Parallel Session on Applied Math

Organizers: Ron Levie and Nadav Dym

Time	Speaker	Title
14:10–14:55	Yoel Shkolnisky	A perturbation-based kernel approximation framework
14:55–15:40	Nir Gavish	Retrospective model-informed analysis of the Israeli booster campaign to curtail COVID-19 resurgence.
15:40–16:00	Break	
16:00-16:45	Aryeh Kontorovich	Local Glivenko-Cantelli (or: estimating the mean in infinite dimensions)
16:45–17:30	Cy Maor	Riemannian metrics on shape spaces

Yoel Shkolnisky

A perturbation-based kernel approximation framework

Kernel methods are powerful tools in various data analysis tasks. Yet, in many cases, their time and space complexity render them impractical for large datasets. Various kernel approximation methods were proposed to overcome this issue, with the most prominent method being the Nystrom method.

In this talk, we present a kernel approximation framework which builds upon results from classical perturbation theory. We show that this framework generalizes the Nystrom method and several of its variants, and moreover, gives rise to new kernel approximation schemes, that can be tuned to take advantage of the structure of the approximated kernel matrix.

Joint work with Roy Mitz (TAU)

Nir Gavish

Retrospective model-informed analysis of the Israeli booster campaign to curtail COVID-19 resurgence

Israel was one of the first countries to administer mass vaccination. Consequently, it was among the first countries to experience substantial breakthrough infections due to the waning of vaccine-induced immunity, which led to a resurgence of the epidemic. In response, Israel launched a booster campaign to mitigate the outbreak, and was the first country to do so. Israel's success in curtailing the Delta resurgence while imposing only mild non-pharmaceutical interventions influenced the decision of many countries to initiate a booster campaign.

In this work, by constructing a detailed mathematical model and calibrating it to the Israeli data, we extend the understanding of the impact of the booster campaign from the individual to the population level. We used the calibrated model to explore counterfactual scenarios in which the booster vaccination campaign is altered by changing the eligibility criteria or the start time of the campaign and to assess the direct and indirect effects in the different scenarios. The results point to the vast benefits of vaccinating younger age groups that are not at a high risk of developing severe disease but play an important role in transmission. We further show that when the epidemic is exponentially growing the success of the booster campaign is highly sensitive to the timing of its initiation. Hence a rapid response is an important factor in reducing disease burden using booster vaccination.

Joint work with Amit Huppert, Guy Katrial, and Rami Yaari

Aryeh Kontorovich

Local Glivenko-Cantelli (or: estimating the mean in infinite dimensions)

If μ is a distribution over the d-dimensional Boolean cube $\set{0,1}^d$, our goal is to estimate its mean $p\in[0,1]^d$ based on n iid draws from μ. Specifically, we consider the empirical mean estimator $\hat p_n$ and study the maximal deviation $M=\max_{j\in[d]}|\hat p_n(j)-p(j)|$. In the classical Universal Glivenko-Cantelli setting, we seek distribution-free (i.e., independent of μ) bounds on M. This regime is well-understood: for all μ, we have $\E[M]\lesssim\sqrt{\log(d)/n}$ up to universal constants, and the bound is tight.

Our present work seeks to establish dimension-free (i.e., without an explicit dependence on d) estimates on M, including those that hold for $d=\infty$. As such bounds must necessarily depend on μ, we refer to this regime as {\em Local} Glivenko-Cantelli, and are aware of very few previous bounds of this type --- which are quite sub-optimal. Already the special case of product measures μ is quite non-trivial. We give necessary and sufficient conditions on μ for $\E[M]\to0$, and discover a novel sub-Gamma-type maximal inequality for shifted Bernoullis.

A number of challenging open problems are posed for future research.

This is joint work with Doron Cohen.

Cy Maor

Riemannian metrics on shape spaces

Consider the space of embeddings of S^1 into R^2 (shapes in the plane), or S^2 into R^3 (shapes in space). These are smooth manifolds, so by endowing them with Riemannian metrics we can evaluate distances on them, find geodesics and so on. This approach is used in various applications in computer vision and medical imaging. But what Riemannian metric should we choose? In this talk I'll present the general geometric framework and sketch what we know (and don't) about properties of several natural choices of metrics.