

# Homework 04

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## Problem 1

### 1. Null and Alternative Hypothesis

Mathematical

- $H_0 : \beta_1 = 0$
- $H_A : \beta_1 \neq 0$

Biological

- $H_0$  : Fish length is not a significant predictor of fish weight for trout perch.
- $H_A$  : Fish length is a significant predictor of fish weight for trout perch.

### 2. Visualize the missing data

```
#clean and select data
fish_data <- sqldf("SELECT year4, spname, length, weight
                    FROM fish_raw_data
                    WHERE spname = 'TROUTPERCH'")

#visualize missing data
vis_miss(fish_data)
```

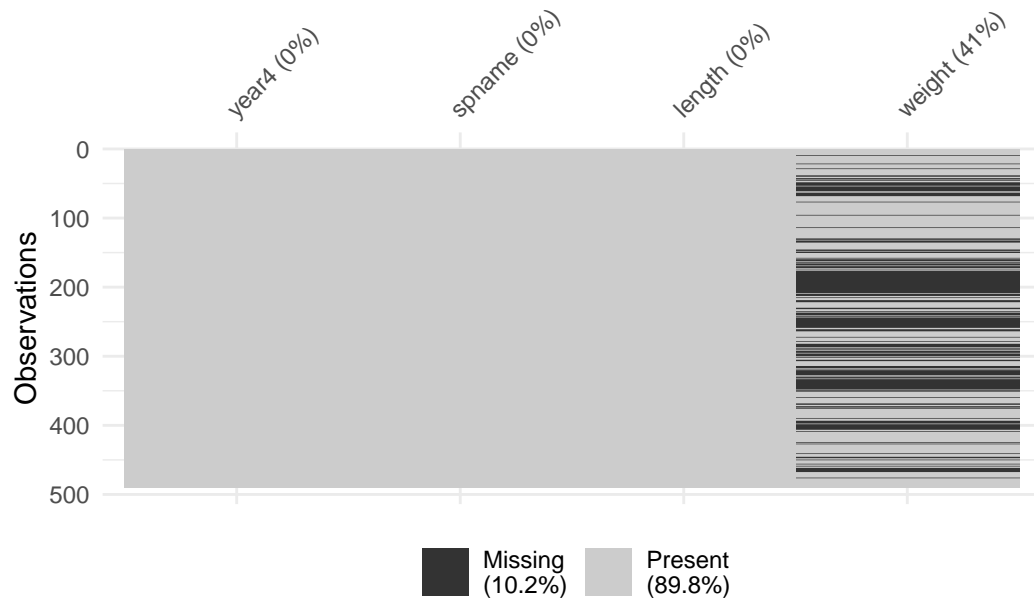


Figure 1: As shown in the figure above, 41% of the weight category has NAs. This is going to limit how many observations I have to use in the linear model, reducing its statistical power.

### 3. Run test

```
#create linear model
fish_lm <- lm(weight ~ length, data = fish_data)

#get residuals
fish_res <- fish_lm$residuals
```

### 4. Visually check assumptions

```
#diagnostic plots
par(mfrow = c(2,2)) #set 2x2 format
plot(fish_lm)
```

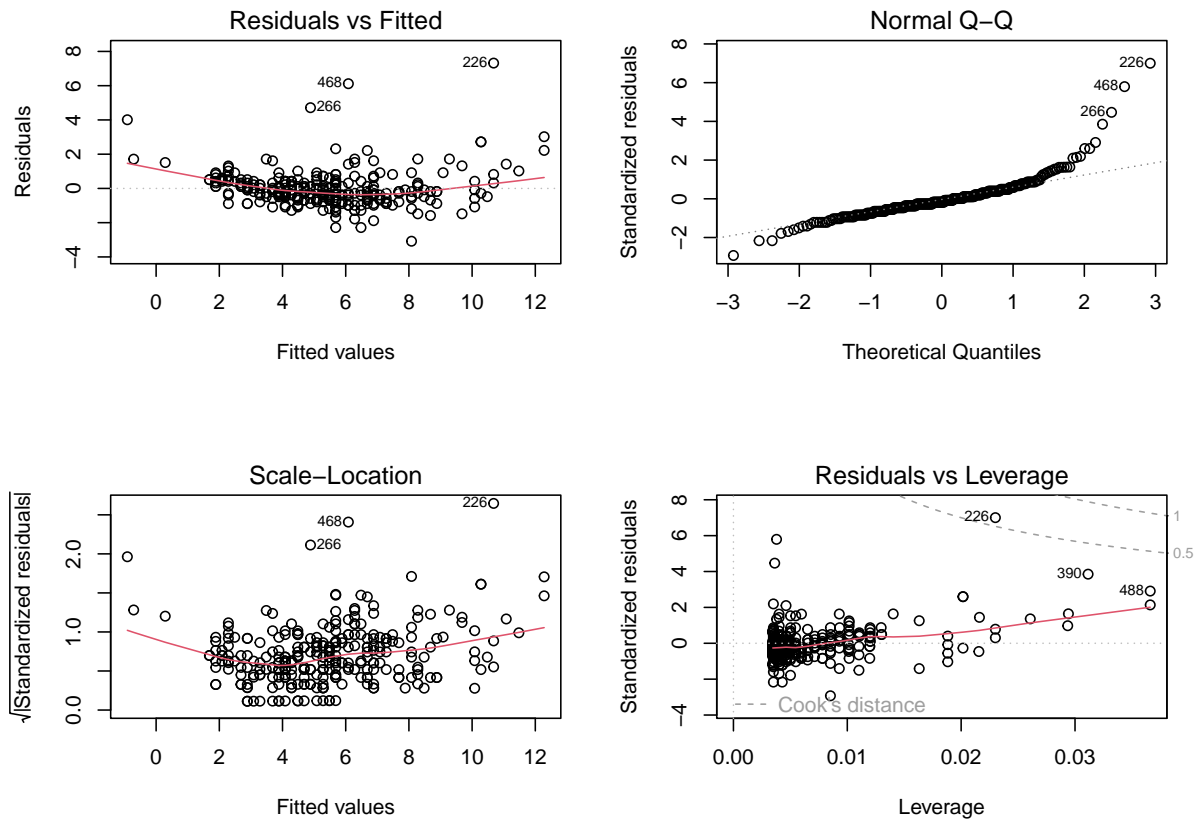


Figure 2: Diagnostic plots for linear model.

## 5. Descriptions of diagnostic plots

- **Residuals vs Fitted:** Shows residuals and fitted line to visualize constant variance. Dots appear to be evenly and randomly distributed around the line.
- **QQ:** Shows both data sets against one another. Data appears to be normally distributed.
- **Scale Location:** Similar to residuals vs fitted, showing homoscedasticity of variance. Data appears to be evenly and randomly distributed around the line.
- **Residuals vs Leverage:** Shows which data points are influential in the model. There are a few outliers identified that could be influential.

## 6. Display summary of model object

```
#summary of model object
summary(fish_lm)
```

```
Call:
lm(formula = weight ~ length, data = fish_data)

Residuals:
    Min       1Q   Median       3Q      Max
-3.0828 -0.4862 -0.1830  0.4128  7.3191

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -11.702476   0.481564  -24.30  <2e-16 ***
length       0.199852   0.005584   35.79  <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.057 on 288 degrees of freedom
(199 observations deleted due to missingness)
Multiple R-squared:  0.8164,    Adjusted R-squared:  0.8158
F-statistic: 1281 on 1 and 288 DF,  p-value: < 2.2e-16
```

## 7. Create summary ANOVA table

```
#store ANOVA table as object
fish_squares <- anova(fish_lm)

fish_squares
```

### Analysis of Variance Table

```
Response: weight
      Df Sum Sq Mean Sq F value    Pr(>F)
length  1 1432.29  1432.29  1280.8 < 2.2e-16 ***
Residuals 288  322.05    1.12
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#create table
fish_squares_table <- tidy(fish_squares) |>
  #round the sum of squares and mean squares columns to have 5 digits
  mutate(across(sumsq:meansq, ~ round(.x, digits = 5))) |>
```

```

#round the F-statistic to have 1 digit
mutate(statistic = round(statistic, digits = 1)) |>
#replace the very very very small p value with < 0.001
mutate(p.value = case_when(
  p.value < 0.001 ~ "< 0.001")) |>
#rename the stem_length cell to be meaningful
mutate(term = case_when( term == "length" ~ "Fish Length (mm)",
  TRUE ~ term)) |>
# format(scientific = T) |>
#make the data frame a flextable object
flextable() |>
#change the header labels to be meaningful
set_header_labels(df = "Degrees of Freedom",
  sumsq = "Sum of squares",
  meansq = "Mean squares",
  statistic = "F-statistic",
  p.value = "p-value")

```

fish\_squares\_table

| term             | Degrees of Freedom | Sum of squares | Mean squares | F-statistic | p-value |
|------------------|--------------------|----------------|--------------|-------------|---------|
| Fish Length (mm) | 1                  | 1,432.2877     | 1,432.28769  | 1,280.8     | < 0.001 |
| Residuals        | 288                | 322.0525       | 1.11824      |             |         |

## 8. Describe how the ANOVA table relates to the information given from summary object.

The information from this table is the relevant information about where the p-value and  $R^2$  come from.

## 9. Summarize results with in-text references to test results.

After checking the assumptions for a linear model (step 4), I performed the linear regression model of length and weight of trout that showed that length is a significant predictor of weight in trout (part 6). It also showed that 81.6% the variance in weight of trout can be explained by length. This is a high percentage, meaning that this model is a good fit.

## 10. Visualize the model predictions and confidence intervals.

```
#generate predictions
predictions <- ggpredict(fish_lm, terms = "length")

predictions
```

# Predicted values of weight

| length | Predicted | 95% CI         |
|--------|-----------|----------------|
| 50     | -1.71     | [-2.12, -1.30] |
| 60     | 0.29      | [-0.02, 0.59]  |
| 65     | 1.29      | [ 1.03, 1.54]  |
| 75     | 3.29      | [ 3.12, 3.45]  |
| 85     | 5.28      | [ 5.16, 5.41]  |
| 95     | 7.28      | [ 7.12, 7.44]  |
| 105    | 9.28      | [ 9.04, 9.53]  |
| 120    | 12.28     | [11.88, 12.68] |

```
#create visualization
plot_predictions <-
  #set global ggplot parameters
  ggplot(data = fish_data, aes(x = length, y = weight)) +
  #plot normal points
  geom_point() +
  #plot regression line
  geom_line(data = predictions, aes(x = x, y = predicted), color = 'red',
            linewidth = 1) +
  #plot confidence interval and make it transperent
  geom_ribbon(data = predictions, aes(x = x, y = predicted,
                                     ymin = conf.low, ymax = conf.high), alpha = 0.2) +

  #set theme
  theme_bw() +
  #create labels and captions
  labs(x = 'Fish Length (mm)', y = 'Fish Weight (g)',
       title = 'Fish Length as a Predictor of Fish Weight',
       caption = "Figure 3: Shows fish lengths' and weights' plotted against the predict
                 interval shaded around the regression line.") +
  #change font type and caption loaction
  theme(plot.caption = element_text(hjust = 0),
```

```
text = element_text(family = 'Times'))  
  
#show plot  
plot_predictions
```

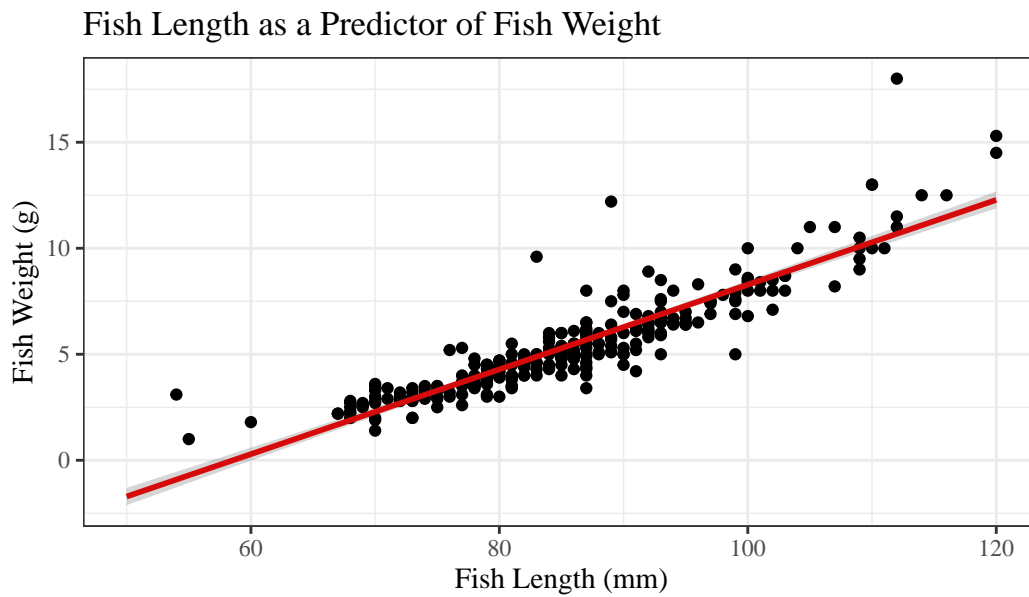


Figure 3: Shows fish lengths' and weights' plotted against the predictions with an accompanying confidence interval shaded around the regression line.

[Repo Link](#)