or throw a horseshoe onto a peg. All of these tasks require you to swing your arm to accelerate the ball to the right speed, and then let go at just the right moment. You can do this, but how do you it? How do you know what the right speed or the right time are?

In this talk, we'll discuss the mathematics of throwing a ball onto a target. Come prepared to think about the problem yourself (laptops are welcome). We'll test our model with a little throwing robot named Cy, which we'll program to throw a ball bearing into a coffee cup from about 3 feet away.

Registration and refreshments move to 1st floor of Snell Hall following the Keynote Talk

Physics and Analytics Session (Friday 4:30-6:20 PM, SH 1108)

Fourier Analysis of Audio Files
Friday 4:30-4:50 PM, SH 1108
Wyatt Ringo*, Western Kentucky University
Jason Tran*, Western Kentucky University

Abstract: Within *Mathematica*, a given audio file is interpreted using Fourier Transforms, which separates a signal into its component frequencies, and this analysis returns sheet music graphics, a playable sound object, and a MIDI file. A given audio sample (within certain restraints) is divided into segments with a duration of a thirty-second note at a given tempo. A Fourier Transform is applied to find all frequencies in each segment, with the frequency of the highest relative magnitude in each segment being attributed to the closest musical note or rest. Repeated pitches are combined to form the largest note sizes possible and are translated to standard musical notation. The note values are plotted onto a standard measure, a recreation of audio is returned to the front end, and a MIDI file is exported.

Modeling Rocket Performance
Friday 5:00-5:20 PM, SH 1108
Drew Aubry*, Western Kentucky University
Caden Dosier*, Western Kentucky University

Abstract: Our project is a computer aided design (or CAD for short) software, written in Mathematica, that aids the user in creating useful model rockets and was a part of our Math 371 course. It was a 6-week project counting as our final grade in the class. It takes in various pieces of user input that changes aspects of the rockets performance. It then gives the user information about how their rocket performs and has them attempt to complete given missions. This is in effort to help the user understand how varying aspects of the rocket make it either more or less efficient.

We had three main goals for our project: the first being to the aid the user in designing a useful rocket, the second being to help the user understand what they created and how it moves, the third being to have them complete simple missions so they can see applications for what they created. All of the calculations done by the software are able to be done by hand, but the program is able to do them many orders of magnitude faster making the design process significantly easier.

Following the Euler-Cromer method of physical analysis, we were able to approximate the performance of a model rocket designed by the user. Using an iterative process, we were able to accurately model the drag, acceleration, velocity, and position of the rocket.

Creating Clock-Centered Diagrams Used to Explain Physics Principles Relating Relativity/Time on Other Planets
Friday 5:30-5:50 PM, SH 1108
Annika Avula*, Western Kentucky University
Anna Strunjas*, Western Kentucky University

Abstract: The purpose of this project was to create a set of diagrams centered on clocks to help visually explain physics principles relating to time relativity/time on other planets and demonstrate their effects. The Theory of Relativity was emphasized, as well as concepts such as the Lorentz Transformation, space contraction, and time dilation. One diagram contained a clock centered on Relativistic Time Dilation that utilized a slider to input rocket velocity and thereby increase or decrease the time discrepancy between the time observed on a clock inside the rocket by a stationary observer, and the time that is actually on the clock. Another diagram showed two clocks, one demonstrating time and one demonstrating the user's age on the specified planet based on respective rotation and revolution periods. The output of this diagram was based on a series of user inputs. The last diagram showed the effects of a Lorentz contraction and calculated time discrepancies in a situation similar to the Twin Paradox. Wolfram *Mathematica* 11.11 was utilized for this project.

So I've Landed My First Analytics Job!...Now What?
Friday 6:00-6:20 PM, SH 1108
Cameron White, Fruit of the Loom

Abstract: In this talk, Cameron will discuss some of the common pitfalls and hiccups that entry-level analysts and data scientists run into beyond mathematics or statistics. Designed to be accessible to all that are interested in the field (not just math majors), this talk will cover topics on presenting data to a non-technical audience, the realities of real world data compared to academic data, and other unexpected pitfalls one may encounter in the field.

Analysis, Algebra, and Probability Session (Friday 4:30-6:20 PM, SH 1101)

Unexpected Zetas! Zeta Functions and Their Values in Undergraduate Mathematics

Friday 4:30-4:50 PM, SH 1101

Dominic Lanphier, Western Kentucky University

Abstract: Zeta functions, such as the Riemann zeta function, are subjects of some of the most difficult problems in mathematics. Indeed, two of the seven millennium problems (the Riemann Hypothesis and the Birch-Swinnerton-Dyer Conjecture) involve zeta functions. Ever since Euler solved the celebrated Basel problem, values of zeta functions have seemed surprising, mysterious, and deep. Nevertheless, zeta functions and their values can and do show up naturally in undergraduate-level problems. We will review some history of zeta functions and their values. Along the way, we will become acquainted with some unexpected appearances of zeta functions and their values.

Results on Non-Nilpotent Graphs of Groups

Friday 5:00-5:20 PM, SH 1101

Andrew Davis, Western Kentucky University**

Abstract: This talk will be an overview of the results from an REU where I explored the properties of non-nilpotent graphs associated with groups. These include results about well known groups like dihedral groups, as well as results on the connection between non-nilpotent graphs and non-commuting graphs.

Algebraic Properties of Neural Codes

Friday 5:30-5:50 PM, SH 1101

Katie Christensen*, University of Louisville**

Abstract: The neural rings and ideals as an algebraic tool for analyzing the intrinsic structure of neural codes were introduced in 2013. Since then they were investigated in several papers, in which the notion of polarization of neural ideals was introduced. In this talk we extend their ideas by introducing the notions of polarization of motifs and neural codes. We show that the notions that we introduced have very nice properties which could allow the studying of the intrinsic structure of neural codes of length n via the square free monomial ideals in $2n$ variables and interpreting the results back in the original neural code ambient space.

Probability and Peremptory Challenges: Is Equal Always Equitable?
Friday 6:00-6:20 PM, SH 1101
Emma Lawson, Western Kentucky University**

Abstract: Mathematics can be applied in nearly any place of work, including the courtroom. In any jury trial, both the prosecution and the defense play an equal role in the jury-selection process. However, does equality ensure equitability? Using Bayes' Theorem and binomial probabilities, we attempt to answer that question and explore the fairness of the current judicial procedures.

Mathematical Biology Session I (Friday 4:30-6:20, SH 1102)

Methodology and Demonstration of Electrocardiogram Interpreter "Jaysax"
Friday 4:30-4:50 PM, SH 1102
Sasha Sairajeev*, Western Kentucky University
Julia Stekardis*, Western Kentucky University

Abstract: In the Spring of 2018, we developed an interactive program in Mathematica named Jaysax: your Healthcare Companion. Jaysax contains cardiac diagnostic tools, as well as educational functions in order to teach the user about the human body. This presentation will detail our methodology, and will include a demonstration of the software. The primary diagnostic tool is the electrocardiogram (EKG) interpreter. An EKG is a cardiac test that records the electrical activity of the heart through electrode patches throughout the body. The program converts an image file of a 6 second, lead-I EKG rhythm strip into point values in *Mathematica*. Using root mean square deviation, calculations across a database of 19 arrhythmias are completed to identify the top five most likely arrhythmia diagnoses. The purpose of Jaysax is not to replace the physician's place in a health care setting, but to provide alternate diagnoses. Further developments to be made to Jaysax include, but are not limited to: lengthening the arrhythmia database, additional educational functions, and improve accuracy of matching algorithm.

Using Mixed Effects Modeling and Global Sensitivity Analysis to Find Influential Parameters in a Wound-Healing Model
Friday 5:00-5:20 PM, SH 1102
Jameelah Alotaibi*, Western Kentucky University**
Abdullah Ateyeh*, Western Kentucky University
Rithik Reddy*, Western Kentucky University

Abstract: To formulate a mathematical model that accurately represents the physiology of a wound, the model must easily predict the most influential factors that affect the chronic wound-healing process. Due to the complexity in treatment and healing process

of chronic wounds, we measure parameters for individual patients when data are sparse. To be able to get sparse data for patients, we use information and data from other patients to help with information for an individual patient. To understand and establish treatment strategies for a chronic wound, mixed effects modeling (MEM) is used. MEM is parameter estimation technique used for curve fitting which splits parameters into fixed and random effects and is used mainly for sparse data. Fixed effect is assumed to be same across each data collection and the other hand random effect varies from parameter to another. Next, by using the differential-equation model that describes the interactions among matrix metalloproteinases, their inhibitors, the extracellular matrix, and fibroblasts (Krishna *et al*., 2015), this two approaches using global sensitivity analyses were performed. In the first approach, two matrices are constructed and then filled with quasi-random numbers chosen from a specified uniform distribution. From this, “Sobol” or “sensitivity” indices are computed for each patient, and then results are evaluated. The next method is Morris screening, which measures the change in the state variables when a specific parameter is slightly modified from the predicted value. A sum of squares of the differences between the old and modified model can be used to give the overall influence each parameter has on the model. Overall, these methods aided in finding the most significant factors in the wound-healing process, which can further be used to more accurately predict the healing process for patients.

Applications of Differential Equations in Chemical Kinetics
Friday 5:30-5:50 PM, SH 1102
Wilson Horner, Western Kentucky University**

Abstract: Differential equations are frequently used to model the physical world, and have wide applications across many fields. One area of study where ordinary differential equations are quite useful is that of chemical kinetics. Chemical kinetics is the field of studying the motion of molecules in chemical reactions. We can successfully utilize differential equations to examine these reactions, and gain applicable knowledge from them. Specifically, knowledge about a reaction’s order, rate, and concentration of species can be gained through the use of ordinary differential equations. Traditional approaches are analyzed for simple zeroth, first, and second-order reactions, and other numerical approaches are viewed for solutions to more complex reactions, some being of higher order.

A Computational Amino Acid Contiguous Sequence Assembler
Friday 6:00-6:20 PM, SH 1102
Matthew Knerr*, Western Kentucky University

Abstract: My presentation is centered on my Computational Problem Solving project: an amino acid contiguous sequence assembler. Normally short DNA reads are assembled into contiguous sequences at the nucleotide level by connecting fragments with similar ends. Because of the limited diversity in nucleotides (ACGT), mismatching of fragments because of similar ends can be a problem in assembly. The question of this project is whether short reads can be translated into their amino acid equivalent and then assembled into long contiguous sequences, thus taking advantage of the increased diversity of the 20 amino acids to more accurately assemble the short DNA fragments.

To initially develop this method we took a known DNA sequence and randomly broke it into 150 bp fragments, a size similar to the fragments generated by DNA sequencing. We next translated each DNA fragment into an amino acid sequence for each of the three forward and three reverse reading frames.

Since it takes three DNA bases to code for one amino acid, there are three reading frames for each of the two strands of DNA. The first frame begins by taking three nucleotides at a time beginning at the 5' end of the DNA and translating each triplet into their corresponding amino acids. For the second frame, you take the original copy of the read, drop the first base off of it and likewise translate it into the corresponding amino acid sequence, which creates a completely different chain. For the third frame, you take the original copy of the read and drop the first two bases and then translate the triplets into their corresponding amino acid sequence, once again creating a completely different chain of amino acids. Likewise, the three frames of the complementary DNA strand can be translated into their amino acid sequence. All six amino acid sequences are saved in a two dimensional array, with links to the original DNA sequence to allow for reassembly of the DNA from the final assembly of the amino contigs.

One set of six translations is used to start the assembly. The ends of each of the six translations are compared to all of the amino acid sequences and contigs are assembled by combining overlapping sequences. The order of the amino acid fragments in these contigs is tracked so that the corresponding DNA fragments can be reassembled. In the end, six amino acid contigs will be generated and they should each generate the same complementary DNA sequence. When applied to actual DNA sequencing products, this redundancy will serve as a quality check for mis-sequenced DNA.

Computational Session I (Friday 4:30-6:20 PM, SH 1103)

Traffic Simulation Coding
Friday 4:30-4:50 PM, SH 1103
Gillian Brown*, Western Kentucky University
Georgia Hoffman*, Western Kentucky University

Abstract: We utilized the computer program *Mathematica* to simulate various traffic scenarios. Our project attempts to determine the "efficiency" of certain traffic intersections and the type of stop that they incorporate. In practical terms, our code will help decide which kind of stop would be the best choice for an area based on the intersection and the amount of traffic that encounters it. In this talk, we will explain how math concepts play a major role in our project.

Rubik's Cube Tutorial Program
Friday 5:00-5:20 PM, SH 1103
Koushik Devarakonda*, Western Kentucky University
Trivan Menezes*, Western Kentucky University

Abstract: The Rubik's Cube is a 3-D puzzle cube invented by Ernő Rubik in 1974. Our project divides the 'Beginner's Method Algorithm' into steps, implementing them in a computer program which walks the user through the solution.

Recreating Deal or No Deal
Friday 5:30-5:50 PM, SH 1103
Evan Hendrickson*, Western Kentucky University
Aashka Sheth*, Western Kentucky University

Abstract: Using *Mathematica*, we re-created a popular TV game show called Deal or No Deal. In this game, there are 26 brief cases, each containing randomly assigned sums of money. The player claims one case at the start of the game, without revealing its contents. The contestant then chooses the other cases, in intervals, to be immediately opened and removed from play. After each interval, the player is offered an amount of money to quit by The Banker. We created an algorithm to generate the banker's offer with dynamic variables that are updated based on how the user is playing, depending on the values of the cases in play and other parameters. If the contestant rejects every deal and eliminates all the other cases, the player keeps the money that was in the original case. Unlike in the TV show version, we created a function that calculates the probability of the user selecting a case higher than the banker's offer, which assists the user in making a mathematically informed decision.

Pancake Stacking
Friday 6:00-6:20 PM, SH 1103
Isabel Chumbler*, Western Kentucky University
Samantha Vaughn*, Western Kentucky University

Abstract: Algorithms are commonly used in the mathematical community: teaching and explaining how problems are solved. The outcome of our research in the course Math 371 - Computational Problem Solving was a code that was heavily founded in functions constructed by the development of unique algorithms. The most significant finding was an elementary algorithm we created to reorganize arbitrarily sized items in descending order. An algorithm can clearly be analyzed through our Wolfram *Mathematica* coded function, which presents visual results. The final product reveals an effective code that can take *n* pancakes and stack them in descending order according to their varying diameters.

Pizza dinner break begins at 6:30 PM on 1st floor of Snell Hall

Career Panel Session (Friday 7:00-7:40 PM, SH 1108)

Career Panel Session Sponsored by the WKU SIAM Student Chapter
Friday 7:00-7:40 PM, SH 1108
Tom Grandine, The Boeing Company
Rachel (French) Lundy, Humana
Cameron White, Fruit of the Loom
Miky Wright, Elizabethtown Community and Technical College

Abstract: A career panel session is an opportunity for students to ask questions regarding your next steps after graduation. Questions can range from, “How did you get into your current position?” to “What courses should I take to best prepare a job in your field?” We have four great panelists: Tom Grandine, an applied mathematician at The Boeing Company; Rachel Lundy, an actuary at Humana; Cameron White, a data analyst at Fruit of the Loom; and Miky Wright, an instructor at Elizabethtown Community and Technical College.

Play (Friday 7:45-8:15 PM, SH 1108)

Math News
Friday 7:45-8:15 PM, SH 1108

Abstract: Regional news broadcast concentrating on top news stories of the week that effect the community of Mathematicians.

SATURDAY, NOVEMBER 10, 2018

Registration and refreshments begin at 8:00 AM on 1st floor of Snell Hall

Data, Computational Algorithms and an Actuary Session (Saturday 8:30-10:50 AM, SH 1108)

Utilizing the Eigenface Algorithm for Facial Recognition Within Small Data Sets

Saturday 8:30-8:50 AM, SH 1108

Devin Davis*, Western Kentucky University
Elvin Irihamye*, Western Kentucky University

Abstract: Early facial recognition techniques developed in 1987, showed how Principal component analysis, a statistical procedure utilizing orthogonal transformation, could be used to identify and compare facial features. Turk *et al*. (1991), expanded these findings by developing a system called the Eigenface method, which allowed for computers to preform Eigen-decomposition on large datasets of faces for facial recognition.We sought to re-create the Eigenface algorithim to work within a relatively small data set of facial images utilizing Mathematica, and to evaluate our methods effectiveness in either identifying the three nearest people based off facial features. In addition, we conducted several statistical tests to determine whether our method can discriminate based off factors like race, gender and body orientation. A method to compare an inputted face with a bank of pre-existing images was created based off the Eigenface algorithim. A user interface allowing for the input of an image for analysis, addition to the bank of faces and an instructions page were also created. Statistical tests showed 70% accuracy in the identification of a chosen person, 80% accuracy in race identification and a 70% accuracy in gender identification within the first three generated faces. Our findings function as a proof of concept for the utilization of the Eigenface algorithim with small-sized face sets, and opens new interesting questions regarding computer recognition.

Performance of Feature Subset Evaluators for Software Engineering Datasets

Saturday 9:00-9:20 AM, SH 1108

Huanjing Wang, Western Kentucky University

Abstract: The objective of feature selection is to identify irrelevant or redundant features, which can then be discarded from the analysis. Reducing the number of metrics (features) in a software dataset can lead to faster defect prediction model training and improve classifier performance. In the context of software defect prediction, we investigated two filter-based and five wrapper-based feature (software metrics) subset evaluators and built classification models using five different classifiers. The

models were evaluated using the area under the Receiver Operating Characteristic (ROC) Curve (AUC). All experiments were conducted on nine imbalanced datasets from a real-world software project. In this study, we have found that Correlation-Based Feature Selection performed best followed by *k*-nearest neighbors wrapper evaluator. The model built with support vector machine performed best.

Bracelet Pattern Generator
Saturday 9:30-9:50 AM, SH 1108
Benjamin Clements*, Western Kentucky University

Abstract: The purpose of this project was to develop an algorithm that can generate bracelets using strings of different colors. To predict the pattern of a specific type of bracelet we organized the bracelet into columns, rows, and assigned each node a number.

Utilizing Dijkstra's Algorithm for Campus Navigation
Saturday 10:00-10:20 AM, SH 1108
Andre Battle*, Western Kentucky University
Ethan Volk*, Western Kentucky University

Abstract: Dijkstra's algorithm developed in 1956, was originally conceived to find the shortest path between two nodes. A similarly innovative variant finds all the available distances from a source node to other available nodes, producing a shortest-path tree. Using Dijkstra's algorithm, I sought to find the distance and times to move from any starting location on campus to any ending location on campus. Within the interface, several additional factors were utilized including body weight and height (BMI) to calculate the average walking pace between the two locations. A user interface including a popup menu describing location names were created to supplement navigation capabilities. Our project serves as a proof of concept for Dijkstra's Algorithm on small scale maps, allowing users to accurately calculate the time needed for the individual to get from point A to B. This project was created with the hope that future developments could allow for the creation of a standalone or supplementary application, saving a couple more people from missing an important meeting, class or appointment.

My Life as an Actuary at Humana
Saturday 10:30-10:50 AM, SH 1108
Rachel (French) Lundy, Humana

Abstract: Rachel, a 2017 WKU graduate, is an actuarial analyst working on trend quantification and projection for Humana's Medicaid finance division. Rachel will talk about her work and some of the steps it took to get into her position.

Knots and Groups Session (Saturday 9:00-10:50 AM, SH 1101)

Gambling and Knot Diagrams
Saturday 9:00-9:20 AM, SH 1101
Uta Ziegler, Western Kentucky University

Abstract: Given a simple game where the player either wins a point or loses a point, with equal probability. How many different win-loss sequences of length 2*n* are there such that the player starts and ends with 0 points and always has a non-negative number of points? How can such a sequence be generated randomly?

This presentation discusses an algorithm to generate random 2-dimensional knot diagrams using the answers to the above question. Such knot diagrams were used to study knots empirically.

Minimal Diagrams of Alternating Knots
Saturday 9:30-9:50 AM, SH 1101
Caitlin Cook*, Western Kentucky University
Eamon O'Connor*, Western Kentucky University

Abstract: To calculate many knot invariants, it is necessary to have all minimal diagrams of a knot. It is known that from one minimal diagram of an alternating knot, all other minimal diagrams of that knot can be reached through a series of flypes, 180 degree rotations of tangles in the knot. We present an algorithm that carries out a flype in an alternating knot.

Braiding of Knots
Saturday 10:00-10:20 AM, SH 1101
Claus Ernst, Western Kentucky University

Abstract: You cannot just braid your hair, you can also braid a knots. This talk gives an introduction into using braids to represent knots.

Isomorphism Among Music Theory and Group Theory
Saturday 10:30-10:50 AM, SH 1102
Rachel Cunningham, Western Kentucky University**

Abstract: This talk will present and analyze the isomorphism between atonal music theory and the D_{12} group and then use such to investigate possible similar isomorphisms among atonal music theory and the groups of the symmetries of the platonic solids, also known as the regular polyhedra. This talk will also involve permutation groups, and isomorphisms among those, atonal music theory, and the groups of the symmetries of the platonic solids.

Mathematical Biology Session II (Saturday 8:30-10:50 AM, SH 1102)

Modeling the Effects of Negative Stimuli on Organs over Time

Saturday 8:30-8:50 AM, SH 1102

Katie Karl*, Western Kentucky University
Emma Lamb*, Western Kentucky University

Abstract: This project was created to be both a tool and a simulator to show and create models of how different negative stimuli affect organs of the human body over time. The code for this tool was developed in Mathematica, a function oriented coding platform. The most important aspect of this project was the versatility of the design tool created. It became essential to design a generalized way to model effects on the organs due to the fact that we needed to create organ models ourselves. We developed a process of overlaying an image with a well fitted grid. The purpose of this grid was to section off an image of an organ into pieces in order to choose various starting points for the spread of effects. The mathematical relevance of this project stems from this methodology of manipulating specific points on a given image. Once this was achieved, it was then necessary to find a way to mimic a gradient effect of damage spreading from these points. We approached this first by creating a lattice of disks, all intertwined with each other. This lattice replaced the colored, clicked rectangles in the grid where after the opacity of the disks was then altered. When animated, this overlay of disks on the organ image without a grid mimics the visual of damage spread over time on an organ's surface and interior. This project is heavily dependent on user interaction. This code relies on a user to use our tool in order for the actual goal of the program to be accomplished. For example, before any negative effect modeling can occur, the user (or the creators) first must use the design tool to indicate where the spreading must come from. The final outcome of this project was a user-interactive visual tool that can be widely used to model the negative effects of organs over time.

Modeling the Change in Relative Frequencies of Blood Types

Saturday 9:00-9:20 AM, SH 1102

William Bennett, Western Kentucky University**

Abstract: Suppose we have a population of an animal species with a life cycle of being born, mating once, and dying. Given that a certain number of the population has one type of blood, a certain number has another type, and so on, how can we expect the numbers to change throughout the succeeding generations?

Discrete Fractional Pharmacokinetics-Pharmacodynamics Model of Tumor Growth in Mice
Saturday 9:30-9:50 AM, SH 1102
Ferhan Atici, Western Kentucky University
Ngoc Nguyen, Western Kentucky University

Abstract: Describing tumor growth in mice with mathematical models can be categorized in two groups: Tumor growth in untreated mice and tumor growth in treated mice with anticancer therapeutics. For each group, we formulate the models with fractional difference equations and estimate the parameters for data fitting. To study drug effects, we introduce a Pharmacokinetics-Pharmacodynamics model as a system of fractional difference equations considering mono-therapy (single drug administration). After the point estimates for all parameters, we apply frequentist and Bayesian approaches to find interval estimates for the parameters. We give an overview on the comparison of the two approaches and the results of the interval estimates. Finally, we compare our findings with the existing results in the literature.

Breast Cancer Diagnoses Through Machine Learning
Saturday 10:00-10:20 AM, SH 1102
Tykeena Watson, Fisk University**

Abstract: Each year it is estimated that over 252,710 in the United States will be diagnosed with breast cancer and more than 40,500 will die. One of eight women will be diagnosed with breast cancer in her life time. In the last few years, breast Cancer has taken its decline because of the advanced technology being able to predict the state of the cancer and gain an immediate medication for the patient. The data set is retrieved from a Wisconsin 15 study that consisted of 569 patients, where 32 different factors were observed from a tumor gained by fine needle aspiration. There are multiple machine learning methods used to predict whether a tumor is malignant or benign and the contribution of each factor. After testing Linear, Support Vector Machine, Artificial Neural Network, and decision tree, we created multiple conclusions about which attributes contribute to the malignancy of a tumor. The most successful method compared to the results of previous studies was the Artificial Neural Method with a 97.02% accuracy for predicting whether a tumor will be malignant or benign.

A Predator-Prey Computational Game
Saturday 10:30-10:50 AM, SH 1101
Rithwik Ghanta*, Western Kentucky University
Elizabeth Roebker*, Western Kentucky University

Abstract: Our project is a cooperative game in which there are two users acting as parent birds who must protect their egg. This project uses the concept of fractals and the creation of various computer algorithms in order for users to be able to play. Users must move in all possible directions in order to protect their egg from predators while collecting food by pressing the spacebar.

Every time the user plays a new game a tree will be generated using fractals, where a similar pattern is recursively generated. This is done by making a recursive definition that a branch is a line with two lines connected to it. To make the two lines connected, the line is extended by 2⁄3 of its length and the extension was rotated by a theta about the endpoint of the un-extended line. The steps were then repeated for each branch until $2^{\text{branchIteration}}$ branches were created ($2^{\text{branchIteration}}$ - 1 times).

In addition, algorithms were used for the crow to appear randomly from a different starting place outside the screen. The worms will appear using an algorithm that randomly places them at different locations on the *x*-axis at random times.

Our algorithm for the predator uses a parametrized line in the form of *startpoint* + *s* (*endpoint* – *startpoint*) where *s*, *endpoint*, and *startpoint* are dynamically updated. The startpoints and endpoints of each "turn" in the path are pre-generated, where the first startpoint is generated outside the frame and the first endpoint is 3⁄4 of the distance to the first branch in the path of the crow's startingPoint and the egg. Then, the crow will move 10 units in a cardinal direction; however, the direction it chooses must have less than or equal to three branch intersections. The crow will not move to the right if it has a positive *x*, or left if it has a negative *x*. The crow moves in a way that it cannot go through 3 branches in any one "turn" and will leave after trying to get to the egg 5 times. The *treeIntersections* are calculated using a parameterized equation for each branch of the tree.

Computational Session II (Saturday 9:00-10:50 AM, SH 1103)

Greedy Minesweeper Algorithm
Saturday 9:00-9:20 AM, SH 1103

Pranay Agrawal*, Western Kentucky University
Abdullah Ateyeh*, Western Kentucky University

Abstract: We sought to re-create a popular online game from the 90s called Minesweeper. In this one-player game, the player is able to open up squares by right-clicking until a bomb is clicked or all non-bomb squares are opened. Using *Mathematica*, we implemented a playable game where the user has options to play randomized boards or a preset board. Unlike in the online version, our game lets the user customize his or her own board and save it for future play. There is also an option in the game for the AI to attempt to solve any board (including preset boards) from scratch, animating the moves taken. The AI can also be used to assist the player solving the game, highlighting the square that is most probable to not be a bomb. In this talk, we will demonstrate our project and discuss the algorithm we developed.

PDE Model for Computation of the Morphologies, Metastability and Coarsening of Quantum Nanoislands
Saturday 9:30-9:50 AM, SH 1103

Donald L Price, Western Kentucky University**

Abstract: Self-organized metal nanoisland arrays are important for the emerging technologies based on the nonlinear optics, plasmonics, photovoltaics, and photocatalysis. We computed morphological evolution of metal nanoislands using the model based on a nonlinear surface diffusion PDE for the film height function $h(x,t)$. This model for the first time incorporates the quantum size effect (QSE), whose origin is the quantization of the electronic energy in the direction across the ultrathin metal film. QSE leads to the terms in the PDE that exhibit complex oscillation (a beating pattern) in $h(x,t)$. Computations help understand the metastability of the strongly preferred heights that was found in experiments, show the morphological transitions and the surface diffusion routes by which a nanoisland reaches its stable height, and provide the coarsening laws for the island density and area. This research was funded by NSF Kentucky EPSCoR grant.

Different Perspectives on Functional Iteration
Saturday 10:00-10:20 AM, SH 1103
Mark P. Robinson, Western Kentucky University

Abstract: Many numerical approximation procedures involve the use of functional iteration, the process of forming a sequence

$$x_0, x_1 = f(x_0), x_2 = f(x_1) = f\big(f(x_0)\big) = f^2(x_0), \ldots$$

by repeated application of a function *f*. The use of such an approach in approximation problems is examined, as well as the global behavior of a sequence $f, f^2, f^3, \ldots$ of composite functions, in both the single-variable and multivariable cases.

Performance of the Parallelized Monte-Carlo Tree Search Approach for Dots and Boxes
Saturday 10:30-10:50 AM, SH 1103
Pranay Agrawal*, Western Kentucky University

Abstract: The Monte-Carlo tree search (MCTS) is a method designed to solve difficult learning problems. MCTS performs random simulations from the current situation and stores the results in order to distinguish decisions based on their past success. MCTS then selects the best decision and finally repeats the process. Parallelizing the MCTS means to divide the learning process among independent learners. Then, after a fixed number of simulations, the data is shared and combined. Past research has shown that this approach is faster than non-parallelized approaches. Therefore, we anticipate that the time reduced from dividing the learning outweighs the potential costs from redundant learning. Since it is often difficult to determine the effectiveness of algorithms in complex environments, it is sometimes more advantageous to develop strategies in simple environments such as games that can then be translated for use in broader real-life fields. In this project, our goal is to determine how controlling various resources affect the win-ratio performance of the game Dots and Boxes learned through a parallelized Monte Carlo Tree Search approach. The factors that can be manipulated are the following: the number of simulations, the number of independent learners, the amount of information shared from these independent learners, and how frequently the independent learners share. The general algorithm that is implemented, along with details of our modified Monte-Carlo tree search will be discussed.

Keynote Talk (Saturday 11:00-11:50 AM, SH 1108)

Applications of Contouring
Talk Sponsored by the WKU SIAM Student Chapter
Saturday 11:00-11:50 AM, SH 1108
Tom Grandine, The Boeing Company

Abstract: This presentation will cover several practical applications of the univariate contouring problem. Such contours can be generated by posing and solving a particular differential algebraic equation, and an effective numerical approach to that problem will be presented. What is particularly striking about the approach is the very large number of diverse applications of the problem which arise in an industrial setting involving both design and manufacturing.

Friday

3:30-4:20
Ogden Hall Auditorium
Keynote Talk: Dr. Jason Cantarella, University of Georgia

	Physics and Analytics Session SH 1108	**Analysis, Algebra and Probability Session SH 1101**	**Mathematical Biology Session I SH 1102**	**Computational Session I SH 1103**
4:30-4:50	Wyatt Ringo*, Jason Tran*, WKU	Dominic Lanphier, WKU	Sasha Sairajeev*, Julia Stekardis*, WKU	Gillian Brown*, Georgia Hoffman*, WKU
5:00-5:20	Drew Aubry*, Caden Dosier*, WKU	Andrew Davis**, WKU	Jameelah Alotaibi***, Abdullah Ateyeh*, Rithik Reddy*, WKU	Koushik Devarakonda*, Trivan Menezes*, WKU
5:30-5:50	Annika Avula*, Anna Strunjas*, WKU	Katie Christensen***, U Louisville	Wilson Horner**, WKU	Evan Hendrickson*, Aashaka Sheth*, WKU
6:00-6:20	Cameron White, Fruit of the Loom	Emma Lawson**, WKU	Matthew Knerr*, WKU	Isabel Chumbler*, Samantha Vaughn*, WKU

6:30-7:00: Break - Dinner

7:00-7:40: Career Panel session
Panelists: Tom Grandine, Rachel (French) Lundy, Cameron White, Miky Wright
SH 1108

7:45-8:15: Play
SH 1108

***Gatton Academy & Undergraduate Student, **Undergraduate Student, ***Graduate Student**

Saturday

	Data, Computational Algorithms and an Actuary Session SH 1108	**Knots and Groups Session SH 1101**	**Mathematical Biology Session II SH 1102**	**Computational Session II SH 1103**
8:30-8:50	Devin Davis*, Elvin Irihamye*, WKU		Katie Karl*, Emma Lamb*, WKU	
9:00-9:20	Huangjing Wang, WKU	Uta Ziegler, WKU	William Bennett**, WKU	Pranay Agrawal*, Abdullah Ateyeh*, WKU
9:30-9:50	Benjamin Clements*, WKU	Caitlin Cook*, Eamon O'Connor*, WKU	Ferhan Atici, Ngoc Nguyen, WKU	Donald Price**, WKU
10:00-10:20	Andre Battle*, Ethan Volk*, WKU	Claus Ernst, WKU	Tykeena Watson**, Fisk U	Mark Robinson, WKU
10:30-10:50	Rachel (French) Lundy, Humana	Rachel Cunningham**, WKU	Rithwik Ghanta*, Elizabeth Roebker*, WKU	Pranay Agrawal*, WKU
11:00-11:50 SH 1108 Keynote Talk: Dr. Tom Grandine, The Boeing Company				

***Gatton Academy & Undergraduate Student, **Undergraduate Student, ***Graduate Student**