



- ▶ The goal of these projects is for students to demonstrate their ability to use appropriate mathematical and statistical tools to solve model problems in Economics, Biology, Physics, Engineering, etc.
- ▶ The following is the outline that will be used for this assignment. You will participate, present your research, and turn in your accompanying report for full credit in this course. You will earn an individual maximum grade of 200 divided into 100 for your report and 100 for your presentation

## 1. Projects Topics

- ▶ You can choose a topic (See the list below) for your presentation.
  - ▶ To be acceptable, your project should be about Mathematical Statistics (You are highly encouraged to discuss it with me to be sure).
  - ▶ Should you find the need to consult with me on a project, please do so during office hours or by appointment only.
- (1) Are SIR models adequate for COVID-19 or noisy models should be used?
  - (2) Stochastic models of COVID-19.
  - (3) Germany used the Reproduction rate number  $\mathcal{R}_0$  for its policy regarding COVID. Would a stochastic version of  $\mathcal{R}_0$  be more appropriate given given new variants?
  - (4) Are PCR (Polymerase Chain Reaction) tests inherently superior to other tests? Comparative analysis based of metric such as PPV (Positive Predictive Value).
  - (5) Neural networks: ANN, CNN, Random Forests.
  - (6) Can a machine effectively learn chaos? If so, test it on Ricker and Logistic Models
  - (7) Is deep learning fundamentally different from shallow learning? Comparative study.
  - (8) Text Data Analysis.
  - (9) Information Theory
  - (10) Probability in Stock Markets
    - Is Warren Buffet an investment genius or incredibility lucky?
    - Does the stock market remember yesterday?
  - (11) Visualizing Probability
  - (12) Gambling
  - (13) Probability and Sports
  - (14) Digital Image or Speech processing
  - (15) Probability and Weather Forecast

- (16) Least Squares Modeling in Digital Communication
- (17) Data Analysis of Electric Cars Versus Gas Cars
- (18) Data analysis for prediction of presidential election.
- (19) Data analysis of black holes.

## 2. Project's Report

### 1.1 General information.

► You should choose an appealing title for your project.

► Your report should be typeset, no more than 20 pages long. Failure to do so will result in grade of 0 for the entire report.

► You can use any software you want for your simulations/calculations: Matlab, Mathematica, Maple, Python, Java, R, Minitab, etc. Just make sure to mention which one was used in your report and provide the code(s) used in an appendix at the end of your report. Rstudio is highly recommended if you're not sure which software to use.

### 1.2 Structure of your report.

► Your report should have the following structure (which is already set up in the Report's Template) to be acceptable. No departure from this format will be accepted.

- (1) Introduction (15 pts) : This is the first section of your report. It should be divided into two parts
  - Motivation:** Briefly describe your motivation for choosing the project and provide the significance of the problem based on a literature review and/or your best knowledge.
  - Literature review:** Provide what studies have been carried out, if any on this topic. If you found nothing, say "To your knowledge, there has not been any study on this topic as of now"
- (2) Statement of the problem (20 pts): This is the second section of your report.
  - (a) Briefly describe the problem, or the specific research question to be answered or the hypothesis to be tested, etc.
  - (b) Clearly state what you want to achieve.
- (3) Methodology (20pts): This is the third section of your report. This should have three subsections.
  - Connection to Probability and Statistics:** Clearly demonstrate the connection of this project to Probability and Statistics.
  - Procedures/methods used:** List the procedures. (A detailed description of what you did and step-by step)

**Data collection and analysis:** Describe data processing and analysis. (How will you collect and analyze the data and why?)

- If you don't have data, make it up or ask the instructor.
- Are the tables and graphs appropriately used?

(4) Results (25 pts): This is the fourth section of your report. Report the results you obtained. It must contain the following three subsections.

**Explanation of the results:** Explain your results clearly and concisely.

**Limitations and challenged encountered:** Discuss the limitations and challenges of the methodology you used.

**Possible extensions:** Briefly discuss what you think can be done to improve or extend your results.

(5) Bibliography (10 pts): This is fifth section of your report. You should list in alphabetic order all the references you used for your project. use any acceptable scientific format for articles, books, websites etc.

(6) Appendix (10 pts): This is the sixth and final part of your report. It must contain the code(s) you used for your project.

### 1.3 Projects Report Milestones.

► A successful project will required four milestones. Less than two milestones achieved by the end of the semester will result in a grade of 0 on the entire project!

► Each progress report must be submitted on TLearn by the date mentioned below.

Progress report	Description	Date
Milestone 1	Layout of goals and objectives	February 29, 11:59 pm
Milestone 2	Implementation of your goals	April 5, 11:59 pm
Milestone 3	Final Presentation	May 5 & 10
Milestone 4	Report Submission	May 12, 11:59 pm

## 3. Project's Final Presentation

► Each project will have to be presented in class by its author.

► The presentation could be prepared using the Presentation Template posted on TLearn. You must use LATEX BEAMER for your presentation.

► Below are the necessary conditions for an acceptable presentation.

(1) Be properly attired (20 pts)

(2) Clearly explain the goal of your project (20 pts)

- (3) Clearly show what you have accomplished (25 pts)
- (4) Submit your presentation on time and it should be about your actual project (20 pts)
- (5) Peer Evaluation. You will provide your evaluation of your peers' presentations (15 pts)