FINAL PROJECT

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Background

This project aims to test the reliability of two popular commercial sealants, Flex-seal and Ruste-oleum. This project specifically addresses two research questions of interest:

1) Is one sealant more reliable than another in terms of plugging leaks.
2) Does the size of a hole have an impact on the reliability of a sealant in plugging leaks?

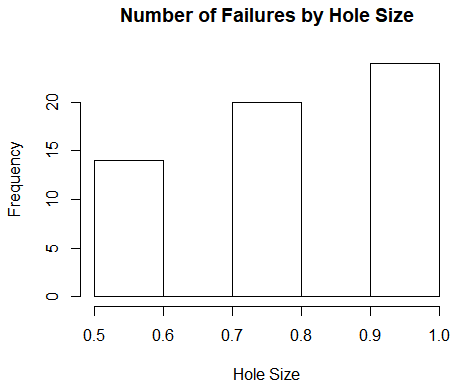
Experimental Procedure

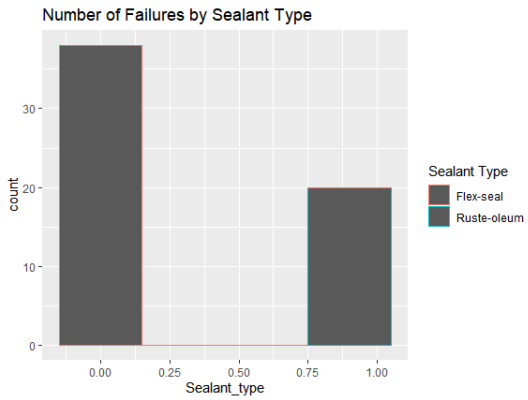
In order to answer the research questions posted above, I collected data on the failures and successes of each sealant in plugging leaks caused by a hole cut in the side of a Styrofoam cup. Specifically, the following procedure was used to collect data for the project:

1) Using a compass and a pin, a hole was cut in the side of the cup.
2) After the hole was cut, a paper rectangle was taped on the inside to cover the hole. This was necessary because the sealant needed something to bind to in order to set properly and seal the hole.
3) The sealant was sprayed until the hole was sealed.
4) Sealant was left to dry for 24 hours. When it was finished drying, the paper was peeled off.
5) Water was poured in the cup and the success and failures were recorded. Note that most failures (if the cup leaked) occurred within the first 2 minutes of the water being poured in the cup.

Exploratory Data Analysis

Based on the histogram below, there is evidence that hole size has an effect on failure rate since cups with smaller holes failed less often that cups with bigger holes. Also note that flex seal seems to be less reliable than Ruste-oleum since it had more failures.





Model for Data Analysis

$$g(\pi) = \beta_0 + \beta_1 \times Hole\_size + B_2 \times Sealant\_Type$$

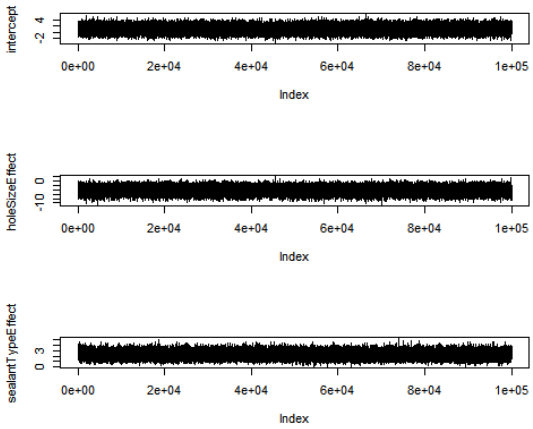
Parameter Definitions:

- π – Vector of probabilities

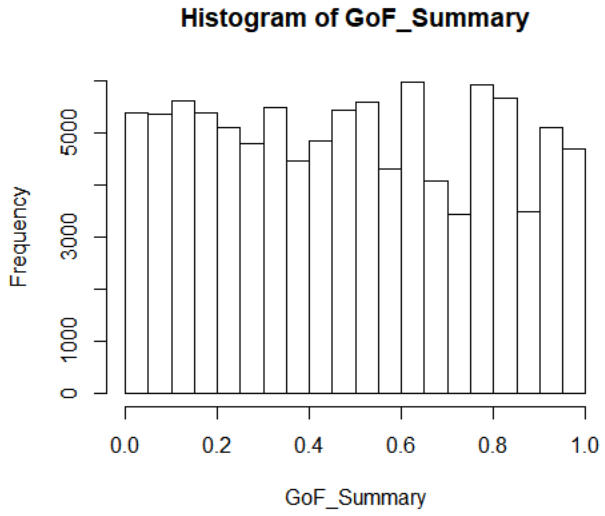
- g – link function, in our case it was a logit link.
- $\beta_{0,1,2}$ – Beta Parameter estimates for the explanatory variable.

Convergence and Goodness of fit of model

The trace plots below suggest that the MCMC samples have converged. Since the upper limit for the Gelman Diagnostic test was one, we have further evidence that the MCMC chains have converged.



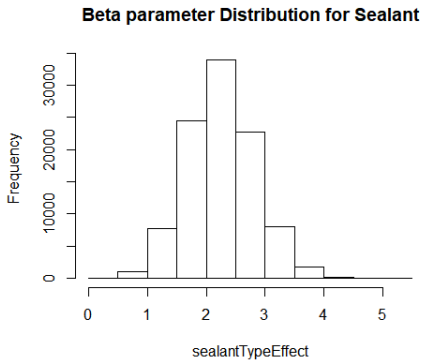
Note that the bins in the histogram below are for the most part, uniform in height. This combined with the fact that the proportion of posterior models with a p-value less than 0.05 was 0.05375 suggests that the model is an incredibly good fit for the data.



Data Analysis

Research Question 1: Is one sealant more reliable when compared to another?

Note that 0 is not contained in the beta parameter distribution for β_2 below and zero is also not in interval (1.18, 3.44) which represents the 95% credible interval for the true posterior mean value of β_2. This implies that sealant has an effect on the probability of failure when it comes to sealing leaks.

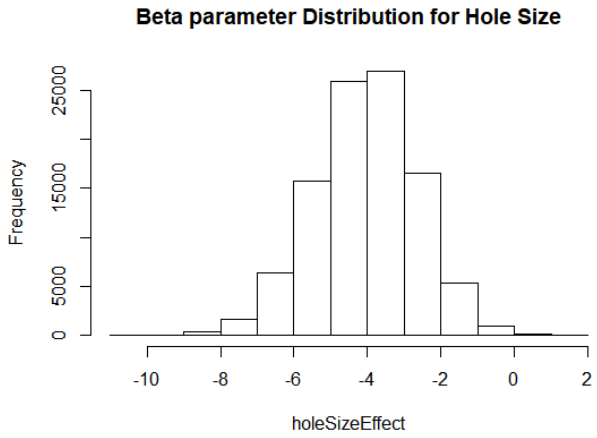


The table below represents the posterior predictive probability that a particular sealant will successfully seal a hole of a certain size. Based on this table, its clear that the Ruste-oleum sealant is expected to perform much better than Flex-seal. Hence, when it comes to sealing leaks, Ruste-oleum should be the sealant of choice.

Hole Size	Sealant Type	Probability of Success Estimate
0.5	Flex-seal	0.28
0.75	Flex-seal	0.13
1.0	Flex-seal	0.06
0.5	Ruste-oleum	0.77
0.75	Ruste-oleum	0.57
1.0	Ruste-oleum	0.33

Research Question 2: Does hole size have an effect on failure rate? If there is an effect, Interpret it.

Note that 0 is not contained in beta parameter distribution for β_1 and it is not in the interval (-6.88,-1.43) which represents the 95% credible interval for the true posterior mean value of β_1. This implies that the size of the hole has an effect on the probability of failures when it comes to sealing leaks.



Using the equation $\frac{1}{1+e^{-x^t\beta}}$, I calculated the expected probability of success for plugging a cup with hole sizes 0.5 and 1 inch, respectively. By subtracting the result, I obtained the value 0.226 which will aid in interpreting the value of β_1 . In R this was accomplished using the following code:

```
mean(ilogit(intercept + holeSizeEffect*0.5)) - mean(ilogit(intercept + holeSizeEffect*1.0))
```

In the context of the project, the value above means that holding all else constant, we expect a decline in the probability of the success of plugging a leak by 0.226 for every 0.5 unit increase in hole size.

Conclusions

The analysis above suggests that Ruste-oleum is a more reliable sealant when it comes to sealing leaks when compared to Flex-seal. Considering that a Flex-seal spray typically costs about $13 while Ruste-oleum typically cost about $9, consumers should favor Ruste-oleum over Flex-seal since it is a cheaper and more reliable.

A future experiment might consider multiple surfaces in order to more thoroughly test the reliability of Flex-seal and Ruste-oleum when it comes to sealing leaks. Conducting this experiment would give the consumers a better idea on what types of surfaces Flex-seals can optimally performs its intended function and the types of surfaces Ruste-oleum is optimized for in terms of plugging leaks.