Seminar Review 5.11-5.17

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SIMONS INSTITUTE 5.11

Title: Theoretically Speaking Series — Computational and Statistical Tools to Control a Pandemic: A Panel Discussion

Presenters: Klaske van Heusden(UBC), Madhav Marathe(UV), Ankur Moitra(MIT), Shai Shalev-Shwartz(HUJ), Anil Vullikanti(UV), Bin Yu(UCB), Peter Bartlett(moderator)

This panel discussion collects some current works on computational and statistical tools that may help to control the pandemic, COVID-19. Topics including policy analysis, resource allocation, modelling challenges are covered by the short talks given by 6 professors.

First presenter aims to find the efficient strategy to prevent the spread of the illness and minimize the impact to economics at the meanwhile. He introduces the simple SIR(susceptible-infected-recovered) model and changes the model into a large Markov Chain model.

Second presenter talks about the feedback and control for designing the re-open policies. COVID-19 grows unstably with many unknown factors and the new infection are always delayed. Control theories using feedback and systematic tools help to give more accurate prediction in the uncertainty and design the policy with better trade-off between people's health and economics consideration.

Third presenter introduces current computational epidemiology models including SIR, IHME, Imperial College model. He questions the goodness of these models due the lack of critical factors such as the growth rate, mortality rate. The strategy may be sub-optimal because of the incomplete data.

Fourth presenter points out the computational tools to analyse the policy contains the total and condition mortality probability, concentration bound of the mortality rate after taking policy and the SEIR model. He proposes a risk-based resource allocation approach and concludes that more resource should allocated for vulnerable people like nursing house.

Fifth presenter also talks about the computational and statistical challenges of using models. The challenges lie in data calibration, computational efficiency, large design and inverse problem.

Sixth presenter discusses about the data repository, severity prediction. She curates the data from various resource and forecasts the county death rate through the weighted average result of linear and exponential prediction.She also sets up a severity index based on the total death and daily death of each hospital and proposes the aid resource allocation suggestions according to the severity index.

MFDS 5.12

Title: Ultra-Sparse Models of Multiway Data

Presenters: Alfred Hero

This talk introduces three methods to learn the representation of sparse multi-way data. Covariance estimation for sample matrix in multivariate normal model is taken as an order-2 example throughout the talk. Denote Ω as the covariance matrix we want to estimate and Σ as covariance inverse. Adding more structure on Σ can obtain better error rate. That motivates the development of a series of generalized Lasso methods for matrix and multi-way data, such as Graphical Lasso(GLasso). KLasso requires a Kroneck-product covariance, where $\Sigma = A \otimes B$. TeraLasso requires a more flexible and sparser Kronecker-sum covariance, where $\Sigma = A \oplus B$. SyGLasso requires physically meaningful covariance with Kronercker-sum structure, where $\Sigma = (A \oplus B)^2$. Likelihood function with proper penalties on A, B is used to get the efficient estimations.

Questions:

1. Which structure we should use in practice?

Possible Answer: We can try to reorganize our model to satisfy the structure assumption. Universal approximation should be developed for practical application.

2. Can we extend these GLasso methods to higher-order data?

Possible Answer: I think the higher-order extension is feasible. In GLasso, the sparsity of factor A, B can represent the sparsity of covariance Σ. In tensor decomposition, the sparsity of factor matrix and core tensor can also represent the sparsity of the whole tensor. The idea of GLasso methods can be generalized to tensor case.