Abstracts

“Directional Bias in 2-Dimensional Particle Swarm”
Aubrey Hormel, Missouri State Univesity
Faculty Advisor: Dr. Steven Senger, Missouri State University

We explore the popular 3-zone model of a particle swarm, basing directional and position algorithms on those published by Couzin et al. We introduce heterogeneity in the form of directional biases to the left and right. The model simulates 200 particles, half of which are biased to each side. Initial runs of the simulation show the particles quickly forming a ring that continually increases in diameter, but by increasing the radius of the zone of orientation, the simulation achieved cohesive, swarm-like behavior. Simulations were ran four times with 100 time steps for each behavior type. We evaluated the simulations with no bias, bias for the full 100 time steps, bias for the first half of time steps, and bias for the second half. In the ring state, the presence of bias made little difference in the overall behavior of the swarm. However in the swarm state, the bias caused the particles to form two distinct swarms which continually translated away from each other. An interesting result was observed in the swarm state during the run with bias in the first of simulation: when the bias is taken away, the two swarms begin to move toward each other once more, forming a quasi-ring by the end of the simulation. Future work involves adjusting time step and bias parameters to achieve a simulation where the two swarms coalesce once more into a single swarm.

“Bifurcation Analysis of Neuronal Bursters, Parts I and II”
Brittany Knowlton, Evangel University, and Ngan Vu, Missouri State University
Faculty Advisor: Jorge Rebaza, Missouri State University

A model of neuronal activity is studied with a focus on bifurcation and stability analysis. In this presentation we will illustrate how bifurcations of codimension one and two help explain the rich dynamics of the system, including existence of equilibrium points, periodic orbits and homoclinic connections. This presentation includes several numerical simulations obtained using Matcont and Xppaut (software for continuation of solutions and bifurcation analysis), and it also provides some rigorous proofs on existence of some of bifurcations as well as proofs on local and global stability of equilibrium points.

Most of this work was done during the REU program at MSU in the summer 2017.

"Conjugacy Class Graphs of Dihedral and Permutation Groups"

Genevieve Maalouf, Hofstra University
Faculty Advisor, Dr. Les Reid Missouri State University

In this talk, we combine the study of group theory and graph theory by generating a graph from a group. If we take a group, *G*, we construct the graph $\Gamma(G)$ by computing the conjugacy classes of $G-Z(G)$. A node is produced by every conjugacy class and labeled with the cardinality of the class, c_i. Lastly, an edge connects two vertices if $\gcd(c_i, c_j)>1$. We say $\Gamma(G)$ is the conjugacy class graph generated by *G*. The main focus is to classify the graphs $\Gamma(D_{2m}, D_{2n})$, where D_{2k} denotes the dihedral group, and to study the completeness of $\Gamma(S_m, \mathrm{S}_n)$, where S_k denotes the symmetric group.

This work was done at the 2017 Missouri State REU and is joint with Taylor Walker (Tuskegee University).

"An Investigation of 2-Distance Sets in Two, Three, and Four Dimensions"

Adam Somers, Missouri State University
Faculty Advisor: Dr. Les Reid, Missouri State University

Given four points in the plane, a priori there are six possible distances between them. However, the four vertices of a unit square only have two distances: 1 (the length of the four sides) and $\sqrt{2}$ (the length of the diagonals). In this presentation, we completely determine all possible configurations of four points in the plane, five points in space, and six points in hyperspace having the property that there are exactly two distances that occur between them. We also describe avenues for future research.