Clark School Engineering Solutions for COVID-19

Balakumar Balachandran, Ph.D.
Department Chair, Mechanical Engineering
Minta Martin Professor
Faculty Member, Applied Mathematics and Scientific Computation

balab@umd.edu

Relevant Expertise:
Data-Driven Approaches and Forecasting, Delay Systems, Nonlinear Dynamics, System Identification

Website(s):
//enme.umd.edu/research/institutes-labs-centers
(Computational Dynamics Laboratory, Dynamics and Control Laboratory, and Vibrations Laboratory)
Balachandran, Balakumar | Department of Mechanical Engineering (umd.edu)

Clark School Engineering Solutions for COVID-19

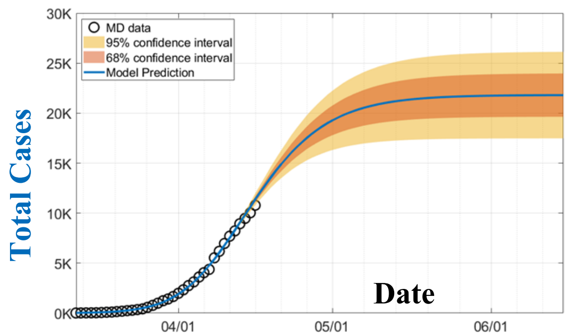
Related Capabilities: **Statistical Modeling, Recurrent and Non-Recurrent Neural Network Models, Data-Driven Dynamics of Nonlinear Systems**

Overall Goal of Study: *To use statistical models (Logistic Function and Generalized Logistic Function based models), physics informed neural networks, and delay dynamics-based models (improved extended compartmental models) to further our understanding of COVID-19 dynamics*

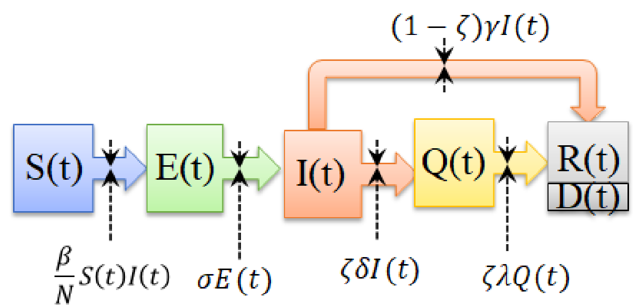
Potential uses of study:

a) *To make forecasts*

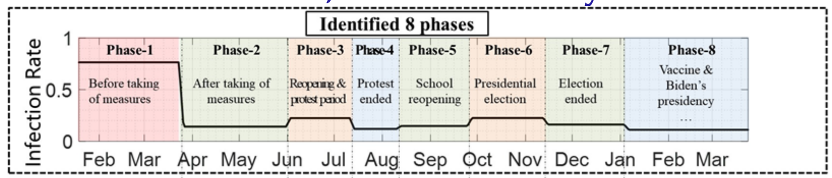
b) *To understand the effectiveness of different measures (e.g., quarantining)*

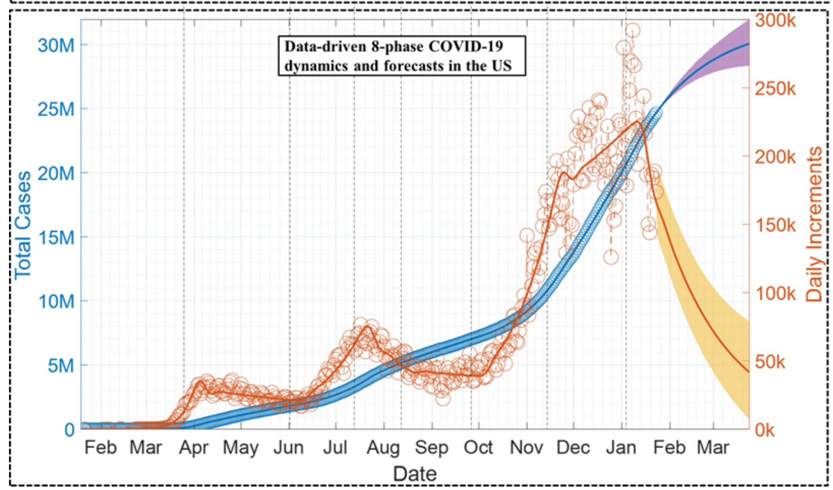


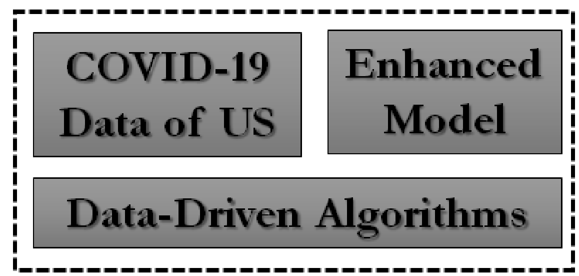
Generalized Logistic Function model



Extended Compartmental Model Developed in ME@UMD





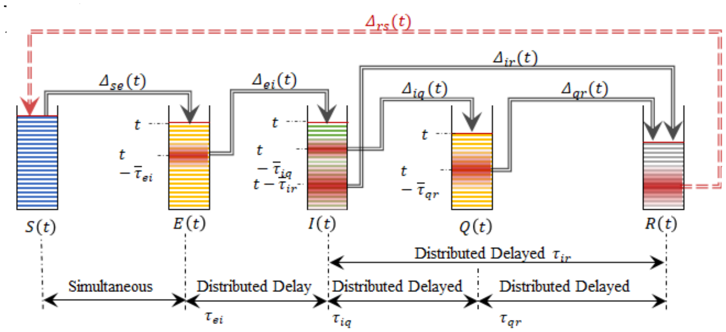


- **Joint Work with Dr. Xianbo Liu and Dr. Xie Zheng, ME, UMD**
- **Other participants: Mr. Agustin Jauregui (sophomore) and Ms. Christina Nikiforidou (junior), ME, UMD**

- **Liu, X., Zheng, X., and Balachandran, B. 2020. COVID-19: data-driven dynamics, statistical and distributed delay models, and observations, Nonlinear Dynamics, Vol. 101, pp:1527–1543. //doi.org/10.1007/s11071-020-05863.**

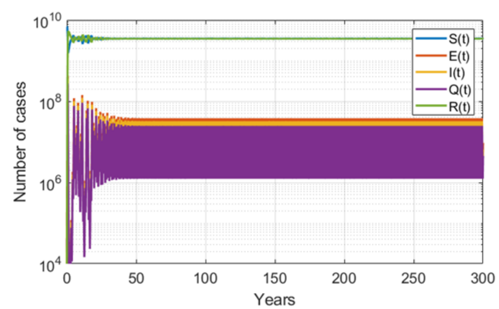
Clark School Engineering Solutions for COVID-19

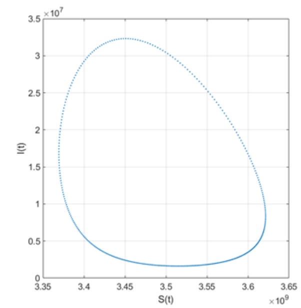
Long-Term Nonlinear Dynamics of COVID-19 Infection



Periodic solution：COVID-19 becomes a stable and predictable seasonal epidemic

With Parameters $\boldsymbol{\beta_0 = 0.3}$, $\delta = 0.3, \omega = 0.0005$





- Understanding of multi-phase and multi-scale behavior and nonlinear dynamics important for long-term forecasts

Consideration 1: Lost immunity from the recovered cases

$$\Delta_{rs}(t) = \omega R(t)$$

Consideration 2: Seasonal dependent infection rate [3]

$$\beta = \beta_0(1 + \delta \cos 2\pi t)$$