COVID-19: Evolution of infection dynamics

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COVID-19 infection dynamics is studied by using statistical models based on the generalized Logistic Function model and enhanced compartmental models with and without delays. It is shown as to how forecasting may be done on the spreading of the infection in a chosen population by using these models. In the compartmental model, the population is divided into susceptible, exposed, infected, quarantined, recovered, and deceased compartments, and a set of delay differential equations are used to describe the system. Some original aspects of the work include the use of distributed time delays to capture the variability in the response of one individual to another and the use of a time varying infection rate parameter. The critical role of data is elucidated, and it is discussed as to how the compartmental model can be used to understand the effectiveness of measures such as quarantining in terms of the flattening the evolution of the daily increment in infection cases. Short-term and long-term forecasts are addressed. The obtained results can be useful for furthering our understanding of disease dynamics as well as for planning purposes and answering questions such as when the COVID-19 infection dynamics may evolve as a seasonal flu.

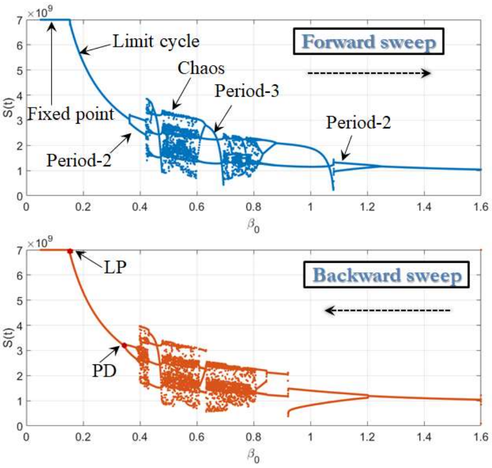

Figure 1: Bifurcation diagram on a Poincaré section shown in the state-control space of the susceptible population and the infection rate.

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Bio-sketch of Bala Balachandran

Dr. Balachandran received his B. Tech (Naval Architecture) from the Indian Institute of Technology, Madras, India, M.S. (Aerospace Engineering) from Virginia Tech, Blacksburg, VA, USA and Ph.D. (Engineering Mechanics) from Virginia Tech. Currently, he is a Minta Martin Professor of Engineering at the University of Maryland, where he has been since 1993. His research interests include nonlinear phenomena, dynamics and vibrations, and control. The publications that he has authored/co-authored include a Wiley textbook entitled "Applied Nonlinear Dynamics: Analytical, Computational, and Experimental Methods" (1995, 2006), a Cambridge University Press textbook entitled "Vibrations" (2019), and a co-edited Springer book entitled “Delay Differential Equations: Recent Advances and New Directions” (2009). Currently, he serves as the Editor of the ASME Journal of Computational and Nonlinear Dynamics and a Contributing Editor of the International Journal of Non-Linear Mechanics. He is a Fellow of ASME and AIAA and a senior member of IEEE.