Carnegie Mellon University
Master of
Software Engineering

17-611: STATISTICS FOR DECISION MAKING
M, W, 2:00 – 3:20 PM, In-person expectation, 3SC 265
B1, Fall 2024, 6 Units

Instructor	Email	Office Location & Hours
Prof. Dr. Eduardo Miranda	mirandae @ andrew.cmu.edu	3SC 268, by appointment

Course Description. From the selection of a software package to the prioritization of requirements, decision making is central to the software engineering discipline. This course is designed to acquaint students with the limitations of unaided decision making and propose structured approaches to overcome them. The course combines a refresher on probability and statistics with an introduction to measurement and decision-making theory, to enable students make better decisions. After completing this course, students will be able to describe the bias that affect the unaided decision-making process and be capable of formulating a decision problem in terms of a matrix of alternatives, preferences, and consequences, as well as defining, collecting and synthetizing the data required to make the decision.

Prior Knowledge. Undergrad course on probability and statistics.

Learning Objectives. After completing this course, you will be able to:

- Apply basic techniques for inferential statistics
- Define valid measurements
- Design and apply structured decision processes

Learning Resources. Reading material is provided.

Probability and Statistics, self-study course, OLI, https://oli.cmu.edu/
Thinking, Fast and Slow, D. Kahneman, Talks at Google
Measurement Theory for Software Engineers, G. Ford, CMU/SEI-93-EM-9
Practical Guidelines for Measurement-Based Process Improvement, L. Briand et al, ISERN
How to construct a questionnaire in Educational Research: Quantitative, Qualitative, and Mixed Approaches, B. Johnson et al, 2020
A Primer on Process Mining, 2nd, D. Ferreira, 2020
Understanding Experimentations Platforms, A. Aijaz et al, 2018
Software Engineering Metrics: What Do They Measure and How Do We Know? C. Kaner et al, 2004

The Human Element of Decision Making in Systems Engineers: A Focus on Optimism, Valerdi et al, 2009

Estimating Probable System Cost, S. Book, 2001

Decision Making and Concept Selection in Engineering Design, G. Dieter et al, 2009

Modeling and Simulation in Practical Risk Assessment for Project Management, S. Grey, 1995

Performance and Decision Making in Group Dynamics 7th, D. Forsyth, 2019

Structured Decision Making, R. Wilson et al, 2011

Diversity and Creativity in Work Groups in Group Creativity Innovation Through Collaboration, F. Milliken et al, 2003

Course and Grading Policies

The course features two parallel tracks. A self-study track which corresponds to the probability and statistical topics, delivered through the Open Learning Initiative (https://oli.cmu.edu/) platform, and a series of instructor led lectures for the measurement and decision-making topics. The rational for the choice of architecture was that the probability and statistics part is a refresher, so it was better to reserve the lecture time for those topics expected to be new for the students. See Figure 1. The grading philosophy is explained in Figure 2.
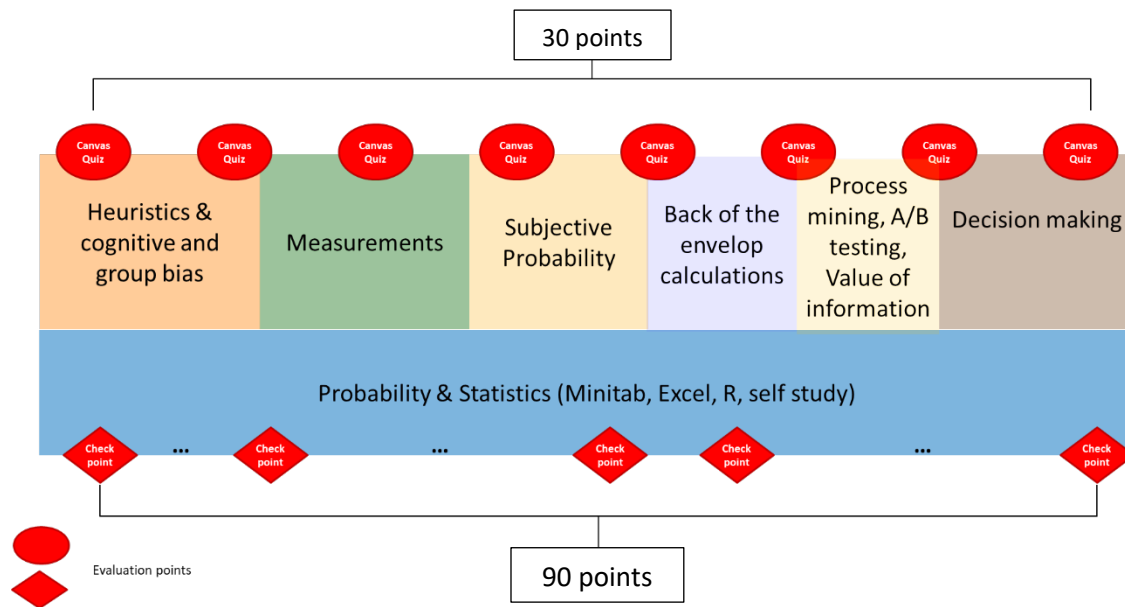

Figure 1 Course architecture

- Low stakes, incremental, self regulated ➡️ Many small evaluations

- Allows for less than perfect
- Tolerates a few mishaps. There are no excuses accepted, except for major cause ➡️ The total of the points adds to more than 100%, so you can get a few bad grades or miss an assignment, and still get an "A"

- <u>Penalizes consistent failure to perform</u> ➡️ If you consistently miss deliveries, skip classes and get bad grades you will fail the course

Figure 2 Grading philosophy

Final grades in the course will be assigned according to the following scale:

- Maximum number of points = 120
- 110+ points, "A+"
- 100+ points, "A"
- 90+ points, "A-"
- 75+ points, "B+"
- 70+ points, "B"
- 65+ points, "B-"
- 55+, "C"
- "D"

Assignments will be graded as follows:

- CANVAS quizzes: 0-2 points each, 30 points maximum
- Self-study exercises, 0-3 points each, 90 points maximum
- The OLI platform grades the assignments on a 0-100% scale, the points for each assignment will be $= 3 \times OliPercentageGrade$, e.g. $OliPercentageGrade = 80\% \rightarrow PointsInAssignment = 2.4$

Grading policy for the self-study assignments

- Only checkpoints are graded. Labs are recommended but not required. Submitting the feedback forms about the course is at your discretion
- Not all assignments require the same amount of effort, some are longer than others. Plan ahead by looking at the syllabus in the OLI website
- All the checkpoints are available now. They can be completed at any time before the due date

- All checkpoints due dates fall on Wednesdays by 11:59PM
- Every checkpoint <u>offers up to two attempts</u>, you can take one or both. The grade will correspond to the maximum score you obtained
- Beware that the questions in the second attempt are different from those in the first
- Feedback explaining why your answer is right or wrong, will be provided after the assignment due date

Grading policy for Canvas assignments

- These quizzes serve a double purpose:
    - To track class attendance
    - To make sure the students comprehend the material presented in class
- Quiz
    - Duration 10 minutes, at any point during the class
    - Typically, 2 multiple choice questions referring to what was presented in the slides in the previous lectures or included in the readings
    - Grading, 1 point for taking the quiz, 0.5/1 point for correct answer

- **Late-work policy**: All work is expected to be handed in at the indicated due date and time. For fairness to the whole class, no late submissions will be accepted. In the first week of classes, you will receive a course schedule for the course; please use them to plan ahead.

- **Participation policy**. The lack of attendance, and the use of mobile devices — including phones, tablets, and laptops — for purposes other than participating in class, is not acceptable.

  This semester involves regular use of technology. Research has shown that divided attention is detrimental to learning; I encourage you to close any windows not directly related to what we are doing while you are in class. Please turn off your phone notifications and limit other likely sources of technology disruption, so that you can fully engage with the material, each other, and me. This will create a better learning environment for everyone. A laptop will be required for our in-person classes. If you do not have access to one, please email me [mirandae @ andrew.cmu.edu](mailto:mirandae@andrew.cmu.edu) as soon as possible so we can find a solution

Attendance. Within the first week of our course, please look ahead and determine if you need to miss class for any excusable reason religious observance, job interview, university-sanctioned event, etc.) and notify me as soon as possible. You will be expected to attend all class sessions (unless otherwise discussed with the instructor); the instructor or TA will record attendance. Additionally, you will be expected to participate fully in all in-class discussions, exercises, and case studies. Make meaningful contributions when and where you can. Please note that I expect that you will abide by all behaviors indicated in [The Word](#), including any timely updates based on current conditions.

Facial coverings. Please follow the COVID guidelines published by the University.

Course Schedule. The following schedule provides a general overview of topics and assignments and <u>will be not updated during the course</u>. For actual dates and changes, please refer to the online syllabus in Canvas.

No.	Lecture topic	Assignment due (All labs and checkpoints for the corresponding modules)	Supporting material
1	Introduction, bias testing, decision quality, policies explanation		
2	Dual process theory of thought: System 1 and System 2, Common cognitive bias: Framing, representativeness, availability, confirmation, anchoring and overconfidence; bounded rationality. Counterproductive group behaviors		Thinking, Fast and Slow | Daniel Kahneman | Talks at Google (Links to an external site.) Groupthink. Watch at least the six first minutes and take note of events that could lead to bad decision outcomes. We will discuss those in class (Links to an external site.)
3	Introduction to measurement. Definitions, representational condition, validity, scales, reliability, resolution	Module 4, 5 & 6	Ford, Measurement Theory for Software Engineers
4	What should we measure? The Goal Question Metrics approach		Briand, Practical Guidelines for Measurement-Based Process Improvement
5	Measuring people's opinion. Survey design	Module 7, 8 & 9	Johnson, Chapter 7, How to construct a questionnaire
6	Metrics frameworks, motivational measurement		Kaner, Software Engineering Metrics: What Do They Measure and How Do We Know?
7	Subjective probability, overconfidence, calibration (1)	Module 10 & 11	Valerdi, The Human Element of Decision Making in Systems Engineers: A Focus on Optimism
8	Subjective probability, overconfidence, calibration (2)		McCahan, Introduction to Estimation
9	Back of the envelope calculations	Module 12 & 13	Book, Estimating probable system cost Ferreira, A Primer on Process Mining, 2nd, Aijaz, Understanding Experimentation Platforms
10	Process mining, A/B Testing, Value of Information, Monte Carlo simulations (1)		Dieter, Decision Making and Concept Selection

11	Process mining, A/B Testing, Value of Information, Monte Carlo simulations (2)	Module 14 & 15	Grey, Modeling and Simulation
12	Decision making. The decision making process, utility theory, decision matrices, consequences: immediate, lifecycle		
13		Module 16 & 17	

Accommodations for Students Disabilities. If you have a disability and have an accommodations letter from the Disability Resources office, I encourage you to discuss your accommodations and needs with me as early in the semester as possible. I will work with you to ensure that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, I encourage you to contact them at access@andrew.cmu.edu.

Academic Integrity. Honesty and transparency are important to good scholarship. Plagiarism and cheating, however, are serious academic offenses with serious consequences. If you are discovered engaging in either behavior in this course, you will earn a failing grade on the assignment in question, and further disciplinary action may be taken.

For each major assessment, you will be asked to sign a statement affirming that you will not cheat, plagiarize, or receive unpermitted assistance on the work that you turn in. For a clear description of what counts as plagiarism, cheating, and/or the use of unauthorized sources, please see the University's Policy on Academic Integrity.

If you have any questions regarding plagiarism or cheating, please ask me as soon as possible to avoid any misunderstandings. For more information about Carnegie Mellon's standards with respect to academic integrity, you can also check out the Office of Community Standards & Integrity website.

Generative Artificial Intelligence (AI) Tools and Academic Integrity. To best support your own learning, you should complete all graded assignments in this course yourself, without any use of generative artificial intelligence (AI). Please refrain from using AI tools to generate any content (text, video, audio, images, code, etc.) for an assignment or classroom exercise. Passing off any AI generated content as your own (e.g., cutting and pasting content into written assignments, or paraphrasing AI content) constitutes a violation of CMU's academic integrity policy. If you have any questions about using generative AI in this course please email or talk to me.

Student Well-Being. The last few years have been challenging. We are all under a lot of stress and uncertainty at this time. I encourage you to find ways to move regularly, eat well, and reach

out to your support system or me if you need to. We can all benefit from support in times of stress, and this semester is no exception.

As a student, you may experience a range of challenges that can interfere with learning, such as strained relationships, increased anxiety, substance use, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may diminish your academic performance and/or reduce your ability to participate in daily activities. CMU services are available, and treatment does work. You can learn more about confidential mental health services available on campus at the [Counseling and Psychological Services](#) website. Support is always available (24/7) from Counseling and Psychological Services: 412-268-2922.

If you are worried about affording food or feeling insecure about food, there are resources on campus who can help. Email (cmu-pantry@andrew.cmu.edu) or call (412-268-8704) the CMU Food Pantry Coordinator to schedule an appointment.

We must treat every individual with respect. We are diverse in many ways, and this diversity is fundamental to building and maintaining an equitable and inclusive campus community. Diversity can refer to multiple ways that we identify ourselves, including but not limited to race, color, national origin, language, sex, disability, age, sexual orientation, gender identity, religion, creed, ancestry, belief, veteran status, or genetic information. Each of these diverse identities, along with many others not mentioned here, shape the perspectives our students, faculty, and staff bring to our campus. We, at CMU, will work to promote diversity, equity, and inclusion not only because diversity fuels excellence and innovation, but because we want to pursue justice. We acknowledge our imperfections while we also fully commit to the work, inside and outside of our classrooms, of building and sustaining a campus community that increasingly embraces these core values.

Unfortunately, incidents of bias or discrimination do occur, whether intentional or unintentional. They contribute to creating an unwelcoming environment for individuals and groups at the university. Therefore, the university encourages anyone who experiences or observes unfair or hostile treatment on the basis of identity to speak out for justice and support, within the moment of the incident or after the incident has passed. Anyone can share these experiences using the following resources:

- **Center for Student Diversity and Inclusion**: csdi@andrew.cmu.edu, (412) 268-2150
- **Ethics Reporting Hotline**. Students, faculty, and staff can anonymously file a report by calling **844-587-0793** or visiting **cmu.ethicspoint.com**.

All reports will be documented and deliberated to determine if there should be any following actions. Regardless of incident type, the university will use all shared experiences to transform our campus climate to be more equitable and just.