东北师范大学
Northeast Normal University

数学与统计学院
School of Mathematics & Statistics

2021 Mathematics-Tianyuan China-Canada Symposium on Modelling, Prevention and Control of Infectious Diseases

CMB
Center for Mathematical Biosciences
Northeast Normal University
数学生物科学中心

CDM Centre for Disease Modelling
CMM Centre de la modélisation des maladies

CSMB

国家自然科学基金委员会
NATIONAL NATURAL SCIENCE FOUNDATION OF CHINA
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Introduction of NENU

Inherit revolutionary spirits and spread them eastward. Northeast Normal University, originally under the name "Northeast University", is the first comprehensive university founded by the Communist Party in Northeast China in 1946. Established in Changchun in 1949, the university was renamed "Northeast Normal University" in 1950. Then it was put under Jilin Province's administration in 1958 and the name 'Jilin Normal University' was adopted. Later it was incorporated into the Ministry of Education, restoring the name "Northeast Normal University" (NENU) in 1980. In 1996, NENU was selected as one of the first group of universities given priority in construction in the "211 Project". And in 2004, NENU was approved to establish the graduate school by the Ministry of Education.

NENU has two campuses (Ziyou campus and Jingyue campus) and a variety of majors. There are over 28,024 full-time students and 1,557 full-time teachers, including 497 professors and 616 associate professors. The university comprises 23 schools, 78 undergraduate specialties, 38 M.A. programs of the first-level discipline, 17 M.A. master programs of professional degree, 22 Doctoral programs of the first-level discipline, two doctoral program of professional degree, 20 Post-doctoral Research Stations and 5 national key disciplines. In all, NENU has all the 11 disciplines except for Military Science and Medicine.

NENU has distinctive characteristics, and it has made great achievements. Education and teaching is regarded as the foundation of the school. Over the past 70 years since the establishment of the university, NENU has formed a distinctive school-running characteristic of "Serving Basic Education", being praised as "The Cradle of the People's Teachers". In the 1950s, President Cheng Fangwu, a famous educator of our country, proposed the educational ideology of serving the primary and secondary education, marking that NENU blazed a trail of correspondence course among Chinese normal universities. In the 1980s, the university took the initiative in serving the basic education in rural areas, opening up the "Changbai Mountain Road" with a prestige for the basic education. In the 1990s, the implementation of "Excellent Educator Project" in NENU contributed to training many excellent teachers for basic education. Ushering into the new century, NENU embarked on "Educator Training Project" and explored "A New Model of U-G-S Teacher Education". "Excellent Teacher Project" and 'A New Model of U-G-S Teacher Education' were awarded the first prize of State-level Teaching Achievements of higher education.

Scientific research strengthens the university, and great successes have been achieved. NENU regards scientific research as the foundation of strengthening school, forming such superior representative disciplines as Education, History, Ideological and Political Education, Biology, Ecology and Chemistry. In recent years, the four disciplines, including Chemistry, Materials Science, Engineering, and Plant and Animal Science, have been listed in the top 1% of the ESI global ranking, and NENU has ranked fourth of the ESI total cited articles among national colleges and universities. There is one national engineering laboratory and six ministerial-level key laboratories for drug gene and protein screening. And there are two key research bases for Humanities and Social Sciences of the Ministry of Education, i.e. The Research Center of World Civilization History and The Institute of Rural Education. Professor Bai Zhidong, Professor Wang Enbo and Professor Liu Yichun were awarded the second prize of the National Natural

Science in 2012, 2014 and 2015. Professor Lin Zhichun and Professor Han Dongyu were awarded the first prize of the Seventh Outstanding Social Science Achievement Award in 2015. The comprehensive strength of NENU's disciplines ranked World Top 500 in 2016. Six disciplines of NENU, Marxism, world history, mathematics, chemistry, statistics, materials science and engineering, have been selected into the "Double First-rate" construction disciplines in 2017.

Adhering to the principle of open-running school, NENU continuously strides forward. It has established cooperation and exchange relations with more than 297 universities and research institutions in over 30 countries and regions, including the U.S., Canada, the UK, Australia, Korea, Japan and Russia, etc. In 2015, NENU co-founded Rutgers University Newark Institute at NENU with Rutgers, the State University of New Jersey. Also, NENU has established Confucius Institutes in Korea, Spain, the U.S., Canada, and Mongolia. Office of Chinese Language Council International (known colloquially as 'Hanban'), Overseas Chinese Affairs Office of the State Council of the People's Republic of China, the Ministry of Education and the Ministry of Foreign Affairs respectively set up "International Chinese Language Teacher Training Base", "Chinese Culture Education Base", "Education Aid Base" and "China-ASEAN Education Training Center" in NENU. Preparatory School for Chinese students to Japan is also founded here.

NENU has cultivated many academic elites and talents of many generations. The university has a number of famous experts and scholars at home and abroad. There were many well-known scholars who were former NENU faculties, including the poet and lyricist of "Chinese People's Liberation Army" Gong Mu(Zhang Songru), the writers Xiao Jun and Wu Boxiao, the literary historian Yang Gongji, the linguist Sun Changxu, the historians Li Xun, Ding Zemin, and Lin Zhichun, the educator Chen Yuanhui, the musicians Ma Ke and Lv Ji, the pathologist Bai Xiqing, the mathematician Zhang Dexin, the nuclear physicist Wang Lin, the geographer Ding Xizhi, the ornithologist Fu Tongsheng, the biologist of Chinese Academy of Sciences Hao Shui, one of the founders of new Chinese school physical education Yang Zhongxiu, and the choreographer and artist of Grand Group Calisthenics Yang Ruixue, etc. Over the past 70 years since the establishment of the university, NENU has cultivated over 300,000 graduates in all fields and at all levels, and a large number of talents have stood out in the field of education, for example, Lu Jiaxi, a teacher of No.9 High School in Baotou who worked out the difficult mathematical problems recognized worldwide; Feng Zhiyuan, a teacher who moved China by his devotion to the border areas education; Guo Lihua, a national model teacher; Dou Guimei, a national Principal Master Teacher; Ma Xianhua, one of National Top 10 Teachers. Meanwhile, the university has also graduated talents in various fields represented by famous academicians—the ecologist Zheng Guangmei, the physicist Sun Changpu, the geographer Liu Xingtu, as well as the renowned writer Zhang Xiaotian.

With a history of 70 years, NENU will inherit the past and open up a path for the future. In 2016, the university ushered its 70th anniversary. NENU will take its 70th anniversary as a fresh starting point and a new opportunity, complying with the concept of “Respectable Education, Creative Education”, adhering to moral education, devoting to education innovation, developing distinctive school-running characteristics, enhancing education equality, and making great efforts to build NENU into a world-wide first-rate normal university.

Introduction of SMS

School of Mathematics and Statistics (SMS) is established in October 1948. In 2004, School of Mathematics and Statistics was established instead of department of mathematics. The school also established the Key Laboratory of Applied Statistics of Ministry of Education. The school has the prima subject of mathematics and prima subject of statistics which can award a doctor degree, we can issue Master and Ph.D. students in all major in mathematics and statistics. The school has post-doctoral research station in mathematics and statistics.

School of Mathematics and Statistics has an academician of Third World Academy of Sciences, each member of Academic Degrees Committee of the State Council, the fourth, fifth, sixth and seventh disciplines, a Renowned Teachers and a young top-notch talent of National High-level Talents Special Support Program, a winner of the National Science Fund for Distinguished Young Scholars, two distinguished professors, a speech professor and a young scholar of Chang Jiang Scholars Program, a professor of the Recruitment Program of Global Experts, two winners of National Science Foundation for the excellent youth scholars, an expert of million young talents plan, two national candidates of the new century millions of talents project, two members of the Ministry of Education Science and Technology Committee faculty of mathematical, eight winners of New century talents of the Ministry of Education, an expert of national outstanding youngs, a winner of the Ministry of Education outstanding young teachers program, a distinguished professor and eleven adjunct professors of Jilin province, an innovation team of the Ministry of Education, "Chang Jiang scholars and innovative Research team", a state-level teaching team. One of the first batch of the National "Huang Danian" Teacher Teams. One teacher with the title "National Role Model of Imparting Knowledge and Cultivating People", two teachers with the title "National Model Teacher" and a National teaching master.

The prima subject of mathematics was approved in 2006, then it was approved core subject in 2011. The statistics was approved the first national prima subject disciplines. And then the statistics was approved Jilin International Science and Technology Cooperation Base, Jilin universities "12th five-year plan" advantage and characteristic key construction disciplines, Jilin Universities priority project construction discipline. Statistics was also approved 5-star and the first discipline in China by the study of China University evaluation which was directed by Chinese University Alumni Network research team. To be approved a doctorate-granting disciplines is a landmark event in the process of development of the school. The institute of Big Data Science which was established with Changchun government was founded in July 2016, it marked the discipline construction entered a new stage of comprehensive and stable development. Since 2016, we have made several remarkable achievements in discipline construction: we have been selected as a first-class discipline in the national "Double First Class" initiative. We have been taking the lead in co-establishing the National Center for Applied Mathematics in Jilin and have been selected into the first batch of national first-class undergraduate programs' construction sites. We have been ranked as Class A among the first-class characteristic disciplines and have won the first place in the Comprehensive Evaluation of Undergraduate Programs in Jilin province. In the fourth round of discipline evaluation by the Ministry of Education of China, Mathematics and Statistics were respectively ranked in B+ and A class.

In the resent five years, the teachers in the School of Mathematics and Statistics accessed National Natural Science Foundation of China key program, National excellent Youth Fund, National "Million Young Talents Plan" youth and

provincial and ministerial projects etc. 161 programs in total. The program "Primary and Secondary Teachers' Training Services Support Reserch and Applied demonstration" directed by professor Ningzhong Shi was the first approved by the National Science and Technology Support Program.

In the resent 10 years, teachers of our school have won 21 scientific research rewards including the natural science prize of Ministry of Education, prize of Guan Zhaozhi and so on. Among which, our academician Zhidong Bai has the honor to get the second class of the National Natural Science prize because of his research achievement "Large dimensional random matrix theory and its application". This has enabled our university to achieve a break through in the same class of national scientific prize. In 2012 and 2015, as the first achieving person, Professor Meng Fan and Daqing Jiang had won the second class prize for excellent achievements of Ministry of Education, respectively. In 2019, one of our research projects was awarded the second prize of Natural Science Award of Ministry of Education of China.

Besides, every year at least 8 young teachers are sent to foreign countries to be academic visitors for more than a year from 2011, which enables young teachers to follow international mainstream researching directions, and also expands teachers' horizons, improves teachers' scientific research levels. We have held academic lectures about 100 times every year in the last 5years. At the same time, we have held kinds of academic conference including National Statistics Summer School, Training Better Teachers' School, Math Summer School and kinds of small academic seminar, which expands both teachers' and students' horizons and expands our school's popularity. One doctor of our school has won the national excellent doctor' thesis prize in 2008. Each one doctor in 2006, 2010, 2013 has a nomination for the national excellent doctor' thesis prize.

Conference Notice

The worldwide pandemic involving COVID-19 is a growing global concern and has produced unprecedented challenges around the world. Currently, there are many challenges on mitigation and control of emerging and re-emerging infectious diseases. This China-Canada Symposium on Modelling, Prevention and Control of Infectious Diseases aims to understand the world-wide challenges and cutting-edge developments, to learn the lessons and to share the timely research findings and experiences. This Tianyuan symposium will advance the interdisciplinary research of mathematics and public health, and provide basis and support for the decision-making on the prevention and control of emerging and re-emerging infectious diseases. It will also provide an excellent opportunity for young researchers and students from China and Canada to interact with our leading active modelers and public health personnel and to learn hands-on research experience on modelling and control of infectious diseases. This China-Canada symposium is jointly organized by Center for Mathematical Bioscience (CMB), Chinese Society of Mathematical Biology (CSMB), and Canadian Centre for Disease Modelling (CDM). The symposium is supported by Tianyuan Mathematics Exchange Project of National Natural Science Foundation of China (NSFC).

Scientific/Organizing Committee

Co-Chairs: Meng Fan (Northeast Normal University)
Huaiping Zhu (York University)
Jingan Cui (Beijing University of Civil Engineering and Architecture)

Members: Julien Arino (University of Manitoba)
Jacques Bélair (Université de Montréal)
Jane Heffernan (York University)
Zhen Jin (Shanxi University)
Michael Yi Li (University of Alberta)
Wei Lin (Fudan University)
Wendi Wang (Southwest University)
James Watmough (University of New Brunswick)
Dongmei Xiao (Shanghai Jiaotong University)
Yanni Xiao (Xi'an Jiaotong University)

Symposium Homepage: http://math.nenu.edu.cn/CCSDMPC/index.htm
Registration: https://www.wenjuan.com/s/UZBZJvxeeV/#
Supporting Committee: Meng Fan, Xinmiao Rong, Zhijun Zeng, Linhua Zhou, Elena Aruffo, Pingping Cong, Liu Yang, Pei Yuan
If you had any question, please contact CCSDMPC@163.com

Distinguished Lectures

Sep 15, Wednesday, ZOOM: 849 6421 9239, PWD: 091519			
Time*	**Chair**	**Lecturer**	**Title**
08:00-08:20	Meng Fan	Opening Ceremony	
08:20-09:50	Jingan Cui	James Watmough	Reproduction numbers and final size relations for disease-transmission models
09:50-10:00 Break			
10:00-11:30	Dongmei Xiao	Jane Heffernan	Modelling infection and immunity
11:30-14:00 Lunch			
14:00-15:30	Michael Yi Li	Yiming Shao	
15:30-15:40 Break			
15:40-17:10	Xuezhi Li	Zhen Jin	Transmission dynamics of COVID-19 in complex networks
Sep 16, Thursday, ZOOM: 849 6421 9239, PWD: 091519			
Time*	**Chair**	**Lecturer**	**Title**
08:00-09:30	Wendi Wang	Jacques Bélair	Time delays in epidemiological model and control strategies
09:30-09:40 Break			
09:40-11:10	Yanni Xiao	Julien Arino	The spatio-temporal spread of infectious pathogens: lessons learned from COVID-19
11:10-14:00 Lunch			
14:00-15:30	Wei Lin	Sanyi Tang	COVID-19 prevention and control---Thinking by data and model anayses
15:30-15:40 Break			
15:40-17:10	Wanbiao Ma	Daihai He	Combining COVID-19 death data and serological survey results to estimate COVID-19 attack rate

***Beijing time (UTC+8)**

Invited Talks

Sep 17, Friday, ZOOM: 849 6421 9239, PWD: 091519

Time*	Chair	Speaker	Title
08:00-08:40	Jacques Bélair	Zhilan Feng	Mathematical models of infectious diseases -- Consequences of underlying assumptions
08:40-09:20		Troy Day	The epidemiology and economics of physical distancing during infectious disease outbreaks
09:20-09:30 Break			
09:30-10:10	Xiaoying Wang	Iain Moyles	Cost and social distancing dynamics in a mathematical model of COVID-19
10:10-10:50		Jude Dzevela Kong	The impact of social, economic, environmental factors on the dynamics of COVID-19
10:50-11:30	Jacques Bélair, Xiaoying Wang, Bouchra Nasri, Xiujun Li, Juan Li		Panel Discussion
11:30-13:30 Lunch			
Time*	**Chair**	**Speaker**	**Title**
13:30-14:10	Zhigui Lin	Yuan Lou	On several PDE models for infectious disease
14:10-14:50		Daozhou Gao	Effects of asymptomatic infections on the spatial spread of infectious diseases
14:50-15:30		Shengqiang Liu	Final size of COVID-19 epidemic model with strains
15:30-15:40 Break			
15:40-16:20	Xinyu Song	Xuezhi Li	Modeling and research on an immuno-epidemiological coupled system with coinfection
16:20-17:00		Wendi Wang	Vaccination games in prevention of infectious diseases with application to COVID-19
17:00-17:40	Zhigui Lin, Xinyu Song, Guiquan Sun, Longxing Qi, Ming Chen		Panel Discussion

***Beijing time (UTC+8)**

Invited Talks

Sep 18, Saturday, ZOOM: 849 6421 9239, PWD: 091519

Time*	Chair	Speaker	Title
08:00-08:40	Jinzhi Lei	Amy Hurford	Modelling COVID-19 in Newfoundland and Labrador during the pandemic
08:40-09:20		Bouchra Nasri	School and community reopening during the COVID-19 pandemic: a mathematical modeling study
09:20-09:30 Break			
09:30-10:10	Jie Lou	Stacey Smith?	Is a COVID-19 vaccine likely to make things worse?
10:10-10:50		Connell McCluskey	Modelling the growth of variants
10:50-11:30	Jinzhi Lei, Jie Lou, Meili Li, Jude Dzevela Kong, Haitao Song		Panel Discussion
11:30-13:30 Lunch			
Time*	**Chair**	**Speaker**	**Title**
13:30-14:10	Zhen Jin	Qiyong Liu	Dengue fever in China: New epidemical trend, prediction, projection and strategies for its control
14:10-14:50		Jianshe Yu	A general periodic discrete model on Wolbachia transmission dynamics in mosquito populations
14:50-15:30		Ling Xue	Mitigating the spread of multi-strain dengue virus via multiple strategies
15:30-15:40 Break			
15:40-16:20	Bo Zheng	Jinzhi Lei	Modeling of epidemic dynamics based on individual contact networks
16:20-17:00		Yanni Xiao	Effect of information transmission on diseases transmission dynamics
17:00-17:40	Zhen Jin, Bo Zheng, Hui Wan, Juping Zhang, Kaifa Wang		Panel Discussion

***Beijing time (UTC+8)**

Invited Talks

Sep 19, Sunday, ZOOM: 849 6421 9239, PWD: 091519

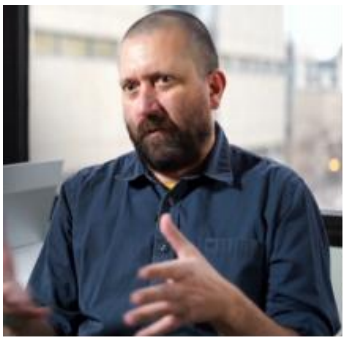
Time*	Chair	Speaker	Title
08:00-08:40	Linhua Zhou	Junling Ma	Does viral diversity drive the development of AIDS?
08:40-09:20		Stéphanie Portet	On combining mathematical modelling and experimental data
09:20-09:30 Break			
09:30-10:10	Xinmiao Rong	Marina Freire-Gormaly	Computational Fluid Dynamics (CFD) modelling of respiratory aerosol transport in indoor spaces, considering the implications of ventilation configurations
10:10-10:50		Carly Rozins	Controlling bovine tuberculosis in wildlife reservoirs
10:50-11:30	Linhua Zhou, Xinmiao Rong, Iain Moyles, Weiming Wang, Kai Wang		Panel Discussion
11:30-13:30 Lunch			
Time*	**Chair**	**Speaker**	**Title**
13:30-14:10	Zhidong Teng	Jin Cheng	A linear nonlocal model for outbreak of COVID-19 and parameter identification
14:10-14:50		Zhihang Peng	Data, model and decision making -- Taking COVID-19 analysis as an example
14:50-15:30	Zhipeng Qiu	Shibing You	Assessment of economic losses in COVID-19
15:30-16:10	Zhidong Teng, Zhipeng Qiu, Guojing Yang, Yanling Yang, Siyu Liu		Panel Discussion
16:10-16:20 Summary			

***Beijing time (UTC+8)**

Distinguished Lectures on Reflections & Lessons of COVID-19

(Alphabetic order)

Prof. Julien Arino
University of Manitoba



Presentation Details

Title:

The spatio-temporal spread of infectious pathogens: lessons learned from COVID-19

Abstract:

Infectious pathogens have been propagating in space and time ever since their hosts have been mobile. In the case of pathogens of humans, spatial spread has been documented for over two and a half thousand years. The different mechanisms contributing to propagation of a disease over vast distances have also been understood for many years. However, how the intervening processes combine to give rise to certain patterns of spread is less understood. Methods to delay or curtail the spread have also been known for a long time, but are similarly poorly understood.

In this context, COVID-19 is providing us with an unprecedented ability to consider these issues. Indeed, no epidemic in history has been documented as much as it has. No epidemic also has been attacked simultaneously in so many different ways by so many different public health jurisdictions, often with a view to delay spread and in particular, importation of cases to the jurisdictions. Novel variants have also acted as new epidemics of sorts and have been tracked with much attention. All of this means that it is possible to compare existing theories on spatial spread and limitation of spread to vast amounts of data.

In this presentation, I will discuss some old ideas about spatio-temporal spread of pathogens and will confront them with lessons learned from COVID-19.

Biography

Julien Arino is a Professor in the Department of Mathematics and a Faculty of Science Research Chair in Fundamental Science at the University of Manitoba. His research is in population dynamics, with particular interest in studying population movement using metapopulation models. His work in mathematical epidemiology has covered a variety of topics but revolves mostly around the spatio-temporal spread of infectious pathogens. In the context of the COVID-19 pandemic, he has focused on the role of case importations. He is a co-director for the Canadian Centre for Disease Modeling (CCDM).

Prof. Jacques Bélair
Université de Montréal

Presentation Details

Title:

Time delays in epidemiological model and control strategies

Abstract:

We present problems arising in the formulation of epidemiological models when the parameters are varying and the proper estimation of dynamical quantities (such as Reproduction Ratios) must take into accounts the fluctuations induced by these variations. In particular, we show how calculations based on reported data must incorporate the reporting delays and the delays in the dynamics of the disease itself to warrant valid predictions. We will also how similar ideas can be applied to explore scenarios of waning immunity.

Biography

Jacques Bélair is Full Professor in the Department of mathematics and statistics at Université de Montréal. He has a PhD in applied mathematics from Cornell University and he was a postdoctoral fellow in the Department of Physiology at McGill University. He has served as associate director of the Centre de recherches mathématiques (CRM), vice-dean of the Faculty of Graduate and Postdoctoral Studies, President of the Canadian Applied and Industrial Mathematics Society (CAIMS) and co-chaired the Organizing Committee of the Annual Meeting of the Society for Mathematical Biology (SMB) in 2019. His research concerns mathematical modeling of dynamic regulatory processes in biology: in the past, cardiac arrhythmias and motor control, presently, blood cell production (hematopoiesis) and the propagation of infectious diseases in general, and currently COVID-19 in particular.

He is a member of the Canadian Mathematical Modeling of COVID-19 Task Force, involved in Canadian Emerging and Infectious Diseases Networks, and serves as co-director for the Canadian Centre for Disease Modeling (CCDM).

Prof. Daihai He
Hong Kong Polytechnic University

Presentation Details

Title:

Combining COVID-19 death data and serological survey results to estimate COVID-19 attack rate

Abstract:

The COVID-19 pandemic has caused a huge impact globally. One usually estimates the COVID-19 attack rate (the proportion of the population infected) in a country or region based on daily new or cumulative cases. However, the daily new cases are affected by the detection capacity and detection rate. Therefore, the estimates could be biased. While, the daily new deaths are relatively accurate. If the infection fatality rate (IFR) is known. Then the attack rate can be calculated based on cumulative deaths. On the other hand, COVID-19 patients have specific antibodies in their serum for a period of time. Through serological antibody surveys, one can also roughly estimate the attack rate. However, due to the sample size and sampling method, the estimates of AR through this method could also be biased. In this report, I will introduce how our team recently combined the death data and the serological survey to estimate the attack rate. I will use cities in India and Brazil as examples.

Biography

He Daihai is an associate professor at the Department of Applied Mathematics, Hong Kong Polytechnic University. He received a Ph.D. in Engineering from Xi'an Jiaotong University in 1999 and a Ph.D. in Mathematics from McMaster University in Canada in 2006. He also did post-doctoral research in the Department of Physics, Beijing Normal University, the Department of Ecology, University of Michigan, and the Department of Zoology, Tel Aviv University, Israel. His main research interests are infectious disease modeling and statistical analysis of data. He has more than 140 papers published in journals such as Sci Adv, Ann Intern Med, Eur Respir J, J R Soc Interface, and the research results have been widely reported by media. The modeling work of yellow fever in Angola in Africa won the second place in the 2018 International Society for Disease Surveillance's Best Scientific Contribution Paper.

Prof. Jane Heffernan

York University

Presentation Details

Title:

Modelling infection and immunity

Abstract:

The ability of an infectious pathogen to invade and persist in pathogens is affected by the existence of immunity in individuals, and in a population. Mathematical models of infectious diseases have typically ignored the dynamic effects of different levels of immunity in disease spread. As such, the predictive capacity of models of population infection and control is limited. In this talk I will give an overview of immunity modelling in immunology. The immunological models will be used to inform population-level distributions of immunity. Distributions of immunity gained from infection and vaccination against COVID-19 in populations will be quantified.

Biography

Jane Heffernan is a Professor in Infectious Disease Modelling in the Mathematics & Statistics Department at York University. She is a co-Director of the Canadian Centre for Disease Modelling, the SMB Math Epi Subgroup Chair, and she leads national and international networks in Mathematical Immunology and the modelling of waning and boosting of immunity. Jane was recently elected to the Royal Society of Canada's College for New Scholars. Jane's Modelling Infection and Immunity Lab tackles important questions in Mathematical Epidemiology and In-host Pathogen Dynamics, using mathematical and computational modelling to ascertain key characteristics of pathogens, individual hosts, and populations that allow for disease spread, and to determine public health and medical intervention strategies that will be needed to contain or eradicate an infectious disease. Her work is funded by NSERC, CIHR, MITACS, NRC, CIRN, and government and industry contracts.

Prof. Zhen Jin
Shanxi University

Presentation Details

Title:

Transmission dynamics of COVID-19 in complex networks

Abstract:

Nonpharmaceutical interventions (NPIs) play a vital role in effectively controlling COVID-19, it can change the structure of human contact network. In the talk, we devised a pairwise epidemic model with NPIs to analyze COVID-19 outbreak in China, we extended this model to the United States to study the transmission of COVID-19 in New York and San Francisco and to investigate the factors determining the severity and duration of outbreak in these two cities. In addition, we built a metapopulation network model incorporating the impact of quarantine and medical resources as well as household transmission to understand how Wuhan curbed the COVID-19 outbreak in 2020. These studies may throw lights on the prevention and control of COVID-19.

Biography

Dr. Zhen Jin received his Ph.D. from the Xi'an Jiaotong University in 2002. He did his postdoctoral work at Shanghai Jiaotong University (2003-2005). Currently, he is a professor of Shanxi University, director of the Shanxi Key Laboratory of Mathematical Techniques and Big Data Analysis on Disease Control and Prevention, president of the Shanxi Provincial Mathematical Society, and vice president of the Chinese Society for Mathematical Biology. His research interests are mathematical biology and complex networks.

Prof. Yiming Shao
Chinese Center for Disease Control and Prevention

Presentation Details

Title:

Abstract:

Biography

Prof. Sanyi Tang
Shaanxi Normal University

Presentation Details

Title:

COVID-19 prevention and control---Thinking by data and model analyses

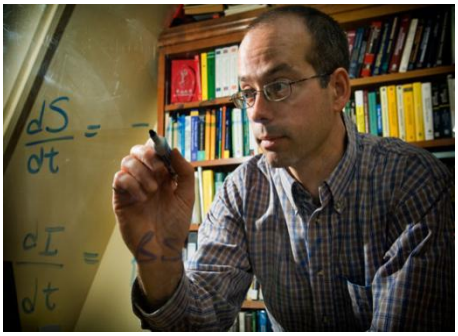
Abstract:

自 2020 年 1 月 10 日我国报道新冠病例以来，COVID-19 病毒肺炎疫情快速传播至全国其他地方。疫情在国内经历了完全由新冠病毒传播机理确定的传染病传播过程，然后是传染病传播过程与采取的不断加强的防空措施并存的阶段，最后完全由包括密切跟踪隔离、检测、筛查等防控措施决定的干预与清零阶段。近一年多来，北京、大连、哈尔滨、石家庄、广州、南京、郑州等地相继由于境外输入病例或局部疫情外溢诱发局部集聚性疫情暴发，除了目前正在流行的南京、郑州关联疫情外，其他地区的集聚性疫情基本都实现了在一个月左右从发现病例到病例清零的防控目标。因此，讲座将基于报告人团队相关连续性工作，介绍从武汉疫情的研究到目前南京关联疫情研究过程中，是如何通过疫情数据、防控策略以及集聚性疫情的特点，构建不同模型、融合多源疫情数据，开展数据和模型驱动的 COVID-19 疫情研究的。特别介绍在研究过程中，是如何利用模型揭示新冠疫情的传播风险和防控策略的有效性和时效性，以及如何为复工复产等提供重要的数据支撑的。讲座过程中，也会基于长期的模型和数据分析，介绍在优化常态化防控与精准防控、疫情外溢、疫苗有效性、不同毒株传播力分析等方面的一些个人思考。

Biography

唐三一教授于 2003 年获得中国科学院数学所博士学位，2003 年至 2007 年在英国 Warwick 大学从事基因调控网络识别、数据分析的交叉学科研究。唐教授主要从事生物数学和生物统计学研究，提出了一系列重要的建模思想，发展了新的理论分析技巧、模型辨识和数值研究方法。发表 SCI 论文 120 多篇，被 SCI 杂志引用超过 6000 次。主持 1 项国家自然科学基金重点项目，完成或主持数理、信息、医学等不同学部国家自然科学基金 5 项，研究成果获陕西省自然科学二等奖 1 项。2018 年获陕西省科技创新领军人才称号。目前主要从事生物医学与传染病防控中问题驱动的核心理论与大数据分析研究。发展和创建了一套分析脉冲半动力系统的定性理论方法，推广了非光滑 Filippov 系统理论在生物医学阈值策略中的广泛应用，解决了非线性、非光滑米氏药动学方程解析求解的理论难题。在混合生物系统以及随机脉冲微分方程模型辨识、随机切换点估计等方面发展了新思想与算法。研究成果在害虫综合治理策略设计、突发性传染病预测预警、药动学参数确定、肿瘤综合治疗与药物毒理效应等方面产生了非常重要的影响。有关甲型 H1N1、COVID-19 等重大突发性传染病防控的研究成果成为国际上评估我国疫情严重程度的重要参考，得到中外媒体的高度关注和广泛报道。

Prof. James Watmough
University of New Brunswick



Presentation Details

Title:

Reproduction numbers and final size relations for disease-transmission models

Abstract:

The early disease transmission model of Kermack and McKendrick established two main results that are still at the core of most disease transmission models today: the basic reproduction number, R_o, as a threshold for disease spread in a population; and the final size of an epidemic. As models become more complex, the relationship between disease spread, final size and R_o are not as clear. In this talk I will review the notions of the next generation matrix, reproduction number, and final size for the simple epidemic model and discuss their extension to more complex models.

Biography

James Watmough obtained his PhD in Mathematics with the Institute of Applied Mathematics at the University of British Columbia and is now a Professor in the Department of Mathematics and Statistics at the University of New Brunswick. He has been a member of the Canadian Centre for Disease Modelling (http://www.cdm.yorku.ca/) since its inception and more recently, a member of the Canadian COVID-19 Math Modelling Task Force, Mathematics for Public Health, and OMNI-RÉUNIS (http://www.omni-reunis.ca). His research interests include mathematical modelling of ecological systems with a focus on the role of heterogeneity in the spread of infectious diseases, biological invasions, and more recently virus and immune system dynamics. He serves as a co-director for the Canadian Centre for Disease Modeling (CCDM).

Invited Talks on Modelling, Prevention & Control of Infectious Diseases

(Alphabetic order)

A linear nonlocal model for outbreak of COVID-19 and parameter identification

Jin Cheng, Fudan University

The novel corona virus pneumonia (COVID-19) is a major event in the world. Whether we can establish the mathematical models to describe the characteristics of epidemic spread and evaluate the effectiveness of the control measures we have taken is a question of concern. From January 26, 2020, our team began to conduct research on the modeling of new crown epidemic. A kind of linear nonlocal dynamical system model with time delay is proposed to describe the development of covid-19 epidemic. Based on the public data published by the government, the information of transmission rate, isolation rate and other information, which may not be directly observed in the process of epidemic development is obtained through inversion method, and on the basis of that, a "reasonable" prediction of the development of the epidemic is made. To provide some reasonable data support for government decision-making and various needs of the public.

The epidemiology and economics of physical distancing during infectious disease outbreaks

Troy Day, Queen's University

People's incentives during an infectious disease outbreak influence their behaviour, and this behaviour can impact how the outbreak unfolds. Early on during an outbreak, people are at little personal risk of infection and hence may be unwilling to change their lifestyle to slow the spread of disease. As the number of cases grows, however, people may then voluntarily take extreme measures to limit their exposure. Political leaders also respond to the welfare and changing desires of their constituents, through public health policies that themselves shape the course of the epidemic and its ultimate health and economic repercussions. In this talk I will use ideas from the study of differential games to model how individuals' and politicians' incentives change during an outbreak, and the epidemiological and economic consequences that ensue when these incentives are acted upon. Motivated by the current COVID-19 pandemic, I focus on physical distancing behaviour and the imposition of stay-at-home orders by politicians. I show that there is a fundamental difference in the political, economic, and health consequences of an infectious disease outbreak depending on the degree of asymptomatic transmission. If transmission occurs primarily by asymptomatic carriers, then politicians will be incentivized to impose stay-at-home orders earlier and for longer than individuals would like. Despite such orders being unpopular, however, they ultimately benefit all individuals. On the other hand, if the disease is transmitted primarily by symptomatic infections, then individuals are incentivized to stay at home earlier and for longer than politicians would like. In this case, politicians will be incentivized to impose back-to-work orders that, despite being unpopular, will again ultimately be to the benefit of all individuals.

This is joint work with David McAdams, Fuqua School of Business and Economics Department, Duke University.

Mathematical models of infectious diseases -- Consequences of underlying assumptions

Zhilan Feng, Purdue University

Mathematical models have been used to study various disease transmission dynamics and control for epidemics. Many of these studies are based on SEIR-types of compartmental models with exponentially distributed stage durations. We examine the underlying assumptions made in some of these model and present examples to illustrate the potential issues associated with these assumptions in terms of model evaluations of control and intervention strategies.

Computational Fluid Dynamics (CFD) modelling of respiratory aerosol transport in indoor spaces, considering the implications of ventilation configurations

Marina Freire-Gormaly, York University

Amid the COVID-19 pandemic, when considering the risk of indoor gatherings, concerns arise as to how the ventilation configuration in indoor environments can affect airborne transmission routes. The ventilation techniques required to mitigate airborne transmission are unique to each space, and thorough research to determine the unique needs of various spaces is still lacking. The intended study will focus on developing a method to determine the risk factors associated with various ventilation configurations, complex room dimensions and dependence of index host location in the domain. The method consists of computational fluid dynamics (CFD) studies to determine possible transport phenomena in different conditions and simulating various possible infection source locations to determine the range of risk scenarios. After a verified method is developed to quantify risk factors based on the above-mentioned parameters, future work can incorporate various room dimensions, occupancies and HVAC designs to determine the risk of transmission associated with commonly used spaces.

Effects of asymptomatic infections on the spatial spread of infectious diseases

Daozhou Gao, Shanghai Normal University

Asymptomatic infection and transmission are common for quite a few directly or indirectly transmitted diseases such as COVID-19, cholera and Zika fever. We propose a susceptible-infective-asymptomatic-recovered patch model to address the influence of asymptomatic infections on the spatial spread of infectious diseases. The multipatch basic reproduction number R_0 of the model is defined and shown to be a sharp threshold for disease eradication and persistence. The dependence of R_0 with respect to dispersal rates is investigated. In particular, for two-patch case, R_0 is either strictly decreasing, or strictly increasing or constant in dispersal rates. However, nonmonotonic dependence is possible for three or more patches case. The asymptotic profiles of the endemic equilibrium (when it exists) as one or all dispersal rates approach zero or infinity are studied. Interestingly, an increase in infectious dispersal may decrease R_0 but increase the nonsusceptible population size. Analytical and numerical results confirm that ignoring asymptomatic carriers not only significantly underestimates the infection risk but also impairs the efficacy of travel restrictions. This is a joint work with Justin Munganga (Unisa), P. van den Driessche (UVic), and Lei Zhang (HITW).

Modelling COVID-19 in Newfoundland and Labrador during the pandemic

Amy Hurford, Memorial University of Newfoundland and Labrador

Mathematical models have informed the public health response during the COVID-19 pandemic. The Canadian province of Newfoundland and Labrador has experienced prolonged periods with no community spread. Consequently, some of the challenges and best approaches to public health policy have been different than for larger jurisdictions. In this talk, I will discuss our modelling which highlights these differences, specifically with respect to travel restrictions, non-pharmaceutical interventions, the alpha variant outbreak in February 2021, vaccine priority groups, and reopening.

The impact of social, economic, environmental factors on the dynamics of COVID-19

Jude Dzevela Kong, York University

The COVID-19 pandemic has passed its initial peak in most countries in the world, making it ripe to assess whether the basic reproduction number (R_0) is different across countries and what demographic, social, and environmental factors other than interventions characterize vulnerability to the virus. In this talk, I will show the association (linear and non-linear) between COVID-19 R_0 across countries and 17 demographic, social and environmental variables obtained using a generalized additive model.

Modeling of epidemic dynamics based on individual contact networks

Jinzhi Lei, Tiangong University

This talk will introduce computational networks of epidemic dynamics based on individual contact networks. The model highlight individual heterogeneity, and the contact networks that may dependent on specific situation. The proposed model is applied to different situations of COVID-19 epidemic, including the non-pharmaceutical intervention against local transmission, community outbreak, and control of short term activities.

Modeling and research on an immuno-epidemiological coupled system with coinfection

Xue-Zhi Li[1†], Shasha Gao[2], Yi-Ke Fu[1], Maia Martcheva[2]
1. Henan Normal University 2. University of Florida

In this talk, a two-strain model with coinfection that links immunological and epidemiological dynamics across scales is formulated. On the with-in host scale, the two strains eliminate each other with the strain having the larger immunological reproduction number persisting. However, on the population scale coinfection is a common occurrence. Individuals infected with strain one can become coinfected with strain two, and similarly for individuals originally infected with strain two. The immunological reproduction numbers R_j, the epidemiological reproduction numbers R_j and invasion reproduction numbers R_{ij} are computed. Besides the disease-free equilibrium, there are strain one and strain two dominance equilibria. The disease-free equilibrium is locally asymptotically stable when the epidemiological reproduction numbers R_j are smaller than one. In addition, each strain dominance equilibrium is locally asymptotically stable if the corresponding epidemiological reproduction number is larger than one and the invasion reproduction number of the other strain is smaller than one. The coexistence equilibrium exists when all the reproduction numbers are greater than one. Simulations suggest that when both invasion reproduction numbers are smaller than one bistability occurs with one of the strains persisting or the other, depending on initial conditions.

Keywords: Immuno-epidemiology; coinfection; reproduction numbers; coexistence
†Speaker

Dengue fever in China: New epidemical trend, prediction, projection and strategies for its control

Qiyong Liu, Chinese Center for Disease Control and Prevention

Dengue fever is the most serious mosquito-borne disease in China and around the world. There are great challenges in the prevention and control of this disease, which poses a great threat to public health and national biosecurity in China. There were significant increases in the number and spatial distribution of dengue cases in China in 2019, which has reached an unprecedented level. Specific and universally applicable strategies and measures for the prevention and control of this disease should be developed and implemented in accordance with local conditions. On the basis of the surveillance of the vector Aedes and dengue cases, risk assessment and early warning were performed with reference to meteorological data, environmental factors, and demographic data. Sustainable vector Aedes control strategies and measures should be adopted based on local conditions. Then, a scientific basis for precise prevention and control of dengue fever may be provided in various regions of China.

Keywords: Dengue fever; Epidemic situation; Prediction; Projection; Prevention and control measure

Final size of COVID-19 epidemic model with strains

Shengqiang Liu, Tiangong University

Dynamical Heterogeneous COVID-19 epidemic model with strains is proposed, final size of the system with/without vaccination is investigated and compared.

On several PDE models for infectious disease

Yuan Lou, Shanghai Jiaotong University, Ohio State University

We will discuss several SIS-PDE models, focusing on the effects of spatial movement and time-periodicity of environment, the role of exposed populations, and the interaction of multiple strains.

Does viral diversity drive the development of AIDS?

Junling Ma, University of Victoria

It has been proposed that viral diversity causes the development of AIDS caused by viral diversity. The theory was illustrated using a model that does not include the details of immune responses. To study if this result still holds with more realistic HIV dynamics, we incorporate viral diversity into our first model. We conclude that the total viral load is positively correlated with the number of viral strains, and viral diversity may drive the development of AIDS. We also find that the total CD4 T cell count does not always decrease with viral diversity.

Modelling the growth of variants

Connell McCluskey, Wilfrid Laurier University

There is a slow growth in the number of variants of concern for COVID-19. We model this growth as proportional to the number of infected individuals worldwide. Let $M(t)$ be the number of variants, and let $i(t,m)$ be the number of individuals infected with variant m at time t. Then

$$\frac{dM}{dt} = \int_0^{M(t)} \rho(m) i(t,m) dm,$$

where $\rho(m)$ is the rate at which variant m slowly produces new variants.

What can we do with this? What impact do vaccines have on $M(t)$?

Cost and social distancing dynamics in a mathematical model of COVID-19

Iain Moyles, York University

We present an SEIAR mathematical model of COVID-19 which includes social distancing and relaxation. Our model has a dynamic behavioural influence where the decision for susceptible people to isolate is a function of the total and active cases, but the decision to stop isolating is a function of the perceived cost of isolation. Along with this social distancing cost, we define an overburden healthcare cost due to the strain placed on the healthcare system with a high caseload. We demonstrate that, non-intuitively, increasing either isolation activity or incentive to isolate do not always lead to optimal health outcomes. We show some preliminary results for the inclusion of vaccines and its impact on the model.

School and community reopening during the COVID-19 pandemic: a mathematical modeling study

Bouchra Nasri, University of Montreal

Operating schools safely during the COVID-19 pandemic requires a balance between health risks and the need for in-person learning. Using demographic and epidemiological data between July 31 and November 23, 2020 from Toronto, Canada, we developed a compartmental transmission dynamical model with age, household, and setting structure to study the impact of schools reopening in September 2020. The model simulates transmission in the home, the community, and schools, accounting for differences in infectiousness between adults and children, and accounting for work-from-home and virtual learning. While we found a slight increase in infections among adults (2.2%) and children (4.5%) within the first 8 weeks of school reopening, schools were not the key driver of the virus resurgence in fall 2020. Rather, it was community spread that determined the outbreak trajectory, primarily due to increases in contact rates among adults in the community. Analyses of cross-infection among households, communities, and schools revealed that home transmission is crucial for mitigating the epidemic and safely operating schools, while the degree of in-person attendance has a marked impact on transmission in schools. This study suggests that schools can open safely under strict maintenance of public health measures in the community.

Data, model and decision making -- Taking COVID-19 analysis as an example

Zhihang Peng, Nanjing Medical University

Ever since the identification of COVID-19 in 2019, countless medical workers around the world have been bleeding and sweating to combat COVID-19, and countless scientists have been racing against time to develop drugs and vaccines. In the meantime, researchers in the fields of epidemiology, physics, applied mathematics, computer science, and network science also contributed to the fight against this pandemic. By model analyses and numerical calculations, researchers estimated key epidemiological parameters to illustrate the epidemic potential of the virus, including the average incubation period and the proportion of severe patients. They were also committed to calculating risk factors, peak scale, final scale, and approximate timeline of the COVID-19 epidemic, as well as evaluating of the effectiveness and timeliness of major control measures including lockdown, contact tracing, testing and isolation. Thus, researchers in these fields laid a solid foundation for formulating scientific prevention policy, and contributed to curbing the spread of the epidemic. Although whether vaccines can block the spread of COVID-19 effectively has not been fully evaluated, vaccines do have a significant effect in reducing the morbidity and mortality of high-risk groups. Therefore, vaccination tends to play an important role in controlling COVID-19 spreading and improving immunity of the population. The prevention and control measures of COVID-19 have been transformed from a simple non-pharmacological intervention to a combination of "vaccination plus non-pharmacological intervention".

On combining mathematical modelling and experimental data

Stéphanie Portet, University of Manitoba

The current pandemic has seen a massive collection of data, which are then used to draw conclusions by using them in mathematical models. In this talk I will highlight how conclusions drawn when combining mathematical modelling and data are impacted by the mathematical translation of biological processes and the data considered. I will illustrate my point with examples in which not a single mathematical model but a collection of models designed to explore different working hypotheses are used with model selection method.

Controlling bovine tuberculosis in wildlife reservoirs

Carly Rozins, York University

Population structure is critical to infectious disease transmission. As a result, theoretical and empirical contact network models of infectious disease spread are increasingly providing valuable insights into wildlife epidemiology. We analyze an exceptionally detailed dataset on contact structure within a high-density population of European badgers. Our simulations reveal the importance of stable social group structure for disease dynamics with important management implications for socially structured populations.

Is a COVID-19 vaccine likely to make things worse?

Stacey Smith?, The University of Ottawa

In order to limit the disease burden and economic costs associated with the COVID-19 pandemic, it is important to understand how effective and widely distributed a vaccine must be in order to have a beneficial impact on public health. To evaluate the potential effect of a vaccine, we developed risk equations for the daily risk of COVID-19 infection both currently and after a vaccine becomes available. Our risk equations account for the basic transmission probability of COVID-19 and the lowered risk due to various protection options: physical distancing; face coverings such as masks, goggles, face shields or other medical equipment; handwashing; and vaccination. We found that the outcome depends significantly on the degree of vaccine uptake: if uptake is higher than 80%, then the daily risk can be cut by 50% or more. However, if less than 40% of people get vaccinated and other protection options are abandoned — as may well happen in the wake of a COVID-19 vaccine — then introducing even an excellent vaccine will produce a worse outcome than our current situation. It is thus critical that effective education strategies are employed in tandem with vaccine rollout.

Vaccination games in prevention of infectious diseases with application to COVID-19*

Jingwen Ge, Wendi Wang†, Southwest University

Vaccination is crucial in prevention of infectious diseases. We propose a mathematical model that simulates the vaccination game where individuals take vaccination on the information of vaccination costs and benefits. Analytical conditions are given for the stability of equilibria and the existence of periodic solutions. For COVID-19, we use numerical simulations to find how individual's attitude, response time, and governmental forced-control policies affect the progression of COVID-19 spread.

*Supported by the NSF of China (12071381)
†Speaker

Effect of information transmission on diseases transmission dynamics

Yanni Xiao, Xi'an Jiaotong University

There are many challenges to quantifying and evaluating the information transmission on the control of emerging infectious diseases like A/H1N1, COVID-19 and etc. In this talk, I initially overview the modelling approaches of how to couple the disease transmission with information transmission dynamics. Then I proposed a delay differential model, associated with the response time for individuals to the current infection, to examine the media impact on the transmission dynamics of infectious diseases. We investigated the global bifurcation and examined the onset and termination of Hopf bifurcations from a positive equilibrium. By fitting the proposed model to the 2009 A/H1N1 pandemic influenza data I estimated the basic reproduction number and the time delay. Further, I applied this methodology to investigate the media impact on COVID-19 infection by combining with data on confirmed cases and news items, obtained the estimation of the basic reproduction number. Sensitivity analysis showed that enhancing the response rate of the public awareness to the media reports can bring forward the peak time and reduce the peak size of the infection significantly. These findings suggested that quick information transmission can effectively mitigate the disease spreading during the initial stage of an outbreak.

Mitigating the spread of multi-strain dengue virus via multiple strategies

Ling Xue, Harbin Engineering University

Dengue virus is transmitted to humans by *Aedes* mosquitoes and can cause dengue fever that threats the health of humans. In this talk, I present the framework formulated to analyze how to vaccinate humans effectively, taking into account the infection by multiple strains of dengue virus and antibody dependent effect, as well as waning and primary failure of vaccines. The model was then extended to take into account multiple mitigation strategies and was optimized given finite economic cost.

Assessment of economic losses in COVID-19

Shibing You, Wuhan University

The report uses Wuhan lockdown in COVID-19 as the research object to assess the monthly economic loss of the city from three aspects including health economic loss, spiritual economic loss and industrial economic loss by using relevant economic theories and methods. On top of this, the report will discuss the increment of infections and treatment costs if the city is not locked down. Further, the report will present thoughts and discussions regarding the economic evaluation methods of the pandemic, data sources and alternative index methods, the economic loss assessment of superimposed multiple epidemics, and the prevention and control system in the post-epidemic era.

A general periodic discrete model on Wolbachia transmission dynamics in mosquito populations

Jianshe Yu, Guangzhou University

How to prevent and control the outbreak of mosquito-borne diseases, such as malaria, dengue fever and Zika, is an urgent worldwide public health problem. The most conventional method for the control of these diseases is to directly kill mosquitoes by spraying insecticides or removing their breeding sites. However, the traditional method is not effective enough to keep the mosquito density below the epidemic risk threshold. With promising results internationally, the World Mosquito Program's Wolbachia method is helping to reduce the occurrence of diseases transmitted by mosquitoes. In this talk, I will introduce a generalized discrete model to study the dynamics of Wolbachia infection frequency in mosquito populations where infected mosquitoes are impulsively released. This generalized model covers all relevant existing models since 1959 as special cases. After talking known results of discrete models deduced from the generalized one, some interesting open questions will be offered to be further investigated for the periodic impulsive releases.