UNM Statistics Qualifying Exam Take-Home
January 2018

Due 12:00pm Jan 12 Friday, 2018. Return to Ana Parra Lombard in the Math/Stat Dept Office SMLC 395.

Directions: The answer to each problem should be presented as a summary. It should be word processed and double spaced, and be identified by your "Code Word" (do not include your UNM ID and name). **A suggested length of the report to each problem is no longer than 3 pages**. Create brief, well-organized appendixes (not included in 3 pages) for each problem.

In your data analysis, RAW AND UNINTERPRETED COMPUTER OUTPUT IS UNACCEPTABLE. You should have a caption by every figure and table that describes it and tells the reader briefly what you see. Organize the sections to tell the story you uncovered, not the circuitous path you may have taken to get there. Remember that even that best data analysis is worthless if your reader cannot understand it.

You may **not** consult any other person when working on this exam or discuss your exam with anyone else regardless of whether or not the person is taking the exam. You may use your course notes as well as any available books or web resources for the exam. Questions pertaining to clarification about these questions can be directed to Guoyi Zhang, gzhang12@math.unm.edu.

Problem 1. The data for this problem comes from a designed experiment conducted by 3M to optimize their production of bump-ons (little rubber bumps used on cabinet doors, etc.). The response of interest is the hardness of the bump-on. The factors selected for consideration are line speed (SPEED), amount of catalyst (CAT), and temperature on the line where the reaction takes place (TEMP). The data is available for download at

`http://www.math.unm.edu/~gzhang12/data/mmmdata.txt`

Suppose you work for 3M and are interested in where to set the input variables to achieve the target hardness. The target hardness (as measured by the amount of depression under a set force) is 0.50mm, while the acceptable range for bump-on hardness is 0.35mm to 0.65mm. Values below this range (harder) results in poor performance for absorbing impact, while values above this range (softer) is also undesirable due to lack of durability. In addition, it is desirable to have the line speed be set as fast as possible while still maintaining the desired hardness.

Using the data, build an appropriate regression model, making sure that you carefully assess all assumptions. Use this model to give advice/recommendations on the best possible settings of the input variables to achieve your goals. Write a succinct, coherent, and complete summary of your analysis.

Problem 2. Vacuum tubes are used in audio equipment. To determine the effect of exhaust index (in seconds) and pump heater voltage (in volts) on the pressure inside a vacuum tube (in micrometers of mercury), three exhaust indexes and two voltages were chosen at fixed levels. It was decided to run two experiments at each experimental condition. In this experiment complete randomization was employed. Given below are the data for this experiment,

Table 1: Data of the pressure inside a vacuum tube (in micrometers of mercury) for problem 2

Pump Heater Voltage	Exhaust Index		
	60(seconds)	90(seconds)	120 (seconds)
127 (volts)	48	28	7
	58	33	15
220 (volts)	62	14	9
	54	10	6

Identify the design and write down the model for this experiment along with assumptions. Be sure to check the model assumptions such as constant variance, independence, normality and also check for outliers. Write a succinct, coherent, and complete summary of your analysis.