EAS 4480: Environmental Data Analysis

Textbook: Martin Trauth, "MATLAB Recipes for Earth Sciences", Springer
Berlin Heidelberg, 2006.

Instructor: Yuhang Wang

Course Summary:
In this course, important data analysis methods often used in earth and atmospheric sciences are discussed. The methods are learned through examples using MATLAB. Data analyzed in the course are those collected for research in atmospheric and earth sciences. The emphasis of the course is on the use of these methods in processing research data and the interpretations of analysis results. As such, the course is taught with a mixture of lectures, hands-on exercises, and an independent student project using data analyses applied to environmental data.

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Course Content:

1. Introduction to data analysis and MATLAB: programming, data handling, and data visualization.

Examples: Visualization of seismology data; Golden section; Estimating π; Butterfly effects – Lorenz attractor; fractals – Mandelbrot set.

2. Univariate statistics: Empirical distributions, central limit theorem, theoretical distributions and the statistical tests (t, F, and χ^2).

Examples: Organic matter measurements; aerosol distributions

3. Bivariate statistics: Linear regression/prediction and its error estimate; linear correlation, confidence level, and error estimate; analysis of variance – forecast skill; principal component regression and EOF analysis; reduced major axis regression; curvilinear regression; analysis of residuals; cross validation; bootstrap and Jackknife estimates of regression coefficients; cross validation.

Examples: Depth-age relationship of sediment; climate "hockey-stick"; ozone-temperature relationship in Atlanta.

4. Time-series analysis: Auto correlation, red noise; fast Fourier transform and periodogram; unevenly-spaced data processing; least-squares spectral analysis; singular spectrum analysis; higher-dimension spectral analysis; crossspectral analysis.

Examples: Sunspots – solar cycle; ENSO index.

5. Signal processing: linear time-invariant systems; convolution and filtering; filtering functions; impulse/frequency response; filter design and adaptive filtering; inversion filter and data assimilation.

Examples: Climate indices.

6. Spatial data: Gridding, contouring, and mapping; map projections; Gridding – 2-D interpolation.

Examples: Visualization of Earth topography; GSHHS shoreline data set; ETOPO2/GTOPO30/SRTM elevation data; satellite measurements of tropospheric NO_2.

7. Multivariate statistics: principal component analysis.

Examples: Minerals in sediments; air quality measurements in Mexico City.

Honor code for student responsibilities:

Students are expected to act according to the highest ethical standards.

Academic misconduct is any act that does or could improperly distort student grades or other student academic records. Such acts include but need not be limited to the following:

- Possessing, using or exchanging improperly acquired written or verbal information in the preparation of any essay, laboratory report, examination, or other assignment included in an academic course;
- Substitution for, or unauthorized collaboration with, a student in the commission of academic requirements;
- Submission of material that is wholly or substantially identical to that created or published by another person or persons, without adequate credit notations indicating authorship (plagiarism);
- False claims of performance or work that has been submitted by the claimant;
- Alteration or insertion of any academic grade or rating so as to obtain unearned academic credit;
- Deliberate falsification of a written or verbal statement of fact to a member of the faculty so as to obtain unearned academic credit;
- Forgery, alteration or misuse of any institute document relating to the academic status of the student.