

STA457H1/STA2202HF Time Series Analysis

Summer 2020

Department of Statistical Sciences

University of Toronto

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Meeting times: WE & FR 14-17

Course Description and Learning Outcomes

Welcome to STA457/STA2202!

This course will introduce you to the analysis of time series, i.e. sequences of data ordered through time, or another dimension. This type of data is ubiquitous in areas such as Economics, Business, Finance, Physical and Environmental Sciences. Since time series do not follow the typical statistical assumptions, we will look at different ways of thinking about and analyzing such data. The course will cover both theoretical and practical aspects of time series analysis, making extensive use of the R statistical software. Upon completion of the course, you will be able to:

- Understand and reason with the basic time series concepts
- Interpret and compare different time series models
- Identify and model different types of time series data
- Perform time series modelling/forecasting and present the results
- Implement time series methods in the R statistical software

Prerequisites

The course prerequisites are STA302H1 & STA235Y1 (or equivalents) covering regression and multivariate calculus. In particular, we will make extensive use of:

- Probability Theory: multivariate distributions (esp. Normal), joint/marginal/conditional distributions, independence, moments (means, variances, covariances), conditional expectations.
- Linear Models: simple & multiple linear regression, parameter estimation (least squares, maximum likelihood), relevant linear algebra calculations
- R programming: basic objects (vectors, arrays), control structures (for/if statements), basic plotting, generating random variates, fitting linear models.

You are expected to have good command of these topics; if not, you should brush up your knowledge.

Textbooks

The main textbook for the course is:

[Time Series Analysis and Its Applications, with R examples, 4th Ed.](#), by R.H. Shumway and D.S. Stoffer

Another textbook we will occasionally use is:

[Forecasting: Principles and Practice](#), by R.J. Hyndman and G. Athanasopoulos

Both are freely available online, and come their own R packages and other useful resources.

Course Structure

- Content is divided into modules, corresponding to the scheduled meeting times. For details on the topics covered, see the lecture schedule at the end.
- Video recordings of the lectures, together with accompanying worksheets, will be posted two days before each scheduled meeting (i.e. twice a week). Before each meeting, you should watch the videos, do the assigned readings, and attempt the worksheets.
- During the meeting, the instructor & TAs will be available online through BbCollaborate to answer questions, provide clarifications, walk through the worksheets, and provide assistance with the assignments.
- At the end of each meeting (4:40-5:00pm) there will be a short quiz on the topics just covered. Quiz grades start counting from the 2nd week of classes.
- There will be three bi-weekly assignments involving theoretical and practical questions (R programming required).
- There will be a midterm and final assessment for the course. The midterm will cover the first 3 weeks (6 lectures), and the final will be cumulative.
- All course materials will be posted on [Quercus](#), and are for the sole use of students currently enrolled in the course (sharing materials with anyone outside of the course is *unauthorized use*).

Evaluation

Assessment	Details	Weight
9 Quizzes	end of each meeting starting May 13, except for May 29	20%
3 Assignments	due May 18, June 1, & June 15	30% (10% each)
Midterm	May 29	20%
Final	(TBA, sometime in June 17-25)	30%

Assessments will combine theoretical (paper-&-pencil) problems, critical thinking questions, R programming, and data analysis write-up & explanation of results.

Graduate students (STA2202) might be required to complete additional parts in these assessments.

Late/Missed Work Policy

For assignments, there are no extensions available. You will lose 1% of total possible marks on the assignment for each hour your assignment is late after the deadline, up to a maximum of 4days 4hrs. There will be no late quizzes or exams allowed.

If you need to miss an assessment (quiz, assignment, midterm or final) for a legitimate reason, you may ask to be excused and have the total missed weight shifted to: a) the final assessment, if the total missed weight is up to 20%, or b) a make-up oral exam, if the total missed weight is greater than 20%. To be excused from an assessment you need to send an email request to the instructor *within one week of the due date of the assessment*. The email should include your full name, student number, the assessment missed, and the following sentence: “I affirm that I am experiencing an illness or personal emergency and I understand that to falsely claim so is an offence under the Code of Behaviour on Academic Matters. I understand that the weight of this assessment will be shifted to the final assessment or a make-up oral exam”.

If the total weight of your excused assessments is *more than 20%* of the course total, which includes missing the final (either on top of other assessments or not), you will be required to take a make-up oral exam. E.g., this will be required if you miss the midterm and one assignment (30%), or if you

just miss the final (30%), or if you miss one assignment and the final (40%), etc. In such cases *the entire total missed weight will be shifted to the oral exam*, which will take place within one week of the final. This will be a one-on-one online interview with the instructor where you will have to answer questions about the course, and which will be recorded for grading purposes.

Students who don't complete either the final assessment or an oral exam will not pass the course!

Communication

Questions about course content should be brought to the meetings, or directed to the course discussion boards. There are two options for the discussion board, and you can use the one you feel comfortable with (the teaching team will monitor both):

- **Piazza:** This is a highly catered system for getting you help fast and efficiently. However, Piazza does allow for substantial sharing and disclosure of your personal information, which affects your privacy. Be sure to read Piazza's Privacy Policy and Terms of Use and, if you decide to participate in Piazza, only provide content that you are comfortable sharing under these terms. Note that, even if you do not feel comfortable posting content on Piazza, you could still open an account just to monitor the discussion. To sign up for the discussion forum click on the link:
<https://piazza.com/utoronto.ca/spring2020/sta457sta2202>
- **Quercus Discussions:** This is Quercus' native discussion board which has all the basic functionality, but is not as streamlined as Piazza. Nevertheless, anything you post here will be treated with the same privacy guarantees as your Quercus information.

Questions regarding private matters can be directly addressed to the instructor by email; make sure to put the course code (STA457/2202) in the title and allow at least two days for a response.

Accessibility

The University of Toronto is committed to accessibility. If you require accommodations for a disability, or have any accessibility concerns about the course, the classroom, or course materials, please contact [Accessibility Services](#) as soon as possible.

Wellness

University life and academic studies can be stressful, so I encourage you to take good care of yourself. Do your best to maintain a healthy lifestyle throughout the semester by eating well, exercising, socializing, getting enough sleep and taking time to relax. This will help you achieve your goals and cope with stress.

If you, or anyone you know, experiences severe academic stress, difficult life events, or feelings of anxiety or depression, I strongly encourage you to seek support. Consider reaching out to a friend, family, or faculty member that you trust, sooner rather than later. Do not hesitate, because learning to ask for help is an important lesson in itself. And keep in mind that the University's [Health and Wellness Centre](#) is always available for counseling and support.

Academic Integrity

In papers and assignments:

- Using someone else's ideas or words without appropriate acknowledgement.

- Submitting your own work in more than one course without the permission of the instructor in all relevant courses.
- Obtaining or providing unauthorized assistance on any assignment.

On quizzes and tests:

- Using cell phones or other devices to communicate about the questions.
- Obtaining or providing assistance on any quizzes or tests.
- Posting or sharing quiz or test questions.
- Misrepresenting your identity.
- Submitting an altered test for re-grading.

Misrepresentation:

- Falsifying or altering any documentation required by the University, including doctor's notes.
- Falsifying institutional documents or grades.

Tentative Lecture Schedule

#	Title	Topics
1	TS Fundamentals	Strict/week stationarity, auto-correlation function (ACF), estimating autocorrelation
2	TS Decomposition	Trend, seasonality, smoothing, differencing, transformations
3	Basic TS Models	linear time series models, auto-regression, moving averages
4	ARMA Models	characteristic polynomials, causality, invertibility
5	ARMA Prediction	best-linear predictors, prediction intervals, long-range behavior
6	ARMA Estimation	maximum likelihood, conditional least squares, model diagnostics
7	ARMA Extensions	integrated and/or seasonal models, unit root tests, model selection
8	Midterm	Review
9	TS Regression	ARMA with exogenous variables (ARMAX), TS cross-validation
10	Multivariate TS Models	cross-correlation, vector autoregressive (VAR) models
11	Multivariate topics	impulse response functions, Granger causality, vector-error correction models (VECM)
12	Volatility models	generalized autoregressive conditional heteroskedasticity (ARCH/GARCH) models