SAMIT BHATTACHARYYA
University of Guelph

A game theoretical approach to modeling non-vaccinator and delayer behaviors in pandemic influenza

The recent emergence of H1N1 (S-OIV) influenza has highlighted the vulnerability of human populations to emerging infectious diseases. While vaccines are quickly developed to mitigate widespread transmission of novel H1N1 influenza strain, vaccination does not always take place in proper time. In many voluntary vaccination programmes, including pandemic influenza vaccination, the role of individual choice is becoming an increasingly important driver of vaccine coverage that subsequently affects underlying disease burden among population. This exemption of vaccination may be caused by fears of vaccine risks, and/or conscious or unconscious exploitation of herd immunity. Additionally, little may be known about vaccine risk before it has been deployed on a large scale. As a result, some individuals may adopt a wait and see strategy of delaying vaccination either until vaccine risk is better understood, or in the hopes that enough other individuals will vaccinate to make their having to vaccinate unnecessary. Using SIR model of disease transmission, we develop a game dynamic model of vaccinators with certain assumptions on individual vaccinating behaviour. The objective of this study is to determine Nash equilibrium strategies relating to timing of vaccination in a scenario of pandemic influenza.

SUE ANN CAMPBELL
University of Waterloo

Approximating the Stability Region of a Neural Network with a General Distribution of Delays

We investigate the linear stability of a neural network with distributed delay, where the neurons are identical. We examine the stability of a symmetrical equilibrium point via the analysis of the characteristic equation both when the connection matrix is symmetric and when it is not. We determine a mean delay and distribution independent stability region. We then illustrate a way of improving on this conservative result by approximating the true region of stability when the actual distribution is not known, but some moments or cumulants of the distribution are. Finally, we compare the approximate stability regions with the stability regions in the case of the uniform and gamma distributions. We show that the approximations improve as more moments or cumulants are used, and that the approximations using cumulants give better results than the ones using moments. This is joint work with Raluca Jessop.

YUMING CHEN
Wilfrid Laurier University

Threshold dynamics of a delayed reaction diffusion equation subject to Dirichlet condition

In this talk, we study a delayed reaction diffusion equation subject to the homogeneous Dirichlet boundary condition, when the delayed reaction term is non-monotone. The threshold dynamics is established and the main results are illustrated with two examples including the delayed Nicholson's blowflies diffusion equation. This is a joint work with Taishan Yi and Jianhong Wu.

MOHAMMAD DUR-E-AHMAD
University of Waterloo

Computational model of CA3 hippocampal network

GUIHONG FAN
York University

The role of vectors in vector-borne disease

There are many vector borne diseases including West Nile virus, Lyme disease, Malaria, Dengue fever, Yellow fever etc. which threat the health of human being and animals. Vectors like mosquitoes play a critical rule in the transmission and spread of vector-borne diseases. To investigate the rule of vectors, we use West Nile virus as an example and formulate a system of delay differential equations to model the interaction between vectors and hosts. The bifurcation analyses show that vectors alone can force the system to oscillate at a sustainable level as long as there is recruitment of the host. In addition, the interaction between vector and amplification host can also cause oscillation in the system. This is a joint work with Huaiping Zhu.

SUMA GHOSH
York University

Characterization of H1N1 pandemic waves under various mitigation strategies

A significant feature of influenza pandemic is multiple waves of morbidity and mortality over a few months or years. The size of these successive waves depends on intervention strategies as well as mutation and enhanced transmissibility. While antiviral agents are used as a primary control measure during the early stages of a pandemic, vaccine is used as a preventive control measure at the commencement of subsequent waves. The combined effect of antiviral and vaccination in successive waves of a pandemic, and effect of acquired immunity from vaccination and previous infection however, has not been studied extensively.

We develop a multi-compartmental SIR model of consecutive two waves of influenza pandemic to characterize the disease dynamics under the effect of drug therapy, vaccination and acquired immunity from prior infection. Vaccine is used as a preventive control measure in the beginning of second wave together with immunity acquired from exposure to the first wave to attenuate level of infection. Using parameter values from recent literature on pandemic (H1N1) influenza, we numerically simulate the model to see that how severity of infection intimately depends on treatment rates, profiles, initial commencement of drug therapy and different vaccination coverage.

HONGBIN GUO
York University

Global stability of the endemic equilibrium for a staged-progression model with immigration

We investigate a class of staged-progression SEIR model with constant immigration to each class. The dynamical behavior is that the system has only one endemic equilibrium if all immigration terms are nonnegative. We prove the global stability of the endemic equilibrium by using a global Lyapunov function recently widely used. We also discuss the possible application in disease modeling.

DAIHAI HE
McMaster University

Likelihood-based inference on the cause of multiple waves in the 1918 influenza pandemic in London

Multiple waves have been observed in the initial phase of influenza pandemics, notably the 1918 pandemic. The mechanisms that account for this phenomenon remain unclear. We used mathematical modeling and likelihood-based inference to shed light on this issue. We started with the simplest, three-compartment model including susceptible(S), infectious (I) and immunized(R) states, and allowing immunity to decay. We focused on the Pneumonia and Influenza (P&I) mortality in London, England, during 1918 influenza pandemic. We employed the R package POMP (statistical inference for partially observed Markov processes) to find the parameter values with maximum likelihood. We considered two time-dependent factors that might lead to multiple waves: (i) changes in the transmission rate and (ii) changes in the rate of decay of immunity. We found that either these factors can lead to good fits to the 1918 P&I mortality in London, but that the second-order Akaike's Information Criterion (AICc) favors changes in the transmission rate. Joint work with David Earn, Troy Day, Jonathan Dushoff and Junling Ma.

JANE HEFFERNAN
York University

An introduction to mathematical immunology

Despite advances in drug therapy and vaccine development, we continue to face serious outbreaks of infectious disease. Mathematical models in epidemiology have aided in our understanding of disease spread in a population and are rich in the literature. Models describing disease progression /within/ an infected person, focusing on the dynamics between the pathogen and the immune system, however, are still in their infancy. Such models have the potential to elucidate the key mechanisms of disease progression, and thus, provide direction for the development of more effective vaccination and drug therapy protocols. In this talk I will describe the immune system and introduce the basic model describing immune system and pathogen dynamics in-host. The basic model will then be extended to look at: HIV, HBV, measles and influenza. The effects of pathogen growth in-host on disease transmission between hosts will be discussed.

SEHJEONG KIM
York University

A multigroup model for a heterosexually transmitted disease

A multigroup model is considered for a disease transmitted heterosexually in which there is a core group that has higher sexual activity than other groups. In order to develop control strategies to eradicate the disease, type reproduction numbers are determined. A two-group model consisting of a core and a non-core group is considered. If disease can persist in the core group in isolation, then the amount of increase of treatment or decrease of the contact rate of infectious males (or females) in the core group that is required to eradicate the disease is expressed in terms of model parameters. If disease cannot persist in either group in isolation, then the amount of reduction of the connection between the two groups needed to eradicate the disease is determined. These two cases are illustrated with parameters applicable to gonorrhea in the US.

VICTOR LEBLANC
University of Ottawa

Realization of multiple Hopf bifurcations in DDEs

We will present some recent results (in collaboration with PL Buono and YS Choi) on the number of delays necessary in a DDE in order to realize the normal form for a multiple non-resonant Hopf bifurcation.

CHENGZHI LI
Peking University and York University

Cyclicities of period annulus for quadratic integrable systems under quadratic perturbations

The maximal number of limit cycles, which can bifurcate from a period annulus of a planar integrable system under certain perturbations, is called the cyclicity of the period annulus. For quadratic integrable systems under quadratic perturbations, the problem is almost solved for the quadratic Hamiltonian class, and only partially solved for other integrable classes (Lotka-Volterra, reversible and codimension 4 classes). For the generic Hamiltonian class, this problem is closely related to the weak Hilbert's 16th problem (for $n = 2$) proposed by V. I. Arnold, asking for the maximum of the numbers of isolated zeros of Abelian integrals of all polynomial 1-forms of degree n over algebraic ovals of degree $n + 1$; for the degenerate Hamiltonian class and non-Hamiltonian classes, it may be related to the study of pseudo-Abelian integrals, which is more difficult.

In this talk we want to give a survey about the problem, the known results and some related methods.

MARY PUGH
University of Toronto

Coating flows on slowly rotating cylinders

We consider a horizontal cylinder, rotating about its center. A viscous fluid is on the outside of the cylinder, coating the cylinder as it rotates. We consider a lubrication approximation of the Navier Stokes equations for the regime in which the fluid film is relatively thin and the surface tension is relatively large. The resulting lubrication model may have no steady state, a unique steady state, or more than one steady state. Using both numerics and analysis, we consider the dynamics of this flow, including whether or not solutions can become singular in finite time. This is joint work with Marina Chugunova and Roman Taranets.

REDOUANE QESMI
York University

Backward bifurcation for a model of Hepatitis B and C virus with age since infection

Despite advances in treatment of chronic hepatitis B virus (HBV) infection, liver transplantation remains the only hope for many patients with end-stage liver disease due to HBV. A complication with liver transplantation, however, is that the new liver is eventually reinfected in chronic HBV patients by infection in other compartments of the body. We have formulated a model to describe the dynamics of HBV after liver transplant, considering the liver and the blood of areas of infection. Analyzing the model, we observe that the system shows either a transcritical or a backward bifurcation. Explicit conditions on the model parameters are given for the backward bifurcation to be present, to be reduced, or disappear. Consequently, we investigate possible factors that are responsible for HBV/HCV infection and assess control strategies to reduce HBV/HCV reinfection and improve graft survival after liver transplantation.

CHRISTIANE ROUSSEAU
Universite de Montreal

Codimension one 1-resonant singularities of analytic dynamical systems

A central problem in local dynamics is the equivalence problem: when are two systems locally equivalent under a change of coordinates? In the neighborhood of a singular point, representatives of equivalence classes could be given by normal forms. But, very often, the changes of coordinates to normal form diverge. In this talk, we will discuss the case of singularities for which the normalizing transformation is 1-summable: this is usually the case when the singularity has codimension 1 and all resonances are generated by a unique resonance equation. We will explain the common geometric features of these singularities, and how the study of the unfolding of these singularities allows understanding the singularities themselves. We will also present examples of moduli spaces for generic 1-parameter families unfolding such families.

LENNAERT VAN VEEN
University of Ontario Institute of Technology

The tangled edge of turbulence in bursting Couette flow

Since the publication of a landmark paper by Kawahara and Kida on the relevance of unstable periodic solutions to shear flow in 2001,the scale of dynamical systems-type computations in turbulence research has increased spectacularly. Equilibrium and periodic solutions have been computed in great spatial detail for Couette flow, pipe flow and many other geometries. One of the main goals of these computations is to explain the process of turbulent bursting in shear flows. Often, the bursting occurs in the presence of an asymptotically stable laminar flow, so that ordinary bifurcation scenarios do not offer an explanation. Instead, the current focus is on so-called "edge states," i.e. saddle-type equilibria or periodic solutions that appear to live on a boundary between turbulent and laminar behaviour in phase space. In principle, we should be able to clarify the bursting process if we know the geometry of the (un)stable manifolds of such states. However, the systematic computation of these manifolds is a hard task. We will present a recently developed algorithm for the computation of unstable manifolds and its application to turbulent Couette flow. This algorithm uses matrix-free linear solving and comes with a strong convergence result. Initial computations indicate that the (un)stable manifolds of an edge state in turbulent Couette flow form a homoclinic tangle, an observation with far-reaching implications for our understanding of the transition to turbulence.

Joint work with Genta Kawahara and Matsumura Atsushi (Osaka University)

HUI WAN
York University

Backward bifurcation in models for West Nile virus

In all of the West Nile virus (WNV) compartmental models in the literature, the basic reproduction number serves as a crucial control threshold for the eradication of the virus. However, our study suggests that backward bifurcation is a common property shared by the available compartmental models with a logistic type of growth for the population of host birds. There exists a subthreshold condition for the outbreak of the virus due to the existence of backward bifurcation. In this paper, we first review and give a comparison study of the 4 available compartmental models for the virus, and focus on the analysis of the model proposed by Gustavo et al. to explore the backward bifurcation in the model. Our comparison study suggests that the mosquito population dynamics itself can not explain the occurrence of the backward bifurcation, it is the mortality rate of amplification avian host due to the infection that determines the existence of backward bifurcation. This is a joint work with Huaiping Zhu.

JIAFENG WANG
York University

Dynamical modeling of mosquito population in Peel Region with weather conditions

In this tak, I will present a dynamical model for the mosquito population in Peel Region incorporating temperature and precipitation. The mosquito surveillance data of Peel Region and weather data will be used for the model simulation. This is a joint work with Huaiping Zhu.