STAT 305 Report
Airplane Etiquette

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1 Introduction

The congested layout of a commercial airplane serves as an interesting setting for examining social norms and expectations. In 2014, FiveThirtyEight.com writer Walt Hickey published a brief piece summarizing data [1] that contained the responses of 1,041 individuals regarding their air-travel behavior and activities they find rude or disturbing [2]. These data are the results of a SurveyMonkey survey, which was commissioned by FiveThirtyEight. The dataset contains 26 variables, 19 of which contain data on air-travel behavior or etiquette, such as who should get the arm rests in a row, while the other seven relate to respondent demographics - height, gender, age, etc...

The survey conduction was motivated by a two-week stretch in September 2014 in which three separate flights were diverted from their original destination after verbal altercations broke out between passengers over reclining seats [3]. The spark of tension inspired Hickey to investigate which behaviors travelers found rude and which ones they did not.

In the brief article written based on the survey data, Hickey summarized the percentage of travelers who found the various air-travel behaviors as rude. However, Hickey failed to conduct any statistical analysis with the data. As such, our goal for this project is to better understand the relationships between various demographic and descriptive characteristics of the population and the tendency of the people who fit in those categories to describe an assortment of air-travel behaviors as rude.

2 Research Questions

We established four research questions from the airplane etiquette dataset. Our first question revolved around babies and children on airplanes. Our primary hypothesis was that passengers with children will be more likely to answer that bringing babies and unruly children onto an airplane is not rude, because of their sympathy rooted in being in that situation at one point themselves. To answer this question, we asked the research question: **Are parents that currently have children under the age of 18 more tolerant of babies or unruly children on airplanes?** The second question was based off of the potential relationship between a person's height and their propensity to recline their seat during a flight, with the prior belief being that taller people would be more likely to recline their seat as it is likely more difficult to be comfortable in a crowded airplane setting. The exact question we created to examine this possible connection was **Is the height of an individual a clear indicator for his/hers likelihood to recline an airplane seat?** Our third question was designed to take a look at the dataset more holistically, in order to determine if frequent flyers are more or less tolerant of 'rude' behaviors than less-frequent flyers. Specifically, we asked **Is there a relationship between the frequency with which a person flies, and the number of behaviors they consider as rude?**. Our final question regarding these data approached the battle over the shared armrest, and how this battle may be affected by variables such as age or gender. Thus, we asked: **How does an individual's gender and age affect their opinion of who can claim a shared armrest on an airplane?**

3 Results

3.1 Question 1: Tolerance of Babies & Unruly Children

With our first question, we wanted to test whether currently having children under the age of 18 would make airline passengers more tolerant of babies and unruly children on their flight. While there was a much greater proportion of passengers in the dataset who did not have children (0.78 to 0.22), the sample size of those with children (188 individuals) was still large enough to warrant an analysis that would produce significant results. However, we believed that these results would be even cleaner if we modified the response variables to have two levels instead of three. Specifically, the initial options for each subject with regard to these questions were "No, not rude at all", "Yes, somewhat rude," and "Yes, very rude"; the two latter levels were combined into one "Rude" category, thus creating binary outcome variables - either "Rude" or "Not Rude."

We decided to answer these two questions separately. For each question, the dataset was split into those passengers with children and those without and treated as two independent random samples. From

there, sample proportions were calculated by dividing the number of passengers who believed that bringing a baby/unruly children on a plane was rude by the total number of passengers within each category. For babies, these equaled 0.16 and 0.34 for passengers with and without children respectively, and 0.73 and 0.85 for unruly children. 95% confidence intervals were derived, using the sample sizes and sample variances of each group without the finite population correction, given that the population sizes were unknown. These confidence intervals and point estimates were plotted together to look for overlap, which would indicate no difference between the groups. However, as seen in Figure 1, the confidence intervals of $(0.107 < p_{\text{child}} < 0.212)$ and $(0.306 < p_{\text{nochild}} < 0.379)$ for babies and $(0.671 < p_{\text{child}} < 0.797)$ and $(0.827 < p_{\text{nochild}} < 0.881)$ for unruly children do not overlap. These intervals indicate a difference in the respective population proportions.

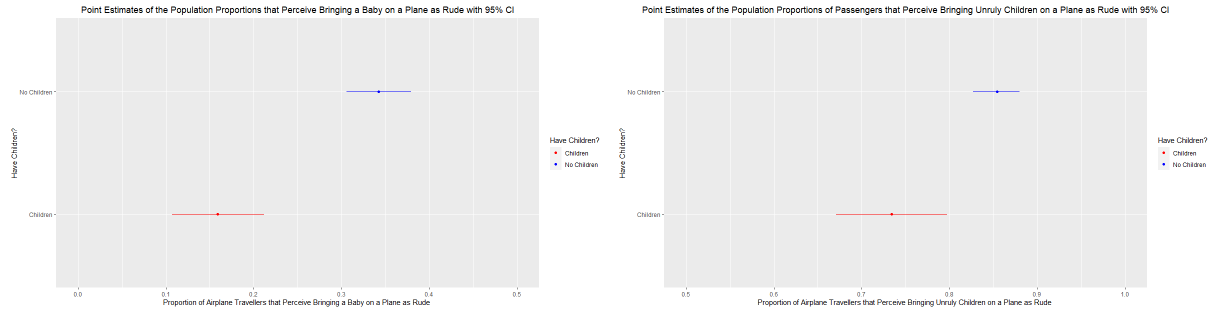

Figure 1: 95% Confidence intervals of the population proportion of passengers with children and passengers without children who believe that bringing a baby and unruly children on a plane is rude. Both plots indicate statistically significant differences between the two groups due to the intervals not overlapping.

To confirm these findings, two one-sided, two-proportion z-tests were conducted using the sample data. These tests were conducted with the null hypothesis being that the population proportion of passengers with children who believe that a baby/unruly children on a plane is rude was greater than or equal to the population proportion of passengers without children, with the alternative being that the proportion for passengers with children was less than that for passengers without children.

For babies, the test conducted at an $\alpha = 0.05$ level returned a p-value of $(p < 0.001)$, so we can reject the null hypothesis and say that the proportion of airplane travelers with children who believe that a baby on a plane is rude is lower than the proportion of travelers without children who believe the same.

For unruly children, the test conducted at an $\alpha = 0.05$ level returned a p-value of $(p < 0.001)$. Thus, we reject the null hypothesis and say that the proportion of airplane travelers with children who believe that unruly children on a plane is lower than the proportion of travelers without children who believe the same.

Both of these results aligned with our initial hypothesis that current parents of children would be less prone to consider the presence of babies or unruly children on a plane as rude. However, an additional interesting find was that more than $\frac{2}{3}$ of both current parents and current non-parents believed that unruly children were rude, but less than 40% of both parties believed babies were rude. Perhaps this trend of less tolerance towards loud children comes from a kind of societal belief that parents should be more capable of coaxing good behavior from children than babies.

3.2 Question 2: Reclining Propensity

To begin answering the question: "Is the height of an individual a clear indicator for his/hers likelihood to recline an airplane seat?", we can first look at the distribution of heights and the responses to how often the respondents recline their seat from the 858 individuals that answered these two questions. The resulting table can be seen below (Table 1). While some responses stick out as being favorites of the survey respondents (e.g., "Once in a while" and "Usually"), when we look at the ends of the height spectrum, we would expect opposite responses from the very short and very tall groups if there were a difference in preferences. However, reclining preferences are almost exactly evenly distributed across the five choices for both the 60in. tall group and the 77-78in. groups. While the 78in. group does have both respondents selecting the "Often" and "Always" choices, with only two people in the group it would be unfair to make

an inference on that height group as a whole with such a sample size. Additionally, the 77in. group, has a more even share across responses, further enforcing the lack of a pattern.

Height of Respondents (in.)

Reclining Preference	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78
Never	5	5	12	8	18	12	16	13	17	9	17	13	10	3	5	5	2	1	0
Once in a while	6	6	16	10	23	23	17	25	17	30	22	16	20	6	11	4	4	1	0
About half the time	7	1	4	14	8	10	14	12	10	8	4	8	6	3	4	4	0	1	0
Usually	6	3	7	7	19	15	18	13	20	17	15	5	9	8	5	3	3	1	1
Always	5	4	6	9	11	11	10	13	12	8	9	12	12	6	2	2	2	2	1

Table 1: Responses to the question "Do you ever recline your seat when you fly?" by the reported heights of the 858 respondents (in.). Respondents 5ft. tall or shorter are included in the 60in. group. Respondents 6ft. 6in. and taller are included in the 78in. group.

A more visual way of seeing the distribution of preferences across height can be seen in Figure 2. Each response's mean height is represented with a bar in the box, with the 1st and 3rd quartile forming the edges of the box. Visually, it appears that "Once in a while" has a significantly higher mean height and the "Always" box extends significantly higher than the other boxes. We can determine whether the groups of responses are actually significantly different in height by running a statistical test. The test we want to use is either a one-way ANOVA or its non-parametric counterpart, Kruskal-Wallis. After testing for normality and equal group variance to fulfill the ANOVA assumptions, we found that there were equal variances but non-normal data distribution so we must utilize the Kruskal-Wallis test. We conduct the Kruskal-Wallis test at the $\alpha = 0.05$ significance level, with the null hypothesis being the groups are the same and the alternate being they differ. After running the test, we get a p-value of 0.542. Therefore, we fail to reject the null hypothesis and say we don't have enough evidence to conclude that the response groups are statistically significantly different.

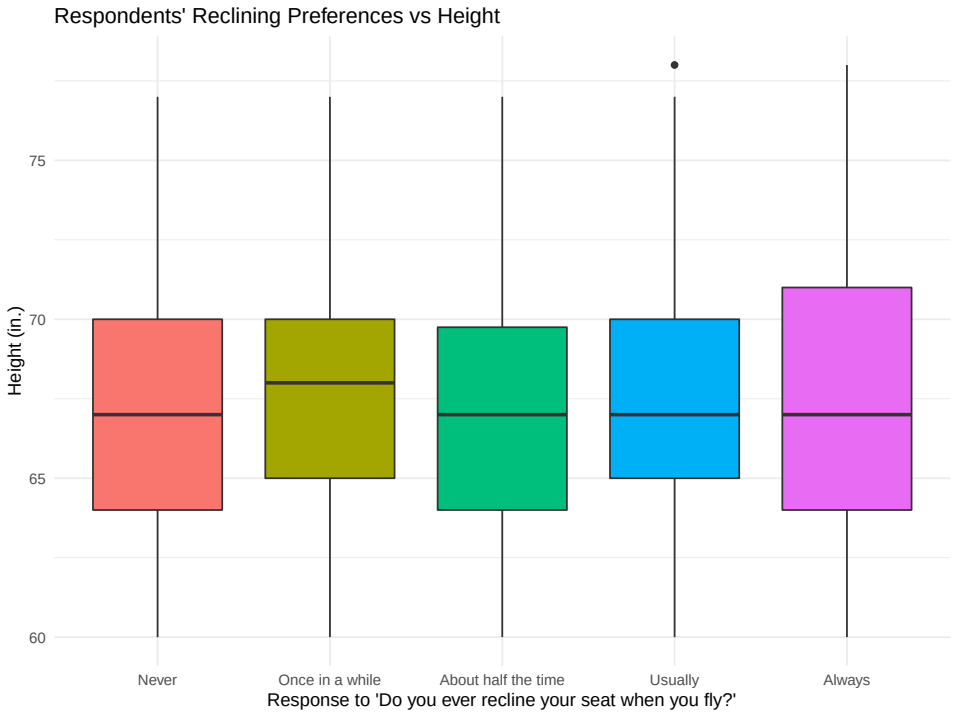

Figure 2: Boxplots of respondents' heights based on how they answered the reclining preference question. Group means are represented by the horizontal bars in the boxes.

After reviewing the plots and running the Kruskal-Wallis test, we can reasonably conclude that a person's height does not significantly contribute to his or hers preference towards reclining their airplane seat. However, we can now say that the decision is purely of individual preference and likely reflects more on how the person wants to be perceived by the passenger behind him/her than for personal comfort.

3.3 Question 3: Frequent Flyers

Survey respondents had the opportunity to rate as many as nine airline behaviors as rude, as well as describe how frequently they fly. To answer the question of whether frequent flyers rated more or less behaviors as rude than non-frequent flyers, these frequencies were first narrowed down to two main groups - those that fly no more than once a year and those that fly at least once a year. Furthermore, just as for question 1, the responses within each question were narrowed down to two outcomes - "Rude" or "Not Rude," - rather than three. Within each group of flyers, a new variable was created with the data that summed up the total number of each behaviors rated as rude for each traveler

As an exploratory investigation into the problem, a density plot was created depicting the densities of the overall rude count variable for each group. When examining the plot, (Figure 3), the densities appeared to be very similar, with nearly identical averages. This led to the hypothesis that there was in fact no difference in the average number of behaviors perceived as rude by frequent and non-frequent flyers.

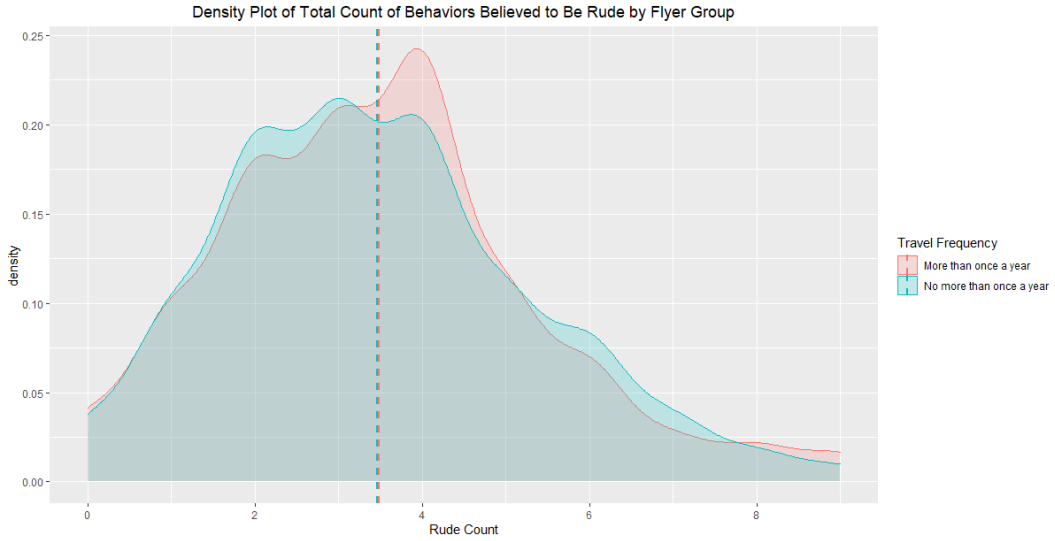

Figure 3: Density plots of the total count of behaviors perceived as rude by frequent and non-frequent flyers indicate that there may be no difference in the average number of behaviors perceived as rude. The average number of behaviors perceived as rude, identified by the dotted lines, were 3.46 for non-frequent flyers and 3.48 for frequent flyers, providing stronger evidence of no difference between the groups

To test this hypothesis, we conducted an unpaired two-sided, two-samples t-test in R to evaluate whether the means between the groups were in fact not different. At an $\alpha = 0.05$ level, with the null hypothesis being that the difference between the two means was equal to 0, the resulting p-value was 0.893. Thus, we fail to reject the null hypothesis and say that there is not enough evidence to say that there is a difference in the true average number of behaviors believed to be rude by frequent flyers and non-frequent flyers. We were somewhat concerned about the assumed normality of the data within both groups, so to ensure an accurate result, we conducted a non-parametric Wilcox test as well. With $\alpha = 0.05$ and the null hypothesis being that the total number of behaviors perceived as rude by frequent and non-frequent flyers come from identical populations, the p-value was 0.847. Thus again we fail to reject the null hypothesis and say that there is not enough evidence to say that the total number of behaviors perceived as rude by frequent and non-frequent flyers come from different populations. These results strongly suggested that there is no difference between the total number of airline behaviors perceived as rude by the two groups of flyers. Thus, we decided to

examine each potential rude behavior individually, to see if there was any specific behavior with a significant difference in the proportion of flyers who perceived that behavior as rude. From Table 2, we found that reclining the seat was the behavior with the greatest difference between the two groups in proportion who believed it to be rude (0.477 to 0.388).

Proportion of Flyers Who Find Each Airplane Behavior as Rude

Travel Frequency	Unsold Seat	Talk Stranger	Recline Seat	Switch Friends	Switch Family	Wake Bathroom	Wake Walk	Bring Baby	Bring Children
More than once a year	0.183	0.221	0.477	0.226	0.153	0.374	0.694	0.323	0.834
No more than once a year	0.192	0.204	0.388	0.269	0.178	0.368	0.749	0.295	0.824

Table 2: Most behaviors have nearly identical proportions of travelers who find them rude between the groups. There were only 3 of the 9 behaviors with a difference in proportion of three points or greater. The largest two were tested for statistical significance.

We were curious whether this difference was statistically significant. Thus, we conducted a one-sided, two-proportion z-test at the $\alpha = 0.05$ level with the null hypothesis that the population proportion of frequent flyers who find reclining the seat to be rude is less than or equal to the population proportion of non-frequent flyers who find reclining the seat to be rude. The corresponding p-value to this test was 0.009. Thus we reject the null hypothesis and say that there is sufficient evidence that the proportion of frequent flyers who find reclining the seat to be rude is greater than the proportion of non-frequent flyers who believe it is rude.

Based on these results, we decided to test if the second largest difference found - that is, the proportion of flyers who find waking your neighbor to walk around as rude, also indicated a significant result. We performed a two-sided, two-proportions z-test with the null hypothesis being that there was no difference in the population proportion of frequent and non-frequent flyers who find waking your neighbor to walk around as rude at the $\alpha = 0.05$ level. The resulting p value was 0.101, so we fail to reject the null hypothesis and say that there is not enough evidence to say that there is a difference in these population proportions.

It was our initial belief that there would be a difference in the total number of rude behaviors perceived by frequent flyers than non-frequent flyers. However, statistical tests showed that there is no meaningful difference between the two groups. In fact, it appears that only one of the nine potential rude behaviors - reclining one's seat - even have a statistically significant difference between the groups.

3.4 Question 4: Armrest Claims

The survey responses about who should own the shared armrest(s) in rows with two and three seats heavily favored sharing the common armrest with about 68% of the share of 837 responses for both rows with two and three seats (as seen in Table 3)[1]. However, these tables don't show how different groups of people based on age and gender behave in regards to the armrest. To answer this question, we must dig deeper.

Response (Two Seats)	Frequency
Other (please specify)	0.044
The arm rests should be shared	0.681
The person by the window	0.048
The person in aisle	0.074
Whoever puts their arm on the arm rest first	0.153

Response (Three Seats)	Frequency
Other (please specify)	0.054
The arm rests should be shared	0.686
The people in the aisle and window seats get both arm rests	0.020
The person in the middle seat gets both arm rests	0.139
Whoever puts their arm on the arm rest first	0.102

Table 3: Responses from 837 individuals over who should have the right to a shared armrest in airplane rows with two (upper) and three (lower) seats. Clearly, the shared armrest is the public's favorite option.

[1]Note: The survey data did not provide what "Other" responses were written-in so we will just take "Other" at face value

To attempt to find distinctions in groups' armrest preferences we can fit a multinomial log-linear model because the response is a nominal variable with more than two levels. Using the fitted model, we can predict the probability that a person of a certain age and gender combination will choose each response. These probabilities can be seen in Figure 4. Of course sharing the armrest remains the clear favorite, however, it is interesting to see how probabilities change as age increases. As individuals get older, it appears as though favorability towards sharing the armrest increases as the others naturally decrease due to the requirement of the sum of proportions to equal 1 for each group. This pattern is particularly prevalent in rows with two seats and, in general, also present in airplane rows with three seats (this difference is likely due to greater complications when there are more seats). Now that we know how the groups act, can we say that they are statistically significantly different? To investigate this question, we can use the previous multinomial model to find each age and gender group's significance level (using $\alpha = 0.05$).

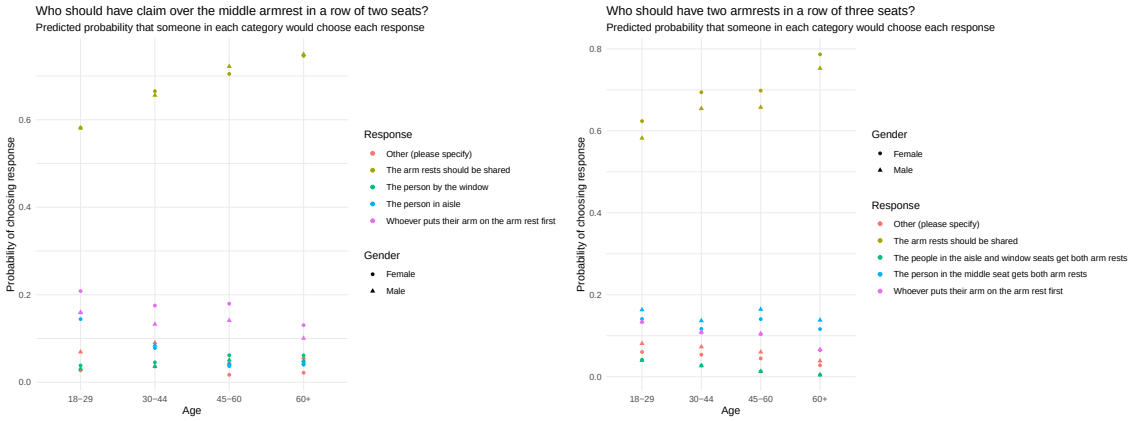

Figure 4: Predictions calculated for each Age/Gender group using a fitted multinomial log-linear model. Clearly, the shared armrest remains the favorite and similar patterns appear across genders. Full-sized plots can be found in the Appendix for easier viewing (Figure 7).

Using the method mentioned above, we found that few demographics across airplane rows with both two and three seats were statistically significant. Compared to females aged 18-29 answering "Other" (the intercept/baseline of the model), the only statistically significant difference was males 18-29 in three of the four remaining responses in rows with two seats. Then, in rows with three seats, only the group of ages 60+ in the "armrest should be shared" group was statistically significantly different at the $\alpha = 0.05$ level. The scarcity of significant groups suggests that we fail to reject a null hypothesis of group equality and say that we would need more evidence to suggest significant group differences.

References

[1] FiveThirtyEight. *flying-etiquette-survey*, 2014. https://github.com/fivethirtyeight/data/blob/master/flying-etiquette-survey/flying-etiquette.csv.

[2] Walt Hickey. *41 Percent Of Fliers Think You're Rude If You Recline Your Seat*. FiveThirtyEight, 2014. https://fivethirtyeight.com/features/airplane-etiquette-recline-seat/.

[3] Pamela Engel. *Another Passenger Fight Over Reclining Seats Has Caused A Flight To Be Diverted*, 2014. https://www.businessinsider.com/another-passenger-fight-over-reclining-seats-has-caused-a-flight-to-be-diverted-2014-9.

4 Affidavit

Both partners contributed equally to the creation of this report. – Quinn Johnson & Jonathan Olds

5 Appendix - Report Code, Full Size Images

```
#### EDA ####
library(tidyverse)
library(ggplot2)
library(knitr)

#### Tolerance of Babies and Children ####
airplane_etiquette = read_csv("airplane-etiquette.csv")
attach(airplane_etiquette)
# Creating subset of data with complete cases for the three questions
children = airplane_etiquette[which(!is.na(`Do you have any children under 18?`) &
                                    !is.na(`In general, is itrude to bring a baby
                                     on a plane?`) &
                                    !is.na(`In general, is it rude to knowingly bring
                              unruly children on a plane?`)),]

# Creating table summarizing counts and proportion of respondents who own children
childrentable = children %>% group_by(`Do you have any children under 18?`) %>%
  summarise(Count = n()) %>%
  mutate(Percent = round(Count/sum(Count),3))

kable(childrentable, format = "latex")

# Distribution of responses to baby question
ggplot(children, aes(x = `In general, is itrude to bring a baby on a plane?`)) +
  geom_bar(stat="count", color = "black", fill = "tan") +
  ggtitle("Distribution of Responses to Baby Question") +
  xlab("Responses to \'In general, is it rude to bring a baby on a plane?\'") +
  ylab("Frequency") +
  theme(plot.title = element_text(hjust = 0.5))

# Distribution of responses to children question
ggplot(children, aes(x = `In general, is it rude to knowingly bring unruly children
on a plane?`)) +
  geom_bar(stat="count", color = "black", fill = "tan") +
  ggtitle("Distribution of Responses to Unruly Children Question") +
  xlab("Responses to \'In general, is it rude to knowingly bring unruly children
  on a plane?\'") +
  ylab("Frequency") +
  theme(plot.title = element_text(hjust = 0.5))

babyunruly = children %>% select(RespondentID, `Do you have any children under 18?`,
`In general, is itrude to bring a baby on a plane?`,
`In general, is it rude to knowingly bring unruly children on a plane?`) %>%
gather("Question", "Response", 3:4)

babyunruly$Question = factor(babyunruly$Question, levels = c("In general,
is itrude to bring a baby on a plane?",
"In general, is it rude to knowingly bring unruly children on a plane?"))

## Distribution of both questions together
ggplot(babyunruly, aes(x = Question, fill = factor(Response))) +
         geom_bar(stat = "count", position = position_dodge()) +
```

```
        ggtitle("Distribution of Baby & Unruly Children Questions") +
        labs(fill = "Response") +
        ylab("Frequency") +
        scale_x_discrete(labels = c("In general, is it rude to bring a baby on a plane?",
        "In general, is it rude to knowingly bring unruly children on a plane?")) +
        scale_fill_manual(values = c("Green4", "Gold2", "Red3")) +
        theme(plot.title = element_text(hjust = 0.5))


#### Reclining vs Height ####
nrow(airplane_etiquette)-
  length(which(is.na(`Do you ever recline your seat when you fly?`) |
  is.na(`How tall are you?`)))

q2 <- airplane_etiquette[-which(is.na(`Do you ever recline your seat when you fly?`) |
is.na(`How tall are you?`)),]
colnames(q2)[c(3,4)] <- c("recline", "height")
length(which(q2$height=="6\'6\" and above"))
length(which(q2$height=="Under 5 ft."))

q2 <- q2 %>%
  mutate(height = if_else(height == "6\'6\" and above","6\'6\"", height)) %>%
  mutate(height = if_else(height == "Under 5 ft.","5\'0\"", height))

q2$inches = sapply(strsplit(as.character(q2$height),"'|\""),
                        function(x){12*as.numeric(x[1]) + as.numeric(x[2])})

ggplot(data = q2, aes(x=inches))+geom_histogram(bins=19, color = "black",
fill = "#0073C2FF")+
  labs(x= "Height (in)", y= "Frequency", title = "Distribution of Heights of Respondents")+
  theme_minimal()

q2$recline <- factor(q2$recline, levels=c("Never", "Once in a while",
"About half the time", "Usually", "Always"))
ggplot(data = q2, aes(x=recline))+ geom_bar(color = "black", fill = "#0073C2FF")+
  labs(x= "Response to \'Do you ever recline your seat when you fly?\'",
  y= "Frequency", title = "Distribution of Reclining Responses")+
  theme_minimal()

library(kableExtra)
reclinetab <- q2 %>%
  count(recline, inches) %>% spread(inches,n)
kable(reclinetab, format = "latex") %>%
  kable_styling(latex_options="scale_down")


#### Armrest ####
nrow(airplane_etiquette)-
  length(which(is.na(`In a row of three seats, who should get to use the two arm rests?`)
  | is.na(`In a row of two seats, who should get to use the middle arm rest?`)
  | is.na(`Gender`)
  | is.na(`Age`)))

armrest <- airplane_etiquette[-which(is.na(`In a row of three seats, who should get to
```

```
use the two arm rests?`) | is.na(`In a row of two seats, who should get to
use the middle arm rest?`)
| is.na(`Gender`)
| is.na(`Age`)),]

#### Q1 ####
## Load Packages
library(tidyverse)
library(ggplot2)
library(knitr)

## Load Data
    airplane_etiquette = read_csv("airplane-etiquette.csv")

    # Creating subset of data with complete cases for the three questions
    children = airplane_etiquette[which(!is.na(`Do you have any children under 18?`) &
                                          !is.na(`In general, is itrude to bring a baby

                                          on a plane?`) &
                                          !is.na(`In general, is it rude to knowingly

                                          bring unruly children on a plane?`)),]

## Exploratory Data Analysis

    # Creating table summarizing counts and proportion of respondents who own children
    childrentable = children %>% group_by(`Do you have any children under 18?`) %>%
      summarise(Count = n()) %>%
      mutate(Percent = round(Count/sum(Count),3))

    kable(childrentable)

    colnames(children)[c(5,19:20)] = c("Have_Children", "Baby", "Unruly_Children")

    children$Baby = ifelse(children$Baby == "No, not at all rude", "No", "Yes")
    children$Unruly_Children = ifelse(children$Unruly_Children == "No, not at all rude", "No", "Yes")

    # Distribution of responses to baby question
    ggplot(children, aes(x = Baby)) +
      geom_bar(stat="count", color = "black", fill = "tan") +
      ggtitle("Distribution of Responses to Baby Question") +
      xlab("Responses to \'In general, is it rude to bring a baby on a plane?\'") +
      ylab("Frequency") +
      theme(plot.title = element_text(hjust = 0.5))

    # Distribution of responses to children question
    ggplot(children, aes(x = Unruly_Children)) +
      geom_bar(stat="count", color = "black", fill = "tan") +
      ggtitle("Distribution of Responses to Unruly Children Question") +
      xlab("Responses to \'In general, is it rude to knowingly bring unruly children on a plane?\'") +
      ylab("Frequency") +
      theme(plot.title = element_text(hjust = 0.5))
```

```
    babyunruly = children %>% select(RespondentID, Have_Children, Baby, Unruly_Children) %>%
      gather("Question", "Response", 3:4)

    babyunruly$Question = factor(babyunruly$Question, levels = c("Baby", "Unruly_Children"))

    ## Distribution of both questions together
    ggplot(babyunruly, aes(x = Question, fill = factor(Response))) +
      geom_bar(stat = "count", position = position_dodge()) +
      ggtitle("Distribution of Baby & Unruly Children Questions") +
      labs(fill = "Response") +
      ylab("Frequency") +
      scale_x_discrete(labels = c("In general, is it rude to bring a baby on a plane?",

                                  "In general, is it rude to knowingly bring unruly

                                  children on a plane?")) +
      scale_fill_manual(values = c("Green4", "Gold2", "Red3")) +
      theme(plot.title = element_text(hjust = 0.5))


    babyunruly = babyunruly %>% spread(Question, Response)

## Babies
    ## Determining sample proportions
    phat_babies_child = sum(babyunruly$Have_Children == "Yes" &
                          babyunruly$Baby == "Yes")/sum(babyunruly$Have_Children == "Yes")

    phat_babies_nochild = sum(babyunruly$Have_Children == "No" &
                                babyunruly$Baby == "Yes")/sum(babyunruly$Have_Children == "No")
    ## Confidence intervals
    n_babies_child = sum(babyunruly$Have_Children == "Yes")
    varhat_phat_babies_child = (phat_babies_child * (1-phat_babies_child))/(n_babies_child-1)
    zscore = qnorm(1-(0.05/2))
    moe_babies_child = zscore * sqrt(varhat_phat_babies_child)
    ci_lower_babies_child = phat_babies_child - moe_babies_child
    ci_upper_babies_child = phat_babies_child + moe_babies_child
    ci_babies_child = cbind(ci_lower_babies_child, ci_upper_babies_child)
    ci_babies_child

    prop.test(x = sum(babyunruly$Have_Children == "Yes" & babyunruly$Baby == "Yes"),
              n = sum(babyunruly$Have_Children == "Yes"), conf.level = .95, correct = FALSE)

    n_babies_nochild = sum(babyunruly$Have_Children == "No")
    varhat_phat_babies_nochild = (phat_babies_nochild * (1-phat_babies_nochild))/(n_babies_nochild-1)
    zscore = qnorm(1-(0.05/2))
    moe_babies_nochild = zscore * sqrt(varhat_phat_babies_nochild)
    ci_lower_babies_nochild = phat_babies_nochild - moe_babies_nochild
    ci_upper_babies_nochild = phat_babies_nochild + moe_babies_nochild
    ci_babies_nochild = cbind(ci_lower_babies_nochild, ci_upper_babies_nochild)
    ci_babies_nochild

    prop.test(x = sum(babyunruly$Have_Children == "No" & babyunruly$Baby == "Yes"),
              n = sum(babyunruly$Have_Children == "No"), conf.level = .95, correct = FALSE)
```

```
    babies_df = as.data.frame(as.matrix(NA, nrow = 2, ncol = 4))
    babies_df[1,1:4] = c("Children", 0.159, 0.107, 0.212)
    babies_df[2,1:4] = c("No Children", 0.342, 0.306, 0.379)
    colnames(babies_df) = c("Own Children?", "P Estimate", "CI Lower Bound", "CI Upper Bound")
    babies_df[,2:4] = lapply(babies_df[,2:4], as.numeric)


    ggplot(babies_df, aes(x =`P Estimate`, y = `Own Children?`, color = `Own Children?`)) +
      geom_point() +
      scale_x_continuous(name = "Proportion of Airplane Travellers that Perceive Bringing a

      Baby on a Plane as Rude ", limits = c(0,0.5)) +
      scale_color_manual(values = c("red", "blue")) +
      geom_segment(aes(x = babies_df$`CI Lower Bound`[1], y = "Children",
                       xend = babies_df$`CI Upper Bound`[1], yend = "Children"), color = "red") +
      geom_segment(aes(x = babies_df$`CI Lower Bound`[2], y = "No Children",
                       xend = babies_df$`CI Upper Bound`[2], yend = "No Children"), color = "blue") +
      ggtitle("Point Estimates of the Population Proportions that Perceive Bringing a

      Baby on a Plane as Rude with 95% CI") +
      theme(plot.title = element_text(hjust = 0.5))

    # Test of Proportions
    babies_test <- prop.test(x = c(sum(babyunruly$Have_Children == "Yes" & babyunruly$Baby == "Yes"),
                                   sum(babyunruly$Have_Children == "No" &

                                   babyunruly$Baby == "Yes")),
                             n = c(sum(babyunruly$Have_Children == "Yes"),

                             sum(babyunruly$Have_Children == "No")), alternative =

                             "less", correct = FALSE)

    babies_test

## Children
    ## Determining sample proportions
    phat_unruly_child = sum(babyunruly$Have_Children == "Yes" &
                              babyunruly$Unruly_Children ==

                              "Yes")/sum(babyunruly$Have_Children == "Yes")

    phat_unruly_nochild = sum(babyunruly$Have_Children == "No" &
                                babyunruly$Unruly_Children ==

                                "Yes")/sum(babyunruly$Have_Children == "No")


    ## Confidence intervals
    n_unruly_child = sum(babyunruly$Have_Children == "Yes")
    varhat_phat_unruly_child = (phat_unruly_child * (1-phat_unruly_child))/(n_unruly_child-1)
    zscore = qnorm(1-(0.05/2))
    moe_unruly_child = zscore * sqrt(varhat_phat_unruly_child)
    ci_lower_unruly_child = phat_unruly_child - moe_unruly_child
```

```
ci_upper_unruly_child = phat_unruly_child + moe_unruly_child
ci_unruly_child = cbind(ci_lower_unruly_child, ci_upper_unruly_child)
ci_unruly_child

prop.test(x = sum(babyunruly$Have_Children == "Yes" & babyunruly$Unruly_Children == "Yes"),
          n = sum(babyunruly$Have_Children == "Yes"), conf.level = .95, correct = FALSE)

n_unruly_nochild = sum(babyunruly$Have_Children == "No")
varhat_phat_unruly_nochild = (phat_unruly_nochild * (1-phat_unruly_nochild))/(n_unruly_nochild-1)
zscore = qnorm(1-(0.05/2))
moe_unruly_nochild = zscore * sqrt(varhat_phat_unruly_nochild)
ci_lower_unruly_nochild = phat_unruly_nochild - moe_unruly_nochild
ci_upper_unruly_nochild = phat_unruly_nochild + moe_unruly_nochild
ci_unruly_nochild = cbind(ci_lower_unruly_nochild, ci_upper_unruly_nochild)
ci_unruly_nochild

prop.test(x = sum(babyunruly$Have_Children == "No" & babyunruly$Unruly_Children == "Yes"),
          n = sum(babyunruly$Have_Children == "No"), conf.level = .95, correct = FALSE)

unruly_df = as.data.frame(as.matrix(NA, nrow = 2, ncol = 4))
unruly_df[1,1:4] = c("Children", 0.734, 0.671, 0.797)
unruly_df[2,1:4] = c("No Children", 0.854, 0.827, 0.880)
colnames(unruly_df) = c("Own Children?", "P Estimate", "CI Lower Bound", "CI Upper Bound")
unruly_df[,2:4] = lapply(unruly_df[,2:4], as.numeric)


ggplot(unruly_df, aes(x =`P Estimate`, y = `Own Children?`, color = `Own Children?`)) +
  geom_point() +
  scale_x_continuous(name = "Proportion of Airplane Travellers that Perceive Bringing

  Unruly Children on a Plane as Rude ", limits = c(0.5,1)) +
  scale_color_manual(values = c("red", "blue")) +
  geom_segment(aes(x = unruly_df$`CI Lower Bound`[1], y = "Children",
                   xend = unruly_df$`CI Upper Bound`[1], yend = "Children"), color = "red") +
  geom_segment(aes(x = unruly_df$`CI Lower Bound`[2], y = "No Children",
                   xend = unruly_df$`CI Upper Bound`[2], yend = "No Children"), color = "blue") +
  ggtitle("Point Estimates of the Population Proportions of Passengers that Perceive

  Bringing Unruly Children on a Plane as Rude with 95% CI") +
  theme(plot.title = element_text(hjust = 0.5))

## Test of Proportions
unruly_test <- prop.test(x = c(sum(babyunruly$Have_Children == "Yes" &

babyunruly$Unruly_Children == "Yes"),

                               sum(babyunruly$Have_Children == "No" &

                               babyunruly$Unruly_Children == "Yes")),

                         n = c(sum(babyunruly$Have_Children == "Yes"),

                         sum(babyunruly$Have_Children == "No")), alternative = "less", correct = FAl
```

```
    unruly_test

#### Q2 ####
library(ggplot2)
library(rstatix)
library(nnet)
library(ggpubr)
library(car)
#Plotting response groups using boxplots
ggplot(q2, aes (x = inches, y = recline)) + geom_boxplot(aes(fill = recline)) +
  theme_minimal() +
  theme(legend.position = "none") +
  ylab("Response to 'Do you ever recline your seat when you fly?'") +
  xlab("Height (in.)") +
  labs(title = "Respondents' Height vs Reclining Preferences")

#Trying pairwise t-test
rec.ttest <- q2 %>% pairwise_t_test(inches ~ recline); rec.ttest
#K-W test
kruskal.test(inches ~ recline, data = q2)

#### Q3 ####
## Load Packages
library(tidyverse)
library(ggplot2)
library(knitr)
detach(package:plyr)
detach(package:dplyr)
library(plyr)
library(dplyr)
## Load Data
airplane_etiquette = read_csv("airplane-etiquette.csv")

    # Creating subset of data with complete cases
    travelfreq = airplane_etiquette[which(!is.na(`How often do you travel by plane?`) &

                                          !is.na(`Is itrude to move to an unsold seat

                                          on a plane?`) &
                                          !is.na(`Generally speaking, is it rude to

                                          say more than a few words tothe stranger

                                          sitting next to you on a plane?`) &


                                          !is.na(`Is itrude to recline your seat on a

                                          plane?`) &


                                          !is.na(`Is it rude to ask someone to switch

                                          seats with you in order to be closer to friends?`) &
```

```
                                    !is.na(`Is itrude to ask someone to switch
                                    seats with you in order to be closer to family?`) &

                                    !is.na(`Is it rude to wake a passenger up if
                                    you are trying to go to the bathroom?`) &
                                    !is.na(`Is itrude to wake a passenger up if
                                    you are trying to walk around?`) &
                                    !is.na(`In general, is itrude to bring a
                                    baby on a plane?`) &
                                    !is.na(`In general, is it rude to knowingly
                                    bring unruly children on a plane?`)),]
# Selecting necessary columns
travelfreq = travelfreq %>% select(c(`How often do you travel by plane?`, `Is itrude to move
to an unsold seat on a plane?`,
                                    `Generally speaking, is it rude to say more
                                    than a few words tothe stranger sitting next to
                                    you on a plane?`,
                                    `Is itrude to recline your seat on a plane?`,
                                    `Is it rude to ask someone to switch seats with
                                    you in order to be closer to friends?`,
                                    `Is itrude to ask someone to switch seats with
                                    you in order to be closer to family?`,
                                    `Is it rude to wake a passenger up if you are
                                    trying to go to the bathroom?`,
                                    `Is itrude to wake a passenger up if you are
                                    trying to walk around?`,
                                    `In general, is itrude to bring a baby on a
                                    plane?`,
                                    `In general, is it rude to knowingly bring
```

```
                                    unruly children on a plane?`))

# Changing column names for simplicity
colnames(travelfreq) = c("Travel_Frequency", "Unsold_Seat", "Talk_Stranger", "Recline_Seat",
                         "Switch_Friends", "Switch_Family", "Wake_Bathroom", "Wake_Walk",
                         "Bring_Baby", "Bring_Children")

# Grouping frequency of travel into two categories
travelfreq$Travel_Frequency = ifelse(travelfreq$Travel_Frequency == "Once a year or less",

"No more than once a year", "More than once a year")

# Change Rude grouping function
rude_group_function = function(columnname){
  travelfreq[[columnname]] = ifelse((travelfreq[[columnname]] == "No, not rude at all" |

  travelfreq[[columnname]] == "No, not at all rude"), "No", "Yes")
}

# Applying Function
travelfreq[,2:10] <- lapply(colnames(travelfreq[,2:10]), rude_group_function)

# Creating variable summing total number of rude behaviors
travelfreq = travelfreq %>% rowwise %>% mutate(Rude_Count = sum(Unsold_Seat == "Yes",
                                                    Talk_Stranger == "Yes",
                                                    Recline_Seat == "Yes",
                                                    Switch_Friends == "Yes",
                                                    Switch_Family == "Yes",
                                                    Wake_Bathroom == "Yes",
                                                    Wake_Walk == "Yes",
                                                    Bring_Baby == "Yes",
                                                    Bring_Children == "Yes"))

colnames(travelfreq)[1] = "Travel Frequency"

# Plotting Density of Rude Count by Travel Frequency
mu <- ddply(travelfreq, "Travel_Frequency", summarise, grp.mean=mean(Rude_Count))

ggplot(travelfreq, aes(x = Rude_Count, color = Travel_Frequency, fill = Travel_Frequency)) +
  geom_density(alpha = 0.2) +
  geom_vline(data=mu, aes(xintercept=grp.mean, color = Travel_Frequency),
             linetype="dashed", lwd = 0.75) +
  scale_x_continuous(breaks = seq(0,10,2)) +
  ggtitle("Density Plot of Total Count of Behaviors Believed to Be Rude by Flyer Group") +
  theme(plot.title = element_text(hjust = 0.5)) +
  xlab("Rude Count") +
  labs(fill = "Travel Frequency", col = "Travel Frequency")

travelfreq = travelfreq %>% group_by(Travel_Frequency) %>% mutate(mean = mean(Rude_Count))

# Plotting Rude Count to check for normality
ggplot(travelfreq, aes(x = Rude_Count, color = Travel_Frequency, fill = Travel_Frequency)) +
  geom_histogram(alpha = 0.25, position = "identity", bins = 10)
```

```
   # Equal variance test
    var.test(Rude_Count ~ Travel_Frequency, alternative = "two.sided", data = travelfreq)

  # T Test
    t.test(travelfreq[which(travelfreq$Travel_Frequency == "No more than once a year"),11],
           travelfreq[which(travelfreq$Travel_Frequency == "More than once a year"), 11],
           alternative = "two.sided", var.equal = TRUE)

  # Wilcox Test
    wilcox.test(x$Rude_Count,y$Rude_Count,
           alternative = "two.sided", var.equal = TRUE)

    ## Comparing each individual behavior
    propyes = function(column){
      round(sum(column == "Yes")/sum(column == "Yes" | column == "No"),3)
    }

    sumyes = function(column){
      sum(column == "Yes")
    }

   travelfreqsum = travelfreq %>% group_by(Travel_Frequency) %>%

   select(Unsold_Seat:Bring_Children) %>% summarise_all(sumyes)

   travelfreqprop = travelfreq %>% group_by(Travel_Frequency) %>%

   select(Unsold_Seat:Bring_Children) %>% summarise_all(propyes)

   kable(travelfreqprop, format = "latex")
   travelfreqib = rbind(travelfreqsum, travelfreqprop)

   n_no = 614
   n_more = 235

   # Proportions test to see if groups vary on reclining seat
   prop.test(x = c(travelfreqib$Recline_Seat[1:2]), n = c(n_more, n_no), correct = FALSE,
             alternative = "greater")

   # Proportions test to see if groups vary on walking to walk around
   prop.test(x = c(travelfreqib$Wake_Walk[1:2]), n = c(n_more, n_no), correct = FALSE)

#### Q4 ####
library(tidyverse)
library(questionr)
library(nnet)
library(ggplot2)
library(data.table)
library(gplots)
library(caret)

#Getting data only necessary for question 4
q4 <- airplane_etiquette %>%
```

```
  mutate(seats3 = `In a row of three seats, who should get to use the two arm rests?`) %>%
  mutate(seats2 = `In a row of two seats, who should get to use the middle arm rest?`) %>%
  select(., seats3, seats2, Gender, Age, `Location (Census Region)`)
#Removing NAs
q4 <- na.rm(q4)

#Renaming "> 60" to "60+"
q4$Age <- ifelse(q4$Age == "> 60", "60+", q4$Age)

#Getting levels of responses
unique(q4$seats3)
unique(q4$seats2)
unique(q4$Gender)
unique(q4$Age)

#Plotting armrest responses
#2 seats
ggplot(data = q4, aes(x = seats2, fill = Age)) +
  geom_bar() +
  labs(title = "Who should have claim over the middle armrest in a row of two seats?",
       subtitle = "Separated by Gender", x = "Response", y = "Frequency") +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 90))+
  facet_wrap(~ Gender) +
  scale_x_discrete(labels = function(x) str_wrap(x, width = 20))

#3 seats
ggplot(data = q4, aes(x = seats3, fill = Age)) +
  geom_bar() +
  labs(title = "Who should have two armrests in a row of three seats?",
       subtitle = "Separated by Gender", x = "Response", y = "Frequency") +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 90)) +
  facet_grid(~ Gender) +
  scale_x_discrete(labels = function(x) str_wrap(x, width = 20))

#Initial multinomial regression test
#Rows with 2 seats
twoseat <- multinom(seats2 ~ Gender + Age, data = q4)
twoseatoutput <- summary(twoseat)
z2 <- twoseatoutput$coefficients/twoseatoutput$standard.errors
p2 <- (1-pnorm(abs(z2),0,1))*2 # I am using two-tailed z test
print(p2, digits =2)

maledf2 <- data.frame(Age = c("18-29", "30-44", "45-60", "60+" ), Gender = "Male")
malepred2 <- predict(twoseat, newdata = maledf2, "probs")
malepred2 <- cbind(maledf2, malepred2)
femaledf2 <- data.frame(Age = c("18-29", "30-44", "45-60", "60+" ), Gender = "Female")
femalepred2 <- predict(twoseat, newdata = femaledf2, "probs")
femalepred2 <- cbind(femaledf2, femalepred2)
pred2 <- rbind(malepred2, femalepred2)
pred2 <- melt(pred2, value.name = "prob")%>%
  rename("Response" = "variable")
```

```
#Plotting predictions
ggplot(pred2, aes(x = Age, y = prob, colour = Response, shape = Gender)) +
  geom_point() +
  labs(title = "Who should have claim over the middle armrest in a row of two seats?",
       subtitle = "Predicted probability that someone in each category would choose each response",
       x = "Age", y = "Probability of choosing response")+
  theme_minimal()

#Rows with three seats
threeseat <- multinom(seats3 ~ Gender + Age, data = q4)
threeseatoutput <- summary(threeseat)
z3 <- threeseatoutput$coefficients/threeseatoutput$standard.errors
p3 <- (1-pnorm(abs(z3),0,1))*2 # I am using two-tailed z test
print(p3, digits =2)

maledf3 <- data.frame(Age = c("18-29", "30-44", "45-60", "60+" ), Gender = "Male")
malepred3 <- predict(threeseat, newdata = maledf3, "probs")
malepred3 <- cbind(maledf3, malepred3)
femaledf3 <- data.frame(Age = c("18-29", "30-44", "45-60", "60+" ), Gender = "Female")
femalepred3 <- predict(threeseat, newdata = femaledf3, "probs")
femalepred3 <- cbind(femaledf3, femalepred3)
pred3 <- rbind(malepred3, femalepred3)
pred3 <- melt(pred3, value.name = "prob") %>%
  rename("Response" = "variable")

#Plotting predictions
ggplot(pred3, aes(x = Age, y = prob, colour = Response, shape = Gender)) +
  geom_point() +
  labs(title = "Who should have two armrests in a row of three seats?",
    subtitle = "Predicted probability that someone in each category would choose each response",
    x = "Age", y = "Probability of choosing response")+
  theme_minimal()

kable(with(q4, table(seats2)) %>% prop.table(), format = "latex") %>%
  kable_styling(latex_options="scale_down")

kable(with(q4, table(seats3)) %>% prop.table(), format = "latex") %>%
  kable_styling(latex_options="scale_down")
```

Figure 5: Full-sized plot for the confidence interval related to the proportion of passengers who think bringing a baby on a plane is rude (Figure 1).

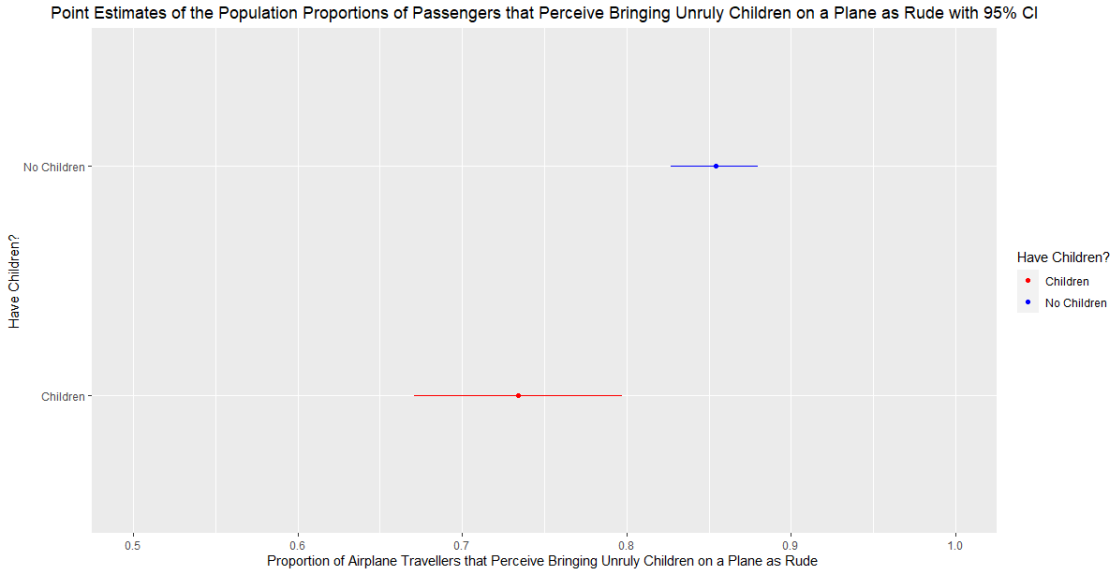

Figure 6: Full-sized plot for the confidence interval related to the proportion of passengers who think bringing unruly children on a plane is rude (Figure 1).

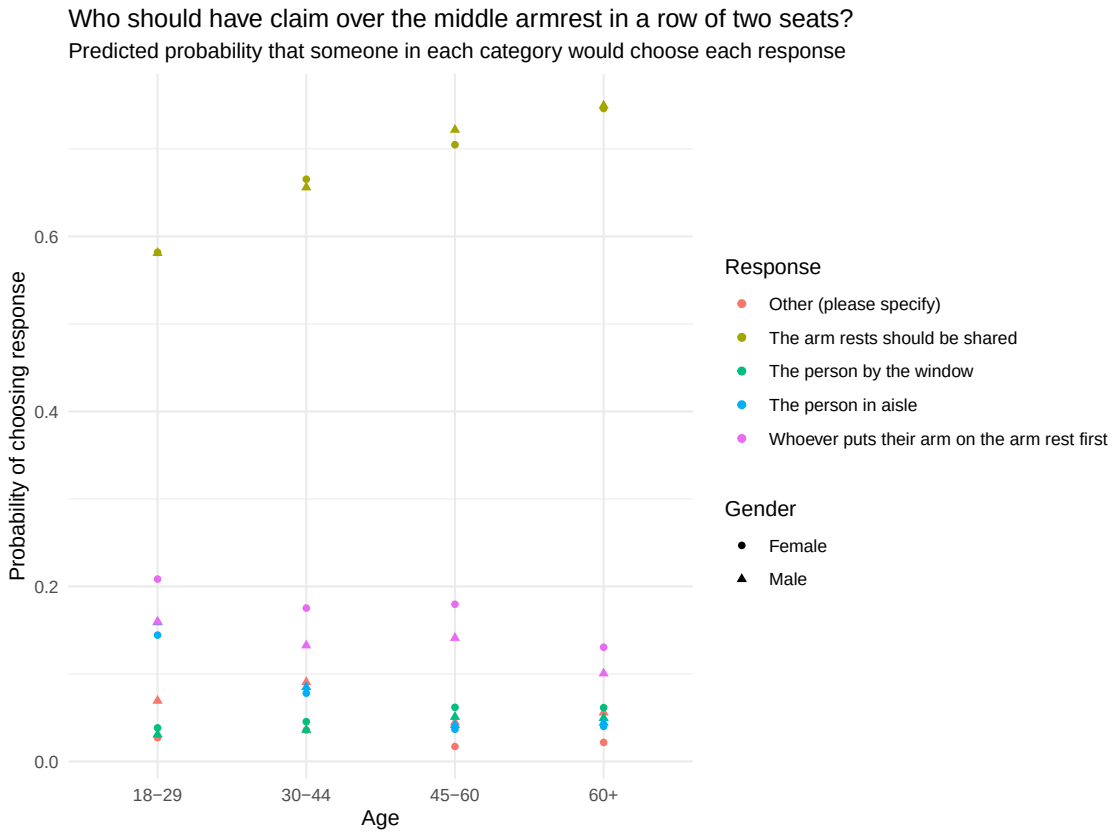

Figure 7: Full-sized plot for Q4 predictions of responses for rows with two seats (Figure 4).

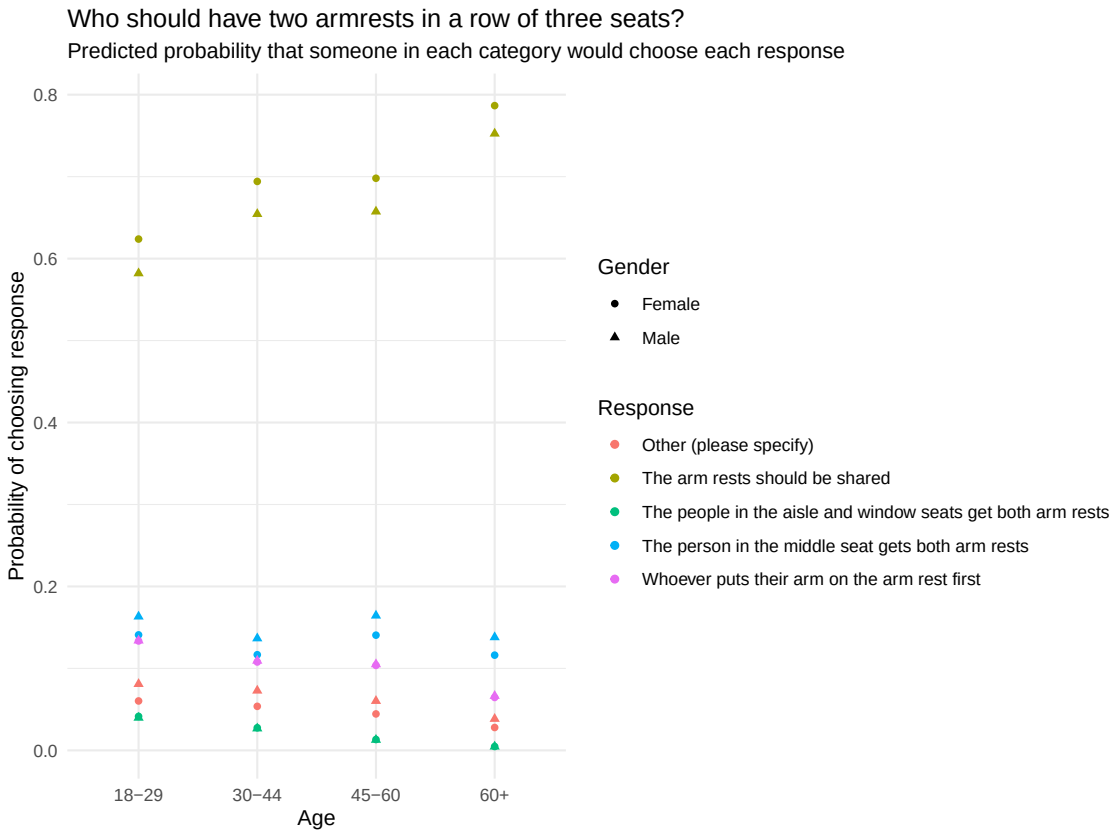

Figure 8: Full-sized plot for Q4 predictions of responses for rows with two seats (Figure 4).