STA322 Project 2

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4 factors, full factorial: 2^4 = 16 possible treatment assignments all low / 0, a, b, c, d, ab, ac, ad, bc, bc, cd, abc, abd, acd, bcd, abcd 5 replicates for each assignment? assume there are interactions, otherwise use half factorial?

a: rotor length = 8.5cm (baseline 7.5cm) b: leg length = 12.0cm (baseline 7.5cm) c: leg width = 5.0cm (baseline 3.2cm) d: paper clip on leg - need to control where we put the paper clip since leg lengths would change based on treatment - 1cm from the bottom? in the middle?

Introduction

This study aims to examine the factors that affect how long a paper helicopter can stay in the air. Specifically, four factors: rotor length, leg length, leg width and paper clip are studied. This report includes details of the study design, procedures of data collection, and analysis of estimation results using regression.

Study Design and Data Collection

The factors we want to study in this experiment are: a: rotor length = 8.5cm (baseline 7.5cm) b: leg length = 12.0cm (baseline 7.5cm) c: leg width = 5.0cm (baseline 3.2cm) d: paper clip on leg, 1cm from the bottom (baseline no paper clip) Because there are four factors with two levels each, there are a total of $2^4 = 16$ total possible treatment assignments. We decide that because we have no prior knowledge of how these factors interact with each other and thus cannot assume their interaction effects are negligible, we use a full factorial design, which allows us to examine all the different interaction effects, for this experiment. We conduct five trials for each of the assignment, which gives us $16 * 5 = 80$ trials in total. During each trial, we drop the paper helicopter at the height of exactly two meters, and the flight time as measured from the time the helicopter is dropped from some height until the time it hits the floor. The data is recorded in the table below.

```
(heliData = read.csv("HeliData.csv"))
```

```
##    a b c d time
## 1  0 0 0 0 1.46
## 2  0 0 0 0 1.62
## 3  0 0 0 0 1.75
## 4  0 0 0 0 1.69
## 5  0 0 0 0 1.56
## 6  1 0 0 0 1.98
## 7  1 0 0 0 1.60
## 8  1 0 0 0 2.41
## 9  1 0 0 0 1.81
## 10 1 0 0 0 1.63
## 11 0 1 0 0 1.71
## 12 0 1 0 0 2.00
## 13 0 1 0 0 1.82
## 14 0 1 0 0 1.85
## 15 0 1 0 0 1.88
## 16 0 0 1 0 2.15
## 17 0 0 1 0 1.84
## 18 0 0 1 0 2.34
```

```
## 19 0 0 1 0 2.41
## 20 0 0 1 0 2.34
## 21 1 1 0 0 2.16
## 22 1 1 0 0 1.75
## 23 1 1 0 0 2.16
## 24 1 1 0 0 1.96
## 25 1 1 0 0 2.09
## 26 1 0 1 0 1.59
## 27 1 0 1 0 1.55
## 28 1 0 1 0 1.60
## 29 1 0 1 0 1.55
## 30 1 0 1 0 1.75
## 31 0 1 1 0 1.89
## 32 0 1 1 0 2.12
## 33 0 1 1 0 1.89
## 34 0 1 1 0 1.93
## 35 0 1 1 0 2.06
## 36 1 1 1 0 2.01
## 37 1 1 1 0 1.85
## 38 1 1 1 0 1.94
## 39 1 1 1 0 1.81
## 40 1 1 1 0 1.83
```

Data Analysis and Results

Discussion

In our data collection process, there are a few possible sources of error. First, the helicopters are dropped by hand. The person who drops them might apply some force on the helicopter upon releasing, resulting in different initial velocities. Second, because the time is recorded by hand, inaccuracy is inevitable.

Code

```
regHeli = lm(time ~ a*b*c*d, data = heliData)
summary(regHeli)
```

```
##
## Call:
## lm(formula = time ~ a * b * c * d, data = heliData)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.3760 -0.0685 -0.0130  0.1225  0.5240
##
## Coefficients: (8 not defined because of singularities)
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.61600    0.07772  20.793  < 2e-16 ***
## a            0.27000    0.10991   2.457  0.01964 *
## b            0.23600    0.10991   2.147  0.03945 *
## c            0.60000    0.10991   5.459 5.22e-06 ***
## d                 NA         NA      NA       NA
## a:b         -0.09800    0.15543  -0.630  0.53285
## a:c         -0.87800    0.15543  -5.649 3.01e-06 ***
```

```
## b:c         -0.47400    0.15543  -3.050  0.00458 **
## a:d               NA         NA      NA       NA
## b:d               NA         NA      NA       NA
## c:d               NA         NA      NA       NA
## a:b:c        0.61600    0.21982   2.802  0.00854 **
## a:b:d             NA         NA      NA       NA
## a:c:d             NA         NA      NA       NA
## b:c:d             NA         NA      NA       NA
## a:b:c:d           NA         NA      NA       NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1738 on 32 degrees of freedom
## Multiple R-squared:  0.5982, Adjusted R-squared:  0.5103
## F-statistic: 6.805 on 7 and 32 DF,  p-value: 5.633e-05
```