ISYE 6501 Week 9 Homework

2023-10-15

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.

A design of experiments approach would be appropriate in the development of a new drug. In this scenario, scientists and researchers would use factorial design to test various combinations of factors. Factors may include drug composition, manufacturing process, and dosage.

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 have? Note: the output of FrF2 is "1" (include) or "-1" (don't include) for each feature.

The real estate agent should use a fractional factorial design approach to solve this problem. If the real estate agent used full factorial design, he/she would have to show 1,024 fictitious houses to potential buyers. This number is pretty unrealistic.

To do this, I loaded the FrF2 package into RStudio and set up a fractional factorial design. I used nfactors=10 to represent the 10 different yes/no features and nruns=16 to represent the 16 fictitious houses the real estate agent wants to show. The output below shows the optimal combinations of features for the 16 houses.

```
#create factor names
factor_names <- c("factor 1", "factor 2", "factor 3", "factor 4", "factor 5",
             "factor 6", "factor 7", "factor 8", "factor 9", "factor 10")

#implement fractional factorial design
houses <- FrF2(nruns=16, nfactors=10, factor.names=factor_names, default.levels=c("Yes", "No"))
houses
```

```
##    factor.1 factor.2 factor.3 factor.4 factor.5 factor.6 factor.7 factor.8
## 1       Yes       No      Yes       No      Yes       No      Yes      Yes
## 2        No      Yes      Yes      Yes      Yes      Yes       No      Yes
## 3       Yes      Yes       No      Yes       No      Yes      Yes       No
## 4        No       No      Yes      Yes       No      Yes      Yes      Yes
## 5       Yes      Yes       No       No       No      Yes      Yes      Yes
## 6        No      Yes       No      Yes      Yes       No      Yes      Yes
## 7        No      Yes      Yes       No      Yes      Yes       No       No
```

```
## 8       Yes       No      Yes      Yes      Yes       No      Yes       No
## 9        No       No       No      Yes       No       No       No      Yes
## 10      Yes       No       No       No      Yes      Yes       No      Yes
## 11       No       No      Yes       No       No      Yes      Yes       No
## 12      Yes       No       No      Yes      Yes      Yes       No       No
## 13       No      Yes       No       No      Yes       No      Yes       No
## 14      Yes      Yes      Yes      Yes       No       No       No       No
## 15       No       No       No       No       No       No       No       No
## 16      Yes      Yes      Yes       No       No       No       No      Yes
##    factor.9 factor.10
## 1       Yes        No
## 2       Yes       Yes
## 3        No       Yes
## 4        No        No
## 5       Yes        No
## 6        No        No
## 7        No        No
## 8        No       Yes
## 9       Yes       Yes
## 10       No       Yes
## 11      Yes       Yes
## 12      Yes        No
## 13      Yes       Yes
## 14      Yes        No
## 15       No        No
## 16       No       Yes
## class=design, type= FrF2
```

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, B) Geometric, C) Poisson, D) Exponential, and E) Weibull.

A) Binomial: the binomial distribution is often used to model situations where there are two possible outcomes. In marketing, the number of customers who make a purchase (success) or do not (failure) after clicking an ad may follow a binomial distribution.

B) Geometric: the geometric distribution is used to model situations where you are interested in the number of trials required until the first success occurs. In the TV show Jeopardy, the number of questions a contestant answers incorrectly before getting their first correct answer may follow a geometric distribution.

C) Poisson: the Poisson distribution is used to model situations where you are interested in the probability of a given number of events happening in a specified time period. The number of people arriving at the Department of Motor Vehicles (DMV) within one business day (8 hour shift) may follow a Poisson distribution.

D) Exponential:the exponential distribution is typically used to model the time between events in a Poisson process. Using the same example as above, the time between each DMV arrival may follow an exponential distribution.

E) Weibull: the Weibull distribution is typically used to model product reliability and time to failure. In medical research, the survival time of patients with a certain disease or condition may be analyzed using the Weibull distribution.

Question 13.2

See additional attachment.