# Abstracts
# Senior Seminar and Research Papers
# Spring 2006
# Simpson College
# Mathematics Department

***Connected Sets*** **by Macy Allen**

Fundamental concepts of Point Set Topology include topology, neighborhood, limit point, and the closure of a set. These concepts allow us to consider separated sets, which is fundamental to understanding connected sets. The wording for the definition of connected sets is somewhat difficult to work with so the definition of a relative topology is introduced so a characterization of connected sets can be proven. This characterization shows that a set, A, is connected if and only if no nonempty proper subset of A is both open and closed relative to A. Using this information, we can examine connected sets in the discrete, indiscrete, and general topologies.

***Monopolist Strategies in a Durable Goods Market*** **by Shikha Basnet (Honors Research Paper)**

In his classical model for durable goods monopoly, Ronald Coase conjectured that a monopoly will never be able to charge a price above the equilibrium competitive price and the monopoly will end up forgoing dominant market power. This talk will begin with discussing the ideas of Coase. Under certain circumstances, the ideas in the Coase conjecture break down, which we can see in high-end fashion industry. We will finish the talk by looking at a model that may shed light on this situation.

***Understanding the Bible Code*** **by Robert Delsing**

In 1994, three mathematicians named Witztum, Rips, and Rosenberg (WRR) published an article in the journal *Statistical Science* claiming that the names of influential rabbis and their birth or death dates were encoded within the Book of Genesis. Three years later, three mathematicians named Bar-Hillel, Bar-Natan, and McKay wrote a series of articles proving that the procedure used by WRR was fundamentally flawed and that these codes could be found in any significantly long text. The purpose of my project is to study the processes used by the mathematicians in order to understand how their results were obtained.

The use of Equidistant Letter Sequences (ELS) is essential to the mathematicians' processes. The names of the rabbis, as well as their birth or death dates, were found in Genesis as ELS's, which are formed by choosing a starting letter and repeatedly skipping over a certain number of letters in the text to obtain the positions of the next letters of the ELS. I have discovered several properties of ELS's and I am working on creating a formula that calculates the total number of ELS's possible in a text with a given number of letters. I am currently researching the use of arrays and distance functions on cylinders, used by the mathematicians to calculate the "distance" between two words, which is crucial to their research.

***The Chaotic World of Dynamical Systems*** **by Melinda Gatton**

Throughout the semester, I will be researching chaotic dynamical systems. This includes analyzing the mathematical equation $x_{n+1} = cx_n(1 - x_n)$. My analysis is focused of the results obtained though the process known as iteration, which is using the output of a previous operation as an input in the next operation calculated. After several iterations, the results could fall into one of three categories: the outputs of the equation could converge to one particular value, oscillate between two or more values, or the outputs are chaotic. The results obtained under one particular $x_0$ value are compared to the results obtained under a second $x_0$ value. In some cases the results obtained under the two $x_0$ values are the same, but in other cases the results are completely different. This difference in results is essentially what deems an equation to be classified as chaotic. My objective is to analyze the particular *c*-values that create chaos in systems.

***Zeta Functions of Finite Graphs*** **by Prakash Kayastha**

In 1966, Ihara defined the zeta function of a finite graph, and in 1989, Hashimoto discovered an equivalent definition. This presentation will focus on the definition given by both Ihara and Hashimoto. This presentation will show the relation between the number of edges and loops in a graph and the zeta function of the graph. We will take a look at an example of two different graphs that have the same zeta function but different number of vertices. Furthermore, we will discuss my programming approach to compute and compare the zeta functions of graphs with different number of vertices.

***Steady State Temperatures*** **by Brad Knox**

During this semester we have been working with conformal mappings. Our specific problem is an insulated, semi-infinite plate in the upper half of the complex $z = x + iy$ plane. In the semi-infinite plate along the $x$-axis the temperature is 0 except for $-1 < x < 1$, where the temperature is 1. Our goal is to find the isotherms in the rest of the plate. We will use a transformation $w = f(z)$ to transform the original region from the $z = x + iy$ plane to the $w = u + iv$ plane. It will be easy to find a harmonic function, $T(u, v)$ to describe the isotherms in the $uv$-plane. Then we will compose $T$ with the inverse function $f^{-1}(w)$ to get $T(x, y)$ which describes the isotherms in the $xy$-plane.

***Why Humans?*** **by Chase Richardson**

What did humans do through the course of evolution that allowed them to advance to the point of being considered one of the more dominant species on the planet? We will look at a mathematical model created by Robert Boyd and Peter Richerson that attempts to address this question. The results of this model provide evidence that the strategy of imitation is an evolutionary stable strategy and the combination of individual and social learning is the possible key.

***Point-Set Topology and Metric Spaces* by Amber R. Schippers**

The essential concepts of point-set topology include open and closed sets, neighborhoods, limit points and closure of a set. In this paper, we use these to prove several results on topological spaces. Using some of these basic principles, as well as the additional concepts of spherical neighborhoods and bases, we show that metric spaces can be created from metric sets and the conditions necessary to do so. We then explore results involving metric spaces, Hausdorff spaces, and regular spaces.

***Folding and Cutting Paper* by Angela Servais**

Everyone has attempted to fold origami paper into a crane. However, did you know that you could create a silhouette of that crane by using a compass, a straight edge, a few folds in the paper and one cut with a scissors? This presentation will introduce the methods behind how to fold a piece of paper in a certain way that you can make one cut to get any polygon or silhouette of an animal, including on the spot demonstrations to create a polygon with one cut. The speaker will cover the origination of cut-and-fold method, flat origami folding, non-flat origami folding and mathematical proofs that you need to understand to form any closed polygon with one cut.

***$T_i$ Properties of Topological Spaces* by Mandi White**

Point-set topology allows us to study numerous structures of sets. This research focuses on separation properties concerning $T_i$ spaces. $T_0$, $T_1$, $T_2$, $T_3$, and $T_4$ spaces are defined and illustrated by various examples. Examples are given to show If $T_i$, then $T_{i-1}$, for $i = 1, 2, 3, 4$, and to show that the converse of these statements are not true. Special attention is given to the topology $\mathfrak{I} = \{\varnothing\} \cup \{\mathfrak{R} - F : F \text{ is a finite subset of } \mathfrak{R}\}$. Also examples for indiscrete and discrete spaces are presented.