STA457H1F/2202H1F
Time Series Analysis

Instructor: Keith Knight (e-mail: `keith.knight@utoronto.ca`)

Office hours: Tentative Fridays from 11am-1pm in room to be determined.

Do not hesitate to contact me by e-mail as many problems you might encounter can be easily resolved this way. The course will also have a discussion group on Piazza.

Textbook: R. Shumway and D. Stoffer: *Time Series Analysis and Its Applications with R Examples (4th edition).* Springer. This book is available at the University of Toronto Bookstore and also available online via the University of Toronto Library system; a link to the online book is provided on Quercus. The textbook will be supplemented by handouts, which will be available through Quercus.

The following books are also good references for this course:

- C. Chatfield: *The Analysis of Time Series: an Introduction (5th edition).*
- P. Brockwell and R. Davis: *Introduction to Time Series and Forecasting.*
- P. Diggle: *Time Series: a Biostatistical Introduction.*

All of these books are available in the University of Toronto library system.

Prerequisites: STA302H (or equivalent) is listed in the calendar as a prerequisite for STA457H1S. Graduate students enrolled in STA2202H1F are exempt from this prerequisite but should be familiar with regression analysis before taking this course.

Evaluation: The main emphasis of the course will be the application of time series methods; however, a solid knowledge of some basic statistical theory is also necessary to understanding the rationale behind the methodology. The course grade will be made up of 3 parts: assignments (20%), midterm exam (35%) and a final exam (45%).

- Assignments will involve both data analysis and theory problems. Two assignments will be submitted (online) before the midterm and two after.
- Students enrolled in STA2202H1F may be required to do some additional work on the homework assignments as well as on the final exam.
- The midterm exam is scheduled during the lecture time (6-9pm) on October 22, 2024; the location(s) will be announced later. If this exam is missed due to illness or any other circumstances (with appropriate documentation), the weight from the midterm will be carried over to the final exam.
- The final exam will be held during the December exam period at a date and time to be announced later.
- **Students should familiarize themselves with the University's policieson academic integrity, which can be found at `https://tinyurl.com/58c2nckc`.**

Computing: We will use the software package R extensively in this course both for data analysis as well as some numerical computation. R is free software and can be downloaded (for Windows, Mac, and Linux operating systems) from `cran.utstat.utoronto.ca`. Of interest to many of you will be RStudio, which provides a very nice environment for using R; information on RStudio (including downloads) can be found at `www.rstudio.com`.

The textbook for this course also provides a lot of examples of R code as will the handouts for the course.

Syllabus: There are two basic approaches to time series analysis: time domain and frequency domain. Many time series analysis books emphasize one approach, most commonly the time domain approach, often to the exclusion of the other, usually because the intended audience; statisticians and econometricians tend to favour the time domain approach while engineers favour the frequency domain. Unfortunately, a very distorted view of time series sometimes results from an overemphasis on one approach. This course will attempt to present both approaches on an equal footing; the main goal of the course is to gain an appreciation of the issues involved in the analysis of time series. The order in which topics are covered will be roughly as follows:

1. Basic descriptive methods: time series plot; correlogram, partial correlogram and periodogram; simple methods for removing trend and seasonality.

2. Theory of stationary stochastic processes: time domain vs frequency domanin; spectral decomposition; filtering and smoothing in time and frequency domains; time series models.

3. Identification of and estimation in time series models: Yule-Walker (and related) estimation; maximum likelihood estimation; tests for white noise; tests for "unit roots"; forecasting; seasonal adjustment.

4. Spectral analysis: nonparametric and parametric spectral estimation; multitaper methods.

5. Additional topics (as time permits): ARCH and GARCH models; spurious correlation and cointegration; regression models with autocorrelated errors; longitudinal data; signal estimation.