Time Series Analysis - ISYE 6402

http://www.isye.gatech.edu/~nserban/classes.html

Instructor:
Dr. Nicoleta Serban
Office: 438 Groseclose, ISyE
Phone: 404-385-7255
E-mail: nserban@isye.gatech.edu
Office Hours: Wednesday 4-6pm

Instructor Assistant:
Xuyuan Liu
E-mail: xliu32@isye.gatech.edu
Office: To be determined
Office Hours: To be determined

Class Schedule

9:35 am - 10:55 am Tuesday and Thursday
No class: March 18 and 20 (Spring break)
Final Exam: Apr 28th (Monday)- 8:00 - 10:50am

Honor Code For any questions involving Academic Honor Code issues, please consult me, my teaching assistants, or www.honor.gatech.edu.

Course Description This course is designed to introduce time series methodology. Standard topics such as univariate ARMA/ARIMA modelling, state-space models, (G)ARCH modeling, forecasting, model identification and diagnostics will be covered. Other possible topics, including multivariate time series, generalized state-space models, and nonparametric analysis, will be covered as time permits.

Students will be given fundamental grounding in the use of some widely used tools, but much of the energy of the course is focus on individual investigation of time series. Active participation in the class is very important. This class is more about the opportunity for individual and team discoveries than it is about mastering a fixed set of techniques.

Course prerequisites: A sound familiarity with undergraduate or graduate statistics and probability.

Textbook: The course material will be based on a set of notes being prepared by the instructor, but two primary textbooks are highly recommended:

1. Brockwell, P.J. and Davis, R.A. (1991), *Introduction to Time Series and Forecasting*, 2nd edition, Springer-Verlag, New York.
2. Tsay, R.S. (2005), *Analysis of Financial Time Series*, 2nd Edition, Wiley Series in Probability and Statistics.

Other recommended books:

1. . Fan, J., Yao, Q. (2003). *Nonlinear Time Series*. Springer-Verlag, New York.
2. Box, G.E.P., Jenkins, G.M. and Reinsel, G.C. (1994). *Time Series Analysis: Forecasting and Control*, 3rd Edition, Prentice Hall, New Jersey.
3. Chatfield, C. (1996). *The Analysis of Time Series*, 5th edition, Chapman and Hall, New York.
4. Shumway, R.H., Stoffer, D.S. (2006), *Time Series Analysis and Its Applications (with R examples)*, Springer-Verlag, New York.

Grading policy: The course will be letter graded. The grade for the course will be based on a final project that will be presented in class, participation in class, assignments during the semester and a final exam.

Project, presentation and class participation: 40%, Assignments: 25%, Final exam 35%.

Assignments: Assignments will include both theoretical and practice problems; the latter problems will ask you to carry out analysis of data sets using computers. Keep in mind that you should not hand in raw computer output. Conclusions and interpretation of results are more important than good printouts. The solutions for all assignments will be provided with one week delay from the due date. Late Homework will not be accepted. You are allowed (and encouraged) to work together with other students on homework, as long as you write up and turn in your own solutions. You are also allowed (and encouraged) to ask me questions, although you should try to think about the problems before asking.

Project: The project will be a time series analysis using real data selected by the student or a group of students (2-3 students). There will be an oral presentation of the project (10-15 minutes). Deadline to submit an abstract of the project: March 7, 2008. Deadline to submit the project work (report and presentation): April 11, 2008. Most of the available time series data have been already analyzed and interpreted. In grading, I will primarily look for a sensible approach to the problem, and clearly-made connections between your analyses and the substantive questions. You can use any computing equipment and any computing resources in the school, any written source material you can find, in or out of the school. However, replicating results which have been already published without referencing to the source of publication is subject to plagiarism. Plagiarizing is defined by Websters as "to steal and pass off (the ideas or words of another) as one's own : use (another's production) without crediting the source." Be sure to document carefully your project work.

Final Exam: There will be only a final exam with problems reviewing the material (lectures and assignments) provided in this course throughout the full semester. The exam is close notes (including homeworks) and books but a two (one-sided) pages with formulas will be allowed.

Objectives: This course will cover a number of areas of time series and data assimilation applied to real, scientific and interesting problems. A tentative list of more specific topics is as follows:

Part 1: Introduction

1. Applications
2. Trend and Seasonality
3. Autocovariance and Autocorrelation Functions
4. Linear Processes
5. Prediction for a Stationary Time Series

Part 2: ARMA models

1. Exploratory Analysis using ACF and PACF
2. Parameter Estimation
3. Residuals and Diagnostics

4. ARIMA models: Forecasting

5. ARIMA models: Unit root non-stationarity tests

Part 3: State-Space Models

1. State-Space Representation for an ARMA model

2. Prediction and the Kalman Recursion

3. The Gaussian Likelihood

4. Generalized State-Space Models

5. The Particle Filter

Part 4: Conditional Heteroscedastic Models

1. The ARCH Model

2. The GARCH Models

3. High-Frequency Data

Part 5: Multivariate Time Series Analysis

1. Weak Stationarity and Cross-correlation

2. Vector Autoregressive (VAR) Models

3. Structural VAR Models

4. Co-integrated VAR Models

5. Multivariate GARCH models

Part 6: Nonparametric Time Series Analysis

1. Smoothing Time Series

2. Functional Data Analysis

3. Functional-Coefficient Autoregressive Models

4. Functional Conditional Variance Modeling