Distributional regression and inference with shapes and their applications to wearables and neuroimaging

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Sunday, Aug 6: 4:00 PM - 5:50 PM
1584
Topic-Contributed Paper Session
Metro Toronto Convention Centre
Room: CC-717B

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Presentations

Shape-Constrained Estimation in Functional Regression with Bernstein Polynomials (index.cfm?do=ev.viewEv&ev=1989)

Shape restrictions on functional regression coefficients such as non-negativity, monotonicity, convexity or concavity are often available as scientific background knowledge or are required to maintain a structural consistency in functional regression models. We develop a computationally efficient estimations for a flexible class of models for shape-constrained functional regression using a sieve of Bernstein polynomials. Specifically, we extend estimation approaches from nonparametric regression to functional data, properly accounting for shape-constraints in a large class of functional regression models such as scalar-on-function regression (SOFR), function-on-scalar regression (FOSR), and function-on-function regression (FOFR). A bootstrap test is developed for testing the shape constraints. Numerical illustrations based on simulated data are used to show the improvement in estimation accuracy compared to other existing methods.

Practical examples based on data obtained from Baltimore Longitudinal Study of Aging are provided. An R software based suite of functions are also made available for end-users.

Speaker

Sujit Ghosh, North Carolina State University

Fréchet Regression Methods for Distributional Response Data (index.cfm?do=ev.viewEv&ev=1990)

Data consisting of samples of probability distributions are increasingly prevalent. In many applications, distributions appear as functional response objects in a regression model with vector predictors. Examples include problems from neuroscience, human mortality, and the analysis of data produced by accelerometers and other wearable devices. Using the Wasserstein geometry of optimal transport, we consider a general framework for Fréchet regression of distributional data, and illustrate both parametric and semi-parametric models and their estimators. For the parametric model, inferential tools comparable to linear models are available, including asymptotically justified hypothesis tests and confidence bands. Semi-parametric variants, including the single index and partially linear models, will also be discussed and illustrated through real data examples.

Speaker

Alexander Petersen, Brigham Young University

Density-on-Density Regression (index.cfm?do=ev.viewEv&ev=1991)

In this study, a density-on-density regression model is introduced, where the association between densities is elucidated via a warping function. The proposed model has the advantage of a straightforward demonstration of how one density transforms into another. Using the Riemannian representation of density functions, the model is defined in the correspondingly constructed Riemannian manifold. To estimate the warping function, it is proposed to minimize the average Hellinger distance which is equivalent to minimizing the average Fisher-Rao distance between densities. An optimization algorithm is introduced by estimating the smooth monotone transformation of the warping function. Asymptotic properties of the proposed estimator are discussed. Simulation studies demonstrate the superior performance of the proposed approach over competing approaches in predicting outcome density functions. Applying to a proteomic-imaging study from the Alzheimer's Disease Neuroimaging Initiative, the proposed approach illustrates the connection between the distribution of protein abundance in the cerebrospinal fluid and the distribution of brain regional volume.

Speaker

Yi Zhao, Indiana University

Distributional outcome regression and its application to modelling continuously monitored heart rate and physical activity (index.cfm?do=ev.viewEv&ev=1992)

We propose a distributional outcome regression (DOR) with scalar and distributional predictors. Distributional observations are represented via quantile functions and the dependence on predictors is modelled via functional regression coefficients. DOR expands existing literature with three key contributions: handling both scalar and distributional predictors, ensuring jointly monotone regression structure without enforcing monotonicity on individual functional regression coefficients, providing a statistical inference for estimated functional coefficients. Simulation studies illustrate a good performance of DOR model in accurately estimating the distributional effects. The method is applied to continuously monitored heart rate and physical activity data of 890 participants of Baltimore Longitudinal Study of Aging. Daily heart rate reserve, quantified via a subject-specific distribution of minute-level heart rate, is modelled additively as a function of age, gender, and BMI with an adjustment for the daily distribution of minute-level physical activity counts. Findings provide novel scientific insights in epidemiology of heart rate reserve.

Speaker

Rahul Ghosal, University of South Carolina