Infectious diseases, such as seasonal influenza, Zika, Ebola, and the ongoing COVID-19, can be spread, directly or indirectly, from one person to another leading to an outbreak, an epidemic, or a pandemic. Infectious diseases place a heavy social and economic burden on our society. Producing timely, well-informed, and reliable spatiotemporal forecasts of the epidemic dynamics can help inform policymakers on how to provision limited healthcare resources, develop effective interventions, rapidly control outbreaks, and ensure the safety of the public. Traditional approaches are mainly based on theory-based mechanistic models (e.g., an agent-based SEIR model) and statistical time series models (e.g., autoregressive models). Recent advances in deep learning have significantly improved the state of the art in computer vision, natural language processing, and many other fields. However, they are not well explored in epidemic forecasting. One challenge is the lack of sufficient good-quality training data, particularly during new emerging epidemics. Another challenge is that existing models are seldom designed to consider both spatial and temporal correlations dynamically for capturing disease spread dynamics. A further challenge is that such models rarely consider epidemiological context. Models in the aforementioned cases are prone to be overfitting and are unlikely to provide explanatory power for the underlying phenomena due to the black box nature. Given the challenges, my research focuses on deep learning-based methods that incorporate spatiotemporal features, theory-based mechanistic models, and ensemble techniques for a better understanding of disease spreading and improving forecasting accuracy and explainability. This talk presents several works evolving around artificial intelligence techniques for reliable epidemic forecasting. Particularly, we explore a new research direction that combining theory and data-driven methods for epidemic forecasting. We also investigate machine learning theory and algorithms, with the aim of building more robust, consistent, and accurate AI-based forecasting systems. The talk will conclude with a discussion of promising future directions and opportunities in AI for social good.

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