Midterm 1, Part 1

S&DS 361

2023-02-21

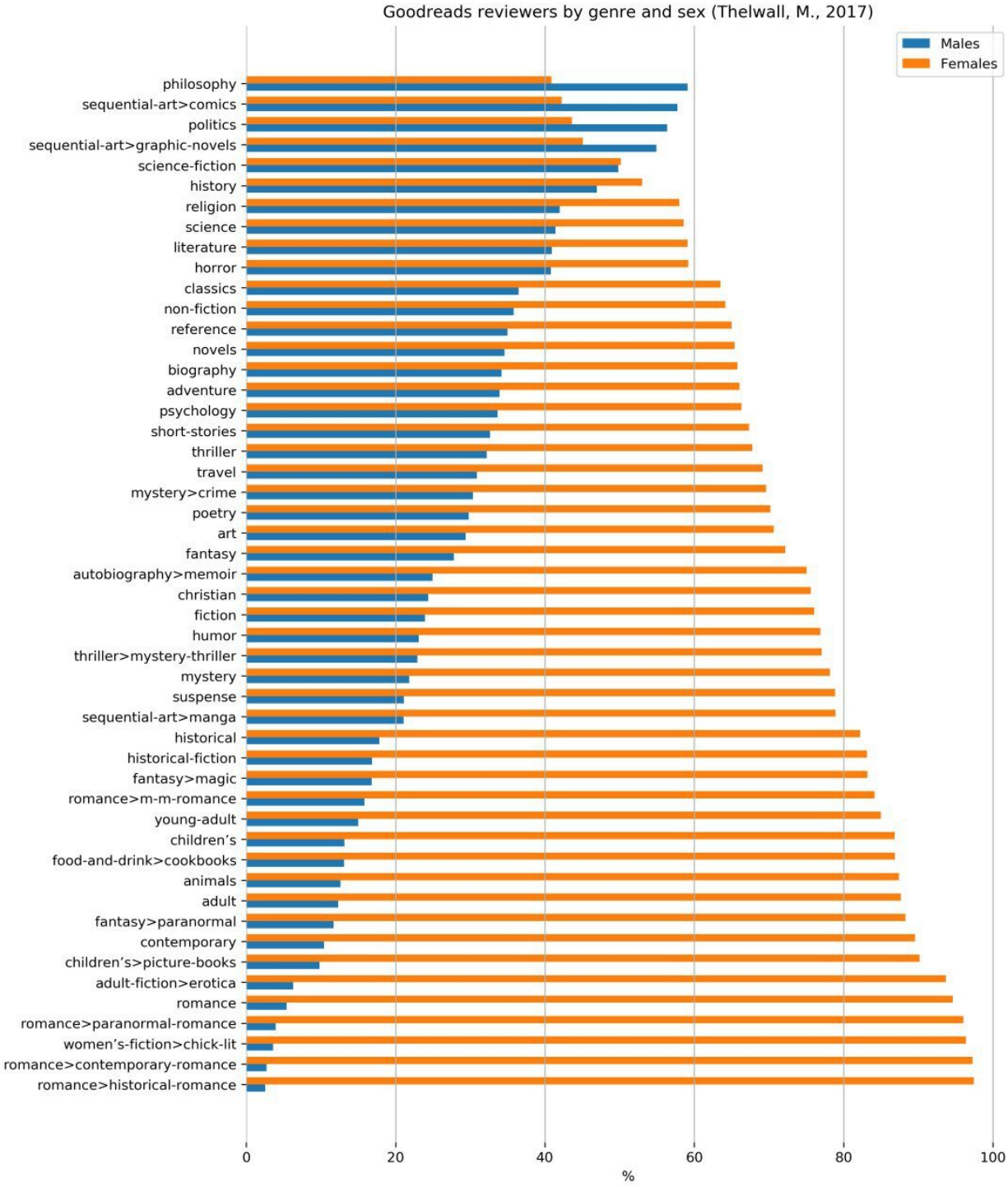
Student Name: _____

For graders:

Problem	Score
Part 1, 1	
2	
3	
4	
5	
6	
Part 2, 1	
Total	

1. Visualization

The following visualization shows the percent of males and females who wrote reviews for various genres of books on Goodreads. Please give short answers (1-ish sentence) to the questions below.



a. Do the title, axis labels, and other text clearly summarize the contents of the visualization? Why or why not?

This visualization demenstrates the percentage ratio of gender (male/female) of the reviewers on Goodreview, differentiated by genre of books. The title looks good to summerize the content but the x-axis label is very vague on delivering the abstract representation. The y-axis label , which should be 'genre', is misssing. And the text on y-axis, which represents the specific genre, is not processed for better understanding.

b. What would you change about the visualization? Include at least one additional comment different from your response given above.

I would change the x-axis label to be 'Percentage of male v.s. female reviewers'. I will add a y-axis label 'Genre'. I will process the y-axis texts to be more concise and precise. I will also add the percentage representation of each grid line to the top of this visualization, as this is a long plot and it is hard to read the percentage for the top bars.

2. Commenting code

Below are the first four and last four rows of `d`, the NBA games data that we worked with previously in class and on assignments.

```
      season      gid team score
1 Season2021 22000001  GSW    99
2 Season2021 22000001  BKN   125
3 Season2021 22000002  LAC   116
4 Season2021 22000002  LAL   109
```

```
         season      gid team score
4617 Season2022 22101229  SAC   116
4618 Season2022 22101229  PHX   109
4619 Season2022 22101230  UTA   111
4620 Season2022 22101230  POR    80
```

Below is some code that processes this data and creates a visualization. Please add comments to the code everywhere there is a ## that explain the chunk of code below that ##.

```
## Find the avarage score of each team in each season


ds = d %>%
  group_by(team, season) %>%
  summarise(score = mean(score)) %>%

  ## Reform the dataframe to have to columns, each represents the average score of a team in one season(one from 2021 and 2022)


  pivot_wider(names_from  = season,
              values_from = score)

## Scatter plot the average scores of each team, where x-axis is the average score of 2021 and y-axis is the average score of 2022


ggplot(ds, aes(x = Season2021,
               y = Season2022,
               label = team))+
  geom_point()+
  geom_text(hjust=-.1)
```

3. dplyr

Suppose the data frame `d` contains the 4 columns `open.date`, `network`, `lev2` and `lev3` from the EV stations data that we worked with previously in class and on assignments. The first 6 rows of `d` are shown below.

```
   open.date       network lev2 lev3
1 2023-01-14           FLO    6   NA
2 2023-01-14           FLO    4   NA
3 2023-01-14    EV Connect   NA    2
4 2023-01-14    EV Connect    2   NA
5 2023-01-14 Blink Network    6   NA
6 2023-01-14 Blink Network    2   NA
```

Suppose we run the following code.

```
dd = d %>%
  mutate(lev2 = ifelse(is.na(lev2), 0, lev2),
         lev3 = ifelse(is.na(lev3), 0, lev3))  %>%
  filter(lev2!=0)
```

Write the first four rows of `dd` below.

FLO , 6 , 0
FLO , 4 , 0
EV Connect, 2 , 0
Blink Network, 6 , 0

4. ggplot

```
head(mtcars,2)
```

```
              mpg cyl disp  hp drat    wt  qsec vs am gear carb
Mazda RX4      21   6  160 110  3.9 2.620 16.46  0  1    4    4
Mazda RX4 Wag  21   6  160 110  3.9 2.875 17.02  0  1    4    4
```

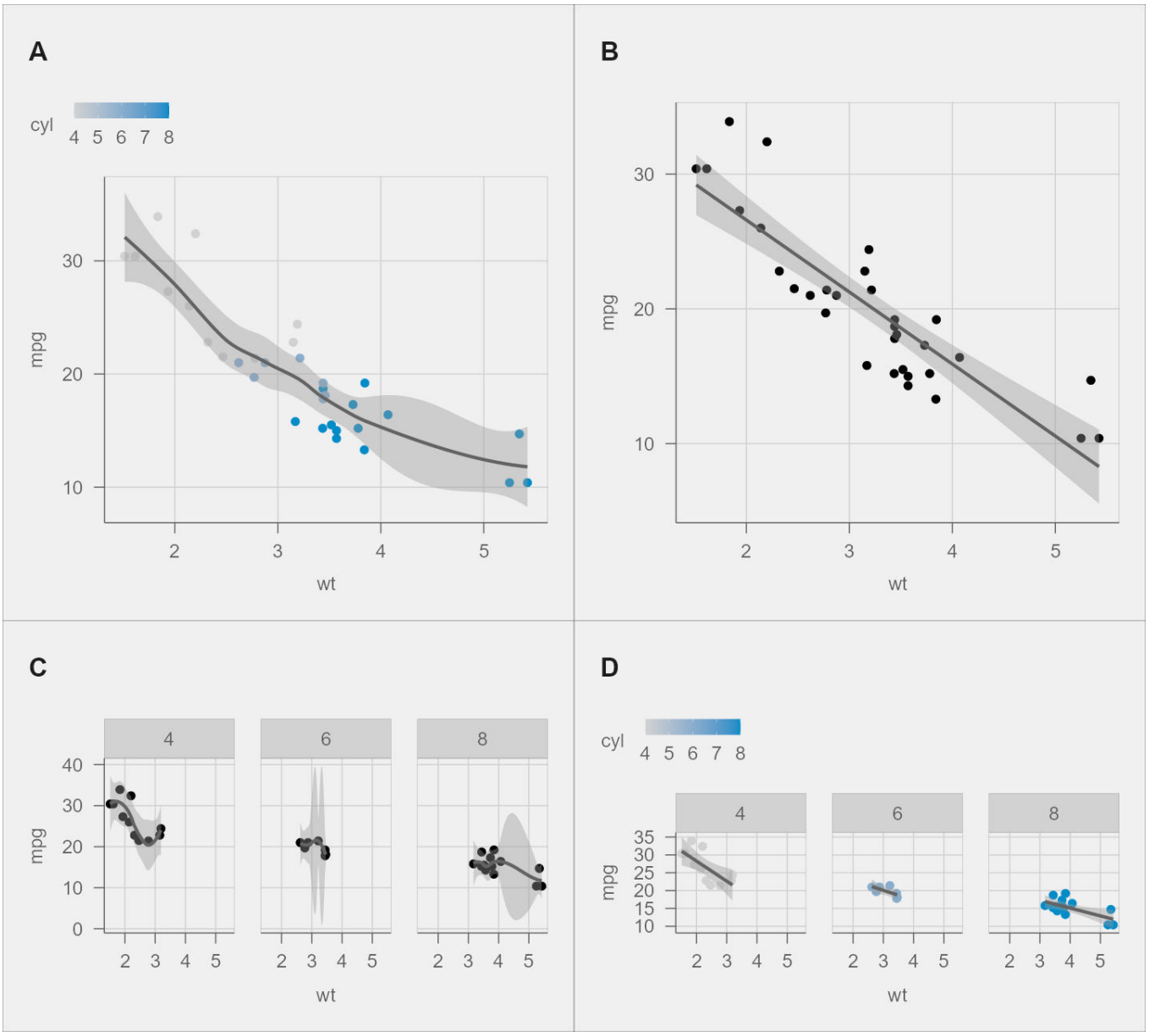
Below are 4 lines of code, each of which creates a visualization of the `mtcars` data. Below the code are 4 visualizations labeled A, B, C, and D, which were generated by one of the four lines of code. Match each line of code to the visualization it generates. Indicate your choice by writing A, B, C, or D in the blank to the left of each line of code.

```
__A__ ggplot(d=mtcars, aes(x=wt, y=mpg)) + geom_point(aes(color=cyl)) + geom_smooth(           )

__D__ ggplot(d=mtcars, aes(x=wt, y=mpg)) + geom_point(aes(color=cyl)) + geom_smooth(method='lm') + facet_wrap(~cyl)

__C__ ggplot(d=mtcars, aes(x=wt, y=mpg)) + geom_point(color='black' ) + geom_smooth(           ) + facet_wrap(~cyl)

__B__ ggplot(d=mtcars, aes(x=wt, y=mpg)) + geom_point(color='black' ) + geom_smooth(method='lm')
```



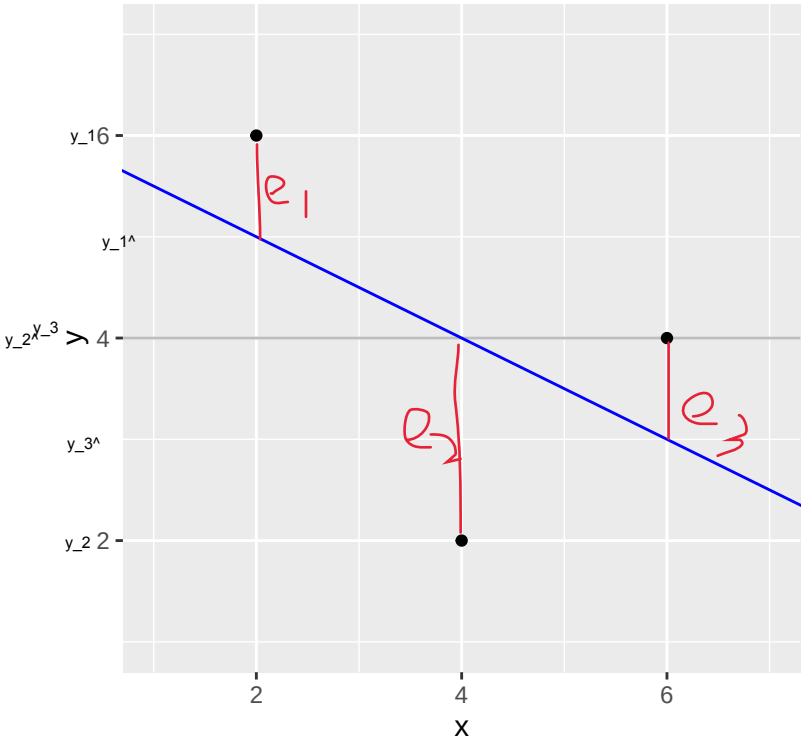
5. Regression

Consider the following three data points, linear model, and scatter plot with the regression line from the model.

$$(x_1, y_1) = (2, 6), \quad (x_2, y_2) = (4, 2), \quad (x_3, y_3) = (6, 4)$$

```
x1=2; y1=6;
x2=4; y2=2;
x3=6; y3=4;
d = data.frame(x=c(x1,x2,x3),
               y=c(y1,y2,y3))
m = lm(y~x, data=d)
m$coefficients
```

```
(Intercept)           x
        6.0        -0.5
```



Use this information to answer the following questions. Do the calculations by hand and show your work.

a. Label y_1, y_2, and y_3 on the graph.

b. Label $\hat{y}_1, \hat{y}_2$, and $\hat{y}_3$, the predicted values of y corresponding to x_1, x_2, and x_3.

c. Label the parts of the graph that represent the error terms (residuals) e_1, e_2, and e_3?

d. What is $\bar{y}$, the sample mean of y?

4

e. Compute SSE for this model.

6

f. Compute SST for this model.

2

g. Compute R^2 for this model.

0.75

h. Name 3 assumptions of a simple linear regression model.

i.

ii.

iii.

6. Multiple Regression

In this question we'll analyze the data `FirstYearGPA.csv`, a new data set. The handout that accompanies this exam contains

- the first 2 rows of the data
- a `ggpairs` plot
- 4 models, along with the `summary` output of those models,

which you will need to use to answer the questions below. Some column definitions:

- GPA is grade point average in first year of college,
- HSGPA is grade point average in high school,
- SATV is SAT verbal score,
- SATM is SAT math score,
- HU is the number of credit hours of humanities courses in high school

a. What percentage of the variation in `GPA` is explained by the model `m1`?

b. If a student got a 4.0 in HSGPA, and 800 on SATV, what can you say about her expected GPA in the first year of college, according to `m2`? (rounded to the nearest 0.0001)

c. If $x = 3.5$, we get $\hat{y} = 3.12$ when using `m1`. Which of the intervals below is the 95% confidence interval for $\hat{y}$, and which is the 95% prediction interval for y, when $x = 3.5$? How can you tell which is which?

```
   fit lwr  upr
1 3.12 2.3 3.95
```

```
   fit  lwr  upr
1 3.12 3.07 3.18
```

Type text here
(continued)

d. Is `m1` useful for predicting `GPA`? Give at least two parts of the `summary(m1)` output that support your answer.

No. The R squared value is less than 0.2, which means this is a very bad linear model

e. Is there any evidence of collinearity that we should be worried about when building a multiple regression model? Explain.

f. Which of the models `m1` thru `m4` would you consider to be the best? Why?

M4, the R^2 is the best among four models, and each of the factor involved in this model is statistically significant.

g. Given what you know about `m1` thru `m4`, what is the next model you would try for `m5`? Why?

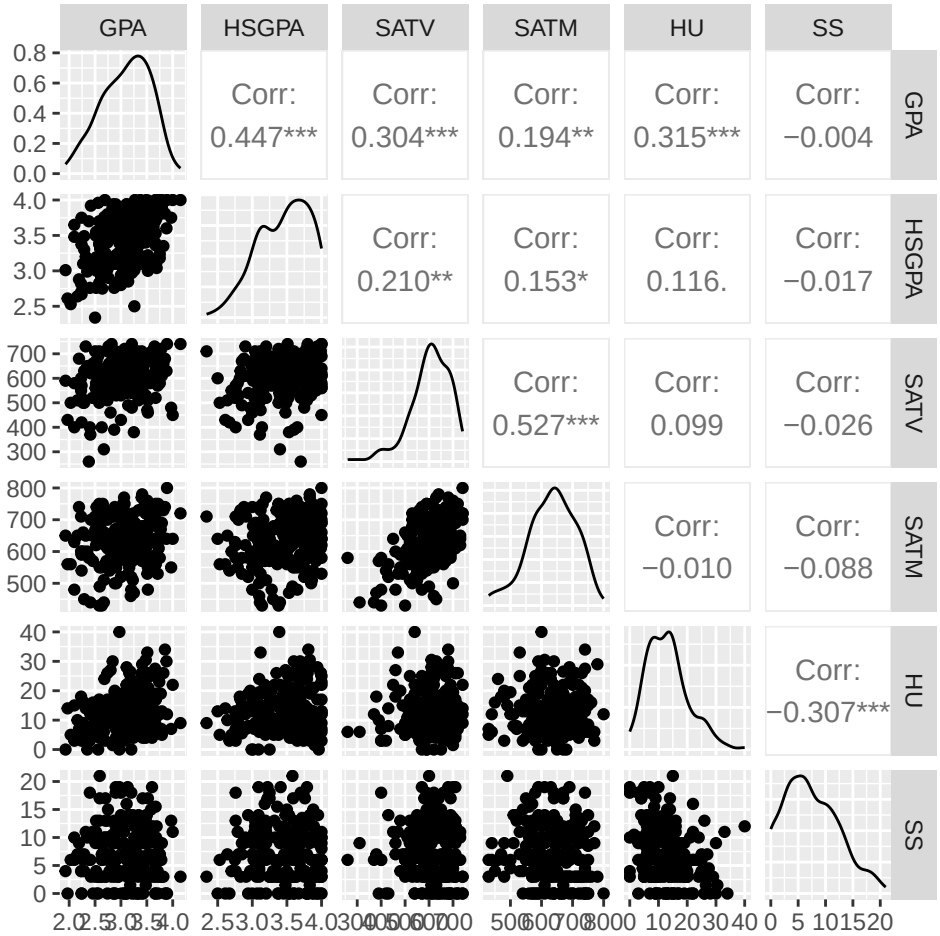
I'll try GPA ` HSGPA, SATV, HU, this is because both SATV in lm2 and HU in lm4 shows significance as a fatcor.

Handout (3 pages)

```
d = read.csv('data/FirstYearGPA.csv')
d = d %>% select(-X)
head(d,2)
```

```
   GPA HSGPA SATV SATM Male HU SS FirstGen White CollegeBound
1 3.06  3.83  680  770    1  3  9        1     1            1
2 4.15  4.00  740  720    0  9  3        0     1            1
```

```
ggpairs(d[,c(1:4,6:7)])
```



```r
m1 = lm(GPA ~ HSGPA       , data=d)
m2 = lm(GPA ~ HSGPA + SATV, data=d)
m3 = lm(GPA ~ HSGPA + SATM, data=d)
m4 = lm(GPA ~ HSGPA + HU  , data=d)

summary(m1)
```

```
Call:
lm(formula = GPA ~ HSGPA, data = d)

Residuals:
     Min       1Q   Median       3Q      Max
-1.10565 -0.31329  0.05871  0.29485  0.82291

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.17985    0.26194   4.504 1.09e-05 ***
HSGPA        0.55501    0.07542   7.359 3.78e-12 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4174 on 217 degrees of freedom
Multiple R-squared:  0.1997,    Adjusted R-squared:  0.196
F-statistic: 54.15 on 1 and 217 DF,  p-value: 3.783e-12
```

```r
summary(m2)
```

```
Call:
lm(formula = GPA ~ HSGPA + SATV, data = d)

Residuals:
     Min       1Q   Median       3Q      Max
-0.97894 -0.27639  0.02867  0.30133  0.87956

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 0.6351217  0.2955033   2.149  0.03272 *
HSGPA       0.4975320  0.0750569   6.629 2.66e-10 ***
SATV        0.0012283  0.0003373   3.641  0.00034 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4061 on 216 degrees of freedom
Multiple R-squared:  0.246, Adjusted R-squared:  0.239
F-statistic: 35.23 on 2 and 216 DF,  p-value: 5.711e-14
```

```
summary(m3)
```

This visualization demenstrates the percentage ratio of gender (male/female) of the reviewers on Goodreview, differentiated by genre of books. The title looks good to summerize the content but the x-axis label is very vague on delivering the abstract representation. The y-axis label is missing

```
Call:
lm(formula = GPA ~ HSGPA + SATM, data = d)

Residuals:
     Min       1Q   Median       3Q      Max
-1.00720 -0.31027  0.04086  0.31148  0.83620

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 0.7579762  0.3274774   2.315   0.0216 *
HSGPA       0.5305151  0.0757139   7.007 3.06e-11 ***
SATM        0.0007985  0.0003772   2.117   0.0354 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4141 on 216 degrees of freedom
Multiple R-squared:  0.216, Adjusted R-squared:  0.2087
F-statistic: 29.75 on 2 and 216 DF,  p-value: 3.869e-12
```

```
summary(m4)
```

```
Call:
lm(formula = GPA ~ HSGPA + HU, data = d)

Residuals:
     Min       1Q   Median       3Q      Max
-1.04272 -0.28375  0.05263  0.26621  0.91674

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 1.087416   0.251617   4.322 2.36e-05 ***
HSGPA       0.516624   0.072705   7.106 1.72e-11 ***
HU          0.017163   0.003772   4.550 8.93e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.3996 on 216 degrees of freedom
Multiple R-squared:  0.2697,    Adjusted R-squared:  0.263
F-statistic: 39.89 on 2 and 216 DF,  p-value: 1.808e-15
```