Sub-Project 2
Data Cleaning
Handling Missing Values and Outlier Analysis

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QUESTION 1

Plot a graph of the attribute names (x-axis) with the number of missing values in them (y-axis).

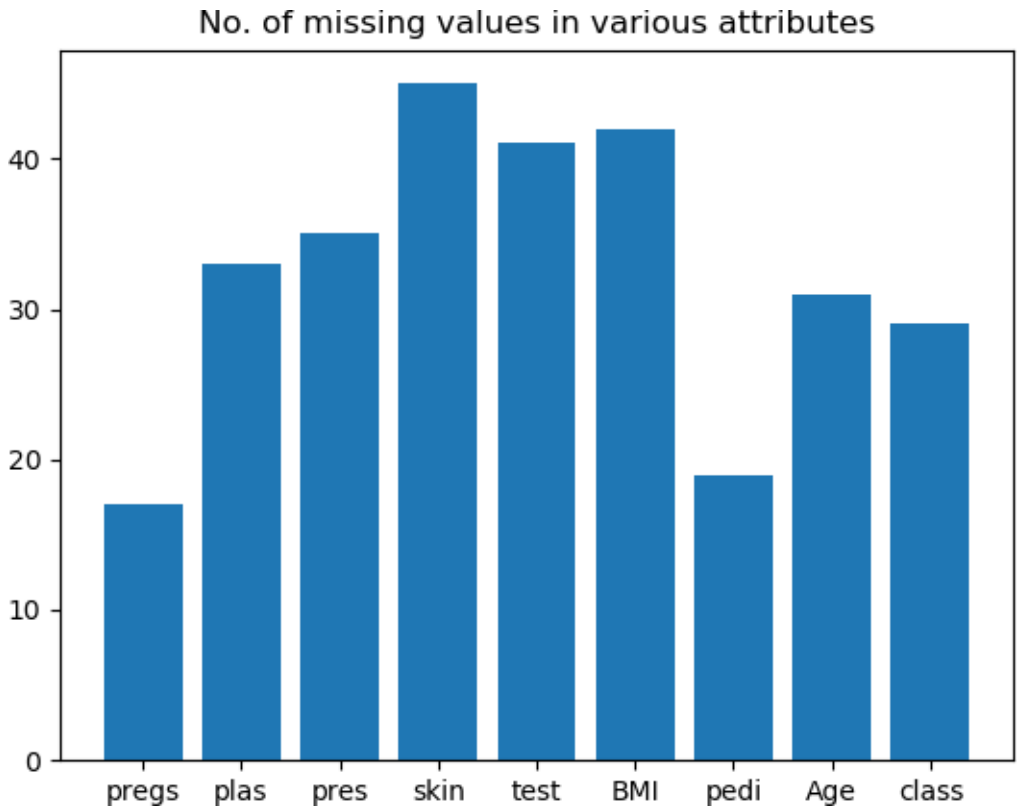


Fig 1

The plot shows the number of missing values in every individual attribute. For a database with around 800 tuples, this isn't that bad.

QUESTION 2A

Delete (drop) the tuples (rows) having equal to or more than one third of attributes with missing values. Print the total number of tuples deleted and also print the row numbers of the deleted tuples.

```
39 tuples were deleted
The row number for the tuples deleted are [1, 39, 40, 53, 54, 83,
 89, 103, 125, 136, 145, 210, 211, 212, 213, 249, 250, 254, 280,
281, 284, 314, 321, 335, 429, 430, 449, 450, 451, 471, 472, 473,
474, 718, 719, 720, 721, 753, 766]
```

Fig 2

QUESTION 2B

Drop the tuples (rows) having missing value in the target (class) attribute. Print the total number of tuples deleted and also print the row numbers of the deleted tuples

```
21 tuples were deleted
The row number for the tuples deleted are [8, 13, 28, 29, 35, 62,
 92, 95, 107, 110, 130, 131, 132, 133, 149, 182, 188, 218, 308, 7
46, 748]
```

Fig 3

QUESTION 3

After step 2, count and print the number of missing values in each attributes. Also find and print the total number of missing values in the file (after the deletion of tuples).

```
The number missing values in the different attributes are:
pregs - 0
plas - 12
pres - 9
skin - 8
BMI - 12
pedi - 2
Age - 18
class - 0
The total number of missing values in the file are 69
```

Fig 4

QUESTION 4A

Replace the missing values by mean of their respective attribute.

i. **Compute the mean, median, mode and standard deviation for each attribute and compare the same with that of the original file.**
ii. **Calculate the root mean square error (RMSE) between the original and replaced values for each attribute. Plot these RMSE with respect to the attributes.**

Original

	Attributes	Mean	Median	Mode	Standard Deviation
0	Pregnancies	3.845052	3.0000	[1]	3.367384
1	Glucose	120.894531	117.0000	[99, 100]	31.951796
2	Blood Pressure	69.105469	72.0000	[70]	19.343202
3	Skin Thickness	20.536458	23.0000	[0]	15.941829
4	Insulin	79.799479	30.5000	[0]	115.168949
5	BMI	31.992578	32.0000	[32.0]	7.879026
6	Diabetes Pedigree Function	0.471876	0.3725	[0.254, 0.258]	0.331113
7	Age	33.240885	29.0000	[22]	11.752573
8	Outcome	0.348958	0.0000	[0]	0.476641

After substituting with mean

	Attributes	Mean	Median	Mode	Standard Deviation
0	Pregnancies	3.885593	3.000000	[1.0]	3.371477
1	Glucose	120.666667	118.000000	[99.0, 100.0]	30.968288
2	Blood Pressure	69.001431	72.000000	[70.0]	19.677448
3	Skin Thickness	20.348571	23.000000	[0.0]	15.934938
4	Insulin	77.814286	36.000000	[0.0]	110.529464
5	BMI	32.009339	32.009339	[32.0]	7.759269
6	Diabetes Pedigree Function	0.476042	0.382500	[0.254, 0.258]	0.332964
7	Age	33.094203	29.000000	[22.0]	11.511532
8	Outcome	0.343220	0.000000	[0.0]	0.474784

Fig 5

The main advantage of substituting with mean is that the values of the central tendencies does not change after addition. We see a change in the values Mean, Median and Standard Deviation because we were asked to do calculations on the original data, before the deletion of rows.

The value of Mode more or less remains unchanged as not many tuples with the Mode were removed. Had that been the case, the values for Mode would've been found to be starkly different too.

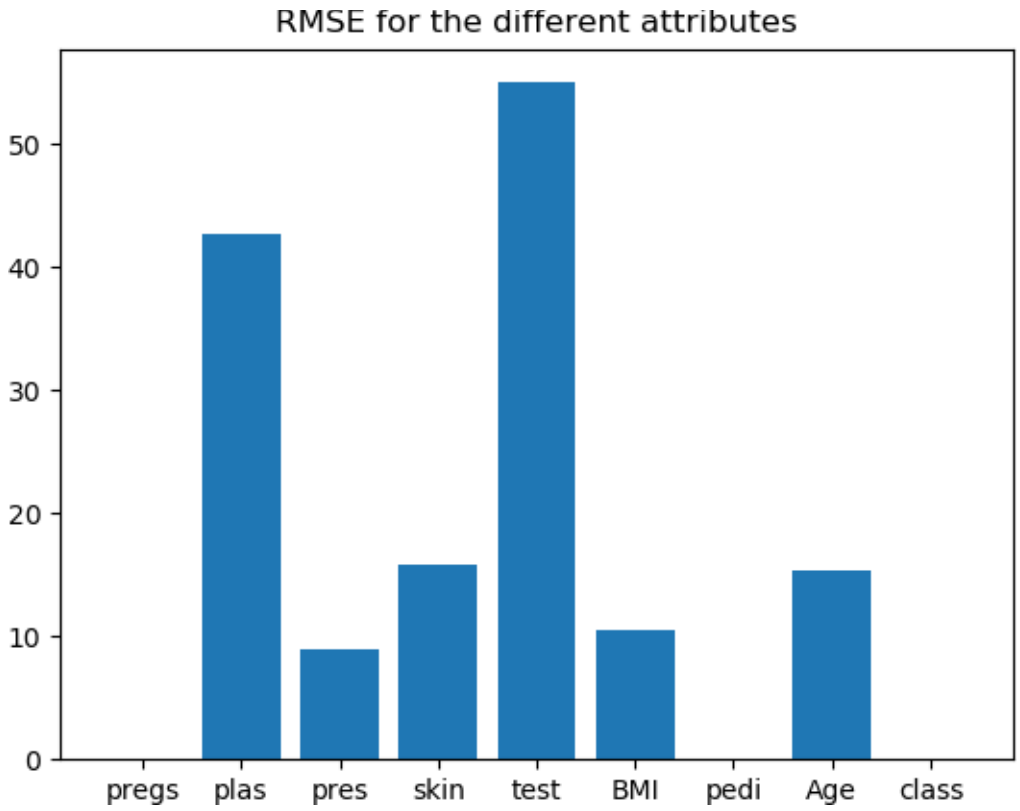


Fig 6

We can observe that the values we put in were very different from the actual values atleast for the attributes test and plas. This is one of the downfalls of simply substituting with mean as it is pretty unlikely that mean is also what the actual/predicted value is.

QUESTION 4B

Replace the missing values in each attribute using linear interpolation technique.

i. **Compute the mean, median, mode and standard deviation for each attribute and compare the same with that of the original file.**
ii. **Calculate the root mean square error (RMSE) between the original and replaced values for each attribute. Plot these RMSE with respect to the attributes.**

Original

	Attributes	Mean	Median	Mode	Standard Deviation
0	Pregnancies	3.845052	3.0000	[1]	3.367384
1	Glucose	120.894531	117.0000	[99, 100]	31.951796
2	Blood Pressure	69.105469	72.0000	[70]	19.343202
3	Skin Thickness	20.536458	23.0000	[0]	15.941829
4	Insulin	79.799479	30.5000	[0]	115.168949
5	BMI	31.992578	32.0000	[32.0]	7.879026
6	Diabetes Pedigree Function	0.471876	0.3725	[0.254, 0.258]	0.331113
7	Age	33.240885	29.0000	[22]	11.752573
8	Outcome	0.348958	0.0000	[0]	0.476641

After Interpolation

	Attributes	Mean	Median	Mode	Standard Deviation
0	Pregnancies	3.885593	3.0000	[1.0]	3.371477
1	Glucose	120.349576	117.0000	[99.0, 100.0]	31.252704
2	Blood Pressure	69.109463	72.0000	[70.0]	19.722043
3	Skin Thickness	20.392655	23.0000	[0.0]	15.964563
4	Insulin	77.355226	27.0000	[0.0]	110.677746
5	BMI	32.046328	32.2500	[32.0]	7.787110
6	Diabetes Pedigree Function	0.477325	0.3825	[0.254, 0.258]	0.334012
7	Age	33.216102	29.0000	[22.0]	11.644416
8	Outcome	0.343220	0.0000	[0.0]	0.474784

Fig 7

All values change just as we expected them to. The value of Mode does not change as it very unlikely that introducing a few interpolated value will cause the number of instances of some other individual value to increase by a huge margin.

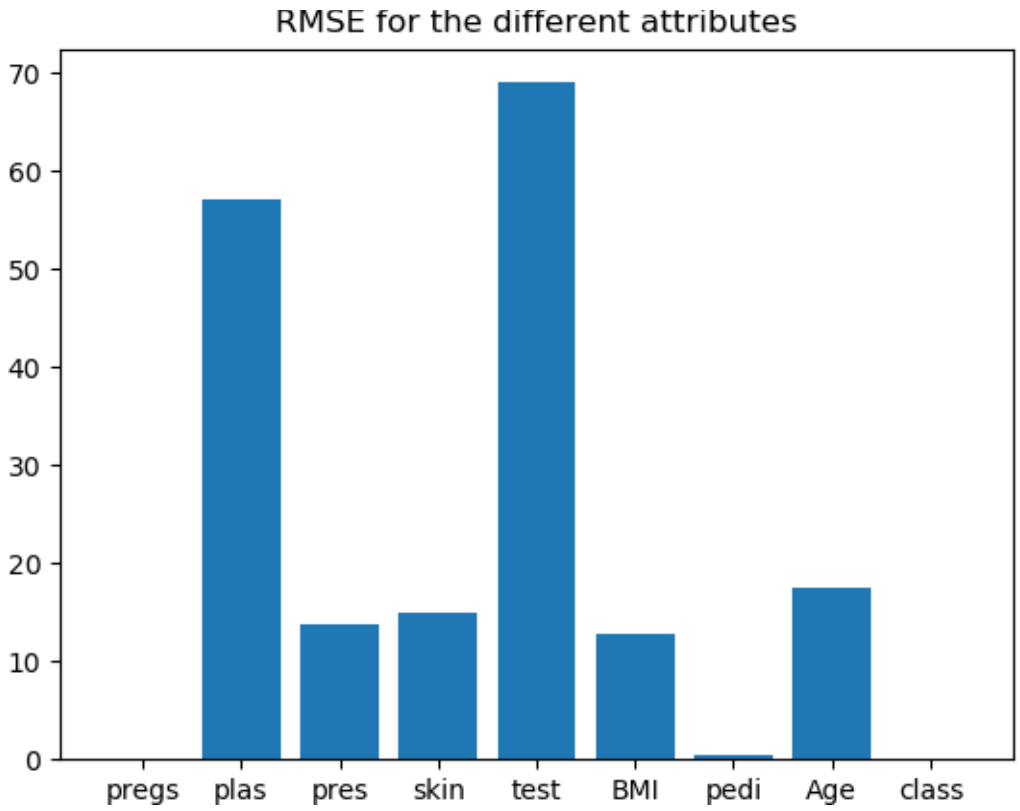


Fig 8

The RMSE is again very high for test and plas. Linear Interpolation works and gives more accurate values when the data is sequential but since here the data did not really have any particular sequence, using Linear Interpolation was as good as any other method and as observed even worse than the others.

QUESTION 5A

After replacing the missing values by interpolation method, find the outliers in the attributes "Age" and "BMI". Outliers are the values that does not satisfy the condition (Q1 – (1.5 * IQR)) < X < (Q3 + (1.5 * IQR)), where X is the value of the attribute, IQR is the inter quartile range, Q1 and Q3 are the first and third quartiles. Obtain the boxplot for these attributes.

The outliers for age are [69., 67., 72., 81., 67., 70., 68., 69.].

Fig 9

The outliers for BMI are [0. , 0. , 0. , 0. , 0. , 0. , 0. , 0. , 0. , 53.2, 67.1 , 52.3, 52.3, 52.9, 59.4, 57.3]

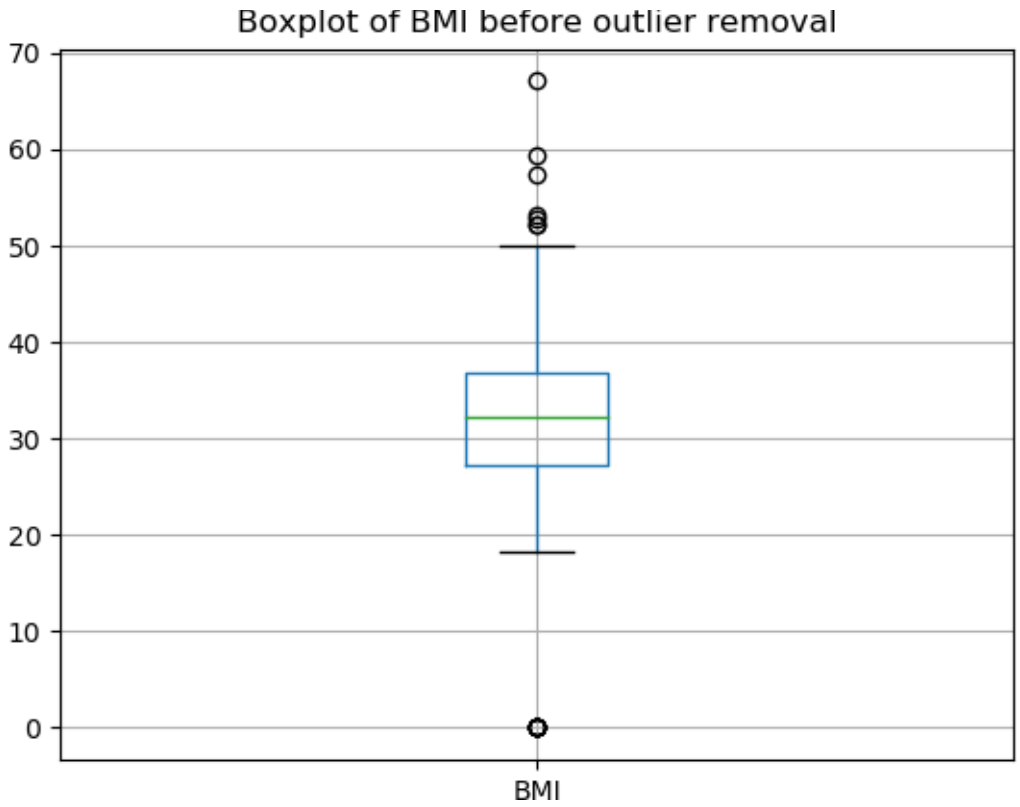
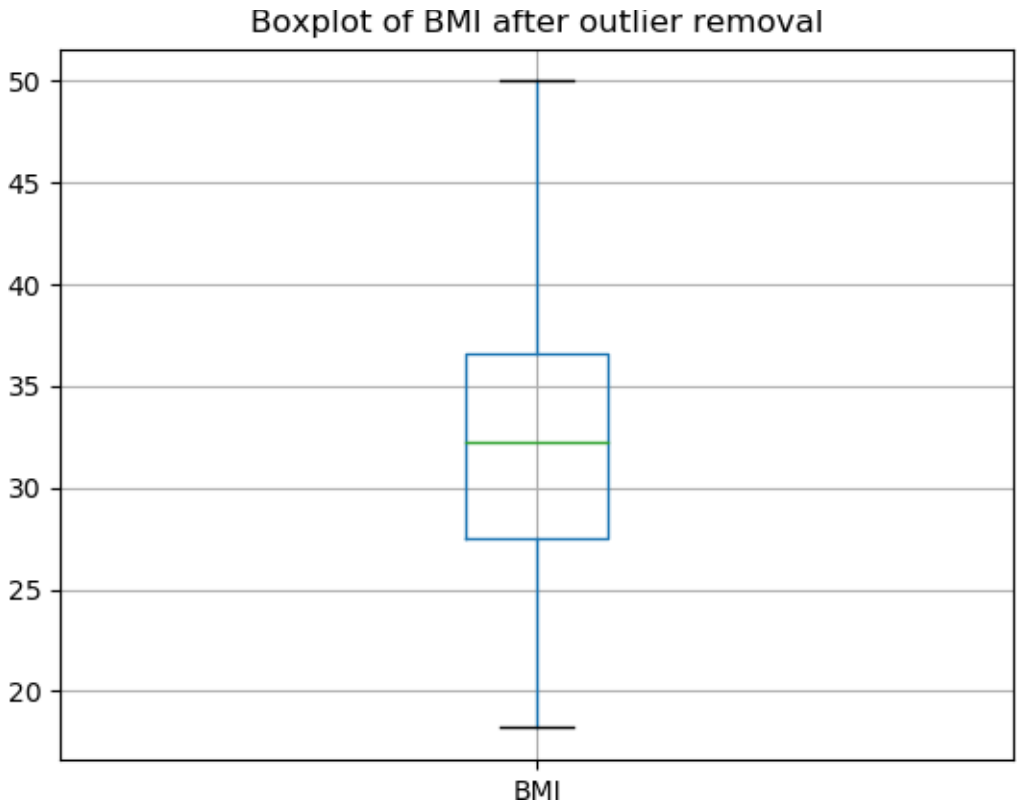


Fig 10

QUESTION 5B

Replace these outliers by the median of the attribute. Plot the boxplot again and observe the difference with that of the boxplot in (5i). Do you still get outliers? Why?Plot the histogram of attribute 'rain' for each of the 10 stations


Boxplot of Age after outlier removal
60
50
40
30
20
Age



We still do get outliers as the overall data has now completely changed and hence the Median and the IQR is different. So, is the boundary for upper whisker and lower whisker and this causes newer extreme values to show up as our outliers.