

**Bryson Cook**  
**ISYE6501, Spring 2018**  
**HW9**

**Question 12.1**

**Describe a situation or problem from your job, everyday life, current events, etc., for which a design of experiments approach would be appropriate.**

With all the political talk of the new tariffs on steel and aluminum, I would think a DOE approach would be useful for simulating the potential of the tariff on US companies and, at the end, the US consumer. Steel prices from each various country, the volume of import into the US, price and volume information from US steel manufacturers, and the type, price, and market share, both before and after the tariff was implemented, of the finished good the steel is used in could all be factors in the study. Many of these factors would have to be controlled for, as price and volume are usually directly correlated due to supply and demand. Also, if the factors tell you if the US consumer is benefiting from the steel tariffs, say due to lower car prices, what if other countries apply retaliatory tariffs on other goods (whiskey and peanuts have been in the news recently)? What factors need to be surveyed to ensure that all angles of the problem are seen?

### Question 12.2

To determine the value of 10 different yes/no features to the market value of a house (large yard, solar roof, etc.), a real estate agent plans to survey 50 potential buyers, showing a fictitious house with different combinations of features. To reduce the survey size, the agent wants to show just 16 fictitious houses. Use R's FrF2 function (in the FrF2 package) to find a fractional factorial design for this experiment: what set of features should each of the 16 fictitious houses? Note: the output of FrF2 is "1" (include) or "-1" (don't include) for each feature.

Using the FrF2() function in R, I created the below fractional factorial design to see how to best varying the features across the survey. A listing for each of the 16 “fake” houses then needs to be created, including or excluding the features as shown below, where +1 means the house includes the feature and -1 means it does not. For example, House 1 would be on a parcel less than .5 acres and would not have a master on main, but would have a newly renovated kitchen and large closets.

[illegible]

### Question 13.1

For each of the following distributions, give an example of data that you would expect to follow this distribution (besides the examples already discussed in class).

**a. Binomial** - Success of a particular opening line/icebreaker on the Tinder dating app in a certain number of matches.

**b. Geometric** - With the above opening line/icebreaker, how many rejections will be seen before the first success/date arranged.

**c. Poisson** – If you are planning a festival or other large gathering, you could use assume the arrival and departure rates of people are modeled by the Poisson distribution, which would allow you to stagger security, refreshment, and sales staff to minimize cost to the times when the people are actually needed.

**d. Exponential** – If the above arrivals and departure rates fit the Poisson distribution, then the spacing between arrivals and departures would fit the exponential distribution, possibly allowing you to time breaks/shift changes of your workers.

**e. Weibull** – I work at a large company and, with such a large amount of people, computers are constantly being fixed/replaced due to failures. I would think that a Weibull distribution would be useful for monitoring or predicting the failure rate of the computers. Currently, employees keep their computers 3 years. Based on my intuition and experience, I think you could apply a Weibull distribution with  $k = 1$  (for a constant failure rate) for the first 18-24 months, then move to model with  $k > 1$  (failure rate increases with time) for the final 12-18 months, with the possibility of  $k$  increasing the closer the computer gets to its 3 year expected life.

### Question 13.2

In this problem you, can simulate a simplified airport security system at a busy airport. Passengers arrive according to a Poisson distribution with  $\lambda_1 = 5$  per minute (i.e., mean interarrival rate  $\mu_1 = 0.2$  minutes) to the ID/boarding-pass check queue, where there are several servers who each have exponential service time with mean rate  $\mu_2 = 0.75$  minutes. [Hint: model them as one block that has more than one resource.] After that, the passengers are assigned to the shortest of the several personal-check queues, where they go through the personal scanner (time is uniformly distributed between 0.5 minutes and 1 minute).

Use the Arena software (PC users) or Python with SimPy (PC or Mac users) to build a simulation of the system, and then vary the number of ID/boarding-pass checkers and personal-check queues to determine how many are needed to keep average wait times below 15 minutes. [If you're using SimPy, or if you have access to a non-student version of Arena, you can use  $\lambda_1 = 50$  to simulate a busier airport.]

I set up a SimPy simulation using a max time period of 10 hours and a total number of passengers of 500. Using these figures, I was able to determine that having 24 ID checks and 15 personal scanners results in an average wait time of 14.7 minutes. I will say that there are a few things that could be done to improve the results:

1. I was unable to figure out how to assign the passenger to the shortest personal scan queue. This would probably bring down the average times.
2. I manually changed the number of ID checkers and personal scanners, but multiple loops could be used to find the optimum solutions.
3. As expected, the number of ID checks and scanners increased with the number of people arriving. However, I could not find a set of numbers that gave a steady state, where the processing rate would equal the arrival rate. This would be interesting to find.