SPATIAL STATISTICS AND SPATIAL ECONOMETRICS

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PRE-REQUISITES : Students should have the knowledge of basic probability and statistics, linear algebra and differential calculus

INTENDED AUDIENCE : Students of physical, computation and social sciences who are interested in characterizing and modeling the spatial dimension in modern datasets and conduct statistical inference for real-world applications, including (but not restricted to) natural resource management, LULC change models, inventory management,

INDUSTRY SUPPORT : Major consulting firms like Deloitte, PwC, McKinsey and Co. etc., specifically for the purpose of risk analysis and management. In addition, the IT sector, Geospatial industry, and several other industrial sectors value the knowledge of spatial data analysis.

COURSE OUTLINE :

The purpose of this course is to introduce the analytical framework for analyzing spatial data and its target audience are students from social sciences (specifically, economics, political science and cognitive psychology), engineers, earth and geosciences, and applied physics. In the past decade or so, much interest has grown in the area due to readily-available spatially-delineated data, particularly when in 2008 the U.S. Geological Survey stopped charging for its high-resolution LANDSAT archive. However, modeling spatial data and spatial relationships necessitate the use of analytic tools beyond the standard statistical methods such as the ordinary least squares. Characterisation of spatial autocorrelation in spatial datasets for the purpose of statistical inference and statistical prediction is a focus of this course. In addition, we will ask: how and why does spatial autocorrelation arise; how is it measured and understood; how does it relate to issues of spatial heterogeneity and spatial dependence; and how these factors inform the specification and estimation of regression models. Specific modeling techniques include spatial autocorrelation measures (Moran's I, Geary's C, Variogram and Kriging estiators) and spatial regression models.

ABOUT INSTRUCTOR :

Prof. Gaurav Arora is an applied microeconomist with specialization in natural resource economics, agricultural economics, applied econometrics and remote sensing. As an empiricist, he enjoys developing and applying econometric models to tease out causal mechanisms that are rooted in the microeconomic theory for decision problems at the intersection of agricultural production and natural resource management. As for research outlook, he is keenly interested in the integration of social sciences and natural sciences, more particularly economics among the social science disciplines, and agronomy and earth sciences among the natural science disciplines. He is a recipient of the Faculty Research Fellowship (2020-2022) at IIIT-Delhi; the James R. Prescott scholarship (2016) for outstanding creativity in research at Iowa State University (ISU); and the Earl O. Heady Fellowship (2012) for academic excellence at ISU. He was inducted as an honorary life member to the Indian Society of Ecological Economics in 2019. Prior to obtaining his PhD in Economics from ISU, he completed M.S. in Agricultural and Resource Economics from the University of Arizona, and Bachelor of Technology in Environmental Engineering from Indian School of Mines, Dhanbad

COURSE PLAN :

Week 1: Introduction to spatial data and spatial models: Geostatistical data; Lattice sata; and Point data.

Week 2: Stationarity and Ergodicity of spatial random process.

Week 3: Characterising Spatial Autocorrelation: Variaogram, Semi-variaogram; Covariogram and Correlogram. Fitting a Variogram: Miminum Norm Quadratic Estimation; Generalized Least Squares Estimation; Maximum-likelihood and Restricted Maximum-Likelihood Estimation.

Week 4: Characterising Spatial Autocorrelation: Variaogram, Semi-variaogram; Covariogram and Correlogram. Fitting a Variogram: Miminum Norm Quadratic Estimation; Generalized Least Squares Estimation; Maximum-likelihood and Restricted Maximum-Likelihood Estimation - Cont.

Week 5: Spatial Prediction: Stochastic approach and decision-theoretic considerations. Spatial Interpolation: Ordinary Kirging; Kriging with Spatial Covariance.

Week 6: Spatial Econometrics and Regional Science: Moving from characterization of spatial pattens to deducing explanatory factors and inference. Spatial Dependence and Spatial Heterogeneity.

Week 7: The formal expression of spatial dependence structures: Spatial contiguity matrix, generalized spatial weight matrix; and spatial lag operators.

Week 8: Spatial externalities: Spatial multipliers and spatial regression; Global and Local Moran's-I Statistics.

Week 9: Estimation and hypothesis testing: Maximum likelihood estimation with spatial dependece in the dependent variable and the model errors. Likelihood ratio test and Lagrange multiplier tests for spatial process models.

Week 10: Applications on ArcGIS (incl. ArcPy - Python for ArcGIS)

Week 11: Applications on ArcGIS (incl. ArcPy - Python for ArcGIS) - Cont.

Week 12: Applications on R.