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Jan Rychtář (ed.)

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It was a very chaotic day, says Kathryn Sikes. Indeed, mutants spread everywhere, according to Brian Stadler. Bacterial wars raged all over the place, adds Dan MacMartin. Everybody was stealing, reported Christian Sykes. There were no limits to it, witnessed by Samuel Grundman. Only the fittest survived and got out of the prison, noted by Joseph Krenicky. The group was set free by Steven Piantadosi. We almost got lost in cyclic paths, said Hether Allmond. At least, our weight was a perfect number, smiles Michael Shiver, because we were not oversized thanks to Martha Shott. Finally, a picture was taken by Gavin Taylor and you could win a date if you listened to David Dombrowski.

Math can be a lot of fun.

Conference Schedule

9:30-10:15 Registration and refreshments

10:15-10:20 Welcoming remarks

Morning sessions

10:20-10:35 Dan MacMartin: Bacterial Wars! A Matlab Simulation

10:40-10:55 David Dumbrowski: Strategically singled out

11:00-11:15 Joseph Krenicky: No Way Out: The Prisoner's Dilemma, an Introduction to Symmetric Normal Form Games

11:20-11:30 Coffee break

11:30-11:45 Gavin Taylor: Imagemosaics: Painting with Pictures

11:50-12:05 Martha Shott: Super Size Me: An Optimization Problem

12:10-12:25 Brian Stadler: Evolutionary Dynamics on Graphs

12:30-1:30 Lunch Break

Plenary Lecture

1:30-2:00 Richard Fabiano: An Optimal Sandwich

2:00-2:10 Coffee break

Afternoon sessions

2:10 - 2:25 Christian Sykes: Stealing's for the Birds: A model of kleptoparasitism

2:30 - 2:45 Kathryn Sikes: How Do I Get to Chaos from Here: Pitchfork Bifurcation and the Feigenbaum Route

2:50 - 3:05 Steven Piantadosi: Symbolic Dynamics and the Free Group

3:10 - 3:20 Coffee break

3:20 - 3:35 Heather Allmond: On The Cyclic Cutwidth of Complete Tripartite and N-Partite Graphs

3:40 - 3:55 Michael Shiver: Perfect Numbers

4:00 - 4:15 Samuel Grundman: Harnessing the Power of Computers to Aid in Evaluating Indeterminate Limits

4:20 - 4:25 Closing remarks

Bacterial Wars! A Matlab Simulation

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Abstract. In Ecology, evidence of biodiversity exists with colicinogenic bacteria and those bacteria who are sensitive to colicin. Sensitive bacteria can mutate to gain defense mechanisms, and then displace the colicinogenic bacteria. The end result is a real-life occurrence of Rock-Paper-Scissors game - Colicinogenic bacteria win over sensitive ones, sensitive ones win over resistant ones, and resistant ones wins over colinogenic ones. We use Matlab to model the situation by modifying and adapting previous studies, making the simulation more realistic by incorporating diffusion. Observations of the new model show this one-chases-the-other phenomenon, and if the model is carefully constructed, a clock-wise spinning is observed. In all models, coexistance of all three bacteria is observed, but eventually one will dominate the environment.

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Strategically singled out

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Abstract. The MTV game show popular in the nineties has interesting implications to game theory. In the game show, three players are standing several steps from the finish line, where the objective of the game is to be the first player to reach the finish. The game commences by a question being asked with only two answers each of which being equally likely, with each correct forward one step none if incorrect. The first player knows no one's answer, the second player knows the first player's answer, and the third player knows the first and the second player's answers. Computer simulation can be used to examine the second and third player's decision making srategy leaving the two players in a nash equilibrium. The small number of steps involved in the Mtv version of this game results in minimal advantage for each player regardless of what strategy they use.

No Way Out: The Prisoner's Dilemma, an Introduction to Symmetric Normal Form Games

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Abstract. Evolutionary dynamics has many applications in biology, economics, and psychology. A basic knowledge of symmetric normal form games lends itself to a greater understanding of dynamic evolutionary theory. Originally developed in earlier biological research, symmetric normal form games try to explain the interactions within a population. When two strategies are available to the population, three classes result: the Prisoner's Dilemma, Coordination, and the Hawk-Dove.

Imagemosaics: Painting with Pictures

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Abstract. A large number of small photographs can be arranged in such a manner as to seem to form a larger photograph to the human eye, creating an effect similar to pointillist art. Naturally, this is a very complicated job best left to mathematics and computers. The technique of integer programming can be used to create an image from a large bank of pictures. The integer programming problem is described in detail, and the advantages and problems with the method discussed.

Super Size Me: An Optimization Problem

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Abstract. In 2003, documentary film-maker Morgan Spurlock set out to expose the fast food industrys role in Americas obesity epidemic by producing the film "Super Size Me." For thirty days, he ate nothing but McDonalds food, and super sized his meal whenever asked by an employee. At the end of his month-long experiment, he had gained twenty-five pounds and had suffered from a wide range of health problems. An integer programming model, designed in Microsoft Excel and executed with the Solver tool, can be used to mimic this experiment so as to minimize caloric intake while also satisfying specific nutritional constraints. Incorporation of Monte Carlo simulation also accounts for the probability of Spurlock being asked to super size his meal. Such a model is employed to determine an optimal McDonalds menu for Spurlock, and the results are analyzed to emphasize both the strengths and weaknesses of the integer programming approach to this problem.

Evolutionary Dynamics on Graphs

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Abstract. Spatial structures can be used to represent populations of individuals, regardless of whether these individuals are humans, genes or cancerous cells. Graphs can then represent these structures and, after applying evolutionary dynamics, we can simulate changes within these populations. However, differing sizes of population and graph structure give rise to a struggle between natural selection and drift. To explore this we study the simplest possible question: what is the probability that a newly introduced mutant generates a lineage that takes over the whole population? From the results we will see that evolutionary dynamics act on populations. Individuals don't evolve, but rather populations.

Stealing's for the Birds: A model of kleptoparasitism

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Abstract. The stealing of food resources, or kleptoparasitism, commonly occurs within the context of intraspecific competition, particularly amongst seabirds. The work here follows several recent papers (e.g. Broom, et al.), in which this phenomenon is modeled for monomorphic populations using game theoretic methods. Of primary interest is the adaptive dynamics of this model; in particular, under what conditions the populational strategy will converge to a given strategy and whether such a strategy is stable. Under the food model introduced in Rychtar & Broom, it is shown that only purely kleptoparasitic strategies may be stable.

The research was supported by UNCG Undergraduate Research Assistantship 2005/6.

How Do I Get to Chaos from Here: Pitchfork Bifurcation and the Feigenbaum Route

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Abstract. With an everyday meaning of a state without order, Chaos in mathematical terms refers to an irregular oscillation governed by a relatively simple rule meaning that however seemingly disorganized a chaotic state may be, that there is a few simple guidelines behind it. As an introduction to some of the basics behind this theory, we will study the behavior of a simple logistics equation and how it goes on to model chaos through the Feigenbaum Route. The results of this model and others like it are useful in making sense of the chaos observed in a variety of physical, biological and chemical systems, particularly in that of population dynamics.

Symbolic Dynamics and the Free Group

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Abstract. Traditional symbolic dynamics studies the properties of the shift operator acting on bi-infinite sequences of symbols. Generalizing this notion, we study the dynamical system consisting of the colorings of a finitely generated group G acted on by the generators of G. When G is a free group, we show the conditions for a shift of finite type on G always to contain a periodic coloring.

On The Cyclic Cutwidth of Complete Tripartite and N-Partite Graphs

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Abstract. The cyclic cutwidth of the complete tripartite graph is explored. Previous work has been done on the cyclic cutwidth of complete bipartite graphs as well as the linear cutwidth of complete tripartite graphs. These results will be used to build on the cyclic cutwidth of the complete tripartite graph. The cyclic cutwidth of complete tripartite and n-partite graphs is found for some cases. An upper bound and lower bound for other cases is also explored. These results are useful in applications of networks, such as electrical networks, telephone communications, road maps, oil pipelines, and subway systems.

Perfect Numbers

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Abstract. A perfect number is a positive integer that is equal to the sum of its positive divisors, not including itself. The first four perfect numbers were known in antiquity, and Euclid's "Elements" contains a proof of a method of constructing them. In his "Introduction to Arithmetic," Nicomachus of Gerasa discusses perfect numbers, and posits certain properties about them as fact. The presentation, itself, builds up to a discussion of the development of the assertions so set forth by Nicomachus.

Harnessing the Power of Computers to Aid in Evaluating Indeterminate Limits

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Abstract. Computers today can quickly compute thousands of operations per second, reducing human error in many fields, such as engineering. We may even use this power to aid us in our attempts to solve indeterminate limits. An indeterminate limit may result when we divide an ever increasingly small number by another ever increasingly small number, leading to zero divided by zero. Such a limit may come out with any possible number. The numerator may be one when the denominator is one billionth, resulting in a billion; or the numerator may be one billionth when the denominator is one, resulting in one divided by a billion. Using computers to compute values close to the point in question may lead to the value of the limit itself.