Saturday, October 19, 2019

9:30am - 10:00am BLOC 141 **Registration and Coffee**

10:00am - 11:00am BLOC 166

Ivan Ivanov, Texas A&M University

Mathematical Models of Gene Regulatory Networks

Abstract: According to the Central Dogma of the Molecular Biology, the information in the living cells flows from the DNA to the functioning proteins. This information flow is facilitated by a complex web of biochemical reactions which ultimately determine the cell's phenotype and fate. Developing quantitative models for those phenomena holds the promise of designing therapeutic interventions that could steer a cell away from undesirable phenotypes such as tumor cells. We will focus on a few of the major challenges in the field and will outline the potential important contributions to it by the mathematical community.

11:15am - 12:15pm BLOC 166

Student Presentations

11:15am - 11:35am

Cosmas Kravaris, Texas A&M University

Calculating the growth of the wallpaper groups using cone types

Abstract: We define the notions of group presentations, Cayley graphs, growth and growth series for a group. Next, we consider the wallpaper groups (2 dimensional crystallographic groups) and describe the method of cone types. Finally, we use cone types to compute the growth of the wallpaper groups.

11:45am - 12:05pm

Clinten Graham and Claire Pearson, Louisiana State University

Computational representation of prefractals and their attractors in R^2

Abstract: Using the Wolfram Language's symbolic geometry tools, we have developed a user interface that allows iterative function systems on regions to be described with concise notation and rendered as geometric attractors. The geometric transformation is described by the software in homogeneous coordinates

allowing the prefractals to be computed efficiently as a region. From the geometric description of the IFS, the software computes rules to draw orbits on the system's attractor through the Chaos Game. This representation of the attractor allows the user to modify the rules of the system and simulate its limit in real time. The software is ideal as a discovery tool for students in driving useful conjecture about phase transition, fractal boundary, and convergence.

12:15pm - 1:30pm	BLOC 141	**Lunch**	
1:30pm - 3:30pm	BLOC 166	**Student Presentations**	
		1:30pm - 1:50pm	**Jacob Bradley and Sean Campbell**, University of Houston ***Delay-induced dynamics of protein production in resource-limited environments*** Abstract: In recent years, work has been done on understanding delay-induced phenomena in gene networks. However, most models assume constant delay times, which does not accurately reflect the noisy environment in a cell. Using a simple framework from queueing theory, researchers have found interesting behavior in signaling times while tuning variance in delay times. We extended this study by including an assumption of limited cell resources and found that this interesting behavior still occurs in more realistic conditions. We also examined the effects of characteristic statistical information other than variance on the signaling dynamics.
		2:00pm - 2:20pm	**Xinyue Tracy Yu**, Louisiana State University ***Effect of photo-isomerization and thermal relaxation on the orientation of solid-state photoactive molecules*** Abstract: Photoactive polymers such as azobenzene are promising candidates for actuators in the creation of soft robots. When azobenzene is exposed to light of certain wavelengths, it undergoes photo-

isomerization, switching from a trans- to a cis-state. After continuous isomerization and thermal relaxation, the molecules will reach thermodynamic equilibrium and orient themselves in the direction orthogonal to the light polarization. When there is no light, the molecules will reach an ordered nematic state if the coupling between them is strong enough compared to thermal fluctuation. This project presents a model that simulates the photo-orientation process, and derives a mean field approximation of the order parameter. We create a 2-dimensional Heisenberg lattice of spins, and use the Metropolis Monte Carlo algorithm to perform importance sampling of the spins. We then compare the order parameter calculated from the simulation with those predicted by the mean field model. These results are expected to help research on photoactive polymers as well as potential actuators for soft robots.

2:30pm - 2:50pm

Lance Fegan, University of Houston

Two approaches for optimal synthesis of a thin wire antenna

Abstract: In this study, we explore a strategy for determining the current distribution of a thin-wire antenna based on a given radiation pattern. By this we mean seeking for a current distribution on the antenna so that the generated radiation pattern closely approximates a prescribed far field pattern. The integral equation that models the relationship between the current distribution and the generated radiation pattern was analyzed using the method of moments. The unknown current distribution was approximated with a truncated series leading to a system of linear equations. This linear system is then solved using Tikhonov regularization.This study directly compares the results obtained from two series representations, namely the Taylor and Fourier series. Our results show that the accuracy of this strategy is primarily dependent upon the approximating series used. The results from this study has potential

applications in radar and radar defense technologies. Further research on this problem may lead to the development of more effective techniques in terms of accuracy and stability.

3:00pm - 3:20pm

Michael Sheppard and Noah Templet, Louisiana State University

An online GUI for EM waves in layered media

Abstract: The goal is to make available to the community a versatile online application for the computation of electromagnetic fields in media with any number of layers having arbitrary electric and magnetic tensors. The objectives are (1) to allow scientists to explore phenomena of scattering, guided modes, and resonance in the most general EM layered media and (2) to provide a pedagogical tool for students and professionals to learn EM in layered media.

3:30pm - 4:00pm	BLOC 141	**Break**
4:00pm - 5:00pm	BLOC 166	**Panel Discussion**

- Weston Baines, Department of Mathematics, Texas A&M University
- Irina Gaynanova, Department of Statistics, Texas A&M University
- Irina Holmes, Department of Mathematics, Texas A&M University
- Ivan Ivanov, Department of Veterinary Physiology and Pharmacology, Texas A&M University
- Jeff Lovering, Customer Marketing Group (to be confirmed)

Sunday, October 20, 2019

8:30am - 9:00am	BLOC 141	**Coffee**
9:00am - 10:30am	BLOC 166	**Student Presentations**

9:00am - 9:20am

Andrew Winn, Texas A&M University

Revisiting a cutting plane method for perfect matchings

Abstract: In 2016, Chandrasekaran, Végh, and Vempala published a method to solve the

minimum-cost perfect matching problem on an arbitrary graph by solving a strictly polynomial number of linear programs. However, their method requires a strong uniqueness condition, which they imposed by using perturbations of the form $c(i)=c_0(i)+2^{-i}$. On large graphs (roughly $m>100$), these perturbations lead to cost values that exceed the precision of floating-point formats used by typical linear programming solvers for numerical calculations. We demonstrate, by a sequence of counterexamples, that perturbations are required for the algorithm to work, motivating our formulation of a general method that arrives at the same solution to the problem as Chandrasekaran \textit{et al}. but overcomes the limitations described above by solving multiple linear programs without using perturbations. We then give an explicit algorithm that exploits are method, and show that this new algorithm still runs in strongly polynomial time.

9:30am - 9:50am

Larry Guan, University of Houston

Defect analysis of 1D spring-mass systems via Laplace transform and asymptotics

Abstract: Spring-mass systems have seen utility for decades in modeling multiple physical phenomena like elastic deformation and wave propagation. Our focus is on linear spring-mass systems and the use of experimental data to analytically locate and characterize defects ("error" masses) along the chain. Asymptotics within the Laplace domain enabled us to numerically trial each block for defect status using the vibrational data of only the first block in the chain while simultaneously counting the number of defects. However, despite the theoretical soundness, this process works only for data without measurement/numerical noise and any defects beyond the first are undetectable.

10:00am - 10:20am

Rohin Gilman, Louisiana State University

Two approaches for optimal synthesis of a thin wire antenna

Abstract: Using Koopman's global linearization approach, we demonstrate how the Chernoff Product Formula can be used to approximate solutions of initial value problems for fully non-linear differential equations of the form $x'(t)=F(t,x(t))$. We demonstrate that the rates of convergence of these non-linear approximations show the same qualitative behavior as their linear counterparts; namely, the Strang Product type approximations appear to be of order $\frac{1}{n^2}$, whereas the Lie-Totter Product type approximations are of order $\frac{1}{n}$. Joint work with Amy Adair, Arun Banjara, and Logan Hart.

10:30am - 11:00am	BLOC 141 & BLOC 1st Floor Lobby	**Break & set-up for Poster Session**
11:00am - 12:30pm	BLOC 1st Floor Lobby	**Poster Session** • **Jacob Bradley and Sean Campbell**, University of Houston • **Lance Fegan**, University of Houston • **Rohin Gilman**, Louisiana State University • **Clinten Graham and Claire Pearson**, Louisiana State University • **Larry Guan**, University of Houston • **Cosmas Kravaris**, Texas A&M University • **Michael Sheppard and Noah Templet**, Louisiana State University • **Alexandra Vaughn**, University of Houston & Michael E. DeBakey High School • **Andrew Winn**, Texas A&M University • **Xinyue Tracy Yu**, Louisiana State University
12:30pm	BLOC 141	**Lunch**