homework_2

2025-10-07

This homework will focus heavily on regression with linear-linear, log-linear, and log-log all making an appearance and indicators as well. My advice is to use the class time to focus on either the log-log models (Q18-25) or indicators (Q26 onwards). The first section is a regular linear model like you explored in the last lab.

HINT: you will make four models (one for linear, one for log-linear, one for log-log and one that deals with indicators) and I suggest you save all four models. My naming scheme is usually along the lines of

mod_line <- LINEAR MODEL CODE

mod_log_line <- LOG-LINEAR MODEL CODE

mod_log_log <- LOG-LOG MODEL CODE

mod_ind <- INDICATOR MODEL CODE

The data set we will be using today is actually a super fun one an old mentor of mine collected on.....LEGOs! I use to love LEGOs growing up so now you get to play with LEGOs (...data set).

First, let's read in the data and look at the first few rows

```
legos <- read.csv('https://vinnys-classes.github.io/data/legos_data.csv')
head(legos)
```

```
##   Item_Number                    Set_Name Theme Pieces Year Pages Minifigures
## 1       10859          My First Ladybird Duplo      6 2018     9          NA
## 2       10860          My First Race Car Duplo      6 2018     9          NA
## 3       10862       My First Celebration Duplo     41 2018     9          NA
## 4       10864 Large Playground Brick Box Duplo     71 2018    32           2
## 5       10867            Farmers' Market Duplo     26 2018     9           3
## 6       10870               Farm Animals Duplo     16 2018     8          NA
##     Packaging Unique_Pieces  Size amazon_price age
## 1         Box             5 Large        16.00   1
## 2         Box             6 Large         9.45   1
## 3         Box            18 Large        39.89   1
## 4 Plastic box            49 Large        56.69   2
## 5         Box            18 Large        36.99   2
## 6         Box            13 Large         9.99   2
```

```
legos$Year <- as.factor(legos$Year)
```

The variables are...

1) Item_Number: ID
2) Set_Name: The selling name of the lego set

3) Theme: One of three themes
4) Pieces: Number of pieces in the set
5) Year: Year the set was made
6) Pages: Number of pages in the booklet
7) Minifigures: Number of "people" sold with the set
8) Package: What type of packaging the set comes in
9) Unique Pieces: How many unique lego blocks are in the set
10) Size: The size of the blocks, with two levels
11) amazon_price: Price of the on Amazon as of a few years ago
12) age: the lowest age the company recommends for the data set

Correlation

Q1

Please make make three scatterplots. All three should have amazon_price as the y-axis and the three x-axis should be the variables Pieces, Pages, and Minifigures.

Q2

Based on the three graphs in question 1, please indicate whether you think Pearson's or Spearman's correlation coefficients is more appropriate for talking about the 3 explanatory variable's relationship with the response. Explain why (note: you don't need to pick a correlation for each graph seperately but just one for all three graphs)

Q3

In your own words, please explain what it means to have a negative correlation. (No, this isn't related to the scatterplot but it's a good question that I want you to try to answer)

Linear Regression

We will continue to use the lego data set for this.

Q4

Using geom_smooth(), please plot a best-fit-line (by using the 'lm' method of geom_smooth) to the scatterplot of amazon price by number of pieces. Describe the scatterplot by noting it's direction, form, outliers, and strength please.

Q5

Using the lm() function, please fit a linear model with amazon price as the response variable and the number of pieces as the explanatory variable. Print out the summary of the model using the summary() function

Q6

Please save your residuals and your predictions from this model. The resid() and predict() functions are useful for this.

Q7

Make a residual scatterplot by having the residuals of your model on the y-axis and the predicted price on the x-axis.

Q8

Please comment on if the homoskedasticity and normality assumptions are met for our linear model by using the graph made in question 7

Q9

Regardless of your answer to question 8, please write down the estimated linear regression equation. Be sure to use the name of the y and x variables in the equation and to indicate y is predicted (and not observed).

Q10

Interpret your intercept from the above equation

Q11

Interpret your slope from the above equation

Q12

Predict the cost a lego set containing 55 pieces.

Q13

The Monster Truck lego set actually has 55 pieces. Using Q12 and the lego set's actual amazon price please calculate the residual. HINT: Monster Truck is the 71st row of our data set.

Q14

Find R^2. There are several ways to do this including using the summary() output for the model earlier or using pearson's correlation coefficient. Interpret it.

Q15

All said and done, do you think this model explains the relationship well?

Transformation

What I dislike about the residual graph I made is that there seemed to be some really outstretched values along the y-axis. That can indicate that the response variable should be transformed via a log() fucntion (but not always!!).

Log-Linear Model

Q16

As such, please make a scatterplot with the log of the amazon price as the y-axis and leave the x-axis as the number of pieces used. Comment on whether you think this graph is sufficently linear.

Q17

Using log(amazon_price) as the response variable and pieces as the x-axis, fit a linear regression model. Plot the residuals similar to question 7 with your residuals as the y-axis and the predicted values on the x-axis. Comment if the normality and homoskedasiticity assumptions are met.

Let's try one more transformation to see if we can get something closer to what we are after

Log-Log Model

Q18

As such, please make a scatterplot with the log of the amazon price as the y-axis and the log of the number of pieces used as the x-axis. Use geom_smooth to fit a best-fit-line similar to question 7.

Q19

Fit a linear model using log(amazon_price) as your response and log(Pieces) as your explanatory variable.

Q20

Create a residual graph for the model created in Q19 and comment on whether the normality and homoskedasiticity assumptions are met.

Q21

Write down your estimated equation. Be sure to indicate what the y and x variables are and that the response is estimated. Also note that in your model both variables are transformed to log()'s. You do not need to back transform for this question.

Q22

Interpret your value for $\hat{\beta}_0$, the intercept of your model. Be careful to differentiate between predicting the mean vs predicting the median.

Q23

Interpret your value for $\hat{\beta}_1$, the slope of your model. Be careful to differentiate between predicting the mean vs predicting the median.

Q24

Again, please find the predicted price for a lego set with 55 pieces using the model you just created. Be sure that the prediction is reported on the linear scale (ie I want the prediction listed in dollars). You will want to back transform for this problem.

Q25

Using Q24's prediction, calculate the residual for the Monster Truck lego set in the data. Be sure that the residual is reported on the linear scale (ie I want the residual listed in dollars).

Indicators

For this we are going to do something a little odd. We are going to treat Year as a categorical variable and just say that 2018, 2019, and 2020 are just labels (ie nominal) that don't mean anything numerically. Making Year nominal has already been done in the code I wrote at the top of the file that reads in the data set.

Q26

Make a plot similar to the one in the class notes. Your x-axis should be Year and your y-axis shoudl be amazon sales price

HINT: Use geom_jitter() and not geom_point(). If the points are spread out too wide, play around with the "widths" parameter in geom_jitter()

Q27

Make a linear model using Year as an explanatory variable and amazon price as the response variable.

Q28

Make a scatterplot with your residuals on the y-axis and the x-axis being Year.

Q29

Comment on if the three categories (years) have heteroskedasticity or if the residuals are not normal.

HINT: Use geom_jitter() and not geom_point(). If the points are spread out too wide, play around with the "width" parameter in geom_jitter()

Q30

Write down your best-fit-line equation. Please use the model form which uses β's, and not the one that uses α's. HINT: run the summary() command on your model and then look at the "Coefficients" table, specifically the "Estimates" column. See the alternative slide deck for indicators for an example

Q31

Predict the cost of a lego set that was made in the 2020.

Q32

Find the residual (again) for the Monster Truck set (which was made in 2020)

Q33

Interpret your $\hat{\beta}_0$ value

Q34

Interpret your $\hat{\beta}_1$ value

Q35

Interpret your $\hat{\beta}_2$ value

Q36

Find the different between $\hat{\beta}_2$ and $\hat{\beta}_1$. What *is* this difference? What does it represent?