THE OHIO STATE UNIVERSITY

COLLEGE OF ARTS AND SCIENCES

# SYLLABUS: STAT 5550
## INTRODUCTORY TIME SERIES ANALYSIS
## SPRING 2021

# Course overview

## Instructor

Instructor: Dena M. Asta
Email address: dasta@stat.osu.edu
Lectures: On CarmenZoom, Monday, Wednesday, and Friday 10:20am-11:15am (some of these lectures will be presented asynchronously; see *Course delivery* below)
Office hours: Virtual Hours via Carmen Zoom: Mondays 11:20-12:20pm and Thursdays 2:00-3:00pm

## Grader

Grader: Yuxuan Xin
Email address: Xin.155@buckeyemail.osu.edu

## MSLC Free Tutoring Hours

Mathematics and Statistics Learning Center (MSLC) offers free online tutoring for students enrolled in selected courses including STAT 5550. The details and tutoring hours can be found at https://mslc.osu.edu/online-tutoring

## Course description

Statistics 5550 introduces the statistical methodology and models required to analyze time series data in practice. The course emphasizes both modeling methodology (model identification, estimation and diagnostics) and the practical implementation of time series modeling using the

statistical software R. Familiarity with introductory mathematical statistics and probability (random variables and their distributions, covariance and correlation, maximum likelihood estimation, confidence intervals, hypothesis tests, regression modeling) at the level of the prerequisites listed below is assumed.

Prerequisites: Statistics 4202 and Statistics 5302, or permission of instructor.

## Course learning outcomes

By the end of this course, students should successfully be able to:

- conduct exploratory data analysis for time series data
- understand and execute methods for modeling trend and seasonality
- estimate mean, autocovariance, and autocorrelation functions
- model both stationary and nonstationary processes.

## Course materials

### Required

Time Series Analysis and Its Applications, With R Examples, by Robert H. Shumway and David S Stoffer, Springer.

Note: The book is available for free at http://www.stat.pitt.edu/stoffer/tsa4/.

## Course technology

For help with your password, university e-mail, Carmen, or any other technology issues, questions, or requests, contact the OSU IT Service Desk. Standard support hours are available at https://ocio.osu.edu/help/hours, and support for urgent issues is available 24x7.

- **Self-Service and Chat support:** http://ocio.osu.edu/selfservice
- **Phone:** 614-688-HELP (4357)
- **Email:** 8help@osu.edu
- **TDD:** 614-688-8743

### Baseline technical skills necessary for online courses

- Basic computer and web-browsing skills
- Navigating Carmen

### Technology skills necessary for this specific course

- CarmenZoom

### Necessary equipment

- Computer: current Mac (OS X) or PC (Windows 10+) with high-speed internet connection
- Webcam: built-in or external webcam, fully installed
- Microphone: built-in laptop or tablet mic or external microphone

### Necessary software

- In this course, you will be required to do some basic statistical analyses on the computer using the statistical software package R (The R Project for Statistical Computing; http://www.r-project.org/). This software package is available as Free Software.
    - You can download R for Windows, Mac, and Linux, from the CRAN archive at https://cran.r-project.org.
    - An in-depth introduction to R is available at http://cran.rproject.org/doc/manuals/R-intro.pdf
    - Hands-on tutorials are available in the Swirl system, which you can learn about at http://swirlstats.com/. In particular, "R Programming: The basics of programming in R" is an appropriate first tutorial for students who have never used R.
- An easier to use interface to R is available in the software package RStudio. This package is available for Windows, Mac, and Linux and can be downloaded for free from http://rstudio.org. **Note that RStudio requires R to be installed.**

## Course delivery

Each week the instructor will deliver live CarmenZoom lectures during the allotted class time. The lectures will be recorded and posted on the class website soon after. The instructor may elect to prerecord several lecture videos that will be posted on the course website.

Each week we will cover approximately 165 minutes of content in total. You will be responsible for watching any live CarmenZoom lectures or recorded videos and studying the material that is assigned. In addition to the lectures, weekly assignments will be posted on the class website. You will be given ample time to complete the assignments.

The instructor will hold weekly office hours via CarmenZoom. The times are given above.

# Grading and faculty response

## Homework and exams

| Assignment or category | Percentage |
|---|---|
| **Homework** | **15** |
| **Midterm Exam I** | **20** |
| **Midterm Exam II** | **20** |
| **Project** | **20** |
| **Final Exam** | **25** |
| **Total** | **100** |

Grades will be recorded on the class website.

**Homework** will be due at the beginning of class on the day it is due (10:20am). No late homework will be accepted. You are encouraged to work together on the homework, but do not copy any part of a homework. Each student must produce his/her own homework to be handed in. All homework must be submitted online as a PDF file through the class website. Feel free to ask me for help after you have made an attempt of the questions.

The grader for the course does not have the time to provide detailed explanations on each question that is graded. To make up for this, I will endeavor to create homework solutions that are detailed enough to allow you to understand how the question could be approached.

**Homework preparation rules:** Put your name and the homework assignment number on the top right-hand corner of every page. Submit the problems in order showing all your work.

**Exams:** There will be two midterms and one final exam:

Midterm 1 tentatively on February 15th (Monday) from 10:20am-11:15am

Midterm 2 tentatively on March 19th (Friday) from 10:20am-11:15am

Final April 26th (Monday) from 10:00am-11:45am

All exams are **closed book/closed notes** and will be **proctored online** – there are no make-up exams. Further details will be given in advance of each exam. A basic calculator is allowed – tablets, laptops, cellphones, and other communication devices are not.

The first midterm covers the material up to and including Friday, February 12th. The second midterm covers the material up to and including Wednesday, February 17th. The final will cover all the material for the course.

## Faculty feedback and response time

I am providing the following list to give you an idea of my intended availability throughout the course. (Remember that you can call **614-688-HELP** at any time if you have a technical problem.)

### Grading and feedback

For weekly assignments, you can generally expect feedback within **7-10 days**.

### E-mail

I will reply to e-mails within **48 hours on school days**.

# Attendance, participation, and discussions

Students may miss class, for a variety of reasons related to COVID-19. As much as possible, please stay in contact with the instructor so that we can discuss accommodations should they be needed.

## Student participation requirements

Because this is a distance-education course, your attendance is based on your online activity and participation. The following is a summary of everyone's expected participation:

- **In live lectures:**
  Students will be expected to participate, discuss, and answer questions in online live lectures.
- **Logging in**: **AT LEAST THREE TIMES PER WEEK**
  Be sure you are logging in to the course in Carmen each week, including weeks with holidays. (During most weeks you will probably log in many times.) If you have a situation that might cause you to miss an entire week of class, discuss it with me *as soon as possible.*
- **Office hours**: **OPTIONAL OR FLEXIBLE**
  All office hours are optional. If you are required to discuss an assignment with me, please

contact me at the beginning of the week if you need a time outside my scheduled office hours.

## Discussion and communication guidelines

The following are my expectations for how we should communicate as a class. Above all, please remember to be respectful and thoughtful.

- **Writing style**: While there is no need to participate in class discussions as if you were writing a research paper, you should remember to write using good grammar, spelling, and punctuation. Informality (including an occasional emoticon) is fine for non-academic topics.
- **Tone and civility**: Let's maintain a supportive learning community where everyone feels safe and where people can disagree amicably. Remember that sarcasm doesn't always come across online.
- **Citing your sources**: When we have academic discussions, please cite your sources to back up what you say. (For the textbook or other course materials, list at least the title and page numbers. For online sources, include a link.)
- **Backing up your work**: Consider composing your academic posts in a word processor, where you can save your work, and then copying into the Carmen discussion.

# Other course policies

## Health and safety

The Ohio State University Wexner Medical Center's Cornavirus Outbreak site (https://wexnermedical.osu.edu/features/coronavirus) includes the latest information about COVID-19 as well as guidance for students, faculty and staff. Guidelines and requirements for campus safety from the University's COVID-19 Transition Task Force were published on July 1 on the Safe and Healthy website (https://safeandhealthy.osu.edu).

## Potential disruptions to instruction

- As much as is possible, students will have access to material online if they are unable to attend class because of positive diagnosis, symptoms, or quarantine required following contact tracing.
- If the instructor is unable to be present in person because of positive diagnosis, symptoms, or quarantine following contact tracing a new instructor will be assigned to the course. Details will be given on the course website.

# Student academic services

Student academic services offered on the OSU main campus
http://advising.osu.edu/welcome.shtml.

# Student support services

Student support services offered on the OSU main campus http://ssc.osu.edu.

# Academic integrity policy

## Policies for this online course

- **Exams**: You must complete the midterms and final exams yourself, without any external help or communication.
- **Written assignments**: Your written assignments, including discussion posts, should be your own original work.
- **Reusing past work**: In general, you are prohibited in university courses from turning in work from a past class to your current class, even if you modify it. If you want to build on past research or revisit a topic you've explored in previous courses, please discuss the situation with me.
- **Falsifying research or results**: All research you will conduct in this course is intended to be a learning experience; you should never feel tempted to make your results or your library research look more successful than it was.
- **Collaboration and informal peer-review**: The course will include opportunities for formal collaboration with your classmates. While study groups are encouraged, remember that comparing answers on a quiz or assignment is not permitted. If you're unsure about a particular situation, please feel free just to ask ahead of time.

## Ohio State's academic integrity policy

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct http://studentlife.osu.edu/csc/.

# Copyright disclaimer

The materials used in connection with this course may be subject to copyright protection and are only for the use of students officially enrolled in the course for the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course.

## Statement on title IX

Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at http://titleix.osu.edu or by contacting the Ohio State Title IX Coordinator, Kellie Brennan, at titleix@osu.edu

## Accessibility accommodations for students with disabilities

**The University strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers based on your disability (including mental health, chronic or temporary medical conditions), please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. SLDS contact information: slds@osu.edu; 614-292-3307; slds.osu.edu; 098 Baker Hall, 113 W. 12th Avenue.**

### Accessibility of course technology

This online course requires use of Carmen (Ohio State's learning management system) and other online communication and multimedia tools. If you need additional services to use these technologies, please request accommodations with your instructor.

- Carmen (Canvas) accessibility
- Streaming audio and video
- Synchronous course tools

## Your mental health

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling 614- 292-5766. CCS is located on the 4th Floor

of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on call counselor when CCS is closed at 614-292-5766 and 24 hour emergency help is also available through the 24/7 National Suicide Prevention Hotline at 1-800-273- TALK or at suicidepreventionlifeline.org

## Disclaimer

This syllabus should be taken as a fairly reliable guide for the course content. However, you cannot claim any rights from it and in particular we reserve the right to change due dates or the methods of grading and/or assessment if necessary. Any changes will be communicated to you through official course announcements.

# Course schedule (tentative)

| Week | Dates | Topics, Readings, Assignments, Deadlines |
|---|---|---|
| 1 | 1/11-1/15 | Topics: time series intro, probability review, and IID, WN, and moving averages<br>Readings: 1.1-1.2 |
| 2 | 1/18-1/22 | Topics: R intro, autoregression, random walks<br>Deadlines: student presentations and Homework 1 |
| 3 | 1/25-1/29 | Topics: ACVF and stationarity<br>Readings: 1.3-1.4<br>Deadlines: Homework 2 |
| 4 | 2/1-2/5 | Topics: estimating the mean and ACVF of stationary time series, sampling distribution of sample ACF, and tests for WN<br>Readings: 1.5<br>Deadlines: Homework 3 |
| 5 | 2/8-2/12 | Topics: sample ACFs for stationary and non-stationary time series, additive models, and regression review<br>Readings: 2.1<br>Deadlines: Homework 4 |
| 6 | 2/15-2/19 | Topics: regression, and estimating seasonal components |
| 7 | 2/22-2/26 | Topics: estimating seasonal components, and differencing<br>Readings: 2.2, 3.2<br>Deadlines: Homework 5 |
| 8 | 3/1-3/5 | Topics: smoothing, ARMA, AR(p), AR(1), MA(q), and MA(1)<br>Readings: 2.3, 3.1 |
| 9 | 3/8-3/12 | Topics: general ARMA models, ACFs, PACF, and forecasting |

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|---|---|---|
| | | **Readings: 3.3-3.4**<br>**Deadlines: Homework 6** |
| **10** | **3/15-3/19** | **Topics: forecasting, and prediction errors** |
| **11** | **3/22-3/26** | **Topics: Yule-Walker estimation for AR(p) models, and MLEs**<br>**Readings: 3.5**<br>**Deadlines: Homework 7** |
| **12** | **3/29-4/2** | **Topics: MLE, Steps for ARMA modeling, and ARIMA models**<br>**Readings: 3.6** |
| **13** | **4/5-4/9** | **Topics: ARIMA models and SARMA models**<br>**Deadlines: Homework 8** |
| **14** | **4/12-4/23** | **Topics: SARIMA models**<br>**Deadlines: Project** |