

Data Analytics for System Monitoring

ESI 6616 Section 27908

Class Periods: M,W,F | Period 6 (12:50 PM - 1:40 PM)

Location: WEIM 1076

Academic Term: Fall 2022

Instructor:

Xin Zan, xin.zan@ufl.edu

Office Hours: Friday 2:00 pm – 4:00 pm, WEIL 373

Course Description (3 Credits)

The course focuses on advanced data analytics techniques for modeling, monitoring, diagnosis, and quality improvement of industrial processes. The techniques introduced have wide applications in manufacturing, health care, service industry applications, and human factors.

Course Pre-Requisites / Co-Requisites

ESI 6325 or Permission by Instructor

Course Objectives

This course will provide the students with understanding of the fundamental and advanced data analytics methodologies on system monitoring, and the ability of formulating and solving real problems with the appropriate modeling strategies and statistical principles. At the completion of this course, it is intended that students will be able to understand and apply techniques including:

- Univariate Statistical Process Control (SPC) on continuous data
- Cumulative sum (CUSUM) and Exponential Weighted Moving Average (EWMA) control charts
- Risk-adjusted control charts
- Multivariate statistics and multivariate SPC
- Data reduction and principle component analysis
- Quality control for autocorrelated data

Materials and Supply Fees

None

Required Textbooks and Software

- *Introduction to Statistical Quality Control*, 7th edition, D.C. Montgomery, Wiley & Sons, 2013.
- *Coding is expected for completion of the project. However, this is **NOT** a software-teaching course. You are free to use any other software you are familiar with.*

Recommended Materials

- *Applied Multivariate Statistical Analysis*, 5e, 2002, R. A. Johnson and D. W. Wichern, Wiley, New York.
- In addition, some topics will not be from this book, but in lecture notes.

Course Schedule

	Topic	Book Chapter	Exam and HWs
Week 1	Introduction to statistical process control (SPC), hypothesis testing	Chapter 4, 5	
Week 2	Univariate SPC for continuous data	Chapter 6	HW1
Week 3	Univariate SPC for continuous data	Chapter 6	
Week 4	CUSUM and EWMA control charts	Chapter 9	HW2
Week 5	Univariate SPC for discrete data	Chapter 7	
Week 6	Univariate SPC for discrete data	Chapter 7	HW3
Week 7	Risk-adjustment control charts	Chapter 12	
Week 8	Risk-adjustment control charts	Chapter 12	HW4

Week 9	Exam and review		Exam
Week 10	Multivariate SPC (Shewhart Chart)	Chapter 11	Project abstracts submission
Week 11	Multivariate SPC (mCUSUM, mEWMA)	Chapter 11	
Week 12	Principal component analysis for monitoring	Lecture notes	HW5
Week 13	Principal component analysis for monitoring	Lecture notes	
Week 14	Time series model for autocorrelated data monitoring	Chapter 10	HW6
Week 15	Project and presentation		
Week 16	Project and presentation		Project due date

Attendance Policy, Class Expectations, and Make-Up Policy

Attendance is required. You are expected to be aware of all announcements made in class and know all previously covered material when you attend the following class.

In general, there will be no makeup exams or assignments given. However, a student is permitted to make up a missed exam/quiz without penalty if he/she has a conflict between an exam/quiz and a scheduled University approved activity. A student needing a make-up exam or assignment due to schedule conflicts must notify the instructor at least *one week* before the day the exam or assignment is scheduled.

Excused absences must be consistent with university policies in the Graduate Catalog (<https://catalog.ufl.edu/graduate/regulations>) and require appropriate documentation. Additional information can be found here: <https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Homework Sets	100 each	40%
Project	100	30%
Exam	100	30%
Total		100%

Assignments

Homework (40%): There will be 5-6 homework assignments throughout the semester, the material of which will be drawn from the textbook and lectures. Coding is expected in home exercises to practice fundamental methods learned in class. Homework assignments must be done individually and their due dates will be announced in advance.

Exam (30%): There will be one in-class 100-minute exam for the course. One-page double-sided hand-written cheat sheet and calculator are allowed. No coding is expected for the exam.

Project (30%): Students are required to work on a project in the context of data analytics and system monitoring to practice the learned skills and explore more methodologies and applications. Students will be working in a group of two, and finish project in one of the following three formats: (i) focused study on a concept/technique from the course pack or lecture material, (ii) focused study on an application or a dataset related to a specific topic or domain of problems, and (iii) advanced theoretical topic to develop a new technique or a new interpretation of an existing technique. An in-class presentation and a report are expected for all teams at the end of the semester. These deliverables should describe clearly the background, objectives, proposed/reviewed concepts/techniques, analysis, results, and conclusions.

Grading Policy

Percent	Grade	Grade Points
90.0 - 100.0	A	4.00
87.0 - 89.9	A-	3.67
84.0 - 86.9	B+	3.33

81.0 – 83.9	B	3.00
78.0 - 80.9	B-	2.67
75.0 - 79.9	C+	2.33
72.0 – 74.9	C	2.00
69.0 - 71.9	C-	1.67
66.0 - 68.9	D+	1.33
63.0 - 65.9	D	1.00
60.0 - 62.9	D-	0.67
0 - 59.9	E	0.00

Exam/Homework grade disputes/inquiries must be made to the instructor within one week after grades are posted. Any grade dispute/inquiry after the specified period will not be considered.

More information on UF grading policy may be found at:
<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades>
<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by

a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <https://counseling.ufl.edu>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the [Office of Title IX Compliance](#), located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling; <https://career.ufl.edu>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>; <https://care.dso.ufl.edu>.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.