Project 3: Assessment instrument details

This document describes in detail two of the assessment instruments for the course on Introduction to Probability and Statistics in Civil Engineering. The learning objectives of my class state that at the end of the course students will be able to:

1. Interpret, formulate, and solve problems involving elementary combinatorics, probability distribution, and inferential statistics
2. Conduct basic descriptive and inferential statistical analysis of data using a software program such as R
3. Identify and demonstrate the use of probability and statistical methods for applications in civil engineering

I plan to employ four types of assessment techniques summarized in Table 1, ranging on the scale of being formative/summative, being formal/informal, and the time commitment required from the instructor.

Table 1 Summary of assessment techniques

Assessment technique	**Learning objective covered**	**Formative/Summative**	**Formal or Informal**	**Time and effort required on instructor's end**
Homework/Exam	Primarily 1; 2 and 3 partially	Formative and Summative	Formal	Medium
Problem recognition tasks	3	Summative	Informal	High
Group project	Primarily 2; 1 and 3 partially	Summative	Formal	Medium
Self-reflection surveys	Primarily 1; 2 and 3 partially	Formative	Informal	Low

In this document, I provide details on the last two assessment techniques: group project and self-reflection surveys.

Assessment instrument 1: Group projects

This assessment instrument tests students' abilities in using a statistical software like R or Excel by making them work through different real-world datasets. This technique will give students an exposure to different applications of probability and statistics in civil engineering and will comprise of 20% of their final grade. The students will also do peer evaluation and get periodic feedbacks to ensure that the learning is uniform and well done across the groups. The following subsections describe the learning objectives specific to this assessment instrument, the split of grading, the tentative timeline of implementation, and the rubric used for evaluating students' performance.

Learning objectives for group projects

After completing the group project, students should be able to do the following:

1. Organize and store the available raw data in formats assessible in commonly used statistical software like R, Excel, etc.
2. Identify questions in the real-world which can be answered using the dataset and formulate a methodology for the solution in probabilistic and statistical notations
3. Describe the assumptions, steps, and math required to solve the formulated problem
4. Identify limitations of the proposed methods and a possible resolve for those limitations
5. Work effectively in group activities by identifying their role and working as a group
6. Present the findings of their group coherently in form of a progress report and a final report

Distribution of points

The project is worth 20% of the grade and will comprise of following components:

1. Progress report 1: 10 points
2. Peer feedback: 20 points
3. Final report: 70 points

Timeline and details of implementation

The class will be divided into 12 groups of 3-4 students each by the end of third week (students will be assigned to each group randomly). Each group will be asked to choose one dataset from 4-5 available datasets from civil engineering applications like travel time data collected on I-35 corridor in Austin, data on rainfall and predicted flooding in each zone in Austin, data on traffic counts made at an intersection, etc. The goal of each group will be to:

- Describe the data using descriptive statistics and visual plots in R or Excel
- Identify the distribution of particular variables and evaluate and interpret the probabilities of the variable being equal to a certain value
- Select a problem of their choice and state how probability and statistics tools can be used to derive meaningful information from the dataset towards solving the selected problem
- Derive inferential statistics about their choice of variable and perform particular hypothesis tests

The groups will be asked to submit a progress report and a mid-semester peer feedback after 6 weeks. In the progress report, the students will describe their selected dataset and talk about the proposed problem they are attempting to solve. Based on the midterm progress report, a

preliminary feedback will be provided to each group. The peer-feedback will be used for my purposes to evaluate and improve the group dynamics.

One week before the finals, the groups will be asked to submit a final report describing the details of the work completed as part of their project. The rubric for the final report is described in the following section. The final report will be graded along with the final exam and final grade allotted at the end of the course.

Rubric for final report

Dimension	Strong	Satisfactory	Weak
Dataset handling (10 points)	The report describes how the data was stored, manipulated, and organized. And shows clear evidence that the organization was done to assist with the formulated problem. A clear understanding of the used software is demonstrated (8-10 points)	The report lacks one of the elements storage, manipulation, and organization of the provided dataset. The formulated problem doesn't correlate well with the data organization. The report lacks demonstration of the use of a data manipulation software (4-7 points)	The report lacks evidence of usage of dataset or does not demonstrate use of any software. (0-3 points)
Identification, formulation, and description of questions from the dataset (30 points)	Problem is identified, formulated, and described appropriately. Relevance to the civil engineering applications is clearly demonstrated. The proposed problem when solved should be of interest and relevance to the real-world. The taught concepts in the course are clearly demonstrated and utilized to solve the problem. The assumptions and technical details are clearly described. The proposed solution is interpreted in context of the problem (25-30 points)	There is some error in details of identification, formulation and description of the question, but the formulated structure still attempts to solve a real-world application problem. There is lack of some details in description of the problem and the solution. The concepts from the course are used but may be incorrect or inappropriate (10-25 points)	The report lacks clear understanding of the provided dataset. No technical detail is provided. The problem is either not formulated or lacks understanding of the civil engineering application it might be applied for. The concepts from the course are not used to solve the problem (0-10 points)

Report Organization (15 points)	The report has a clearly visible structure to help with reader's understanding. Sections are clearly marked and the topics progress in a logical manner for the reader to understand the work done and its significance. The report is of an appropriate length: comprehensive, yet succinct (12-15points)	The general structure is sound, but the ordering of the sections could be improved and certain topics can be covered in different order. The length of some sections can be improved (6-11 points)	No structure is apparent, and topics simply flow out of order. The length is either too short or too long. (0-5 points)
Report Mechanics (15 points)	Author's spelling, grammar and usage are flawless, and information is communicated effectively. Figures and tables are clear with marked captions and they complement the text. Mathematical notations are consistent and well defined. The report formatting is consistent throughout (12-15 points)	The authors' use of English language is average and can be improved. There might be slight inconsistency in mathematical notation, formatting, and figures/tables. (6-11 points)	The authors have clearly spent little time proofreading and preparing the document. Tables and figures are completely unhelpful and may be unreadable in some instances. Overall, the report looks highly unprofessional (0-5 points)

Assessment instrument 2: Self-reflection surveys after each midterm

This informal assessment instrument scheduled to be taken after every midterm will ask students to reflect on their learning and to answer multiple choice questions indicating their level of knowledge against the detailed learning objectives of the course. The material covered before each exam will be organized as modules and students will rate how well they believe they can solve a problem in each module. The students will also answer reflective questions like what did they learn from this exam and how will they approach preparing for an exam/assignment differently in the future.

The survey will be put up online after each exam and students will have a week to fill it out. The survey will count for 5 points towards their next homework grade which will enforce that students have a motivation to fill it out. This technique is selected because self-reflection will encourage students to take a step back and get a holistic picture of how they approach their learning. It serves an important component of metacognition. The survey results will be a good indicator of the level of perception of students' learning by the students against the detailed learning objectives of the class. It will also provide a subjective evidence for the ability of students to interpret, formulate and solve problems in descriptive and inferential statistics.

The details of the surveys after each midterm are listed in the following subsections. The ideas and questions for this survey have been borrowed from Carnegie Mellon University's Open Learning Initiative course on Probability and Statistics[1] and are modified a bit to suit the flow of content as per my course plan based on the feedback from my advisor, Dr. Stephen Boyles.

Self-reflection survey after exam 1

Evaluate your ability to perform each of the following tasks. In other words, how well can you do each task? (Check one box for each of the tasks)

Task	Not at all yet	With a lot of support	With some support	With minimal support	On my own
Descriptive statistics					
Evaluate descriptive statistics from given data (mean, median, mode, variance and standard deviation)					
Axioms of probability					
Determine the sample space of a given random experiment					
Apply probability rules in order to find the likelihood of an event					
When appropriate, use tools such as Venn diagrams or probability tables as aids for finding probabilities					
Conditional probability and independence					
Explain the reasoning behind conditional probability, and how this reasoning is expressed by the definition					

[1] Available at http://oli.cmu.edu/courses/all-oli-courses/statistics-course-details/

of conditional probability.					
Find conditional probabilities and interpret them.					
Determine whether two events are independent or not.					
Use Bayes' theorem to evaluate conditional probability					
Counting techniques					
Explain the reasoning behind the formula for counting techniques (ordered and unordered sampling, sampling with and without replacement)					
Identify whether to use permutation and combination to evaluate the likelihood of an event					
Discrete random variables					
Identify the random variable in an experiment and find its probability mass function					

What new skills have you learned so far in this course?

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Thus far, what study strategies have you been using to learn the material, complete the homeworks, and study for exams?

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Are there any changes you plan to make for how you learn the material, complete assignments, and study for exams?

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Self-reflection survey after exam 2

Evaluate your ability to perform each of the following tasks. In other words, how well can you do each task? (Check one box for each of the tasks)

Task	**Not at all yet**	**With a lot of**	**With some**	**With minimal**	**On my**

		support	support	support	own
Continuous random variables					
Identify the random variable in the experiment as one of special distribution and determine its probability density function					
Use the properties of special distribution to evaluate the asked probability					
Use the z-table for evaluating probabilities on standard normal distribution					
Joint random variables					
Determine the marginal pmfs/pdfs for a given joint					
Determine if the two random variables are independent or not					
Evaluate the covariance and correlation of two random variables					
Evaluate the multiple integral for joint continuous random variables given a domain of the variables					
Evaluate expectation and variance of linear combination of random variables					
Central limit theorem					
Explain the central limit theorem and use it to evaluate probabilities of the average of several independent and identically distributed random variables					

What new skills have you learned after exam 1?

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What changes did you incorporate in your learning after exam 1? How effective were the changes?

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What modifications will you make to your approach towards preparation for the finals and the group project?

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