Centroid estimation based on symmetric KL divergence for Multinomial text classification problem

Jiangning Chen

We define a new centroid estimator for text classification based on the KL-divergence of the classes. The score favors documents that have a similar distribution in documents of the same class but different distributions in documents of different classes. Experiments on several standard data sets indicate that the new method outperforms better than traditional Naive Bayes classifier, especially for larger training data.

The Local Walk Dimension and Local Hausdorff Dimension in Diffusion on Fractals and Metric Spaces

John Dever

In this talk we define and investigate a local space scaling exponent α and a local time scaling exponent β. The exponent α is the local Hausdorff dimension. We provide several examples of spaces with continuously variable α. We also investigate a local Hausdorff measure and establish uniqueness up to a strong equivalence of measures satisfying the Ahlfors regularity property $\mu(B_r(x)) \asymp r^{\alpha(x)}$. The exponent β is roughly defined as a critical exponent as γ varies of the expected number of steps needed for a discrete time random walk on an approximation of the space at scale ϵ to leave a ball multiplied by a power ϵ^γ as the scale ϵ goes to zero. This exponent can then be localized. Next, we use β to re-normalize the time scale by introducing local exponential waiting times with mean at site x of $\epsilon^{\beta(x)}$. We then examine the exit time regularity condition that if $\mathcal{T}(B)$ is the supremum of the exit times from a ball B then $\mathcal{T}(B_r(x)) \asymp r^{\beta(x)}$. We then investigate convergence of approximating forms using Γ-convergence and Mosco convergence techniques." "In this talk we define and investigate a local space scaling exponent α and a local time scaling exponent β. The exponent α is the local Hausdorff dimension. We provide several examples of spaces with continuously variable α. We also investigate a local Hausdorff measure and establish uniqueness up to a strong equivalence of measures satisfying the Ahlfors regularity property $\mu(B_r(x)) \asymp r^{\alpha(x)}$. The exponent β is roughly defined as a critical exponent as γ varies of the expected number of steps needed for a discrete time random walk on an approximation of the space at scale ϵ to leave a ball multiplied by a power ϵ^γ as the scale ϵ goes to zero. This exponent can then be localized. Next, we use β to re-normalize the time scale by introducing local exponential waiting times with mean at site x of $\epsilon^{\beta(x)}$. We then examine the exit time regularity condition that if $\mathcal{T}(B)$ is the supremum of the exit

times from a ball B then $\mathcal{T}(B_r(x)) \asymp r^{\beta(x)}$. We then investigate convergence of approximating forms using Γ-convergence and Mosco convergence techniques.

Hybrid Clustering based on Content and Connection Structure using Joint Nonnegative Matrix Factorization

Rundong Du

A hybrid method called JointNMF is presented which is applied to latent information discovery from data sets that contain both text content and connection structure information. The new method jointly optimizes an integrated objective function, which is a combination of two components: the Nonnegative Matrix Factorization (NMF) objective function for handling text content and the Symmetric NMF (SymNMF) objective function for handling network structure information. An effective algorithm for the joint NMF objective function is proposed so that the efficient method of block coordinate descent (BCD) framework can be utilized. The proposed hybrid method simultaneously discovers content associations and related latent connections without any need for post-processing of additional clustering. It is shown that the proposed method can also be applied when the text content is associated with hypergraph edges. An additional capability of the JointNMF is prediction of unknown network information which is illustrated using several real world problems such as citation recommendations of papers and leader detection in organizations. The proposed method can also be applied to general data expressed with both feature space vectors and pairwise similarities and can be extended to the case with multiple feature spaces or multiple similarity measures.

Perfect Domination on Knights Graphs

Todd Fenstermacher

For a graph $G = (V, E)$, a subset S of V is a perfect dominating set of G if every vertex not in S is adjacent to exactly one vertex in S. Results are given for perfect dominating sets of knights on $n \times n$ chessboards as well as infinite chessboards.

Spectral Computed Tomography with Linearization and Preconditioning

Yunyi Hu

In the area of image sciences, the emergence of spectral computed tomography (CT) detectors highlights the concept of quantitative imaging, in which not only the reconstructed images are offered, but also the weights of different materials that compose the object are provided. In this paper, we present a linearization technique to transform the nonlinear matrix equation that models spectral computed tomography into an optimization problem that is based on a weighted least squares term and nonnegative bound constraints. To solve this optimization problem, we propose a new preconditioner that can reduce the condition number significantly, and with this preconditioner, we implement a highly efficient first order method, Fast Iterative Shrinkage-Thresholding Algorithm (FISTA), to achieve remarkable improvements on convergence speed and image quality.

Deterministic and stochastic acceleration techniques for Richardson-type iterations

Massimiliano Lupo Pasini

The next generation of computational science applications will require numerical solvers that are both reliable and capable of high performance on projected exascale platforms. In order to meet these goals, solvers must be resilient to soft and hard system failures, provide high concurrency on heterogeneous hardware configurations, and retain numerical accuracy and efficiency. This work focuses on the solution of large sparse systems of linear equations, for example of the kind arising from the discretization of partial differential equations (PDEs). Specifically, the goal is to investigate alternative approaches to existing solvers (such as preconditioned Krylov subspace or multigrid methods). To do so, we consider stochastic and deterministic accelerations of relaxation schemes. On the one hand, starting from a convergent splitting of the coefficient matrix, we analyze various types of Monte Carlo acceleration schemes applied to the original preconditioned Richardson (stationary) iteration. These methods are expected to have considerable potential for resiliency to faults when implemented on massively parallel machines. In this framework, we have identified classes of problems and preconditioners that guarantee convergence. On the other hand, we consider Anderson-type accelerations to increase efficiency and improve the convergence rate with respect to one level fixed point schemes. In particular, we focus on a recently introduced method called Alternating Anderson-Richardson (AAR). We provide theoretical results to explain the advantages of AAR over other similar schemes presented in literature and we show numerical results where AAR is competitive against restarted versions of the generalized minimum residual method (GMRES) for problems of different nature and different preconditioning techniques.

A Chiral triply-periodic family of minimal surfaces from the Quartz network

Shashank G Markande

A minimal surface invariant under the action of elements of a space group is triply-periodic. Variants of these striking, intricate two dimensional structures are responsible for much of the vivid structural coloration seen in butterfly wing scales and in the shells of beetles. Ordered states in block copolymers, lyotropic liquid crystals, micellar solutions and lipid bilayer membranes form cubic mesophases i.e., triply-periodic minimal surfaces of cubic symmetry such as Schwarz's D surface, Schwarz's P surface and Schoen's gyroid. Here, we describe the QTZ-QZD family of triply-periodic minimal surfaces with tunable chiral pitch. We devise an algorithm to generate the QTZ-QZD surface as a function of the chiral pitch, within a suitable range.

Measurement Error Correction Methods to Improve Parameter Estimation of 2D Body Composition Data

Anarina Murillo

This study illustrates the use and value of methods available to correct for measurement error in data collection. Measurement error may be inherent or unavoidable and could lead to biased estimates of the association between variables and outcomes. This study evaluates the performance of three methods to correct model parameters using to reduce potential biases due to measurement errors when evaluating the effects of body fat on the probability of being physically active. Three methods were applied to real data including: regression calibration (RC), simulation extrapolation (SIMEX), and multiple imputation (MI). Results showed that unadjusted body fat had upward biases of 30%. MI-corrected values had a 9% downward bias, RC-corrected values had a 13% upward bias, and SIMEX-corrected values had an 91% downward bias. In conclusion, measurement error correction methods can improve the reliability of analyses relating variables to health outcomes.

Pointwise estimates on the Green's function of a linearized chemotaxis model

Jean Rugamba

We consider a Keller-Segel type chemotaxis model with a logistic growth term. For the corresponding linear system, linearized around a constant equilibrium

state, we study the Green's function for the Cauchy problem. We are able to obtain detailed, pointwise estimates on the Green's function, using spectral analysis and other analytical tools. The result allows us to study pointwise time asymptotic behavior of solution to the nonlinear system via Duhumel's principle in a subsequent work.

An Uncertainty-Weighted Asynchronous ADMM Method for Large-Scale PDE Parameter Estimation

Samy Wu Fung

We consider a global variable consensus ADMM algorithm for computing the maximum a posteriori (MAP) estimate of large-scale PDE parameter estimation problems. We obtain an efficient optimization scheme by partitioning the data and solving the resulting subproblems in parallel. The parallelization can be implemented asynchronously, and each subproblem can be associated with different forward models and/or right-hand-sides, leading to ample options for tailoring the method to different applications.

A drawback of consensus ADMM is its slow convergence, especially when there are a large number of subproblems. This is particularly challenging in PDE parameter estimation due to the immense costs per iteration. To accelerate the convergence in the first few iterations, we introduce a novel weighting scheme in the algorithm that accounts for the uncertainty associated with the solutions of each subproblem. We also consider the asynchronous variant of the weighted conseusus ADMM to reduce communication and latency. We exemplarily show that the weighting scheme reduces the time-to-solution of a multiphysics parameter estimation problem.