

Environmental Statistics and Research Methods

United Nations University (UNU-IAS)

Spring 2023

Location: 6F Lecture Room

Time: From April until July 2023

Lecturer: Shengru Li, Jian Pu

Contact Information: (li@unu.edu, pu@unu.edu)

Office Hours: by appointment

As of 3 February 2023

Course Description

The environmental statistics and research methods is a course designed to help the students to understand and apply quantitative research methods in their research activities. This course is focused on the application of relevant research methodology for the research problems that students are interested in solving. Thus, presentation and explanation of instructor is combined with discussion of practical issues related to the application of research methods. Individual consultation of students with professors is expected to take place during the semester. Critical analysis of relevant research articles is a part of the requirements. Considering that environmental investigation often covers a broad range of disciplines from the social science to natural science, and the study systems/problems are complex, the course contain information about the main statistical methods to interpret project results.

The latter half of the course will focus on learning Python for Data Analysis. This portion of the course assumes no prior knowledge of computer science for students and is a primer of computer science with a particular focus on working with data in Python. The classes will require students to use their own computers in the classroom to practice programming along with the instructor. Students will be able to gain solid foundation in Python working environment, data structures, data wrangling, data plotting, modelling, and get exposed to popular libraries such as NumPy, pandas, matplotlib, Patsy among others. The aim of this educational opportunity is to provide students with an entry point to the world of computing and showcase the usefulness of Python in addressing real-world data analysis challenges.

Course Objectives and Learning Goals

1. Enhance students' understanding of the research process from idea formulation to data analysis and interpretation;
2. Enable students to use gained knowledge to design their own research on a topic of personal interest;
3. Improve students' ability to critically read and understand the research literature;
4. Improve students' confidence in applying selected research methods; and

5. Equip students with the foundational knowledge and practical skills necessary to effectively use Python for data analysis, including data cleaning and wrangling, visualization of data and modelling, through hands-on exercises and real-world examples.

Requirements and Grading Policy

All students are expected to conduct active class participation and complete the analysis tasks in each class. At the end of the semester, students are required to take a test.

- Active class participation (30%, more than 80 % attendance is required)
- Assignments (70%)
 - Data analysis basics (35%)
 - Data analysis in Python (35%)

Class Participation

The course requires students to attend all classes, to finish tasks in each class. At the discretion of the instructor, frequent late arrivals or absences may result in a lower grade. Please note that the first session is of particular importance and cannot be missed. Materials of each class will be shared by the instructor before the class.

Course Outline

Lecture No.	Title	Date	Instructors/Invited Speakers if any
1	Understand the purpose of data analysis; Introduction of data analysis process in environmental research	April 7 (Fri), 2023 ~ 9:30-13:00	Jian Pu
2	Data analysis basics; one-way and two-way ANOVA analysis		Jian Pu
3	Information visualization; Least Squares Method; Outliers in environmental data analysis	April 14 (Fri), 2023 ~ 9:30-13:00	Jian Pu
4	Newton's Method; Excel Solver; Indicators of multivariate analysis; Standardization of variates		Jian Pu
5	Multivariate analysis: multiple regression analysis, principal component analysis, discriminant analysis (1)	April 28 (Fri), 2023 ~ 11:20-13:00	Jian Pu
6	Multivariate analysis: multiple regression analysis, principal component analysis, discriminant analysis (2)	May 12 (Fri), 2023 ~ 9:30-13:00	Jian Pu
7	Multivariate analysis: multiple regression analysis, principal component analysis, discriminant analysis (3)		Jian Pu

8	Statistical analysis and applications in ESG research (TBA)	May 19 (Fri), 2023 ~ 11:20-13:00	Jian Pu/Jiaqi Yang (Guest speaker will be online)
9	Python for Data Analysis: introduction, environment set-up, and language basics	May 26 (Fri), 2023 ~ 11:20-13:00	Shengru Li
10	Python for Data Analysis: built-in data structures, functions, and files	June 2 (Fri), 2023 ~ 11:20-13:00	Shengru Li
11	Python for Data Analysis: NumPy basics, arrays and vectorized computation	June 9 (Fri), 2023 ~ 11:20-13:00	Shengru Li
12	Python for Data Analysis: getting started with pandas	June 16 (Fri), 2023 ~ 11:20-13:00	Shengru Li
13	Python for Data Analysis: data loading, storage, cleaning and preparation, and data wrangling	June 23 (Fri), 2023 ~ 11:20-13:00	Shengru Li
14	Python for Data Analysis: plotting and visualization	June 30 (Fri), 2023 ~ 9:30-13:00	Shengru Li
15	Python for Data Analysis: introduction to modelling libraries and data analysis examples		Shengru Li

Course Readings

1. *How to design and evaluate research in education (ninth edition)* by Jack Fraenkel & Norman Wallen 2014 McGraw-Hill Companies New York, NY
2. *Educational research: Planning conducting, and evaluating quantitative and qualitative research.* John W. Creswell, (sixth edition) 2014 Pearson Education, Inc., Upper Saddle River, New Jersey.
3. *Survey research methods (fifth edition)* by Floyd J. Fowler, Jr. (Applied social research methods; v.1) 2014 Sage Publications, Inc., Thousand Oaks, CA
4. *Moustakes, C.E. 1994 Phenomenological research methods.* Sage publications, Inc. Thousand Oaks, CA
5. *Efron S.E., & Ravid R., 2020. Action research in education: a practical guide. (second edition)* The Guilford Press. New York, NY
6. *Creswell J. W., & Poth C.N. 2018. Qualitative Inquiry & research design: Choosing among five approaches.* Sage Publications, Inc. Thousand Oaks, CA
7. *C. Philip Wheeler & Penny A. Cook (2000): Using Statistics to Understand the Environment,* Routledge.
8. *McKinney, W. (2022). Python for Data Analysis, 3rd Edition.* O'Reilly Media, Inc. <https://wesmckinney.com/book/>

Additional reading materials: to be determined and selected by instructors for each session.

Important Information

Class Conduct & Etiquette

Students are expected to arrive on time and not to engage in disruptive behavior during class. This includes, among other things, private side conversations, the use of cellphones and other electronic devices, or the reading of newspapers. Cellphones should be switched off and stored in the bag. We wish to create an atmosphere of open and tolerant discussion in the classroom and request students to recognize every individual's right to have an opinion. The lecturer and other students should be treated with dignity and respect, in discussions on contentious political issues where a diversity of opinion is likely to arise. However, we also recognize that there are limits to tolerance and the lecturer reserves the right to request disciplinary action against any student who violates this policy or repeatedly shows disruptive behavior in class.

Computer Use in Class

Students are required to bring computers installed with Excel to the class. Python working environment will be set-up together with instructor.

The use of computers (including tablets) in the classroom is restricted to carrying out course related software use, taking notes, reading of the course material, or searching for course related information on the internet. Any disruption of the class by cell phones, instant messaging programs or other communication devices will not be tolerated. The lecturer reserves the right to revoke this permission if a student is found using a computer for any non-course related activities.

Plagiarism & Academic Misconduct

Please be aware that the consequences of plagiarism are severe and students found guilty of academic misconduct will be punished in accordance with UNU's academic honesty policies. The lecturer reserves the right to run all assignments through an anti-plagiarism software provided by the UNU. If evidence of academic misconduct on the assigned presentations, the mid-term exam or the final essay should be found, the assignment will receive a failing grade. In case of repeated violations of academic conduct, the student may receive a failing grade for the entire course and will be reported to the appropriate authorities for disciplinary action.

Invited Speakers/Lecturers Bio

Dr. Jiaqi Yang (Lecture 8)

Data Scientist & ESG Analyst, Sustainable Lab Inc., Japan

Jiaqi Yang holds a doctoral degree in Environmental Studies from The University of Tokyo. He is working as data scientist in Sustainable lab Inc, a Japanese fintech start-up company specializing in ESG/SDGs big data. He is specifically in charge of ESG/SDGs data research and analysis. He holds his PhD degree in Sustainability science from the University of Tokyo. Before joining the current company, he also did internship at the United Nations Department of Economic and Social Affairs (UNDESA) with experience in designing evaluation on SDGs practices.