Stat 6021: Addressing Guided Question Set 2

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For this exercise, use the `.csv` data file that you created at the end of the previous guided question set, `new_students.csv`. As a reminder, the dataset contains information on students taking an introductory statistics class at a large public university. The columns of data are:

- `Student`: ID number on survey
- `Gender`: gender of student (male / female)
- `Smoke`: whether the student smokes (yes / no)
- `Marijuan`: whether the student smokes marijuana (yes / no)
- `DrivDrnk`: whether the student has ever driven while drunk (yes / no)
- `GPA`: student's current GPA
- `PartyNum`: number of days per month the student parties
- `DaysBeer`: number of days per month the student has at least two alcoholic drinks
- `StudyHrs`: number of hours spent studying per week
- `PartyAnimal`: whether the students parties more than 8 days per month (yes / no)
- `GPA.cat`: "low" if GPA is less than 3.0, "moderate" if GPA is at least 3.0 and less than 3.5, "high" if GPA is at least 3.5

```
students_dataframe <-
    read.csv(
        file = "../../Module_1--Data_Wrangling/Guided_Question_Set/new_students.csv"
    )
head(students_dataframe, n = 3)
```

```
##   Student Gender Smoke Marijuan DrivDrnk  GPA PartyNum DaysBeer StudyHrs
## 1       1 female    No      Yes      Yes 3.40        4        6        7
## 2       2 female    No       No       No 3.45        4        0       20
## 3       3   male    No       No      Yes 3.89        9        4       30
##   PartyAnimal  GPA.cat
## 1          no moderate
## 2          no moderate
## 3         yes     high
```

1. Produce a frequency table of the number of students in each level of `GPA.cat`. If needed, be sure to arrange the order of the output appropriately. How many students are in each level of `GPA.cat`?

   ```
   table(students_dataframe$GPA.cat)[c("low", "moderate", "high")]
   ```

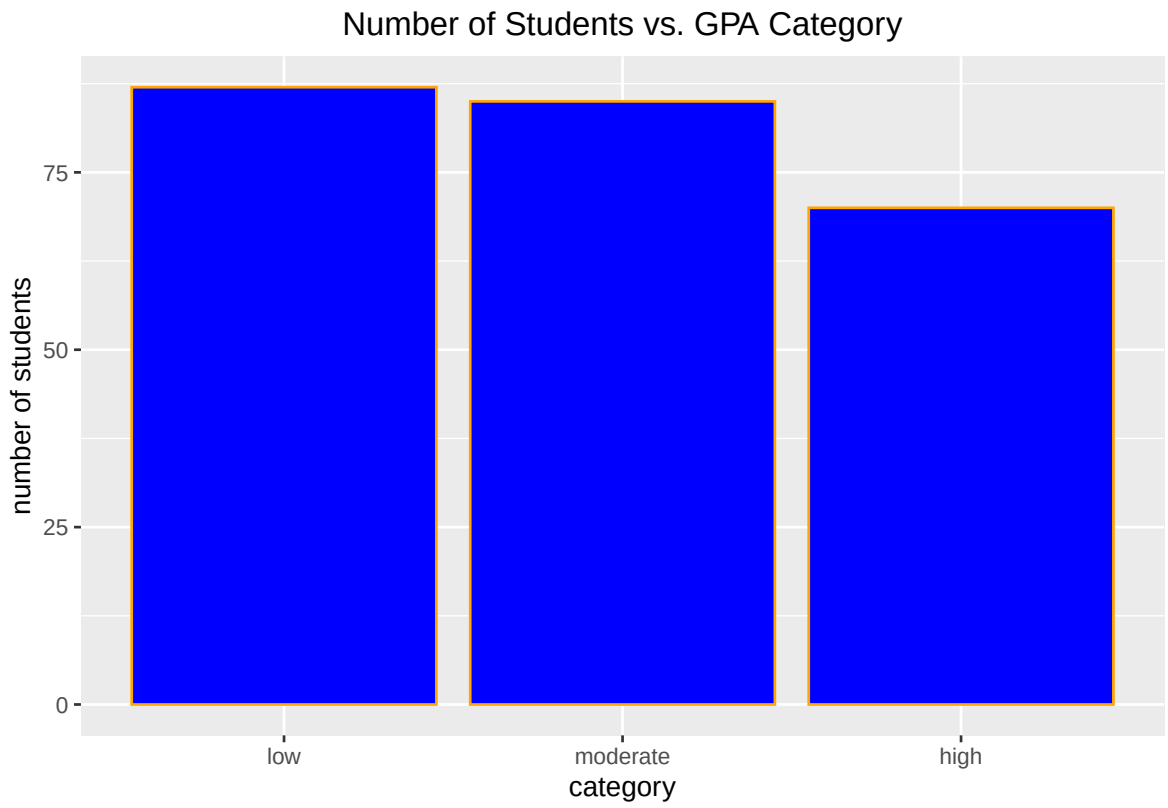
   ```
   ##
   ##      low moderate     high
   ##       87       85       70
   ```

   For the students taking an introductory statistics class at a large public university, 87 have low GPA's, 85 have moderate GPA's, and 70 have high GPA's.

2. Produce a bar chart that summarizes the number of students in each level of `GPA.cat`. Be sure to add appropriate labels and titles so that the bar char conveys its message clearly to the reader. Be sure to

remove the bar corresponding to the missing values.

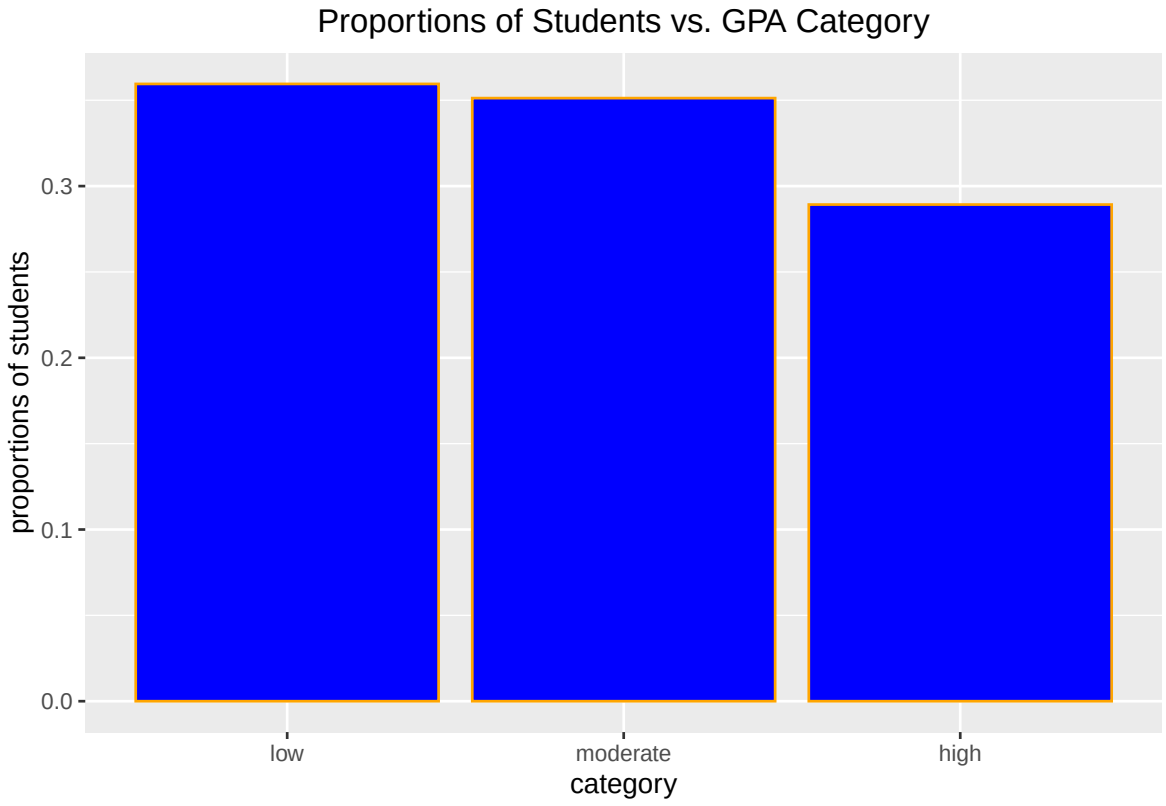
```
library(dplyr)
library(ggplot2)
GPA_category <- students_dataframe %>% select(GPA.cat) %>% filter(!is.na(GPA.cat))
colnames(GPA_category) <- "GPA_category"
ggplot(data = GPA_category, aes(x = GPA_category)) +
    geom_bar(fill = "blue", color = "orange") +
    scale_x_discrete(limits = c("low", "moderate", "high")) +
    theme(
        plot.title = element_text(hjust = 0.5),
        axis.text.x = element_text(angle = 0)
    ) +
    labs(
        x = "category",
        y = "number of students",
        title = "Number of Students vs. GPA Category"
    )
```



3. Create a similar bar chart as you did in Part 2, but with proportions instead of counts. Be sure to remove the bar corresponding to the missing values.

```
number_of_students <- nrow(GPA_category)
proportion <-
    GPA_category %>%
        group_by(GPA_category) %>%
        summarize(numbers_of_students = n()) %>%
        mutate(proportions_of_students = numbers_of_students / number_of_students)
ggplot(data = proportion, aes(x = GPA_category, y = proportions_of_students)) +
```

```
    geom_bar(stat = "identity", fill = "blue", color = "orange") +
    scale_x_discrete(limits = c("low", "moderate", "high")) +
    theme(
        plot.title = element_text(hjust = 0.5),
        axis.text.x = element_text(angle = 0)
    ) +
    labs(
        x = "category",
        y = "proportions of students",
        title = "Proportions of Students vs. GPA Category"
    )
```



4. Produce a frequency table for the number of female and male students and the GPA category.

```
numbers_of_students_by_gender_and_GPA_category <-
    table(
        students_dataframe$Gender, students_dataframe$GPA.cat
    )[, c("low", "moderate", "high")]
numbers_of_students_by_gender_and_GPA_category
```

```
##
##          low moderate high
##   female  41       52   46
##   male    46       33   24
```

```
chisq.test(numbers_of_students_by_gender_and_GPA_category)
```

```
##
##  Pearson's Chi-squared test
```

```
##
## data:  numbers_of_students_by_gender_and_GPA_category
## X-squared = 6.2312, df = 2, p-value = 0.04435
```

Given a significance level 0.05, since the above probability 0.04435 is less than the significance level, we reject the null hypothesis of the Pearson's Chi-squared test of independence, which states that there is no association between the row variable `Gender` and the column variable `GPA category`. We have sufficient evidence to conclude that there is an association between the row variable `Gender` and the column variable `GPA category`.

In a graph of gender by GPA category, the proportions of female and male students for low GPA are approximately equal. As GPA increases, the proportion of female students increases and the proportion of male students decreases. For high GPA, the proportion of female students is significantly greater than the proportion of male students. Based on this last fact, GPA is dependent on gender.

5. Produce a table for the percentage of GPA categories for each gender. For the percentages, round to 2 decimal places. Comment on the relationship between gender and GPA category.

```
percentages_of_students_by_gender_and_GPA_category <-
    round(prop.table(numbers_of_students_by_gender_and_GPA_category, 1) * 100, 2)
percentages_of_students_by_gender_and_GPA_category
```

```
##
##            low moderate  high
##   female 29.50    37.41 33.09
##   male   44.66    32.04 23.30
```

```
chisq.test(percentages_of_students_by_gender_and_GPA_category)
```

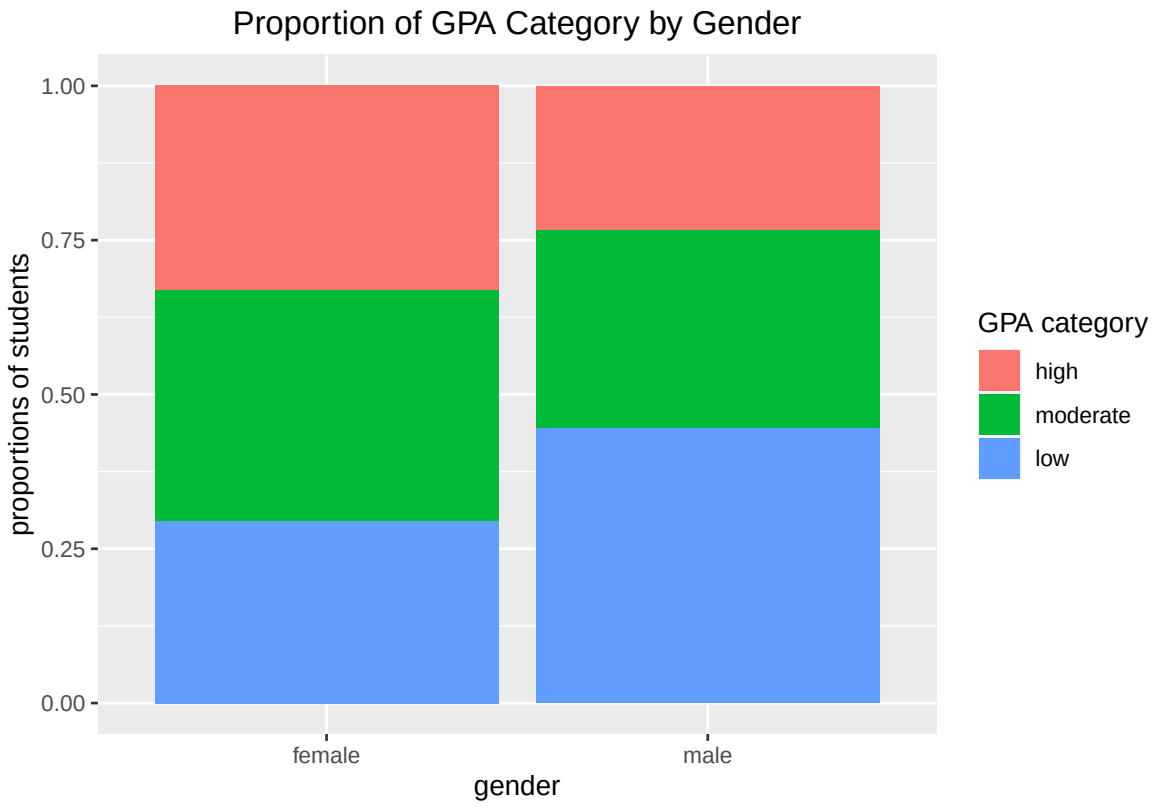
```
##
##  Pearson's Chi-squared test
##
## data:  percentages_of_students_by_gender_and_GPA_category
## X-squared = 5.2139, df = 2, p-value = 0.07376
```

See above comment. The two tests of independence produce different probabilities due to the fact that each row is divided by its own row total. The above comment is based on a test closer to the raw data.

6. Create a bar chart to explore the proportion of GPA categories for female and male students. Be sure to remove the bar corresponding to the missing values.

```
gender_and_GPA_category <-
    students_dataframe %>% select(Gender, GPA.cat) %>% filter(!is.na(GPA.cat))
colnames(gender_and_GPA_category) <- c("gender", "GPA_category")
proportion_of_GPA_category_by_gender <-
    gender_and_GPA_category %>%
        group_by(gender, GPA_category) %>%
        summarize(proportions_of_students = n()) %>%
        mutate(
            proportions_of_students = proportions_of_students / number_of_students
        )
ggplot(
    proportion_of_GPA_category_by_gender,
    aes(
        fill = factor(GPA_category, levels = c("high", "moderate", "low")),
        x = gender,
        y = proportions_of_students
    )
```

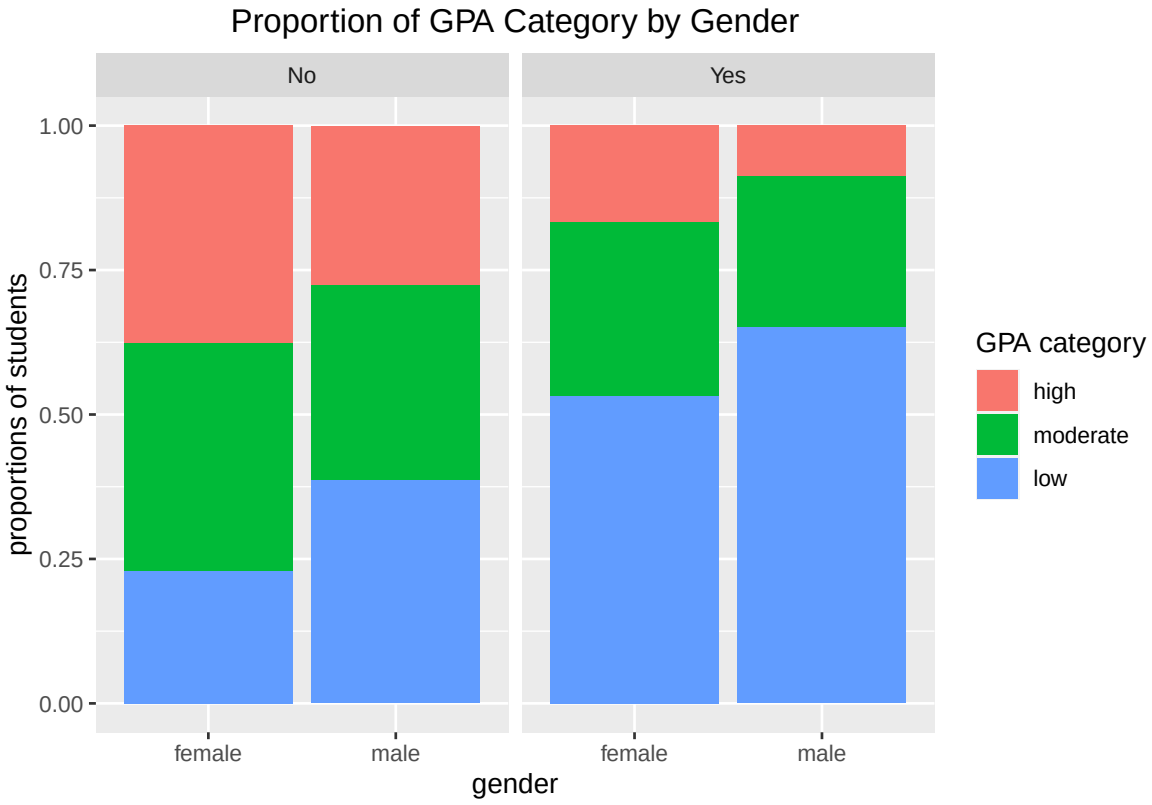
```
) +
    geom_bar(position="fill", stat="identity") +
    scale_fill_discrete(name = "GPA category") +
    labs(
        x = "gender",
        y = "proportions of students",
        title = "Proportion of GPA Category by Gender"
    ) +
    theme(
        plot.title = element_text(hjust = 0.5),
        axis.text.x = element_text(angle = 0)
    )
```



7. Create a bar chart similar to the bar chart in Part 6, but split by smoking status. Comment on this bar chart.

```
gender_smoking_status_and_GPA_category <-
    students_dataframe %>% select(Gender, Smoke, GPA.cat) %>% filter(!is.na(GPA.cat))
colnames(gender_smoking_status_and_GPA_category) <-
    c("gender", "smoking_status", "GPA_category")
proportion_of_GPA_category_by_gender_and_smoking_status <-
    gender_smoking_status_and_GPA_category %>%
        group_by(gender, smoking_status, GPA_category) %>%
        summarize(proportions_of_students = n()) %>%
        mutate(
            proportions_of_students = proportions_of_students / number_of_students
        )
ggplot(
```

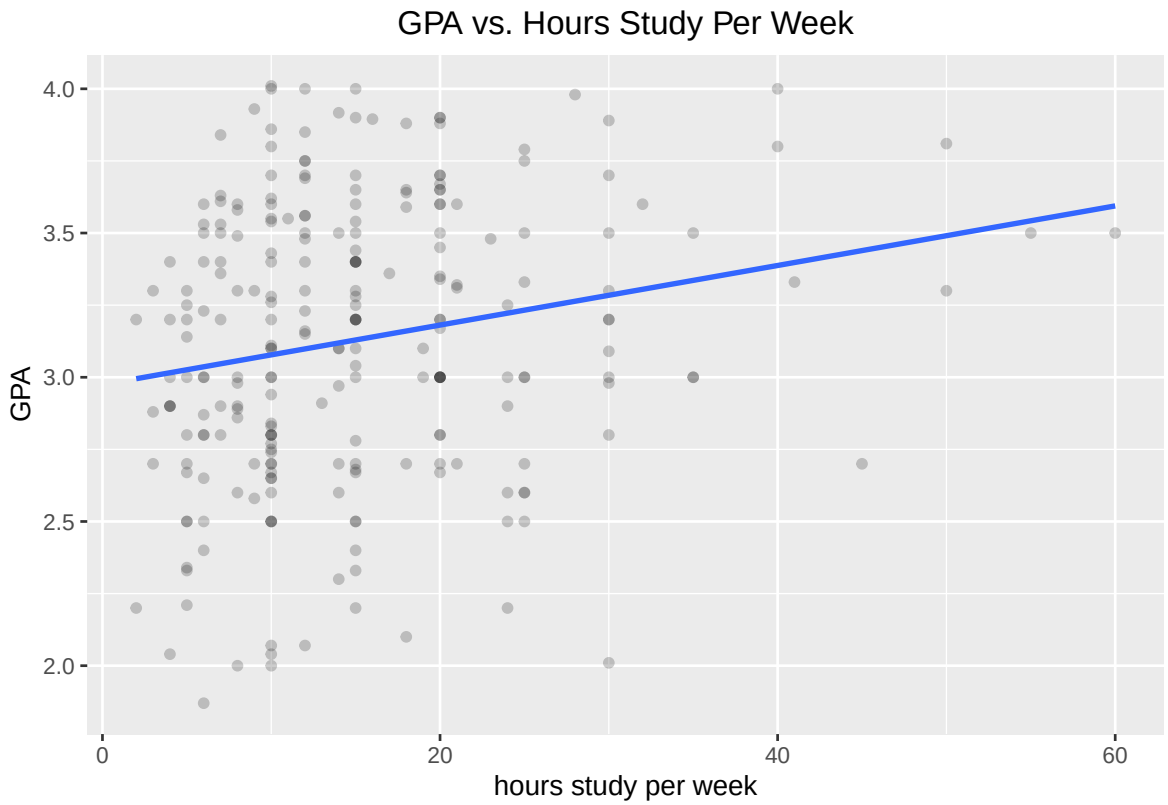
```
    proportion_of_GPA_category_by_gender_and_smoking_status,
    aes(
        fill = factor(GPA_category, levels = c("high", "moderate", "low")),
        x = gender,
        y = proportions_of_students
    )
) +
    geom_bar(position="fill", stat="identity") +
    scale_fill_discrete(name = "GPA category") +
    labs(
        x = "gender",
        y = "proportions of students",
        title = "Proportion of GPA Category by Gender"
    ) +
    theme(
        plot.title = element_text(hjust = 0.5),
        axis.text.x = element_text(angle = 0)
    ) +
    facet_wrap(~smoking_status)
```



The proportion of students with low GPA who smoke is approximately double the proportion of students with low GPA who do not smoke. The proportion of students with moderate GPA who smoke is approximately two thirds the proportion of students with moderate GPA who do not smoke. The proportion of students with high GPA who smoke is approximately one third the proportion of students with high GPA who do not smoke.

8. Create a scatterplot of GPA against the amount of hours spent studying per week. How would you describe the relationship between GPA and amount of time spent studying?

```
hours_study_per_week_and_GPA <-
    students_dataframe %>% select(StudyHrs, GPA) %>% filter(!is.na(GPA))
colnames(hours_study_per_week_and_GPA) <- c("hours_study_per_week", "GPA")
ggplot(hours_study_per_week_and_GPA, aes(x = hours_study_per_week, y = GPA)) +
    geom_point(alpha = 0.2) +
    geom_smooth(method = "lm", se = FALSE) +
    labs(
        x = "hours study per week",
        y = "GPA",
        title = "GPA vs. Hours Study Per Week"
    ) +
    theme(
        plot.title = element_text(hjust = 0.5),
        axis.text.x = element_text(angle = 0)
    )
```




```
linear_model_for_GPA_versus_hours_study_per_week <-
    lm(GPA ~ hours_study_per_week, data = hours_study_per_week_and_GPA)
summary(linear_model_for_GPA_versus_hours_study_per_week)
```

```
##
## Call:
## lm(formula = GPA ~ hours_study_per_week, data = hours_study_per_week_and_GPA)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.27420 -0.33379  0.01744  0.39737  0.93237
##
```

```
## Coefficients:
##                       Estimate Std. Error t value Pr(>|t|)
## (Intercept)           2.97435    0.05749  51.734  < 2e-16 ***
## hours_study_per_week  0.01033    0.00322   3.208  0.00152 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4777 on 240 degrees of freedom
## Multiple R-squared:  0.04111,    Adjusted R-squared:  0.03712
## F-statistic: 10.29 on 1 and 240 DF,  p-value: 0.00152
```

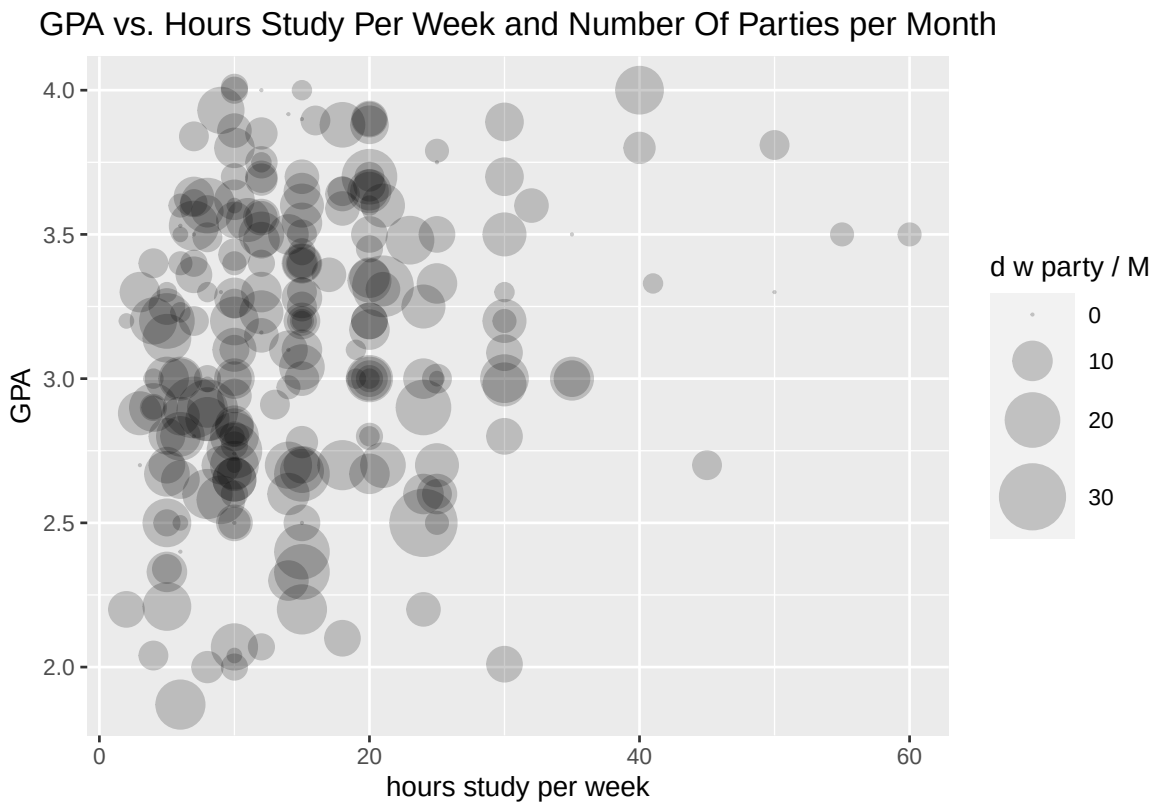
Because there is a difference in the numbers of data above and below the line of best fit, and a difference between the extremities of the data above and below, a linear regression t test is invalid. Conducting the linear regression t test anyway:

Given a significance level 0.05, since the above probability 0.002 is less than the significance level, we reject the null hypothesis of the linear regression t test, which states that there is no correlation between GPA and hours study per week. We have sufficient evidence to conclude that there is a correlation between GPA and hours study per week.

The proportion of the variation in GPA that is explained by the linear relationship between GPA and hours study per week is 0.037. Because this proportion is less than 0.8, this linear model is neither good for prediction nor precise.

9. Edit the scatterplot from Part 8 to include information about the number of days the student parties in a month.

```
hours_study_per_week_number_of_days_with_party_per_month_and_GPA <-
    students_dataframe %>%
        select(StudyHrs, PartyNum, GPA) %>%
        filter(!is.na(PartyNum) & !is.na(GPA))
colnames(hours_study_per_week_number_of_days_with_party_per_month_and_GPA) <-
    c("hours_study_per_week", "number_of_days_with_party_per_month", "GPA")
ggplot(
    hours_study_per_week_number_of_days_with_party_per_month_and_GPA,
    aes(
        x = hours_study_per_week,
        y = GPA,
        size = number_of_days_with_party_per_month
    )
) +
    geom_point(alpha = 0.2) +
    labs(
        x = "hours study per week",
        y = "GPA",
        size = "d w party / M",
        title = "GPA vs. Hours Study Per Week and Number Of Parties per Month"
    ) +
    scale_size(range = c(0.1, 12)) +
    theme(
        plot.title = element_text(hjust = 0.5),
        axis.text.x = element_text(angle = 0)
    )
```



10. Edit the scatterplot from Part 9 to include information about whether the student smokes or not.

```
hours_study_per_week_number_of_days_with_party_per_month_smoking_status_and_GPA <-
    students_dataframe %>%
        select(StudyHrs, PartyNum, Smoke, GPA) %>%
        filter(!is.na(PartyNum) & !is.na(GPA))
colnames(
    hours_study_per_week_number_of_days_with_party_per_month_smoking_status_and_GPA
) <-
    c(
        "hours_study_per_week",
        "number_of_days_with_party_per_month",
        "smoking_status",
        "GPA"
    )
ggplot(
    hours_study_per_week_number_of_days_with_party_per_month_smoking_status_and_GPA,
    aes(
        x = hours_study_per_week,
        y = GPA,
        size = number_of_days_with_party_per_month,
        color = smoking_status
    )
) +
    geom_point(alpha = 0.2) +
    labs(
        x = "hours study per week",
        y = "GPA",
```

```
    size = "d w party / M",
    color= "smoking status",
    title = "GPA vs. Hours Study Per Week"
) +
scale_size(range = c(0.1, 12)) +
theme(
    plot.title = element_text(hjust = 0.5),
    axis.text.x = element_text(angle = 0)
)
```