**Outliers:**

All code used is in the folder Task2 on GitHub and all figures can be found on the last page

How do outliers affect the estimate of the coefficients?

Outliers can have an effect on the linear regression in many ways and one of the ways is that it can affect the outcome of the coefficients like the correlation coefficient and variance.

The way it impacts the correlation coefficient is it can make the line steeper or less steep depending on where the outlier lies on the graph. For example if you have an outlier below the regression line it means that it has a negative residual so it brings the correlation coefficient down and therefore makes the line less steep and vice versa for if the outlier is above the line it has a positive residual so makes the coefficient bigger and makes the line steeper.

Example:

I manually plotted some points here of a plot with no outliers, in figure 1.1, and has a regression line as shown below. It has the regression coefficient of 1.1583 and intercept 0.825

Now when we add one outlier to this csv file and I will add it below the line first to see the impact it has. So for the first graph, fig 2.2, you can see the outlier is below the line at the coordinates (19, 1) and in the second the outlier is above the line with the coordinates (20, 50). In the first graph which the outlier has a negative residual the line becomes less steep and the regression coefficient became 0.229 from the 1.15 before the outlier and the intercept is 7.79 from 0.825. And for the outlier with a positive residual it became 2.276 and the intercept became -7.7 which is an increase also. This shows how much outliers can have an impact on the coefficients and that it impacts their correlation coefficient.

How can we detect them and remove outliers?

In the version we did with graph and a regression line you can see that it is quite simple to spot an outlier as I have circled in the graphs because they do not fit a pattern however there are ways to find outliers if you don’t have a graph as well.

There are numerous ways to detect outliers could be with box plots, percentiles, z-score and standard deviation. I will be using standard deviation for my example.

So first thing we have to do is to use the equation of the line to work out the predicted y value from x and in my case I will be using figure 2.1 and 2.2 for the outlier detection example. So with the prediction I have the equation of the line which I worked out from doing regression.coef\_ and regression.intercept\_ in python and it gave me the equation of the line of y = 1.158x + 0.825. And from this I have to make a new column called y\_prediction so I substitute every value of x into the formula to work out the y value we are predicted to get with the model. After this we can then work out the residuals of the points with accurate numbers we got from the table in the csv file and you do that by doing the y value subtract the y-prediction. After you do this you can work out the standard deviation of the residuals and then do 2\*standard deviation. This value will allow you to then look for values that have residual out of that range is therefore an outlier. (All in fig 3.1) From the figure you can see that the outlier value is the last row because the y value lies outside of 2 standard deviations from the prediction we got from the line therefore it is an outlier and is one way to predict it.

How to spot in covariate:

A covariate variable is an independent variable so it is what we are predicting an outcome to be. So to spot outliers in this variable we can see if an outcome looks impossible to have for example if there’s an independent variable of age we probably have an outlier if the age is somewhere above 120 years old it is probably an outlier.

How to spot in Noise:

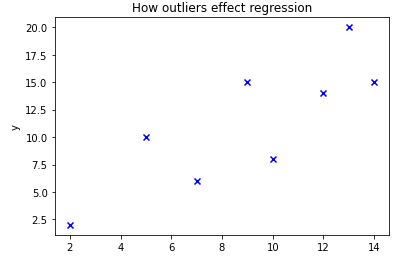
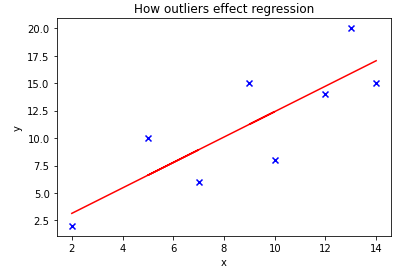


Fig 1.1

Fig1.3

Fig 1.2



Fig 2.1

Fig2.4

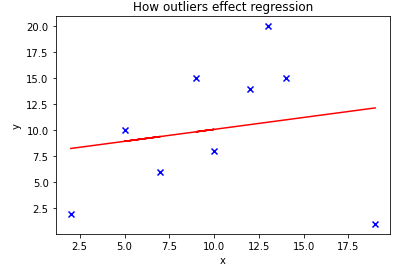
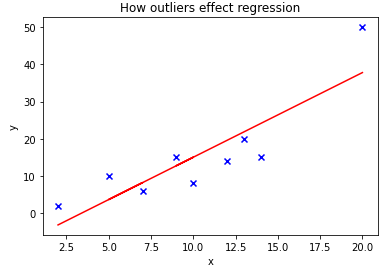


Fig2.3

Fig2.2



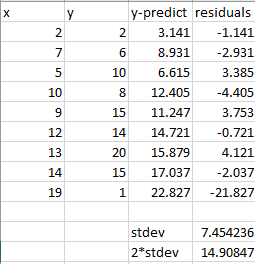


Fig 3.1