INDO-US CONFERENCE - II

ON

THE SCIENCE OF MATHEMATICAL MODELING, AND DECISION-MAKING:

A CHANGING TRAJECTORY INTO THE FUTURE, FROM PAST TO POST COVID-19 PANDEMIC

OCTOBER 28-30 2021
BOOK OF ABSTRACTS

Department of Mathematics and Computer Science(DMACS)
Sri Sathya Sai institute of Higher Learning(SSSIHL)

Morning Session - Thursday, 28 October 2021

8:15 am – 8:30 am (India-IST)	*Lighting the Ceremonial Lamp and Vedam Chanting*
8:30 am – 8:45 am (India-IST)	*Welcome Remarks* Dr. Krishna Kiran Vamsi Dasu, DMACS, SSSIHL
8:45 am – 9: 00 am (India-IST)	*Introductory Remarks & Setting the Tone for the Conference* Dr. Anuj Mubayi PRECISIONheor, Illinois State University
9:00 am – 9:30am (India-IST)	*Inaugural Address* Dr. C. B. Sanjeevi Vice Chancellor, SSSIHL

Morning Session - Thursday, 28 October 2021

09:30 am – 10:15 am (India-IST)	*Special Keynote Address* Dr. Gautam Menon Ashoka University, Haryana
10:15 am – 11:00 am (India-IST)	*Plenary Address* Dr. Sudha Seshayyan Vice-Chancellor, The TamilNadu Dr. MGR Medical University
11:00 am – 11:15 am (India-IST)	Break
11:15 am – 12:00 pm (India-IST)	*Keynote Address (from India)* Dr. Srinivas The TamilNadu Dr. MGR Medical University, Chennai

Dr. C. B. Sanjeevi

Inaugural Address

Date: October 28th, 2021

Time: 9:00 am – 9:30am (India-IST)

Brief Bio

- Dr. Sanjeevi has been at the Karolinska Institute, a medical university in Stockholm, Sweden, since 1989. Karolinska Institute is known for selecting and awarding Nobel Prize for Physiology and Medicine and the Institute was established in 1810. He heads the Diabetes-Immunology research group at the Center for Molecular Medicine, and is affiliated to the Dept of Medicine. His group's focus is on Autoimmune diabetes.

- Dr. Sanjeevi has won several awards, and the most notable one was the Pravasi Bharathiya Samman Award from the Government of India for 'Eminence in one's field or outstanding work (Medicine). It is the highest honour conferred on Persons of Indian origin by the Government of India in recognition of their achievements both in India and abroad.

- Prof. (Dr.) C B Sanjeevi assumed charge as the eleventh Vice-Chancellor of SSSIHL on 23 November 2019.

Dr Gautam Menon

Title of the talk:

Models for COVID-19 in India: What they can (and cannot) do

Special Keynote Address

Date: October 28th, 2021

Time: 09:30 am – 10:15 am (India-IST)

BRIEF BIO

- Gautam Menon is a Professor of Physics and Biology at Ashoka University, Sonepat, currently on lien from the Institute of Mathematical Sciences, Chennai where he was the founding dean of the Computational Biology group. He is the Director of the Centre for Climate Change and Sustainability at Ashoka University. He was awarded the Swarnajayanti Fellowship of the DST, was an Outstanding Research Investigator of the DAE-SRC, has been named an Outstanding Referee of the American Physical Society and is a Fellow of the National Academy of Sciences (India). Apart from his scientific work, he is interested in making science accessible to the public.e

Abstract of the talk

- I'll summarize what we know of the current state of COVID-19 in India. I'll then discuss the role of mathematical and computational models in policy formulation, concentrating on school reopenings, optimal testing scenarios and vaccination methodologies. I will make the point that models for COVID-19 should not be trusted in detail and especially not for long-term projections. However, used carefully and in the right way, sensible models can provide useful and often surprising intuition as well as afford the possibility of testing potential policy interventions against each other.

DR. SUDHA SESHAYYAN

Title of the talk:

Progressive Significance of Projection Studies

Plenary Address

Date: October 28th, 2021

Time: 10:15 am – 11:00 am (India-IST)

Brief bio

- An outstanding academician with rich administrative experience Dr. Sudha Seshayyan, Vice-Chancellor, The Tamil Nadu Dr MGR Medical University, Chennai has been a medical doctor, a medical teacher and a medical administrator for over 30 years at various levels.

- Having been exposed to medical administration quite early in her career, she has been able to successfully scale its heights with relative ease and grit. Sudha has been teaching both at the undergraduate and postgraduate levels. This has given her the advantage of moving with successive generations and has contributed greatly to the understanding of the milieu.

- She has been a regular contributor to popular magazines as well as the journals of the academia. With decades of experience in teaching and scientific writing, she has served in the International advisory and editorial boards of Gray's Anatomy and has also edited a Text Book of Anatomy in three volumes.

DR. SRINIVAS

Title of the talk:

India's efforts to Combat Current Pandemic and Miniature experience of The Tamilnadu Dr MGR Medical University in Forecasting the COVID-19 Outbreak through Susceptible-Infectious-Recovered-Dead (SIRD) modelling

Keynote Address(from India)

Date: October 28th, 2021

Time: 11:15 am – 12:00 pm (India-IST)

Brief bio

- Dr G Srinivas Professor & H.O.D. in Dr. MGR Medical University. He did MBBS and MD in Community Medicine. He has Postgraduate Teaching experience of 11 years and Extensive Research & Project Management experience.

- He is a Member of Indian Clinical Epidemiological Network. He was awarded first prize in Phytochemical validation of siddha classical drug PARANGI RASAYANAM at The World Congress on Holistic Health International Conference.

- He also taught 'Tropical Diseases – Leprosy/TB/Buruli ulcer' at the Institute of Tropical Medicine and International Health in Berlin, Germany 2011 to 2014 for the Masters in International Health Course. He led & organized 25 plus workshops in Research methods, evidence based medicine, scientific writing and Statistical softwares in Health.

Abstract of the Talk

- The COVID -19 pandemic has become the biggest tragedy since the end of the 1922 Spanish flu global pandemic. We have never witnessed such a large-scale human disaster. The challenge of COVID 19 is diverse. So far, and until 26 th October 2021, 245,007,726
  people have been infected across the world and 4,973,772 deaths have occurred due to COVID. In the same time in India, 34,203,007 people were infected and 455126 people have died. Some of the South East Asian countries, including India in particular, have kept the COVID-19 death rates per million of the population (326 per million population) low compared to Western countries (about 2000 per million population) where the pandemic broke out around the same time. This could be the benefit of multiple factors in India such as younger age group, more rural population, the benefits the containment measures, early lockdown, as well as may be the temperature and climatic conditions.

- Still we do not know much about the RNA viruses' mutation; the viruses we are encountering today and what we will encounter in the next several months may or may not the same viruses; if the tested vaccines continue to protect us, how long?

  Hence we need modelling for pandemic risk reduction, and robust response planning. The projection exercise we conducted at the Tamilnadu Dr MGR Medical University through SIRD modeling (during the May 2020 to August 2020) for the State of Tamilnadu & Chennai did provide a useful measure on the expected cases, deaths, and supported in planning beds, ICUs, HPOs (High Pressure Oxygen) & others for the next few months for better planning by the state. The predictive dynamic models provide some insights into how we understand COVID-19 transmission and control. The risks may be an overestimate but its worth being prepared for worst-case scenario that may help enough to contain it.
  "The success of disease modelling is when its overestimated prediction fails"

Afternoon Session - Thursday, 28 October 2021

02:00 pm – 02:30 pm (India-IST)	*Keynote Address (from India)* Dr. Dharmendra Tripathi NIT Uttarakhand, Uttarakhand
02:30 pm – 03:30 pm (India-IST)	*Paper Presentation Sessions by the Participants* Session Chair: Dr. BSRV Prasad, Vellore Institute of Technology, Vellore
03:30 pm – 04:00 pm (India-IST)	Keynote Address (from India) Dr. Subhas Khajanchi Presidency University, West Bengal

DR. DHARMENDRA TRIPATHI

Title of the talk:

Virus Transport in Fluid Medium: Mathematical Modelling

Keynote Address(from India)

Date: October 28th, 2021

Time: 02:00 pm – 02:30 pm (India-IST)

BRIEF BIO

- Dr DharmendraTripathi has been working as Associate Professor in Department of Mathematics, National Institute of Technology, Uttarakhand. He has completed his PhD in Applied Mathematics (Mathematical Modelling of Physiological flows) in 2009 from Indian Institute of Technology BHU and MSc in Mathematics from Banaras Hindu University.

- He has supervised 06 PhD students and 03 are working under his supervision. He has also guided 20 B.Tech projects. He has published more than 150 papers in reputed international journals, 01 Book in Springer, 05 book chapters and presented more than 40 papers in International and National Conferences. He has delivered more than 50 lectures as Invited Speaker, Keynote Speaker and Resource person in various conferences, workshops etc., His research h-index is 40 and i-10 index is 119 and his papers have more than 4800 citations. He has recently achieved World rank 375 & Indian Rank 6 in top 2% researchers/scientist across the World as per Updated science-wide author databases of standardized citation indicators in field of Mechanical Engineering and Transport published on October 16, 2020.

- His research work is focused on the mathematical modelling and simulationof biological flows in deformable domains, Peristaltic flow of Newtonian and non-Newtonian fluids, Dynamics of various infectious diseases; microfluidics; CFD, Biomechanics; Heat Transfer; Nanofluids; Energy Systems; Numerical methods; etc.

ABSTRACT OF THE TALK

The worldwide spread of coronavirus in various strains and various waves is a challenging problem for the scientist and researchers to control it. It is noticed that SARS-Cov-2 virus is being transmitted through solid surfaces, air medium, and fluid medium to infect the persons. My talk is aimed to discuss a mathematical model on movement of viruses (SARS-Cov-2, Influenza A, Influenza B, and Swine Influenza) through fluid medium. An Eulerian-Lagrangian approach is adopted to examine the virus spread in axial and transverse directions. Basset-Boussinew-Oseen (BBO) equation is considered for the virus transport where effects of various forces(applicable to spread of viruses) gravity, virtual mass, basset force, and drag forces on velocity field vectors, axial and transverse velocities are discussed. A comparative analysis for all types of viruses will also be presented. This model may define the importance of the fluid dynamics in prevention of the Covid-19 spread and other similar viruses. Future works may focus on the various non-Newtonian fluids model to see the rheological effects on transmission of virus.

Dr. Subhas Khajanchi

Title of the talk:

How a simple Mathematical model encapsulates the dynamics of infectious diseases?

Keynote Address(from India)

Date: October 28th, 2021

Time: 03:30 pm – 04:00 pm (India-IST)

Brief Bio

- Dr. Subhas Khajanchi is currently an Assistant Professor in Department of Mathematics, Presidency University, Kolkata.

- He did his Bachelor of Science and Master of Science in Applied Mathematics from Jadavpur University, Kolkata, West Bengal, India. He did his Ph.D. in mathematics from Indian Institute of Technology (IIT) Roorkee, Uttarakhand, India on "Mathematical Modeling of Malignant Brain Tumor with T11 Target Structure".

- His area of research includes Mathematical Biology, Mathematical Modeling and Nonlinear Dynamics. He works on Tumor - immune competitive system, Growth of malignant gliomas and invasion, Infectious diseases (COVID 19, TB transmission, HTLV-I viral dynamics, SEIR models etc.) and Ecological modeling.

ABSTRACT OF THE TALK

- In India, 34,111,769 confirmed cases and 452,714 deaths of people who tested positive for SARS-CoV-2 were registered as of 20 April 2021. Ending the global SARS-CoV-2 pandemic requires implementation of multiple population-wide strategies, including social distancing, testing and contact tracing. We proposed a compartmental model that stratifies into nine stages of infection: susceptible (S), exposed (E), asymptomatic (A), pre-symptomatic (P), symptomatic undetected (U), symptomatic detected (D), isolation(I), recovered (R) and dead (H), collectively termed SEAPUDIRH. A sensitivity analysis is conducted to determine the robustness of model predictions to parameter values and the sensitive parameters are estimated from the real data on the COVID-19 pandemic in India. Performed short-term predictions for the daily and cumulative confirmed cases of COVID-19 pandemic in India. Long-term predictions, on the other hand, reveal the possibility of oscillatory dynamics. Our model simulation demonstrates that the COVID-19 cases across India at the end of September 2020 obey a power law.

Evening Session -Thursday, 28 October 2021

06:30 pm – 07:00 pm (India-IST) 09:00 am – 09:30 am (USA-EDT)	*Keynote Address (from USA)* Dr. Olcay Akman Illinois State University, Normal
07:00 pm – 07:40 pm (India-IST) 09:30 am – 10:10 am (USA-EDT)	*Keynote Address- Part I (from USA)* Dr. Guo-Wei Wei Michigan State University, Michigan
07:40 pm – 07:50 pm (India-IST) 10:10 am – 10:20 am (USA-EDT)	*Keynote Address-Part II (from USA)* Dr. Guo-Wei Wei Michigan State University, Michigan
08:00 pm – 08:30 pm (India-IST) 10:30 am – 11:00 am (USA-EDT)	*Keynote Address (from USA)* Dr. Edwin Michael University of South Florida, Tampa

Evening Session -Thursday, 28 October 2021

08:30 pm – 09:00 pm (India-IST) 11:00 am – 11:30 am (USA-EDT)	*Keynote Address (from USA)* Dr. Lance Waller Emory University, Georgia
09:00 pm (India-IST)	***End of Day 1***

Dr. Olcay Akman

Title of the talk:

On The Parameter Estimation in Compartmental Models Under Frailty

Keynote Address(from USA)

Date: October 28th, 2021

Time: 06:30 pm – 07:00 pm (India-IST)

09:00 am – 09:30 am (USA-EDT)

Brief bio

- Dr. Olcay Akman is a professor of mathematics at Illinois State University in Normal, IL.

- He is the director of the intercollegiate Biomathematics Alliance, a consortium of universities collaborating and sharing resource in the pursuit of scholarships, teaching, and advanced research development.

- Dr. Olcay Acman is currently Editor-in-Chief of the journal *Letters in Biomathematics* and a journal for undergraduate research, *Spora*.

- His research interests include computing-intensive modeling, using evolutionary computing or machine learning based methods.

Abstract of the Talk

- In most infectious diseases patients' varying immune response plays a role in its spread. This factor creates an obvious need to identify groups of individuals that are at an increased risk of mortality from the virus. We propose including so-called frailty parameter in model development for such cases. We use this approach to examine the hidden heterogeneity of patient frailty.

PROF. GUO-WEI WEI

Title of the talk:

Forecasting vaccine-breakthrough SARS-CoV-2

variants

Keynote Address(from USA)

Date: October 28th, 2021

Time: 07:00 pm – 07:40 pm (India-IST)

09:30 am – 10:10 am (USA-EDT)

Brief bio

- Prof. Guo-Wei Wei is a Michigan State University Foundation Professor. He received his Ph.D. degree from the University of British Columbia in 1996. With a postdoctoral fellowship awarded by the Natural Sciences and Engineering Research Council of Canada, he did research work at the University of Houston, where he became a Research Assistant Professor of Chemistry in 1997.

- In 1998, he joined the faculty of the Department of Computational Science at the National University of Singapore and was promoted to Associate Professor in 2001. In 2002, he relocated to Michigan State University, where he is a Professor of Mathematics, Professor of Electrical and Computer Engineering and Professor of Biochemistry and Molecular Biology.

- Over years, Dr. Wei has accumulated research experience in many disciplines, including mathematics, physics, chemistry, biology, computer science and engineering. His current research interests include mathematical molecular bioscience and biophysics, drug design, deep learning and bioinformatics. Dr. Wei has served extensively in a wide variety of national and international panels, committees and journal editorships.

Abstract of the Talk

Understanding the mechanisms of SARS-CoV-2 transmission and evolution is one of the greatest challenges of our time. We accurately predicted two vital spike protein receptor-binding domain (RBD) residues (452 and 501) responsible for all the prevailing SARS-CoV-2 variants in May 2020 (Journal of Molecular Biology (2020) 432, 5212). We predict that the combination of RBD mutations in these two sites will generate future variants ten times as contagious as the original virus. Essentially, all known RBD mutations belong to a list of 1149 mutations predicted by us as the most likely ones out of 3686 possible ones. We unveiled in July 2020 that natural selection is the mechanism governing SARS-CoV-2 evolution out of a variety of competing theories (see the above reference), which laid a foundation for us to accurately forecast emerging SARS-CoV-2 variants. We revealed that vaccine-resistance is a new transmission pathway in highly vaccinated populations. We forecast that two complementary transmission pathways, i.e., infectivity-strengthening and vaccine-resistance, will prolong our battle with COVOD-19 for years. Continuously confirmed by new experiments, our predictions are based on all available viral genomes isolated from millions of patients, tens of thousands of mutational data, all available antibodies (currently over 130), algebraic topology, and deep learning.

DR. EDWIN MICHAEL

Title of the talk:

Forecasting the future paths of the COVID-19 pandemic using adaptive data-driven simulation

Keynote Address(from USA)

Date: October 28th, 2021

Time: 08:00 pm – 08:30 pm (India-IST)

10:30 am – 11:00 am (USA-EDT)

Brief bio

- Dr. Edwin Michael is an epidemiologist who studies the spread and control of global infectious diseases. The overriding objective of Michael's research is to address the next generation of critical questions regarding the Epidemiology, Population Biology, and Computational Disease Dynamics.

- He got his MSc from Madras University, 1984. Then did his PhD, Imperial College of Science, Technology and Medicine, 1990. He was a member of British Society for Parasitology and British Society for Immunology.

- Currently, he leads the development of the SEIRcast covid-19 modelling portal for supporting population-level response and hospital surge planning to contain the pandemic at the county level. The SEIRcast COVID-19 Forecasting & Planning Portal provides daily unique, locally applicable epidemic forecasts.

Abstract of the Talk

The ability to predict the turning points and the future dynamics or paths of a pandemic is important for managing its ending and planning for a return to normalcy. Here, we highlight how integrating diverse data sources into a socio-ecological model of disease dynamics can provide a predictive framework for addressing these questions for the COVID-19 pandemic.

Dr. Lance Waller

Title of the talk:

Using what you have: Infectious disease surveillance with limited data and time.

Keynote Address(from USA)

Date: October 28th, 2021

Time: 08:30 pm – 09:00 pm (India-IST)

11:00 am – 11:30 am (USA-EDT)

Brief Bio

- **Lance A. Waller** is Professor in the Department of Biostatistics and Bioinformatics, Rollins School of Public Health, Emory University. He received his B.S. in Mathematics from New Mexico State University (1986), and his Ph.D. in Operations Research from Cornell University (1991). Prof. Waller leads the Woodruff Health Science Center's Strategic Initiative in Data Science. He is currently a member of the U.S. National Academy of Science Board on Mathematical Science and Analytics and serves as co-Chair of the Committee on Applied and Theoretical Statistics. Prof. Waller was recently appointed to a three-year term on the US Census Bureau's Scientific Advisory Committee.

- His research involves the development and application of statistical methods for spatially referenced data including applications in environmental justice, neurology, epidemiology, disease surveillance, conservation biology, and disease ecology. He has published in a variety of biostatistical, statistical, environmental health, and ecology journals and is co-author with Carol Gotway of the text *Applied Spatial Statistics for Public Health Data* (2004, Wiley)

Abstract of the Talk

- The COVID-19 pandemic continues to generate a flurry of reports, models, and projections as well as a wave of increased interest in epidemiology and infectious disease surveillance. In this presentation, we will review some classic ideas from disease surveillance, probability, and statistics and the roles these play (or don't play) in an ongoing pandemic.   In the urgency of the situation, some old ideas are being rediscovered and others ignored, some new tools are providing new insight, and new opportunities abound for statistical thinking in monitoring, analyzing, and understanding large-scale data streams. We will discuss the relationships between individual-level testing and public-level interpretations as well as the role of statistical thinking in new developments in data science. Our goal is to work toward building intuition around seemingly conflicting reports and interpretations.

Morning Session - Friday, 29 October 2021

09:00 am – 09:45 am (India-IST)	*Research Musings (Part-I) with Reference to COVID-19* Dr. Krishna Kiran Vamsi Dasu & Mr. Ananth V S from DMACS, SSSIHL
09:45 am – 10:40 am (India-IST)	*Research Musings (Part-II) with Reference to COVID-19* Mr. Bishal Chettri & Mr. Bhanu Prakash D from DMACS, SSSIHL
10:40 am – 11:00 am (India-IST)	*Break*
11:00 am – 12:00 pm (India-IST)	*Research Musings (Part-III)* Dr. N Uday Kiran, DMACS, SSSIHL

Dr. Krishna Kiran Vamsi Dasu

Title of the talk:

Research Musings with Reference to COVID-19

Keynote Address(from India)

Date: October 29th, 2021

Time: 09:00 am – 09:40 am (India-IST)

Brief Bio

- Dr. Vamsi is a Math Modeller. His expertise in this field is reflected in over the numerous credentials such as publications and Young Scientist awards, he has received. He is actively involved in research work apart from his full-time teaching duties and academic responsibilities.

- He graduated from Sri Sathya Sai Institute of Higher Learning in 2004 with a B.Sc. (Hons.) in Mathematics, where he also pursued his masters in Mathematics. He then completed his M.Phil. in 2008 and Doctorate degree in 2011 from Sri Sathya Sai Institute of Higher Learning. He was awarded a gold medal for academic excellence in M.Phil. He then joined Sri Sathya Sai Institute of Higher Learning as a Assistant Professor in 2011.

- Dr. Vamsi is working in the area of Mathematical Ecology and Epidemiology over the last few years. Specifically, he is working on epidemiolgical diseases like COVID-19, Leprosy, Dengue and TB. He is also working on additional food provided predator-prey systems. The Biological Insights from his research provide strategies to eco-managers facilitating biological conservation and Bio-Control.

Mr. Ananth V S

Mr. Ananth V S is a Doctoral Research Scholar in Department of Mathematics and Computer Science, Sri Sathya Sai Institute of Higher Learning.

He is an academic gold medalist and the all-rounder gold medalist in his undergraduation from SSSIHL.

He presented his work in Mathematical Models in Ecology and Evolution, Lyon, France in 2019. He is currently a CSIR Senior Research Fellow

Mr. Ananth V S has published 5 papers, 1 accepted for publication and 2 papers are under-review

Mr. Bishal Chhetri

Mr. Bishal Chhetri is a Doctoral Research Scholar in Department of Mathematics and Computer Science, Sri Sathya Sai Institute of Higher Learning.

His Master's Thesis was accepted in International Conference on Computer Modelling and Simulation Australia.

Mr. Bishal Chhetri has published 5 papers and 3 papers are under-review

Mr. Bhanu Prakash D

Mr. Bhanu Prakash D is a Doctoral Research Scholar in Department of Mathematics and Computer Science, Sri Sathya Sai Institute of Higher Learning.

Mr. Bhanu Prakash D has published 4 papers and 1 paper is under-review.

Abstract of the Talk

We have done mathematical modeling studies on COVID-19 at three different levels: within-host, between-host and multi-scale level. At within-host level, we developed a model based on the pathogenesis of COVID-19 disease and initially, studied the natural history of the disease. We then formulated the optimal control problem and studied the role and efficacies of antiviral drugs and immunomodulators in treating the COVID-19 infected individual. Filippov's existence theorem and Pontryagin's maximum principle are used to show the existence and characterization of optimal controls. To overcome the asymptotic nature of the equilibrium points, in the third part of our study at within-host level we have formulated a time optimal control problem with antiviral drugs and second line drugs as the controls. At between-host level, we developed an age structured model and formulated an optimal control problem and studied the spread of COVID-19 infection among different age groups with vaccination and treatment as control measures. Finally, we developed a multi-scale mathematical model integrating the within-host and between-host submodels and studied the influence of within-host parameters on community level infection.

DR. N UDAY KIRAN

Title of the talk:

A bird's eye view of DMACS, SSSIHL.

Keynote Address(from India)

Date: October 29th, 2021

Time: 11:00 am – 12:00 pm (India-IST)

BRIEF BIO

- Dr. N Uday Kiran is an Associate professor in Department of Mathematics and Computer Science(DMACS), Sri Sathya Sai Institute of Higher Learning. He completed his masters and doctorate degrees from the Sri Sathya Sai Institute of Higher Learning.

- Dr. Uday Kiran is an expert in Mathematical Analysis. His is interested in diverse fields of mathematical analysis that include microlocal analysis, functional analysis and algebraic analysis. He uses these methods to study the behaviour of differential equations and to analyse medical images. He is actively involved in research work along with full-time teaching duties. He also loves teaching students the art of problem solving through puzzles, games and anecdotes.

- His research interest is in the investigation of mathematical objects such as differential equations, polynomials and digital images through functional, symplectic and algebraic methods. Broadly, his research areas include microlocal analysis, algebraic analysis, pesudo-differential calculus, symplectic geometry and medical image processing.

Afternoon Session - Friday, 29 October 2021

02:15 pm – 03:00 pm (India-IST)	*Keynote Address (from India)* Dr. Ashish Awasthi Public Health Foundation of India, Delhi
03:00 pm – 03:30 pm (India-IST)	*Keynote Address (from India)* Dr. Jai Prakash Tripathi, Central University of Rajasthan, Rajasthan

Dr. Ashish Awasti

Title of the talk:

Cardiovascular risk prediction from a cross-sectional survey in India and its importance in COVID-19 modelling

Keynote Address(from India)

Date: October 29th, 2021

Time: 02:15 pm – 03:00 pm (India-IST)

Brief Bio

- Dr Ashish Awasthi is working as Assistant Professor (INSPIRE Faculty) and leading a DST funded research project. He has qualified UGC NET, ICMR JRF exam and completed his PhD in Biostatistics from Sanjay Gandhi Postgraduate Institute of Medical Sciences (SGPGIMS), Lucknow. He is a gold medalist in his M.Sc. from Banaras Hindu University, Varanasi.

- Apart from many national conferences and seminars, He has presented research findings in different countries and participated in a workshop in Singapore.

- Dr Awasthi received many international conference/ workshop travel scholarship for participation in various conferences. Dr Awasthi authored, more than 100 peer-reviewed publications in various high impact journals and have academic collaborations with various International and National Institutes .

ABSTRACT OF THE TALK

- Cardiovascular disease (CVD) is the leading cause of mortality in India. Yet, evidence on the CVD risk of India's population is limited. CVD risk and associated factors vary by states in India, by rural and urban locations, and by individual-level sociodemographic characteristics. Cardiovascular disease (CVD) and its traditional risk factors may affect severe COVID-19, length of hospitalization, and the outcome of the disease.

DR. JAI PRAKASH TRIPATHI

Title of the talk:

An epidemic Model using

Non-pharmaceutical Interventions

Keynote Address(from India)

Date: October 29th, 2021

Time: 03:00 pm – 03:30 pm (India-IST)

Brief Bio

- Dr. Jai Prakash Tripathi is presently working as an Assistant Professor in the Department of Mathematics, Central University of Rajasthan, Rajasthan, India. Dr. Tripathi completed his PhD in Mathematical Ecology from IIT Mandi in 2015.

- Dr. Tripathi is currently supervising 4 PhD students and one Junior research fellow. He has also guided more than 20 post graduate dissertations. Dr. Tripathi is currently running different research projects by different scientific bodies including SERB, UGC.

- He is also life member of various professional bodies, for example, Society of Mathematical Biology (SMB), USA, Indian Mathematical Society (IMS), India, Society of Pure and Applied Mathematics (SIAM), USA, Indian Science Congress Association (ISCA), India.

- Dr. Tripathi's research interests include Mathematical Biology, Theoretical Ecology, Differential Equations, Nonlinear Dynamics and Epidemiology.

Abstract of the talk

In this talk, different types of basic non-pharmaceutical interventions (NPIs), such as nationwide lockdown (travel restrictions and the closure of schools, shopping malls, and worshipping and other gathering places), quarantining of exposed individuals, and isolation of infected individuals would be discussed. In particular, a compartmental epidemic model incorporating quarantine and isolation compartments will be presented to (i) investigate the transmission patterns of COVID-19 in India, (ii) assess the impact of NPIs, and (iii) predictions related to the pandemic with various scenarios of NPIs in India.

Evening Session - Friday, 29 October 2021

06:30 pm – 08:30 pm (India-IST) 09:00 am – 11:00 am (USA-EDT)	**Panel Discussion** **Theme: The Hard Lessons from Modeling COVID-19 Dynamics and Health Policies** **Panelists:** Dr. Mac Hyman, Tulane University, New Orleans, Louisiana Dr. Kavita Kachroo, Kalam Institute of Health Technology, A.P. Dr. Ravishankar Ramachandran, CSIRCentral Drug Research Institute, U. P. Dr. Brian Wahl, John Hopkins, U.S.A Dr. Jianhong Wu, York University, Canada **Moderators:** Dr. Anuj Mubayi, PRECISIONheor & Dr. B V K Bharadwaj, SSSIHL

Evening Session - Friday, 29 October 2021

08:30 pm – 09:00 pm (India-IST) 11:00 am – 11:30 am (USA-EDT	Keynote Address (from USA) Dr. Alun Lloyd, North Carolina State University, North Carolina
09:00 pm (India-IST)	**End of Day 2**

29 OCTOBER 2021

06:30 PM – 08:30 PM (INDIA-IST)
09:00 AM – 11:00 AM (USA-EDT)

PANEL DISCUSSION

Theme: The Hard Lessons from Modeling COVID-19 Dynamics and Health Policies

Moderator 1: Dr. Anuj Mubayi

I am currently Associate Director in the Advanced Modeling Group of the PRECISIONheor and Distinguished IBA fellow at the Center for Collaborative Studies in Mathematical Biology, Illinois State University.

I am former faculty of the Arizona State University where I directed presidential award winning Mathematical Theoretical Biology Institute (MTBI).

I am an Applied and Computational Mathematical Scientist with more than 10 years of experience in disease modeling and health decision analysis. My research is driven by the quantitative and qualitative modeling of problems of interest to the public health or social sciences communities. My recent research interests include the development of new cost-effective tools for ameliorating the impact of infectious diseases while increasing understanding of mechanisms that drive their prevalence and mitigating morbidity related consequences.

MODERATOR 2: DR. B V K BHARADWAJ

I am currently Assistant Professor in the Department of Mathematics and Computer Science(DMACS) at Sri Sathya Sai Institute of Higher Learning(SSSIHL).

I graduated from Sri Sathya Sai Institute of Higher Learning with an M.Sc. degree in 2006. I also did my M.Phil. from the same Institute before pursuing my doctoral work on qualitative study of nonlinear ordinary differential equations.

I work mainly on differential equations and their qualitative study. I am interested in working on application of analytical techniques to study behaviour of solutions of different types of ordinary differential equations.

PANELIST 1: DR. MAC HYMAN
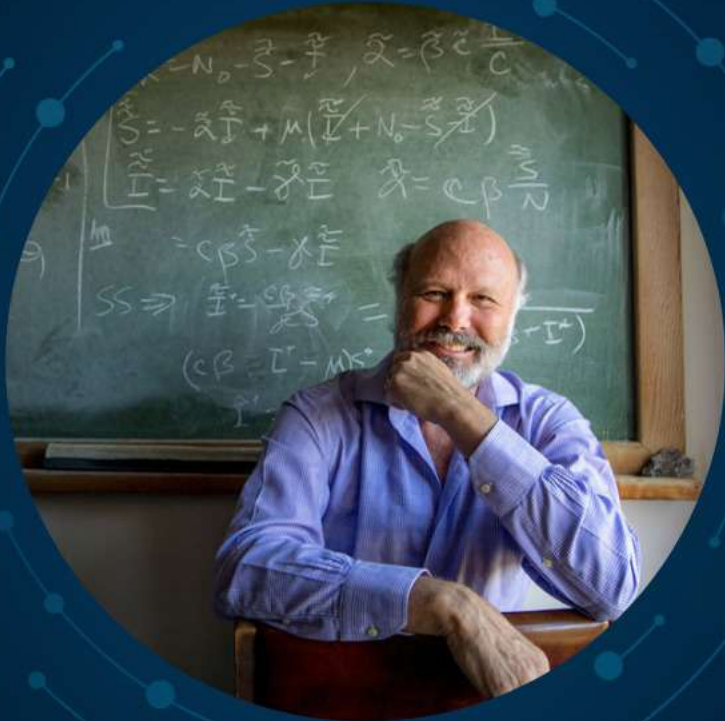
He holds the Evelyn and John G. Phillips Distinguished Chair and professor in Mathematics at Tulane University, is the past President of the Society of Industrial and Applied Mathematics (SIAM), and an AAAS Fellow.

He is the former group leader of the Los Alamos National Laboratory Mathematical Modeling and Analysis Group and former faculty of the Department of Mathematics at the University of Arizona.

Panelist 2: Dr. Kavita Kachroo

Dr. Kavita Kachroo is the Head of the Department for Health Economics and Outcomes Research division at Kalam Institute of Health Technology, a project of Department of Biotechnology, Government of India with 12 years of experience.

Kalam Institute of Health Technology (KIHT) is a Government of India funded health technology policy institute, which aims to facilitate focused research on critical components pertaining to medical devices and drugs by supporting institutions involved with R&D, industry, policy makers and knowledge repositories.

PANELIST 3: DR. RAVISHANKAR RAMACHANDRAN

Chief Scientist,Molecular and Structural Biology, Sophisticated Analytical Instrument Facility, CSIR-Central Drug Research Institute, U. P.

His work represents fundamental contributions to the disease biology of TB and in the development of new therapeutic approaches against anti-microbial resistance (AMR).

PANELIST 4: DR. BRIAN WAHL

John Hopkins, U.S.A

He is an epidemiologist with a broad interest in the relationship between health systems and infectious diseases in low- and middle-income countries.

His research focuses on understanding the changing epidemiology of pediatric respiratory diseases in the context of new health interventions. He has experience contributing to field studies and disease burden/transmission modeling projects.

Panelist 5: Dr. Jianhong Wu

York University, Canada

Jianhong Wu is an applied mathematician and the founding Director of the Laboratory for Industrial and Applied Mathematics at York University. He holds the life-time title of University Distinguished Research Professor.

Professor Wu is the first recipient of the Canadian Applied and Industrial Mathematical Society's Research Prize, for his "very significant contributions in the area of infinite dimensional differential equations with applications to neural networks and population dynamics".

He is recognized for his expertise and contribution in the following fields: nonlinear dynamics and delay differential equations; neural networks and pattern recognition; mathematical ecology and epidemiology; big data analytics.

Dr. Alun Lloyd

Title of the talk:

Contact Tracing for Controlling COVID-19 Outbreaks

Keynote Address(from USA)

Date: October 29th, 2021

Time: 08:30 pm – 09:00 pm (India-IST)

11:00 am – 11:30 am (USA-EDT)

Brief Bio

- Alun Lloyd is Drexel Professor of Mathematics and Director of the Biomathematics Graduate Program at North Carolina State University.

- Following an undergraduate degree in mathematics from Cambridge University, he received a PhD in biological sciences from the University of Oxford under the supervision of Robert May. After postdocs at Oxford and the Institute for Advanced Study, Princeton, he took up a faculty position in the Mathematics Department at NC State University.

- He has interests in infectious disease epidemiology, with a particular interest in mosquito-borne infections.

Abstract of the Talk

Contact tracing is critical to controlling COVID-19, but most protocols only "forward-trace" to notify people who were recently exposed. Using a stochastic branching-process model, we find that "bidirectional" tracing to identify infector individuals and their other infectees robustly improves outbreak control. In our model, bidirectional tracing more than doubles the reduction in effective reproduction number, R_{eff}, achieved by forward-tracing alone, while dramatically increasing resilience to low case ascertainment and test sensitivity. The greatest gains are realized by expanding the manual tracing window from 2 to 6 days pre-symptom-onset or, alternatively, by implementing high-uptake smartphone-based exposure notification; however, to achieve the performance of the former approach, the latter requires nearly all smartphones to detect exposure events. With or without exposure notification, our results suggest that implementing bidirectional tracing could dramatically improve COVID-19 control.

Morning Session - Saturday, 30 October 2021

09:00 am – 09:30 am (India-IST)	*Keynote Address (from India)* Dr. Sudipa Chauhan, Amity University, Noida
09:30 am – 10:00 am (India-IST)	*Keynote Address (from India)* Mr. Satya Sai Mudigonda, SSSIHL, A.P.
10:00 am – 10:30 am (India-IST)	*Keynote Address (from India)* Dr. B V Rathish Kumar, Indian Institute of Technology, Kanpur
10:30 am – 11:00 am (India-IST)	*Keynote Address (from India)* Dr. Malay Banerjee, Indian Institute of Technology, Kanpur

Morning Session - Saturday, 30 October 2021

11:00 am – 11:15 am (India-IST)	Break
11:15 am –12:00 pm (India-IST)	*Keynote Address (from India)* Dr. Vijay Bhagat, Central Leprosy and Teaching Research Institute, Chennai

Dr. Sudipa Chauhan

Title of the talk:

Investigating Economic Quandaries through Mathematical Modelling: Quantifiable Predictions and Augmentation with Epidemic Models

Keynote Address(from India)

Date: October 30th, 2021

Time: 09:00 am – 09:30 pm (India-IST)

Brief Bio

- Dr Sudipa Chauhan is an Asst. Professor (Grade-III) in Amity Institute of Applied Sciences. She did her Post Graduation : M.Sc(Mathematics)-2005,Jiwaji University.

- She is a member of World Academy of Science, Engineering and Technology(WASET) and also a member of International Association of Engineers(IAENG)

- She is a reviewer of International journal of Biomathematics, World Scientific.

- She gave an Invited lecture on "Simultaneous effect of disease and toxicant on prey-predator system" at TIFR Banglore on 20th March, 2014 by Skype.

Abstract of the talk

This talk would encapsulate a brief on different areas of economic modelling by understanding a few concepts on business cycle model, the assumptions of classical's and keynes theory, Investment- Saving Liquidity Preference Money Supply Model, Kaldor's Model, Solow's Economic Growth Model and how natural calamities such as the ongoing pandemic, can affect the dynamics of economic models/system. Health and economy share a bidirectional relationship. The ongoing pandemic is a multifaceted crisis encompassing both economic and epidemic factors, hence formulating amalgamated epidemic-economic model can act as a lodestar to not only analyse economy v/s infections but to make effective forecasts imbibing both financial and health factors in direct relationship with each other.

Mr. Satya Sai Mudigonda

Title of the talk:

A study of correlation between pre and post COVID-19 claims using CANN (Combined Actuarial Nueral Networks) Models

Keynote Address(from India)

Date: October 30th, 2021

Time: 09:30 am – 10:00 am (India-IST)

Brief Bio

- Mr. Satya Sai Mudigonda is a Senior Tech Actuarial Consultant with more than 30 years of consulting in actuarial and tech domains in USA and India.

- With a wide skill set, he managed numerous multi-million-dollar international assignments for major insurance companies across the globe.

- He is a visiting faculty at Sri Sathya Sai Institute of Higher Learning (Deemed University). He has several international journal research publications and book chapters to his credit in the field of Actuarial Data Science and has presented in many international conferences. His area of current research is Healthcare.

Abstract of the Talk

Claims in health insurance saw a spike as the world entered the COVID-19 pandemic. This increase in claims brought an increased chance of fraud in the health insurance business. This work demonstrates the implementation of Combines Actuarial Neural Networks in building a fraud detection model with embedded classical generalized linear model (GLM) to mitigate this fraud in the pre-COVID-19 and COVID-19 times. There was a positive correlation observed, between increase in health insurance claims and COVID-19 cases which enabled to find features specific to the pandemic apart from other features. This work uses two datasets: health insurance dataset and Kaggle dataset on active COVID-19 cases for the same select geographical location in India (Ayushman Bharat)during a particular time frame.

Brief Bio

- Prof. B. V. Ratish Kumar has done his PhD from SSSIHL, Prasanthi Nilayam.

- He is currently a Professor in Department of Mathematics and Statistics, IIT Kanpur.

- His research interests include Parallel Computing, Numerical Methods For PDEs, Computational Fluid Dynamics, Finite Element Analysis, Computational Biomechanics, Porous Media, Image Processing.

Abstract of the Talk

- Hand washing and maintaining social distance are the main measures recommended by the World Health Organization (WHO) to avoid contracting COVID-19. Unfortunately, these measures do not prevent infection by inhalation of small droplets exhaled by an infected person that can travel distance of meters in the air and carry their viral content. Science explains the mechanisms of such a transport and there is evidence that this is a significant route of infection in indoor environments. In this study, we attempt to model and simulate such a potential transmission of SARS-COV-2 Virus in a realistic Indoor Context. Details on the modelling and numerical simulations together the obtained results will be discussed in the talk.

Dr. Malay Banerjee

Title of the talk:

Two-group epidemic model of COVID-19 with varying infectivity

Keynote Address(from India)

Date: October 30th, 2021

Time: 10:30 am – 11:00 am (India-IST)

Brief Bio

- Dr. Malay Banerjee got his M.Sc. degree and PhD degree from University of Calcutta in 2005.

- He is currently a Professor in Department of Mathematics and Statistics in IIT Kanpur.

- His research Interest are in Mathematical Ecology and Eco-epidemiology, Nonlinear Dynamics, Pattern Formation and Spatio-temporal chaos.

Abstract of the talk

- Main objective of the talk is to discuss a multi-compartment two-group epidemic model which can capture successive outbreaks with variable infectivity. Non-conventional vaccination strategy for two-group epidemic model will be discussed in brief.

Brief Bio

- DR. VIJAY BHAGAT finished his MD and Ph.D.

- He is currently the Deputy Director and Head, Division of Epidemiology & Statistics, Central Leprosy Teaching & Research Institute, Ministry of Health & Family Welfare (Govt. of India)

- He is also a member of National Technical Resource Group-NLEP.

Abstract of the talk

- The standard way of synthesis of medical evidence

- The evolvement of Medical Evidence for Covid-19

- Major lessons learnt through Covid-19

- The way ahead for mitigation of the Pandemic

Afternoon Session - Saturday, 30 October 2021

02:00 pm – 02:30 pm (India-IST) 10:30 am – 11:00 am(Spain-CEST)	Keynote Address (from Spain) Dr. Maira Aguiar, Basque Center for Applied Mathematics, Spain
02:30 pm – 03:30 pm (India-IST)	*Paper Presentation Sessions by the Participants* Session Chair: Dr Surabhi Pandey, Indian Institute of Public Health, Delhi

Brief Bio

- Dr. Maíra Aguiar is a mathematical epidemiologist working on infectious disease dynamics. With a multidisciplinary research profile, Dr. Aguiar has a double European PhD degree, PhD in Life Sciences, from the Vrije Universiteit Amsterdam, The Netherlands, and PhD in Population Biology, from the University of Lisbon, Portugal. Dr. Aguiar is trained in dynamical systems theory, stochastic processes, nonlinear dynamics, bifurcation analysis and biostatistics and her scientific interests addresses significant mathematical and fundamental questions in biology and medicine, with special focus on public health epidemiology modeling.

- Dr. Aguiar is a former Marie Curie Fellow at Trento University, Italy and is currently the group leader of the Mathematical and Theoretical Biology Group at the Basque Center for Applied Mathematics (BCAM) in the Basque Country, Spain. Dr. Aguiar is member of the Board of Directors of the European Society for Mathematical and Theoretical Biology (ESMTB), serving as Vice-President from 2018-2020. As a member of the Basque Modeling Task Force, Dr. Aguiar is currently assisting the Basque Health Managers and the Basque Government during the COVID-19 responses.

Abstract of the talk

In March 2020, a multidisciplinary task force (so-called Basque Modelling Task Force, BMTF) was created to assist the Basque health managers and Government during the COVID-19 responses. BMTF is a modelling team, working on different approaches, including stochastic processes, statistical methods and artificial intelligence. Here we describe the efforts and challenges to develop a flexible modeling framework able to describe the dynamics observed for the tested positive cases, including the modelling development steps. The results obtained by a new stochastic SHARUCD model framework are presented. Our models differentiate mild and asymptomatic from severe infections prone to be hospitalized and were able to predict the course of the epidemic, providing important projections on the national health system's necessities during the increased population demand on hospital admissions. Short and longer-term predictions were tested with good results adjusted to the available epidemiological data. We have shown that the partial lockdown measures were effective and enough to slow down disease transmission in the Basque Country. The analysis of the growth rates from the data led to improved model versions describing after the exponential phase also the new information obtained during the phase of response to the control measures. This framework is continuously being used to monitor disease transmission while control measures are tightened and relaxed over time.

Evening Session - Saturday, 30 October 2021

06:00 pm – 06:30 pm (India-IST) 07:30 am – 08:00 am (Peru)	*Keynote Address (from Peru)* Dr. Roxana Lopez Cruz Universidad Nacional Mayor de San Marcos, Peru
06:30 pm – 07:00 pm (India-IST) 09:00 am – 09:30 am (USA-EDT)	*Keynote Address (from USA)* Dr. Aditi Ghosh, Texas A&M University,Commerce
07:00 pm – 07:30 pm (India-IST) 09:30 am – 10:00 am (USA-EDT)	*Keynote Address (from USA)* *Dr. Maia Martcheva, University of Florida, Gainesville*
07:30 pm – 08:00 pm (India-IST) 10:00 am – 10:30 am (USA-EDT)	*Keynote Address (from USA)* Dr. Padmanabhan Seshiyer, George Mason University, Fairfax
08:00 pm – 08:30 pm(India-IST)	*Valedictory Function & Vote of Thanks*

DR. ROXANA LOPEZ CRUZ

Title of the talk:

Media coverage of infectious diseases, how does it affect their propagation?

Keynote Address(from USA)

Date: October 30th, 2021

Time: 06:00 pm – 06:30 pm (India-IST)

07:30 am – 08:00 am (USA-EDT)

Brief Bio

- Dr. Roxana Lopez did her PhD in Mathematics at Arizona State University. Currently, she is Full Professor and Researcher of the Faculty of Mathematical Sciences, UNMSM and external Advisor of national institutions on research projects in Mathematics and its Applications.

- In Latin America, she is recognized as an expert in the fields of mathematics (biomathematics, Functional Analysis and Delay Differential Equations) and the teacher training of young researchers for these areas.

- Her research interests deal with the Biomathematics. She has developed scientific initiation courses and special topics in biomathematics. She ventured into areas of Health Consulting with the dissemination of mathematical models in epidemiology, with exhibitions in offices related to that area in Peru.

Abstract of the Talk

Epidemics, due to their dynamic nature, have their basic mathematical modeling which becomes more complex depending on how more factors that characterize each disease are considered. This work aims to study the dynamical behavior of a SAIRD (Susceptible-Isolated-Infected-RecoveredDead) epidemiological model by introducing the negative feedback caused by media coverage. Controlling the information about non pharmaceutical interventions is considered by the addition of a new variable which measures how the behavioral changes about isolation influence of pandemics. A Hopf bifurcation is analytically verified for the delay parameter. The qualitative ana-lysis shows that feedback information index promotes more changes to the propagation of the disease than other parameters.

Dr. Aditi Ghosh

Title of the talk:

Building Capacity for Sustained Collaboration and a Study on Optimal Dynamic Strategies of COVID-19 Transmission in Close-Contact facilities

Keynote Address(from USA)

Date: October 30th, 2021

Time: 06:30 pm – 07:00 pm (India-IST)

09:00 am – 09:30 am (USA-EDT)

Brief Bio

- Dr. Aditi Ghosh is an Assistant Professor, Texas A&M University, Commerce.

- She did her Ph.D. Mathematics, Texas A&M University, College Station. She has a Certificate of achievement for STEM faculty launch participation from Worcester Polytechnique University.

- Her research interests lies in the area of Mathematical and Statistical Modeling, Computational Mathematics with application to Mathematical Biology. Her research is driven by problems on public health issues, disease dynamics, epidemic spread, liver mechanism, social issues that requires mathematical formulation for its solution using modeling techniques.

ABSTRACT OF THE TALK

- In this talk here, I would show my collaborations with personels from different stages in academia. In paticular, I will discuss a study on close-contact places such as long-term facilities that have been found to be high-risk andhigh-morbidity places in the US for COVID-19 outbreaks. The reasons include a vulnerable resident population, limited resources in facilities, close contacts with visitors and workers, contaminated resources, and ill-trained workers. In this study, such placesare modeled to evaluate the impact of different transmission pathways of the COVID-19outbreaks in the presence of various types of interventions. The model captures a coupled dynamics between three subpopulations (staff, the residents, and the visitors) andincorporates infection from infectious individuals and through the environment.

BRIEF BIO

- Maia Martcheva is a professor of mathematics at University of Florida. She obtained her PhD at Purdue University in 1998. After that she was a postdoc at IMA, University of Minnesota, Arizona State University and an NSF Advance Fellow at Cornell University in 2002-2003. Since 2003 she has been an Assistant, Associate and Full Professor at the Department of Mathematics, University of Florida.

- Maia Martcheva has published around 120 papers. She has also published 3 books: Gender Structured Population Modeling (2005, SIAM), An Introduction to Mathematical Epidemiology (2015, Springer), and Age Structured Population Modeling (2020, Springer). Her research has been supported by the National Science Foundation.

- In 2016-2018 Maia Martcheva was a Managing Editor of Journal of Biological Systems. Maia Martcheva has mentored 3 MS students, 13 PhD students, and two postdoctoral associates.

Abstract of the Talk

We introduce a SARS-CoV-2 outbreak model with asymptomatic and symptomatic infections, as well as, hospitalized individuals. We fit the model to US data of COVID-19 cases and deaths.

We conclude that the model is not structurally identifiable. After fixing 4 parameters and expressing one of the transmission rates through the known Ro the model becomes structurally identifiable. Practical identifiability of the model through Monte Carlo simulations reveals that if the transmission rates are written as multiples of one transmission rate then that transmission rate and one of the proportionality constants are not practically identifiable. We generalize the model to forecast the multiple outbreaks in the US data. With identified parameters, we set up an optimal control problem with social distancing and isolation as the control variables. The control problem suggests that social distancing and isolation should be maintained at 100% during most of the pandemic. The optimal control leads to drastic reduction in the infected classes early of the pandemic and shifts the peaks to occur even earlier.

Brief Bio

- Dr. Padmanabhan Seshaiyer is a tenured Professor of Mathematical Sciences at George Mason University and serves as the Director of the STEM Accelerator Program in the College of Science as well as the Director of COMPLETE (Center for Outreach in Mathematics Professional Learning and Educational Technology) at George Mason University in Fairfax, Virginia.

- His research interests are in the broad areas of computational mathematics, computational data science, scientific computing, computational biomechanics, design and systems thinking, entrepreneurship and STEM education.

- In 2019, he was selected as Figures that Matter and was awarded a honorary doctorate from Vrije Universiteit Brussel. This was given to committed scientists who transcend the boundaries of their own disciplines and to personalities that have been at the frontiers of societal change.

Abstract of the Talk

- While most models introduced during the past several months have attempted to address the critical need to understand both the likely number of infections due to COVID-19 and their time course to inform both public health and health care system responses, there has also been a great need to understand additional challenges created by COVID-19 that may often be ignored within these models. In this talk, we will identify, review and share some such challenges and discuss some inclusive modeling practices that can provide useful insights.

THANK YOU...

Sri Sathya Sai Institute of Higher Learning

Illinois State University