The Fifteenth Annual
*Harriett J. Walton Symposium*
on
Undergraduate Mathematics Research

Program and Abstracts
Saturday, April 1, 2017
The Fifteenth Annual

*Harriett J. Walton Symposium*

on

Undergraduate Mathematics Research

Sponsored by

The Department of Mathematics
Morehouse College

The Division of Science and Mathematics
Morehouse College

Morehouse College

Saturday, April 1, 2017
Greetings from

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March 8, 2017

To those attending the annual Harriet J. Walton Symposium:

It is my great pleasure to welcome you to 15th annual Harriet J. Walton Symposium on Undergraduate Mathematics Research. As a mathematician myself, I deeply appreciate the value of this opportunity to engage in and then present your own research. Mathematical ideas can be particularly challenging to penetrate—both in terms of understanding and making new discoveries—and certainly to explain, especially to audiences outside of mathematicians. I applaud the students practicing and developing the skills required to do both. By investigating new problems, exercising the creativity required in developing new solutions, and clearly and concisely articulating the complex ideas they have encountered in their research, students are honing skills that will serve them well, whatever they pursue moving forward, and again, I applaud their efforts.

This symposium is named after Harriet J. Walton, a faculty member who taught in the mathematics department at Morehouse for over four decades. Colleagues of Dr. Walton have said that she brought both skill and enthusiasm to the classroom, and touched the lives of thousands of Morehouse men with her dedication and compassion. This Symposium helps to ensure the continued intellectual growth of the students about whom Dr. Walton cared so much.

Best wishes for a rewarding experience.

Sincerely,

Garikai Campbell
March 7, 2017

Dear Student Presenters and Colleagues:

On behalf of the division of Science and Mathematics at Morehouse College as Chair, I want to welcome you to the 15th Annual Harriet Walton Symposium. To the student presenters, I would first like to congratulate you and also encourage you to continue to pursue your research. Remaining active in research is important whether you intend to pursue a research career or not. Being involved in research will enhance your skills in critical thinking, problem solving and analytical reasoning. To the faculty, as an active researcher who has been heavily involved with training undergraduate laboratory assistants, I want to express my thanks for your commitment to provide guidance and opportunities for students to engage in active learning through conducting research.

I can think of no better person to honor than Harriet Walton, who over the course of forty-two years was an outstanding mathematics teacher and valued member of the Morehouse community. I wish all of the students who are sharing the results of their research today; much continued success and that some of you will pursue a career in research. I wanted to express to the faculty that your effort and commitment to training students in research is greatly appreciated.

Sincerely,

Duane Jackson, PhD
Professor of Psychology &
Chair of the Division of Science and Mathematics

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1 April 2017

Dear symposium attendees and presenters:

We are happy to have you participate in this Fifteenth Annual Harriett J. Walton Symposium on Undergraduate Mathematics Research. Since 2003, this symposium has become a highlight in the academic year for this region’s mathematics students and a valuable opportunity for them to synthesize their research experiences, hone their presentation skills, and share the results of their work with each other and with the accompanying faculty and guests.

We in the Morehouse College Department of Mathematics are appreciative of the work you have done and of your travels, in many instances, to join us today. Undergraduate research like that presented at today’s symposium serves to motivate and inform students about possibilities beyond the Bachelor’s degree and to develop skills and habits of mind that can benefit them in graduate study and beyond.

Thank you for your participation this year, and we hope you will continue your support, joining us again in 2018 and beyond.

Duane Cooper
Assoc. Professor and Chair
Department of Mathematics
dcooper@morehouse.edu
Professor Harriett J. Walton

In September 1958, Harriett J. Walton joined the faculty of Morehouse College during the presidency of Benjamin Elijah Mays. She became a member of a team of three persons in the Department of Mathematics where she worked with the legendary Claude B. Dansby who served as Department Chair. Dr. Walton and her two colleagues taught all of the mathematics for the majors as well as the mathematics for non-science students. Dr. Walton relates that two of her favorite courses that she taught during this period were Abstract Algebra and Number Theory. The three-member mathematics department did an excellent job of preparing their mathematics majors for graduate school and the other students for success in their respective disciplines. In fact it was during this period of history that Morehouse gained the reputation of being an outstanding Institution especially for African American men. As the department grew, Dr. Walton shifted her attention away from mathematics majors and began to concentrate on students who needed special attention and care in order to succeed in mathematics. She became an advisor, mentor, tutor and nurturer to a large number of students matriculating at Morehouse College. Because of the caring attitude that she had for her students, some of them to this day refer to her as “Mother Walton.”

Dr. Walton has never been satisfied with mediocrity. Throughout her teaching career she demonstrated a love for learning. In 1958 when she arrived at Morehouse College she had an undergraduate degree in mathematics from Clark College in Atlanta, Georgia, a Master of Science degree in mathematics from Howard University, Washington D.C., and a second Master's degree in mathematics from Syracuse University. While at Morehouse teaching full time and raising a family of four children, Dr. Walton earned the Ph.D. degree in Mathematics Education from Georgia State University. After receiving her doctorate, Dr. Walton realized the emerging importance of the computer in education so she returned to school and in 1989 earned a Master’s degree in Computer Science from Atlanta University. She is indeed a remarkable person.

Dr. Walton’s list of professional activities, awards and accomplishments during her career is very impressive and too lengthy to be enumerated here. However a few special ones are her memberships in Alpha Kappa Mu, Beta Kappa Chi, Pi Mu Epsilon, and the prestigious Phi Beta Kappa Honor Society. Additionally she was selected as a Fulbright Fellow to visit Ghana and Cameroon in West Africa. Dr. Walton’s professional memberships included the American Mathematical Society, the Mathematical Association of America, National Council of Teachers of Mathematics (NCTM) and the National Association of Mathematicians (NAM). She served as Secretary/Treasurer of NAM for ten years. In May 2000, Dr. Walton retired from Morehouse College after forty-two years of service.
Foreword

The Department of Mathematics and the Division of Science and Mathematics of Morehouse College would like to thank the student presenters and their advisors for their participation in the Fifteenth Annual Harriett J. Walton Symposium on Undergraduate Mathematics Research, a Regional Undergraduate Mathematics Conference (RUMC).

The purposes of the Symposium are the following:
- to encourage students to do more undergraduate mathematics research,
- to introduce students to their peers from various institutions and related fields,
- to stimulate student interest in pursuing graduate degrees in mathematics and science and
- to give students experience in presenting their research, both orally and in written form.

To all supporters, thank you for your help to make the Fifteenth Annual Harriett J. Walton Symposium on Undergraduate Mathematics Research a success. We hope to continue this event for many years to come.
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The Fifteenth Annual
*Harriett J. Walton*
Symposium on Undergraduate Mathematics Research
Saturday, April 1, 2017

**Schedule**

11:00 am - 11:20 am - Welcome in Dansby Hall, Room 200

11:30 am - 12:45 pm - Lunch

12:50 pm - 3:15 pm - Student Presentations

3:20 pm - 3:40 pm - Closing in Dansby Hall, Room 200

**Session 1: Dansby Hall, Room 300**

12:50 pm - 1:10 pm  **Mary-Stewart Wachter**
Birmingham-Southern College
*Simulating the Rotation of a Tornado*

1:15 pm - 1:35 pm  **Keyanna Davis**
Albany State University
*Applications of Parabolic Partial Differential Equations to Food Processing, Food Preservation and Cylinder Manufacturing*

1:40 pm - 2:00 pm  **Catherine Konde, Maurice Howard, Ne’kera Smith and Vreonna Strong-Belin**
Albany State University
*A Comparative Analysis of Retention and Graduation in the University System of Georgia*

2:05 pm - 2:25 pm  **Foster Johnstone**
Birmingham-Southern College
*Modeling Invasive Lionfish Growth and Diffusion*

2:30 pm - 2:50 pm  **Jesse Handlon and Austin Martin**
Birmingham-Southern College
*An Introduction to the Black-Scholes Formula*
Session 2: Dansby Hall, Room 302

12:50 pm - 1:10 pm  **Audrey Goodnight**  
Agnes Scott College  
*Cyclic Dynamical Systems*

1:15 pm - 1:35 pm  **Emily Piff**  
Agnes Scott College  
*P-adic Geometry in Two Dimensions*

1:40 pm - 2:00 pm  **Tanner Dixon**  
Birmingham-Southern College  
*Analyzing the Flow Free Problem and the Decomposition of Graphs into Paths*

2:05 pm - 2:25 pm  **Jasmine Key**  
Birmingham-Southern College  
*Invariant Elements in Permutation Groups to Generate Magic*

2:30 pm - 2:50 pm  **Brennan Farmer**  
Albany State University  
*Buying Versus Renting a Home*

Session 3: Dansby Hall, Room 306

12:50 pm - 1:10 pm  **Tiffany Heppard, Kierra Goodwin, Brandi Sumter and Alson Rice**  
Albany State University  
*Numbers Don’t Lie*

1:15 pm - 1:35 pm  **Thomas G. Floyd**  
Albany State University  
*Using Agricultural and Fixed-Income Investments to Enhance Economic Growth of Early County, Georgia*

1:40 pm - 2:00 pm  **Tracey Vu**  
Birmingham-Southern College  
*Mathematical Strategies for the Game 2048*

2:05 pm - 2:25 pm  **Daphne Chen, Qizuan Hou, Sai Naidu, Bob Sun, Tiantong Wang and Joy Lee**  
Georgia Institute of Technology  
*Word Trees and Bubble Trees: A Comparison of Data Visualization Methods for Search Optimization of Research Paper Databases*
2:30 pm - 2:50 pm  Terrence Brown  
Morehouse College  
The Five Color Theorem

Session 4: Dansby Hall, Room 307

12:50 pm - 1:10 pm  Leandre Kibeho  
Morehouse College  
Matroids

1:15 pm - 1:35 pm  Peter Mi  
Birmingham-Southern College  
The Classification of Timbres via Overtone Sequences

1:40 pm - 2:00 pm  William Dula  
Morehouse College  
NSFD Discretization for the Lotka-Volterra Predator-Prey Mathematical Model

2:05 pm - 2:25 pm  Brishanti Weaver  
Albany State University  
Solving Systems of Equations Using Mathematical Software

2:30 pm - 2:50 pm  Mohlomi Taoana  
Morehouse College  
Devil Facial Tumor Disease (DFTD)

Session 5: Dansby Hall, Room 308

12:50 pm - 1:10 pm  Keyanna Davis, Jessica Haynes, Katlynn Stodghill and Thomas Floyd  
Albany State University  
Analytical Case Studies of Incarceration in Dougherty County, GA

1:15 pm - 1:35 pm  Vernard Hurd and Alston Rice  
Albany State University  
The Application of Polynomial Regression to Agricultural Predictive Analysis

1:40 pm - 2:00 pm  Dru Home  
University of Georgia  
Counting Graph Derangements of the Ladder Graph $L_n$

2:05 pm - 2:25 pm  Cynthia Kagambirwa  
Birmingham-Southern College  
One-sided incomplete information in a three-person bargaining game
2:30 pm - 2:50 pm Cedric Campbell and Jamar Posey
Birmingham-Southern College
Colley Matrix with NEW lead change factor

2:55 pm - 3:15 pm Qixuan Hou
Georgia Institute of Technology
Modeling Distinct Flight Boarding Procedures
Abstracts

Terrence Brown, Department of Mathematics, Morehouse College
Title: The Five Color Theorem
Advisor: Dr. Curtis Clark

My Senior Seminar project is on a topic in Graph Theory, known as the Five Color Theorem. In it, we will learn some introductory definitions used all the time in Graph Theory like a graph, vertex, edge, and degree. From there, we will learn about different types of graphs and we will discuss Euler's Formula. Then we will discuss a concept called coloring, briefly discuss the Four Color Theorem and finally, we will state and prove the main theorem, the Five Color Theorem.

Cedric Campbell and Jamar Posey, Department of Mathematics, Birmingham-Southern College
Title: Colley Matrix with NEW lead change factor
Advisor: Dr. Doug Riley

We will examine the Colley Matrix and use its system to rank college football. This matrix system has played a pivotal role for years in the ranking of this college sport. In conjunction with the Colley Matrix, we have added another dimension to strengthen its rankings method. To fortify the matrix, we will use lead changes to help ensure a team has the proper ranking from week to week. We believe lead changes play a big role in determining if a team should receive a better ranking than another, based on a quality win or horrible loss. Our results will be compared to the previous football season rankings as well as the new College Football Playoff Committee. Our ranking system will be a new and improved measure that takes out bias in relation to college football standings. It will be an actual representation of how a team performs week in and week out.

Daphne Chen, Zixuan Hou, Sai Naidu, Bob Sun, Tiantong Wang and Joy Lee, Department of Mathematics, Georgia Institute of Technology
Title: Word Trees and Bubble Trees: A Comparison of Data Visualization Methods For Search Optimization of Research Paper Databases
Advisor: Dr. Robert Lee

Modern research institutions have large amounts of data to process, organize, and search. Searching through data individually is time-consuming and inefficient, so it is necessary to create tools to improve this process. Current methods of database searching raise issues
such as yielding results with jargon words or little relation to the query. These methods also frequently lack a useful priority ranking for each result. Furthermore, modern research archives such as PubMed limit their search to title-only, abstract-only, keyword-only, or figure caption text. This widely hinders the depth of the search, leaving multiple potential papers out of the results. Even if full-text search were an option, this would still leave the persisting problem of false-positive (incorrect indication that a word is present) and false-negative (incorrect indication that a word is absent) results. This study approaches these issues with data visualization techniques, since we sought to improve not only the results, but also the way the user interacts with them.

Through this study on data visualization (DV) of biomedical research text, we developed two methods of solving these issues by presenting search result data in an intuitive, functional format. The first uses the Word Tree (WT), which displays multiple branching relationships between the most frequently used words/phrases. The second is the Bubble Tree (BT), which provides a keyword’s related words within a file to specify users’ search. Both methods provide an additional data point, the “weight” of the word or phrase, which describes how often the specified text is used in the file.

We investigate and compare these two methods of DV: WT and BT, to determine which is better at reducing the number of jargon results and conveying the relevance of each result. Compared to existing methods, our proposed DV technique provides more accurate full-text database search results in addition to the ability to further narrow down results with a graphical display. We will demonstrate two DVs with “astrocyte” (a biomedical term) as the keyword.

Firstly, we produced customized word lists using statistical analysis and machine learning processes based on 200 papers about “astrocytes” as our training set. Secondly, we collected and summarized words from existing biomedical ontologies, such as RGDWeb, MeSH, and cellML. Each DV technique illustrates how creating a DV out of research paper text generates a dynamic map of a keyword to its related words/phrases, letting the user interact with the results beyond merely clicking on a top result. These techniques also mitigate the issue of false-positive results, since false-positives will have lower weights – saving the user time and effort.

Both methods assist researchers’ database searching, and optimize search results. Our data visualization strategy demonstrates a new approach to the issues that searching currently presents, which would give greater flexibility, accuracy, priority, and function to database search results.
Keyanna Davis, Department of Mathematics and Computer Science, Albany State University
Title: Applications of Parabolic Partial Differential Equations to Food Processing, Food Preservation and Cylinder Manufacturing
Advisor: Dr. Zephyrinus C. Okonkwo

Parabolic partial differential equations belong to one of the major classes on partial differential equations, with the other two classes being elliptic partial differential equations and hyperbolic partial differential equations. In this paper, we study analytical solutions of a class of parabolic partial differential equations with Initial-boundary conditions. Furthermore, we apply the methods studied to application problems: food processing, food preservation, and cylinder manufacturing.

Keyanna Davis, Jessica Haynes, Katlynn Stodghill and Thomas Floyd, Department of Mathematics and Computer Science, Albany State University
Title: Analytical Case Studies of Incarceration in Dougherty County, GA
Advisors: Dr. Vijay Kunwar and Dr. Laxmi Paudel

Incarceration, in the United States, is the common form of punishment for felonies and lower level offenses. With only representing 4.4 percent of the world population, the United States houses 22 percent of the world’s offenders. This research project will analyze the statistics of the incarcerations in the county jail in Dougherty County, GA from 2010-15. From the analysis of the criminal statistics, the correlation between ages, genders, and race will be determined.

Tanner Dixon, Department of Mathematics, Birmingham-Southern College
Title: Analyzing the Flow Free Problem and the Decomposition of Graphs into Paths
Advisor: Dr. Doug Riley

In this paper we generalize the puzzle game application Flow Free into a mathematical n x n graph. Applying certain chosen in-game restrictions and rules, we analyze when weak and strong solutions exist. We decompose the original graph into useful paths in order to properly analyze particular and general graph constructions.

William Dula, Department of Mathematics, Morehouse College
Title: NSFD Discretization for the Lotka-Volterra Predator-Prey Mathematical Model
Advisor: Dr. Ronald E. Mickens

The Lotka-Volterra model was the first attempt at deriving a mathematical representation of the interaction between predator and prey populations. While it is known not to provide an accurate model of this class of population dynamics, it does give several important insights into predator-prey phenomena. Since the two coupled non-linear
differential equations can not be solved explicitly in terms of the elementary functions, numerical solutions can be obtained by means of a variety of standard numerical integration techniques. Our major goal is to construct a discretization based on the Non-Standard Finite Difference Methodology of Ronald E. Mickens. We investigate this scheme and compare its mathematical properties to those of corresponding original differential equations. Particular features of interest include the number, location, and linear stability of the fixed-points; and the positivity of the solutions. Our calculations show that the NSFD discretization is dynamically consistent with the important features of the Lotka-Volterra system.

**Brennan Farmer**, Department of Mathematics and Computer Science, Albany State University
Title: Buying Versus Renting a House
Advisor: Dr. Laxmi P. Paudel

In this project, we visit various mortgage banks serving in Southwest Georgia to find out the lowest mortgage interest rate offered to a loan seeker with a given credit score. We collect the available combinations of the interest rates and service charges for a loan. We initially go with the 15-yr fixed mortgage plan to win the lowest mortgage interest rate. Later, we assume that monthly payment is higher than the minimum mortgage as per the 15-year fixed mortgage plan and prepare a dynamical system, consisting of difference equations, corresponding to the interest rate. We solve and analyze the dynamical system, display the amount of loan at various months under a higher fixed payment scheme. We display the results in the spread sheet as well as in the graphs. At the end, we compare the benefits of buying versus renting a house by taking into consideration of the real world situations, and provide a strong argument supported by our data.

**Thomas G. Floyd**, Department of Mathematics and Computer Science, Albany State University
Title: Using Agricultural and Fixed-Income Investments to Enhance Economic Growth Of Early County, Georgia
Advisor: Dr. Zephyrinus C. Okonkwo

For many years, counties in rural Georgia, including Early County, have been decreasing in population. This decrease has had immense negative economic impact on such counties: the tax base has decreased, other economic activities have dwindled. There is therefore the need to use statistical and financial mathematical tools to determine those attributes which could increase economic viability of such counties. Early County is on the Southwest quadrant of Georgia. It is mostly rural, with agriculture as the major source of economic income. The population of the county is about 11,713, with one county high school. While many citizens embark on small agricultural productions for food and sustenance, Early County has some large agricultural companies and ranches, and there is room for young people to consider self-employment through agriculture and other fixed income investments. In this study, we present a statistical study on agriculture, time series graphs, and forecast based on available data. The role of agriculture and fixed
income investments in the improvement of Early County’s viability and growth is delineated.

**Audrey Goodnight**, Department of Mathematics, 
Agnes Scott College 
Title: Cyclic Dynamical Systems 
Advisor: Dr. Rachel Bayless

Our research concerns finite dynamical systems generated by a function $f_r$ Defined by Adamaszek, Adams and Motta (2016). The function takes a set of points $X$ on a circle of unit circumference to itself by mapping each $x$ in $X$ to the clockwise furthest point within a given arc length $r$ with $0 < r \leq 1$. Although the eventual periodicity of any point in a finite dynamical system is well known, the specific behavior of this system in and before a periodic orbit presents an interesting avenue for further study. In particular, Adamaszek, Adams and Motta identified a special class of points denoted q-swift points. The existence of at least one q-swift point was found to imply a single periodic orbit in the entire system. We extended this definition to dq-swift points which were found to imply d periodic orbits.

**Jesse Handlon and Austin Martin**, Department of Mathematics, 
Birmingham-Southern College 
Title: An Introduction to the Black-Scholes Formula 
Advisor: Dr. Doug Riley

We introduce financial mathematics and examine the Black-Scholes formula. To understand the Black-Scholes formula one must understand its components. We then go through the process of pricing an option using the Black Scholes formula, and give reasons to why an investor would consider purchasing options. We focus on developing mathematical intuition as a tool for stimulating further undergraduate interest in financial mathematics.

**Tiffany Heppard, Kierra Goodwin, Brandi Sumter and Alston Rice**, Department of Mathematics and Computer Science, 
Albany State University 
Title: Numbers Don’t Lie 
Advisors: Dr. Vijay Kunwar and Dr. Laxmi P. Paudel

The purpose of the research is to determine the future outcome of the NFL Draft. The project will take the data from 2000-2016 NFL Draft and apply several parameters which will produce the percentage of what schools produce the most draftees. Upon seeing which schools produce the most draftees, the researchers will apply another set of parameters to specifically find the trend of why schools have more draftees than others.
Dru Horne, Department of Mathematics, University of Georgia
Title: Counting Graph Derangements of the Ladder Graph \( L_n \)
Dr. Maurice Hendon

Permutation and derangements on \( n \) letters are well understood, and these can be viewed as graph permutations and graph derangements on \( K_n \). What can we say about a general simple graph \( G \)? How many graph permutations are there for \( G \)? How many graph derangements? In this talk, we will look at the simple graph \( L_n \), the ladder graph, and count the number of graph derangements. In the process, we will generate a surprising sequence of numbers that is related to a well understood combinatorial sequence.

Qixuan Hou, Department of Industrial and Systems Engineering, Georgia Institute of Technology
Title: Modeling Distinct Flight Boarding Procedures
Advisor: Dr. Siva Theja Maguluri

In order to achieve high aircraft utilization, commercial airlines has made efforts to improve its turnaround performance, which is measured by the time between an airplane’s arrival and its departure. Passenger boarding is one of the many factors which determine turnaround time. We simulate distinct airline boarding procedures with Python, such as outside-in, random, rear to front, reverse pyramid, rotating zone, zone/block style, and also provide a mathematical model to measure the goodness of each procedure. By analyzing the model, we want to evaluate distinct boarding processes and to identify the most efficient boarding strategy. Ideally, with field observations and data analysis, a new procedure will be proposed to optimize the boarding time and improve turnaround performance.

Vernard Hurd and Alston Rice, Department of Mathematics and Computer Science, Albany State University
Title: Modeling Distinct Flight Boarding Procedures
Advisor: Dr. Robert Steven Owor

In a previous study, we applied simple linear regression to the estimation of regression parameters in Agricultural data modeling. Monotonic nonlinear transformations such as logarithmic, inverse or exponential functions of independent and/or dependent variables may model predictions accurately for Fibonacci type growth patterns, but if the relationship between \( X \) and \( Y \) is not monotonic, a polynomial regression becomes more accurate. A polynomial has two or more terms. The polynomials we most often use in simple polynomial regression are the quadratic, and the cubic. With a quadratic, the slope for predicting \( Y \) from \( X \) changes direction once, with a cubic it changes direction twice.

In this study, we transition the Predictive model from Simple Linear Regression to Polynomial Regression in order to better estimate the curvilinear relationship between Land Crop Rent Value and Crop Yield Values.
Some of the key questions we ask and attempt to answer in this research are:
a) What does the scatter diagram of the land rental rate versus crop yield value data look like?
b) Is there evidence that the polynomial model (specifically the quadratic and cubic model) could be more accurate than the simple linear regression model in predicting regression parameters in Land Crop Rent Rates versus Crop Yield Values?
c) Is there evidence of significant curvature to the relationship between Land Crop Rent Rates and Crop Yield Values?
d) How do Linear and Polynomial Regression Estimates compare asymptotically?
e) Could a mix of the two methods produce even more accurate results?

Foster Johnstone, Department of Mathematics,
Birmingham-Southern College
Title: Modeling Invasive Lionfish Growth and Diffusion
Advisor: Dr. Doug Riley

Over the years, invasive species have proven to cause harmful problems to Biological ecosystems. Coral reefs in the Western Atlantic and Caribbean have been plagued by one particularly harmful species, lionfish. Lionfish, native to the Indo-Pacific, were introduced off the coast of Florida in 1985. Since then, their population has increased at an alarming rate, and they have spread up the coastline of the Eastern United States, to islands in the Caribbean and throughout the Gulf of Mexico. In a report with CNN, Graham Maddocks, president and founder of the Ocean Support Foundation, states the lionfish invasion is probably the worst environmental disaster the Atlantic will ever face. The National Oceanic and Atmospheric Administration says that research has shown that a single lionfish can reduce the amount of native fish on a reef by up to 79 percent. Because of the abundance of prey, favorable climate and lack of natural predators, aside from humans, lionfish populations have exploded throughout the Caribbean and Western Atlantic. Understanding population dynamics for lionfish is important in addressing the threat they pose to these reefs. This paper discusses and models the growth and diffusion of lionfish throughout the Caribbean and Western Atlantic, making use of subpopulations in each area. There are seven subpopulations and each one is broken up into two parts, juveniles and adults. To control movement of lionfish between subpopulations and the adult and juvenile populations, a set of fourteen differential equations are used. Using this model can provide a better understanding of travel patterns and lead to solutions for controlling their spread.

Cynthia Kagambirwa, Department of Mathematics,
Birmingham-Southern College
Title: One-sided incomplete information in a three-person bargaining game
Advisor: Dr. Doug A. Riley

Most games are comprised of repetition, this is the foundation of our research. We analyze a three-person bargaining game with one-sided incomplete information. This research studies a game in which two informed players repeatedly alternate making offers
to divide a pot of size $T$ among the three players. One player is uncertain of the payoff function or the size $T$. We use Rubinstein’s model on two-person alternating-offer bargaining game with two sided incomplete information to generalize the three-person situation; we will investigate the short-term and long-term effects of one-sided incomplete information in the game. Meanwhile, we consider how players with extra information use the additional information to their advantage and how the uninformed player should gather information based on past plays or conflicts. Generally, repetition will drive players to cooperative agreements despite conflicts of interests among players.

**Jasmine Key**, Department of Mathematics, Birmingham-Southern College
Title: Invariant Elements in Permutation Groups to Generate Magic
Advisor: Dr. Doug Riley

Magic tricks are grounded in distorting the spectator’s reality. The magician is able to provide an unexpected result by misguiding the focus of a trick and leaving important elements invariant throughout the trick. Through the exploration of invariant elements, we will embark on a mathematical analysis of a card trick in the permutation group $S_5$. This card trick allows the spectator the freedom to alter the positions of the cards but consistently produces the predicted result using invariant elements.

**Leandre Kibeho**, Department of Mathematics, Morehouse College
Title: Matroids
Advisor: Lamar Tuwaner

Matroids were introduced by Whitney in 1935 to try to capture abstractly the essence of dependence. In this paper, I will present the background history of matroids and their definition. I will discuss the different types of matroids and their properties and also the proof of those properties. I will also discuss the basis, rank and circuit of matroids and their properties. In this paper, I will also present the application of matroids in different fields of optimization mostly in construction of the matroidal network coding capacity of networks under various network coding schemes. In this paper, I am going to address the problem with the approach of matroidal networks. In this approach, I will prove the converse of the theorem which states that, if a network is scalar-linearly solvable, then it is a matroidal network associated with a representable matroid over a finite field.

**Catherine Konde, Maurice Howard, Ne’kera Smith and Vreonna Strong-Berlin**, Department of Mathematics, Albany State University
Title: A Comparative Analysis of Retention and Graduation in the University System of Georgia
Advisors: Dr. Laxmi Paudel and Dr. Vijay Kunwar
This research project seeks to investigate the increase or decrease of students from the University System of Georgia (USG). The data that will be used for this research focuses on the first-time, full-time freshmen from the fall 2009 cohort. The research will collect, compile, and examine the data on the graduation rates of the undergraduates from the fall 2009 cohort, who completed their degree program within four years, five years, and six years. Similarly, data showing the retention rates of first-time, full-time undergraduates, who continued their education at the same school within a six-year period (2009-2015), will be compiled and examined. After comparing the data, we will discuss how the institutions have fared in retaining and graduating their students.

Peter Mi, Department of Mathematics,  
Birmingham-Southern College  
Title: The Classification of Timbres via Overtone Sequences  
Dr. Doug. Riley

Scientists commonly use “three elements of sound” to describe a certain sound: amplitude, frequency and timbre. Timbre, also known as tonal color, has the most complicated mechanism of the three, and it depends on the overtone sequence. Using software that can produce and edit sounds, I classify the timbres in a mathematical way, looking for mathematical description of musical categories.

Emily Piff, Department of Mathematics,  
Agnes Scott College  
Title: P-adic Geometry in Two Dimensions  
Advisor: Dr. Alan Koch

Let p be prime. We generalize the notion of p-adic valuation to define a new distance on QxQ. We compare the geometric behaviors between traditional Euclidean geometry and our extended p-adic geometry. As an application, we look at triangles in QxQ and study their properties.

Mohlomi Taoana, Department of Mathematics,  
Morehouse College  
Title: Devil Facial Tumor Disease (DFTD)  
Advisor: Dr. Shelby Wilson

Devil Facial Tumor Disease (DFTD) is one of the three rarest transmissible cancers affecting the last surviving carnivorous marsupial known as Tasmanian Devils, which are native to the island of Tasmania. We develop a mathematical model of the spread of the disease throughout the population of Tasmania and develop methods to curb the spread of the disease. In doing so, we model the cancer similarly to an infectious disease by exploring the commonly used Susceptible Infected and Recovered (SIR) model. Since recovery in cancer is not possible, the R term is disregarded thereby changing the model into an SI model. We then explore methods to decrease the spread of DFTD. We separate portion of the infected population annually for two reasons, namely; to reduce the frequency of contact between infected and susceptible, secondly, we allow for breeding
to happen among the quarantine infected devils. A mathematical simulation of this strategy portrays a decline in prevalence of DFTD with disease extinction expected within ten to fifteen years. These results suggest a path to disease eradication; hence the model can be used to in conjunction with the current strategies to curb the prevalence of DFTD.

Tracey Vu, Department of Mathematics, Birmingham-Southern College
Title: Mathematical Strategies for the Game 2048
Advisor: Dr. Doug Riley
The game 2048 is a new game that was first introduced as an online game by Gabriele Cirulli on March 9, 2014. The game is now a popular app for mobile devices. 2048 involves powers of 2 and swiping motions to move and combine the numbers on the grid with a goal in mind to create a space on the grid containing 2048. In this paper, matrices and counting functions will be observed in order to create a strategy in order to win the game. It is proven in this paper that a smaller 2x2 version of the game and its moves can be fully represented by matrices and transition matrices. It is also proven that a player can at least reach a space containing 8 in every game.

Mary-Stewart Wachter, Department of Mathematics, Birmingham-Southern College
Title: Simulating the Rotation of a Tornado
Advisor: Dr. Doug. Riley
In the field of Meteorology, there is still much to be discovered about tornadoes. There is a considerable gap in research for how they are formed. To contribute to this, we must fully understand the fundamentals of how the atmosphere is governed by particular equations. Narrowing our search, we will analyze the Navier-Stokes equations for the velocity components of wind speed. Using applied numerical analysis, we will enter these equations into Matlab. By fixing certain components of the Navier-Stokes equations, we will see if pressure alone is able to overcome the dispersion factor and cause rotation, thus simulating a simplified model of a tornadoes rotational aspects.

Brishanti Weaver, Department of Mathematics and Computer Science, Albany State University
Title: Solving Systems of Equations using Mathematical Software
Advisor: Dr. Vijay J. Kunwar
Consider the following system of equations:
\[ x + y - 3z = -8, \quad 3x - 2y + z = 11 \quad and \quad 2x + 5y - 7z = -22. \]
We can easily solve this system through hand-held computations:
\[ x = 2, \quad y = -1 \quad and \quad z = 3. \] The task becomes more challenging when (i) the degree goes higher and (ii) the system goes bigger. Now consider the following system of equations used to find a special rational function called the Belyi function:
c(a + 2h + 4) = 0, -be^2 + cd^2 = 0, -c(4a – 2g – h^2 + 6) = 0,
2c(3a + f + gh + 2) = 0, 2cdf + 2be + e^2 = 0, 2cdg + cf^2 – b – 2e = 0,
-c(4a – 2d – 2fh – g^2 + 1) = 0 and 2cdh + 2cfg + ac + 1 = 0.

This is a system of 8 equations and 8 unknowns. It is too difficult to solve this system manually. This is one example to reinforce the necessity of computer software to solve mathematical problems. Our Maple implementation returns the following solution to the above system:

\[ a = \frac{-8}{7}, b = \frac{25}{21}, c = \frac{343}{192}, d = \frac{-1000}{2401}, e = \frac{25}{49}, f = \frac{340}{343}, g = \frac{-15}{49}, h = \frac{-10}{7}. \]

In this presentation, we will implement efficient techniques to solve systems of equations like above arising from real world applications using mathematical software like Maple.