Abstracts
Senior Seminar and Honors
Fall 2008 Simpson College
Mathematics Department

Baseball Hit Streaks and World Series Simulations **by Curt Bjork**

I examined the likelihood of Joe DiMaggio's 56-game hit streak and the outcome of the 2008 World Series using simple models and Monte Carlo simulation. This approach shows that Joe DiMaggio's streak is not as unlikely to have occurred as previously thought in the history of baseball. It also shows the 2008 Philadelphia Phillies had a better offensive team than the 2008 Tampa Bay Rays.

Homomorphic and Color-Critical Graphs: Easing the Search through Computer Programming **by Chelsy Croson**

The necessary properties for a graph to be color-critical are addressed, while specific examples are examined. A program that systematically searches all simple graphs with j vertices and compares these graphs to an original graph will be described. This program eases the process of finding all j-vertex graphs that are homomorphic to a given graph, which inevitably means a faster route to finding color-critical graphs.

Basic Mathematical Modeling of Diseases in Human Populations **by Kendra Frush**

Mathematical models of diseases are an important part of predicting and treating disease outbreaks. These models are found for progression of diseases both in the body and in the larger human population. My research this semester involved learning the differential equations used by both types of basic models and progressing to more advanced population models. Focusing specifically on HIV and AIDS, I developed a mathematical model using differential equations which will be refined next semester.

Stock Options: The Binomial Pricing Model **by Raena Gordon**

A stock option is a special type of derivative, in which value is based on that of an underlying stock, such that each stock option costs only a fraction of the price of its related stock yet represents the same amount of shares. Due to the nature of these options, special prices, or premiums, must be assigned to each contract to compensate the seller for being at a disadvantage at the expiration of the option. Models, such as the binomial option pricing model, are used to determine the possible values of an option over time and to ultimately assign the value of the premium.

Reverse Sealed Bid Dutch Style Auctions With Bribery **by Cassie Lacina**

The Reverse Sealed Bid Dutch Style Auction is one in which a client puts out an order to several contractors in order to receive the lowest bid on for a project to be built, i.e. a building. Using two and three contractor cases in order to generalize to n-contractor’s I was then able to find the maximum bidding strategy, the expected bid to the client, the expected profit to the contractor and the variance for each. Then adding bribery into the picture, the two contractor case was simulated and the average winning bid, average profit and the savings to the client were calculated.

***Ellipses from Triangles* by Jessica Lashier**

"Ellipses from Triangles" is a study of pedal triangles, pedal points, and loci. We will examine three cases of a triangle; the excircle, circumcircle, and incircle. Through this research we are looking to prove that the loci that is formed by tracing the midpoints of the pedal triangle is an ellipse.

***Bankruptcy: A Fate Worse than Debt? The Mathematics of Bankruptcy* by Suzanne Renée Schnell**

With the economy in the state it is in right now, more and more individuals and companies are filing for bankruptcy. Have you ever wondered how the powers that be go about dividing up a bankrupt company's estate in the fairest way possible? In this paper, I have researched the mathematics behind bankruptcy and fairness. It turns out that there are multiple bankruptcy algorithms and fairness rules that define the amount of an estate each agent is awarded, and in this paper I will illustrate these different rules.

Let's suppose there is a company that files for bankruptcy. There are multiple agents hoping to be paid their full claim amount, but the estate is worth less than the sum of the claims. The following describes the abstract setting of a bankruptcy problem.

Let N be a finite set of agents. The estate to be distributed among the agents is referred to as E. Each agent $i \in N$ has a claim $c_i \geq 0$ on the estate E, such that $\sum_{i \in N} c_i \geq E$ where L is defined as the aggregate loss, and $L = C - E$, where C is the aggregate claim. We call this bankruptcy problem an allocation situation.

***The Centipede Game and the Evolution of Cooperation* by Stephanie Steffens**

In this paper we look at possible explanations for the evolution of cooperation in a game theoretic setting. Finding such models has been very difficult. We will introduce the model called the Centipede Game as well as the evolutionary model called the Moran Process. The combination of these two models along with certain assumptions provides a setting where the strategy of cooperation can persist through time.