Week 3 Tasks Solutions

```
library(tidyverse)
library(tidymodels)
library(moderndive)
library(gapminder)
library(skimr)
library(mvtnorm)
library(gridExtra)
library(ISLR)
```

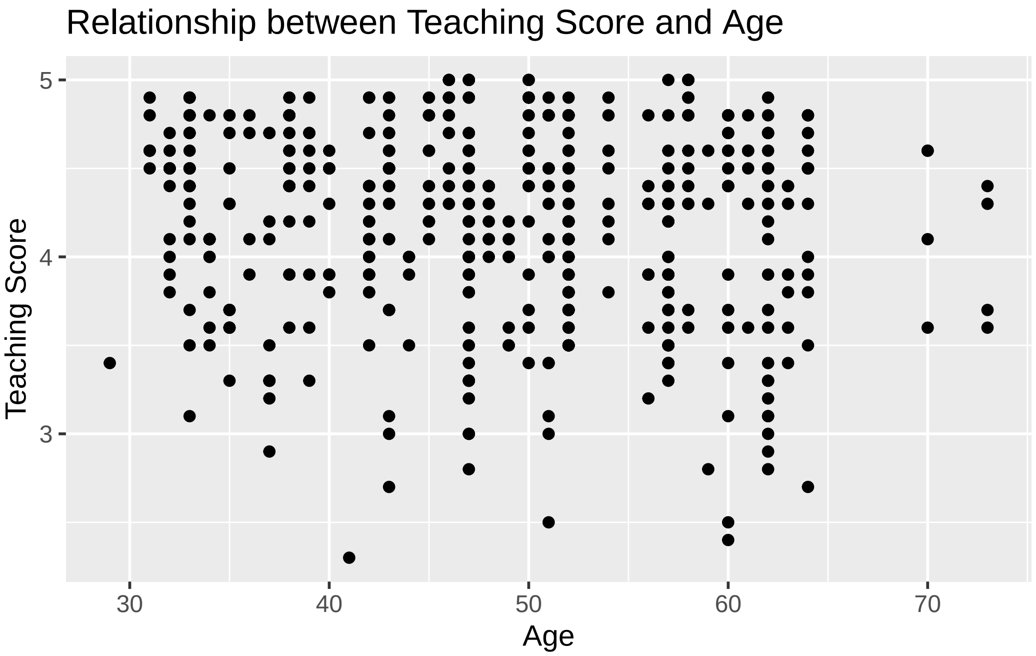
Tasks

1. Examine the relationship between teaching score and age in the `evals` data set. What is the value of the correlation coefficient? How would you interpret this verbally? Finally, produce a scatterplot of teaching score and age.

```
evals.age <- evals |>
  select(score, age)
evals.age |>
  get_correlation(formula = score ~ age)
```

```
# A tibble: 1 x 1
     cor
   <dbl>
1 -0.107
```

```
ggplot(evals.age, aes(x = age, y = score)) +
  geom_point() +
  labs(x = "Age", y = "Teaching Score",
title = "Relationship between Teaching Score and Age")
```



2. Perform a formal analysis of the relationship between teaching score and age by fitting a simple linear regression model. Superimpose your best-fitting line onto your scatterplot from Task 1.

```r
evals.age <- evals |>
  select(score, age)
model <- linear_reg() |> fit(score ~ age, data = evals.age)
model$fit
```

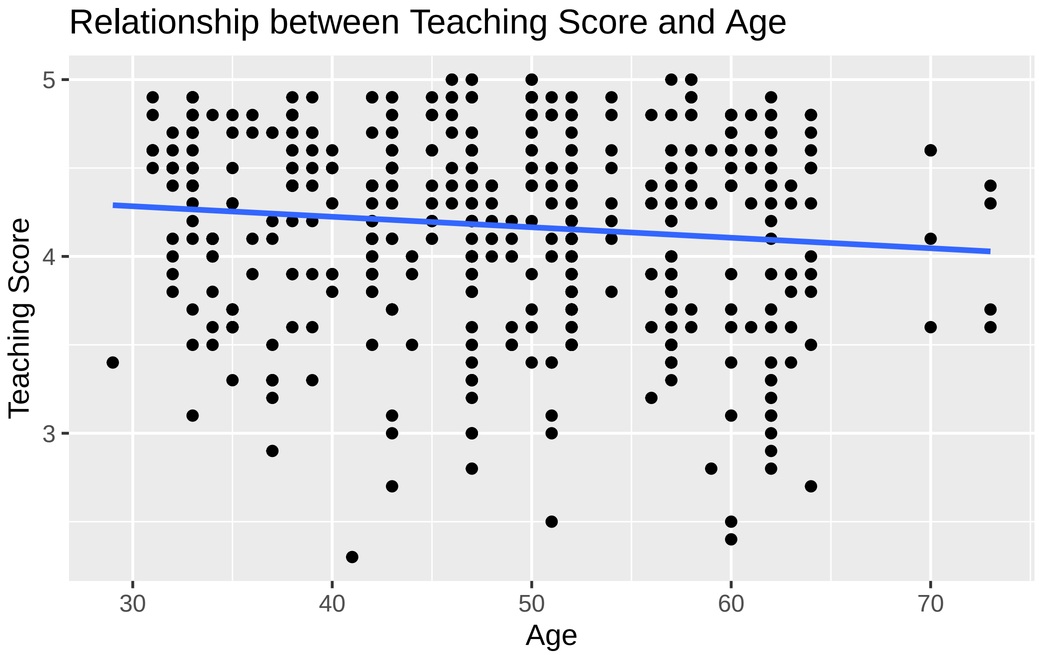
```

Call:
stats::lm(formula = score ~ age, data = data)

Coefficients:
(Intercept)          age
   4.461932    -0.005938
```

```r
ggplot(evals.age, aes(x = age, y = score)) +
  geom_point() +
  labs(x = "Age", y = "Teaching Score",
       title = "Relationship between Teaching Score and Age") +
  geom_smooth(method = "lm", se = FALSE)
```

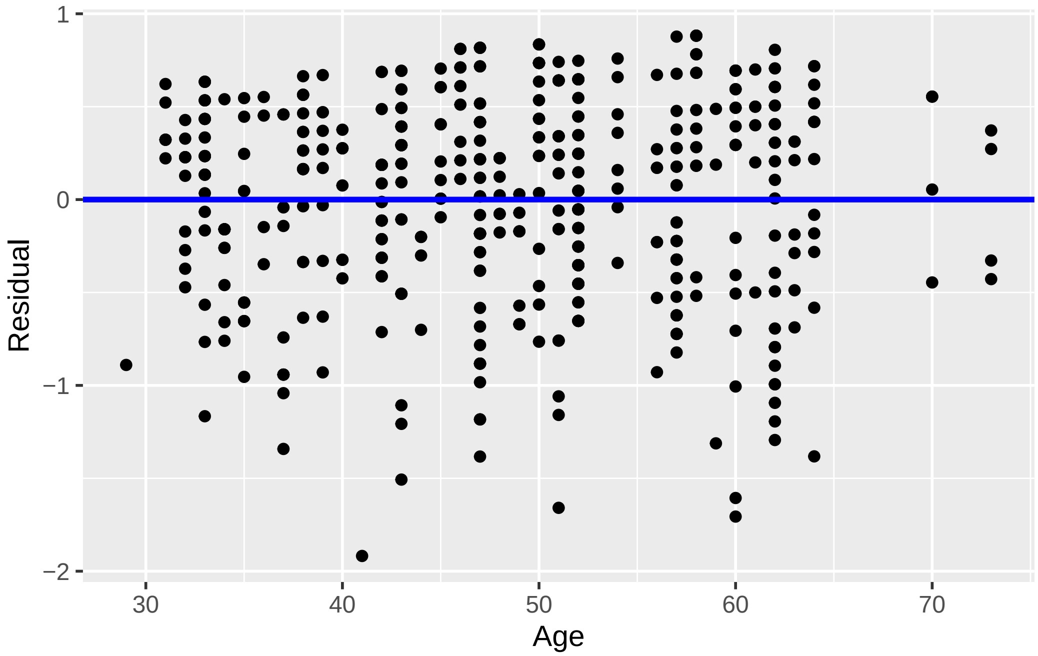
```
`geom_smooth()` using formula = 'y ~ x'
```


Relationship between Teaching Score and Age
Teaching Score
5
4
3
30
40
50
60
70
Age

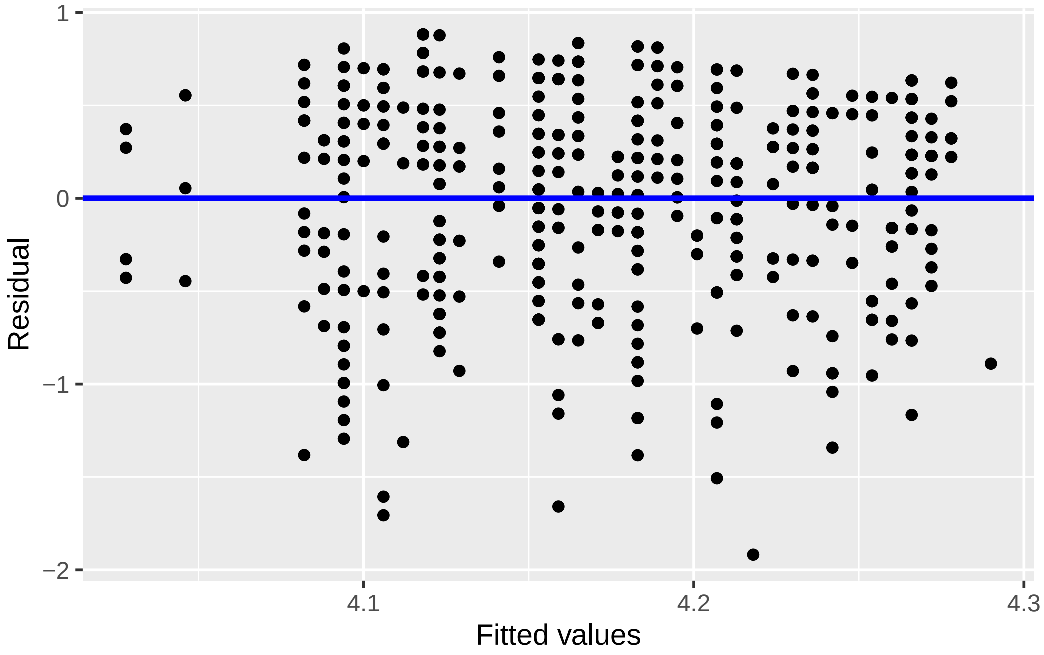
3. Assess the model assumptions from Task 2 by plotting the residuals against the explanatory variable and fitted values, respectively. Also, plot a histogram of the residuals to assess whether they are normally distributed.

```r
evals.age <- evals |>
  select(score, age)
model <- linear_reg() |> fit(score ~ age, data = evals.age)
regression.points <- get_regression_points(model$fit)
ggplot(regression.points, aes(x = age, y = residual)) +
  geom_point() +
  labs(x = "Age", y = "Residual") +
  geom_hline(yintercept = 0, col = "blue", size = 1)
```

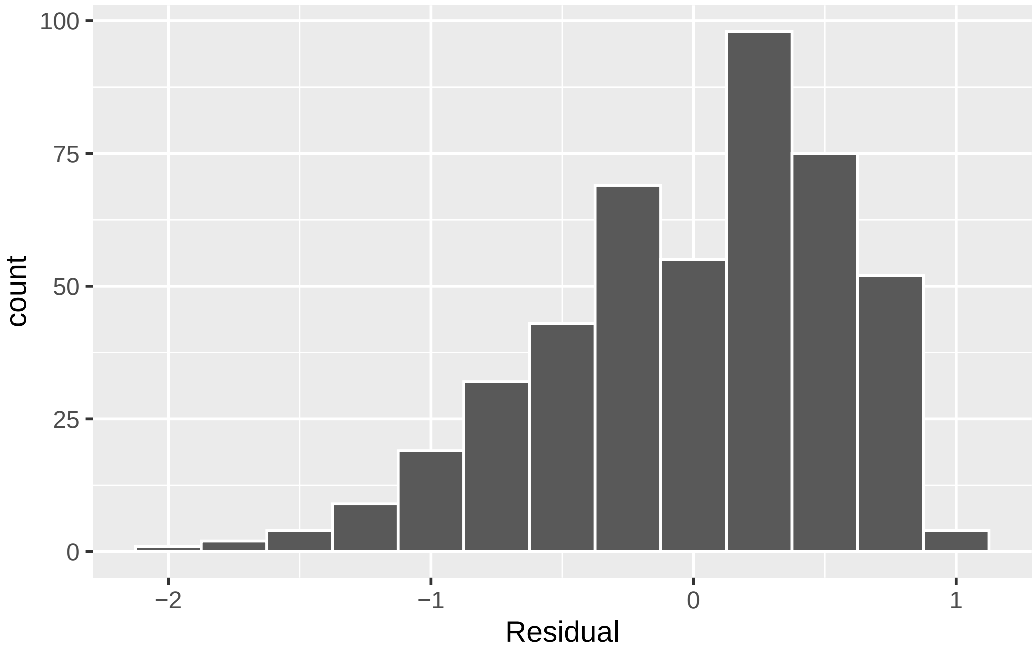
```
Warning: Using `size` aesthetic for lines was deprecated in ggplot2 3.4.0.
i Please use `linewidth` instead.
```



```r
ggplot(regression.points, aes(x = score_hat, y = residual)) +
  geom_point() +
  labs(x = "Fitted values", y = "Residual") +
  geom_hline(yintercept = 0, col = "blue", size = 1)
```



```
ggplot(regression.points, aes(x = residual)) +
  geom_histogram(binwidth = 0.25, color = "white") +
  labs(x = "Residual")
```


count
100
75
50
25
0
−2
−1
0
1
Residual

4. Perform the same analysis we did on life expectancy from the `gapminder` data set in 2007. However, subset the data for the year 1997. Are there any differences in the results across this 10 year period?

```
gapminder1997 <- gapminder |>
  filter(year == 1997) |>
  select(country, continent, lifeExp)

lifeExp.continent <- gapminder1997 |>
  summarize(median = median(lifeExp), mean = mean(lifeExp),.by=continent)
lifeExp.continent
```

```
# A tibble: 5 x 3
  continent median  mean
  <fct>      <dbl> <dbl>
1 Asia        70.3  68.0
2 Europe      76.1  75.5
3 Africa      52.8  53.6
4 Americas    72.1  71.2
5 Oceania     78.2  78.2
```

```
lifeExp.model <- linear_reg() |> fit(lifeExp ~ continent, data = gapminder1997)
lifeExp.model
```

```
parsnip model object


Call:
stats::lm(formula = lifeExp ~ continent, data = data)

Coefficients:
      (Intercept)  continentAmericas      continentAsia    continentEurope
            53.60              17.55              14.42              21.91
 continentOceania
            24.59
```

5. Return to the `Credit` data set and fit a multiple regression model with `Balance` as the outcome variable, and `Income` and `Age` as the explanatory variables, respectively. Assess the assumptions of the multiple regression model.

```
Cred <- Credit |>
  select(Balance, Income, Age)

Cred |>
  skim()
```

Table 1: Data summary

Name	Cred
Number of rows	400
Number of columns	3
Column type frequency:	
numeric	3
Group variables	None

Variable type: numeric

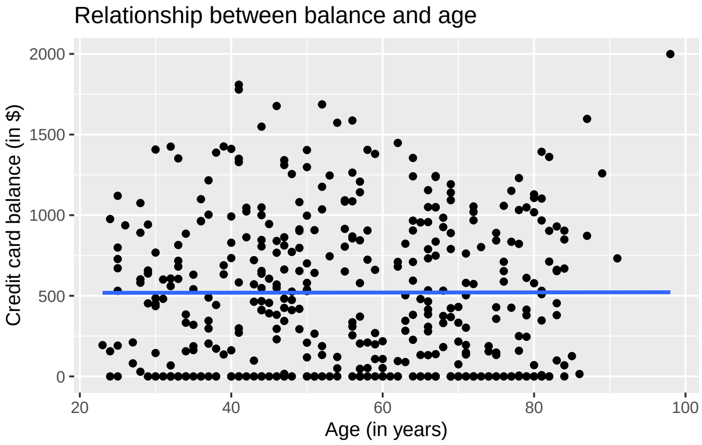
skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
Balance	0	1	520.02	459.76	0.00	68.75	459.50	863.00	1999.00	
Income	0	1	45.22	35.24	10.35	21.01	33.12	57.47	186.63	
Age	0	1	55.67	17.25	23.00	41.75	56.00	70.00	98.00	

```
Cred |>
  cor()
```

```
            Balance    Income         Age
Balance 1.000000000 0.4636565 0.001835119
Income  0.463656457 1.0000000 0.175338403
Age     0.001835119 0.1753384 1.000000000
```

```
ggplot(Cred, aes(x = Age, y = Balance)) +
  geom_point() +
  labs(x = "Age (in years)", y = "Credit card balance (in $)",
       title = "Relationship between balance and age") +
  geom_smooth(method = "lm", se = FALSE)
```

```
`geom_smooth()` using formula = 'y ~ x'
```

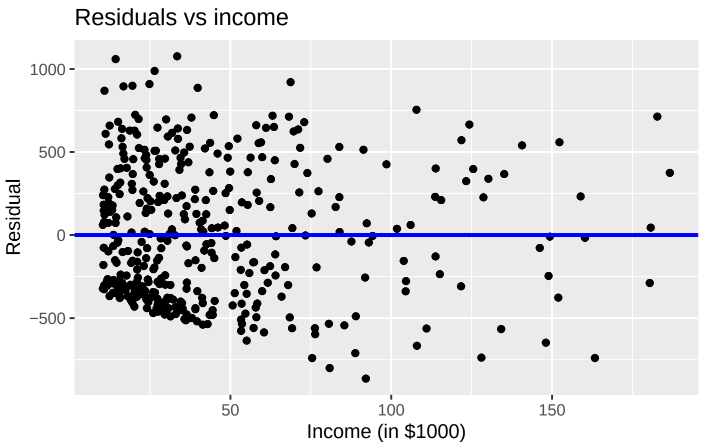


```
Balance.model <- linear_reg() |> fit(Balance ~ Age + Income, data = Cred)
tidy(Balance.model)
```

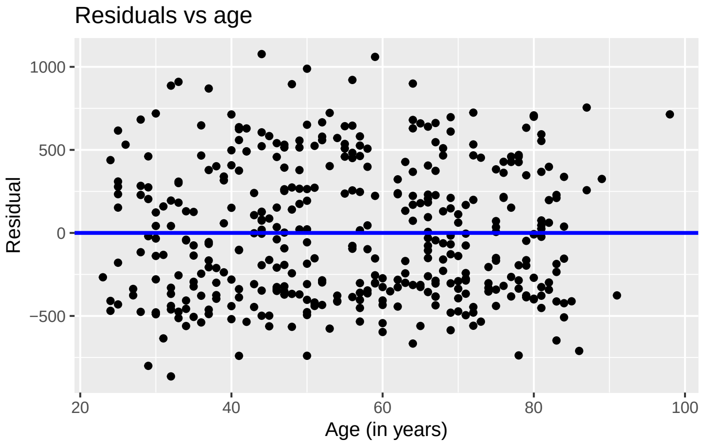
```
# A tibble: 3 x 5
  term        estimate std.error statistic  p.value
  <chr>          <dbl>     <dbl>     <dbl>    <dbl>
1 (Intercept)   360.       70.4       5.11 4.97e- 7
2 Age            -2.19      1.20     -1.82 6.91e- 2
3 Income          6.24      0.587    10.6  2.20e-23
```

```
regression.points <- get_regression_points(Balance.model$fit)

ggplot(regression.points, aes(x = Income, y = residual)) +
  geom_point() +
  labs(x = "Income (in $1000)", y = "Residual", title = "Residuals vs income")  +
  geom_hline(yintercept = 0, col = "blue", size = 1)
```

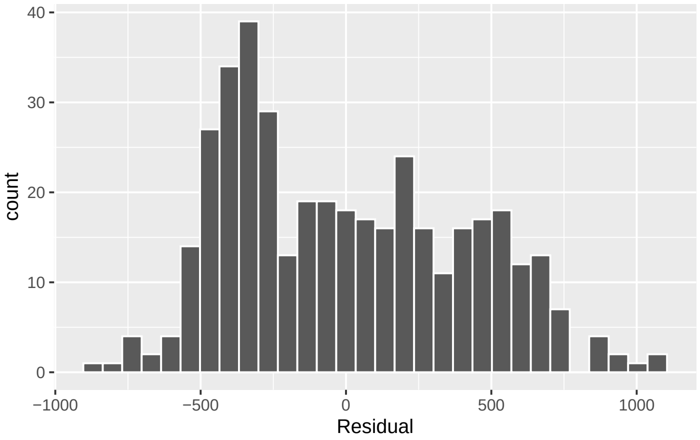


```
ggplot(regression.points, aes(x = Age, y = residual)) +
  geom_point() +
  labs(x = "Age (in years)", y = "Residual", title = "Residuals vs age")  +
  geom_hline(yintercept = 0, col = "blue", size = 1)
```



```
ggplot(regression.points, aes(x = residual)) +
  geom_histogram(color = "white") +
  labs(x = "Residual")
```

```
`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```


40
30
20
10
0
count
−1000
−500
0
500
1000
Residual