Systems Design Engineering
SYDE631: Time Series Modelling
Fall Term 2022

Instructor: Poornima Unnikrishnan

Course Description

The time series models that are discussed include AR, MA, ARMA, nonstationary ARIMA, seasonal ARIMA, and periodic models. Extensive hydrological, water quality, environmental, and other applications are given for demonstrating how the time series models can be systematically fitted to real world data sets by following the identification, estimation, and diagnostic check stages of model construction. A major emphasis of the course is the use of exploratory data analysis graphs. Other topics covered include applications of time series modeling in forecasting and simulations.

Course Objectives

- Learn the fundamentals of time series analysis and modeling
- Learn time series model identification, parameter estimation and diagnostic check
- Learn a variety of time series models such as ARMA and ARIMA, SARIMA models
- Learn forecasting and simulations using time series models
- Utilize R for visualization, analysis, and modeling of time series data

Pre-requisite Course

At least one university course in probability and statistics

Class Time

- Every Monday 3:30pm-4:50pm and Wednesday 3:30pm-4:50pm at E5 6127

Office Hours

- Time: Wednesday 2:00pm-3:00pm
- Location: E7-6358
- Email: poornima.unnikrishnan@uwaterloo.ca

Course Website

Course material, news, announcements, and grades will be regularly posted to the SYDE 631 Learn platform.

Course Content

- Fundamentals of Time Series Analysis
- Stationary Time Series Models(AR, MA, and ARMA)
- Nonstationary Time Series Models (ARIMA)
- Model Identification
- Parameter Estimation, Diagnostic Checking and model selection
- Forecasting and Simulation
- Seasonal Time Series Models (SARMA, SARIMA, Periodic Models)
- Other topics include intervention analysis, transfer function models, state space models, applications of machine learning in time series forecasting.

Course Material

Lecture notes will be posted on LEARN

Additional References

- Shumway, Robert H., David S. Stoffer, and David S. Stoffer. *Time series analysis and its applications with R examples*. Vol. 3. New York: springer, 2000.
- K. W. Hipel and A. I. McLeod: Time Series Modelling of Water Resources and Environmental System. 1013 pp. Amsterdam, Elsevier, 1994, XXXII. ISBN 0–444–89270–2.
- Cryer, Jonathan D., and Kung-Sik Chan. *Time series analysis: with applications in R*. Vol. 2. New York: Springer, 2008.
- Wei, William WS. *Time series analysis Univariate and Multivariate Methods*-2nd ed. Pearson Education, 2006

Simulation Software

Statistical Computing Software R: Download and Install R from https://www.r-project.org/

Time Series Data Resources

A variety of time series data can be found at:

▪ R Dataset:

https://stat.ethz.ch/R-manual/R-devel/library/datasets/html/00Index.html

▪ Statistics Canada : https://www150.statcan.gc.ca/n1/en/type/data?HPA=1

▪ Time Series Datasets at Kaggle website

https://www.kaggle.com/datasets?search=time+series

Assessments

▪ Assignments (30%): 2 in total (15% each): a mix of problem-solving questions and simulations

▪ Project (40%):

Includes a presentation worth 10% and a report worth 30%.

▪ Final Exam (30%)

Student COVID-19 cases: Students should be instructed not to come to class or other in-person activities if they are experiencing COVID-19 symptoms or are required to self-isolate. In the event of absence due to influenza-like illness or required self-isolation, students shall submit an Illness Self-declaration. Students can find the Illness Self-declaration form in the Personal Information section of Quest. A doctor's note for accommodation is not required. Direct students to contact the COVID-19 Support and Advice line to report their illness.

Academic integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check the Office of Academic Integrity for more information.]

Grievance: A student who believes that a decision affecting some aspect of their university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4. When in doubt, please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for their actions. [Check the Office of Academic Integrity for more information.] A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate associate dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline. For typical penalties, check Guidelines for the Assessment of Penalties.

Appeals: A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition) or Policy 71, Student Discipline may be appealed if there is a ground. A student who believes they have a ground for an appeal should refer to Policy 72, Student Appeals.

Note for students with disabilities: Accessibility Services, located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with Accessibility Services at the beginning of each academic term.

Turnitin.com: Text matching software (Turnitin®) may be used to screen assignments in this course. Turnitin® is used to verify that all materials and sources in assignments are documented. Students' submissions are stored on a U.S. server, therefore students must be given an alternative (e.g., scaffolded assignment or annotated bibliography), if they are concerned about their privacy and/or security. Students will be given due notice, in the first week of the term and/or at the time assignment details are provided, about arrangements and alternatives for the use of Turnitin in this course.

It is the responsibility of the student to notify the instructor if they, in the first week of term or at the time assignment details are provided, wish to submit alternate assignment.