Data Warehousing and Data Mining

Tutorial 1

Student Details

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In [56]:

```
import pandas as pd
import math
from copy import deepcopy
from pyod.models.hbos import HBOS

print("Imports loaded")
```

```
Imports loaded
```

In [57]:

```
file_name = "Histograms.csv"

file_name
```

Out[57]:

```
'Histograms.csv'
```

In [58]:

```
# load dataset into pandas df
df = pd.read_csv(file_name)
df.head()
```

Out[58]:

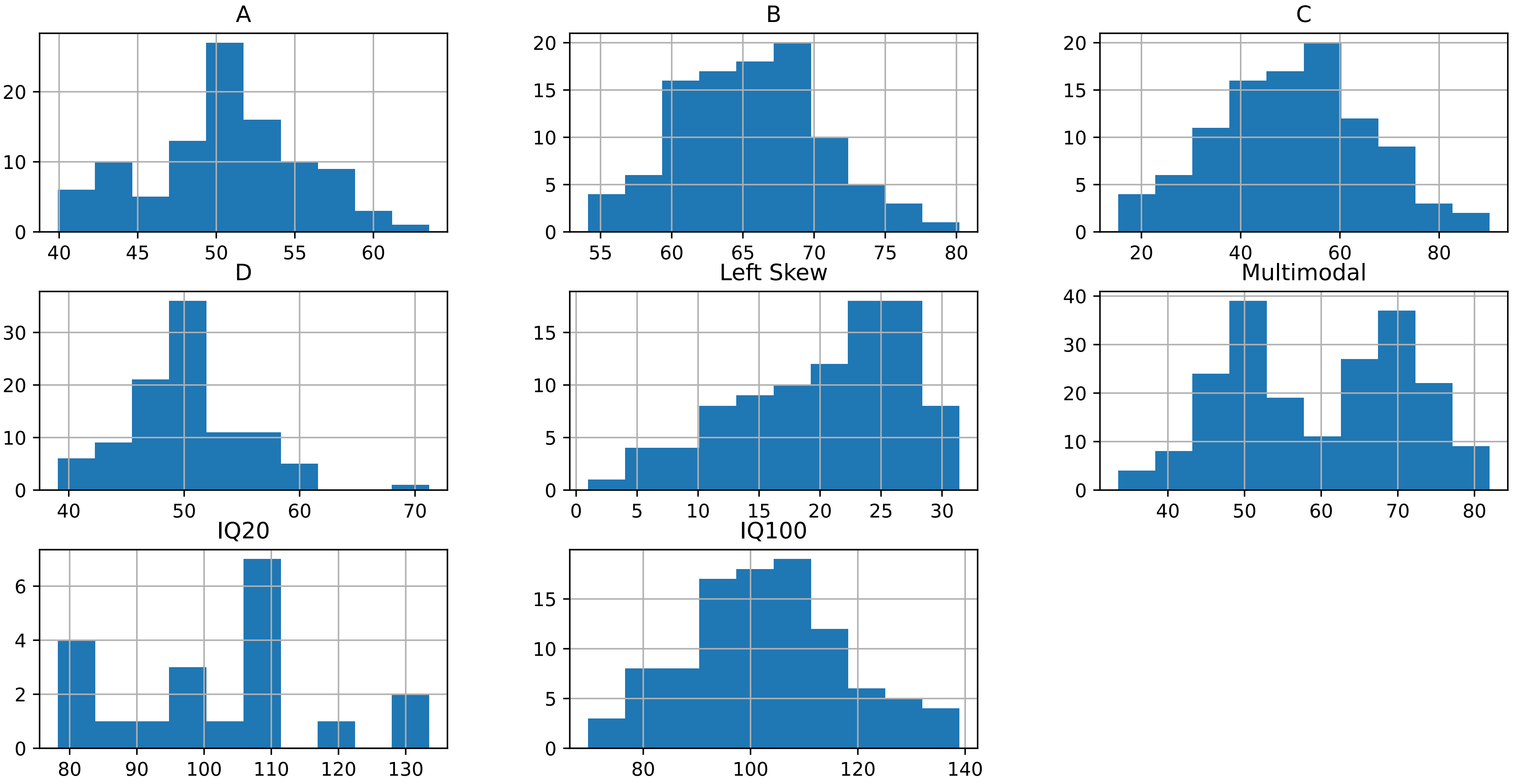
	A	B	C	D	Left Skew	Multimodal	IQ20	IQ100
0	48.916926	67.223785	55.917225	45.561471	23.1	37.632318	120.459951	93.041368
1	47.692726	68.175751	30.174288	47.825783	18.2	49.244001	107.418864	93.806158
2	48.629579	61.753451	43.641583	59.699370	14.6	37.780203	95.006312	135.339681

	A	B	C	D	Left Skew	Multimodal	IQ20	IQ100
3	58.544034	69.783507	53.738745	45.704638	21.2	56.827208	96.522192	100.772632
4	44.821338	70.730153	67.829659	44.254419	24.5	54.513731	108.878563	91.600053

1. Generate the histograms for the frequency of values in the dataset uploaded to the classroom and study statistical characteristics like Mean, Mode, Median, Variance of any sample (Histograms can be generated in Excel/Python/Orange, etc).

In [59]:

```
# histograms
hist = df.hist(figsize=[14,7])
```



In [60]:

```
# mean, median, mode, variance for all columns
print(f"Mean\n{df.mean()}")
print("")
print(f"Median\n{df.median()}")
print("")
print(f"Variance\n{df.var()}")
```

```
Mean
A               50.632133
B               65.544513
C               50.851334
D               50.211539
```

```
Left Skew      20.107609
Multimodal     59.734576
IQ20          102.132401
IQ100         102.925179
dtype: float64

Median
A              50.673711
B              65.898797
C              51.654882
D              49.726685
Left Skew      21.500000
Multimodal     60.602041
IQ20          105.608402
IQ100         101.426575
dtype: float64

Variance
A              25.635211
B              25.861999
C             235.387254
D              27.339516
Left Skew      49.665985
Multimodal    132.553093
IQ20          241.831182
IQ100         231.757566
dtype: float64
```

2. Perform skewness analysis for the data and decide the suitable missing valuereplacement for the ratio scale and interval scale numerical data attributes.

In [61]:

```
# skewness analysis
print(f"Skewness\n{df.skew()}")
print("")
# kurtosis analysis
print(f"Kurtosis\n{df.kurt()}")

# As you can see in the below data, the absolute skewness of D and Left Skew is fairly high and requires use of median
# instead of usual mean to fill NaN values
#
```

```
Skewness
A            -0.060298
```

```
B             0.166426
C            -0.036257
D             0.662782
Left Skew    -0.615309
Multimodal   -0.043677
IQ20          0.274567
IQ100         0.249707
dtype: float64

Kurtosis
A            -0.292248
B             0.063429
C            -0.304000
D             1.711042
Left Skew    -0.499210
Multimodal   -1.164263
IQ20         -0.297661
IQ100        -0.278870
dtype: float64
```

3. Perform Missing value replacement by Mean, Mode, Median on the A attributes. Intentionally remove two values from that attribute and find the value of the X and Y for given data using mean value replacement (perform the operation on first 12 records).

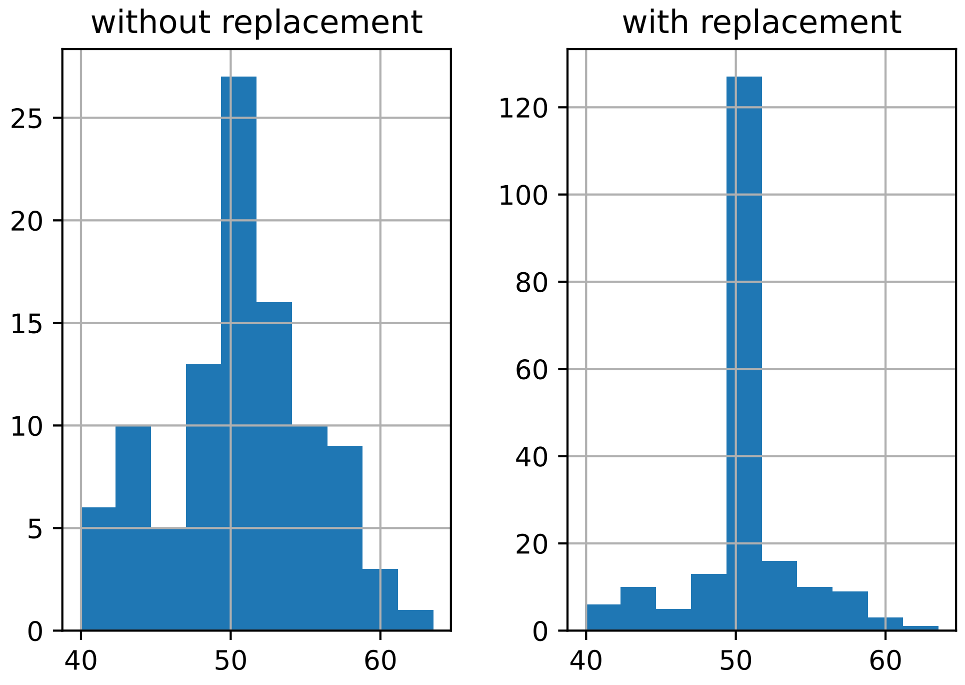
In [62]:

```python
# replacing with mean values
col_a_mean = deepcopy(df["A"])
mean = df["A"].mean()
col_a_mean = col_a_mean.fillna(mean)
mean_df = pd.DataFrame({"without replacement":df["A"],"with replacement":col_a_mean})

mean_df.hist()
```

Out[62]:

```
array([[<AxesSubplot:title={'center':'without replacement'}>,
        <AxesSubplot:title={'center':'with replacement'}>]], dtype=object)
```



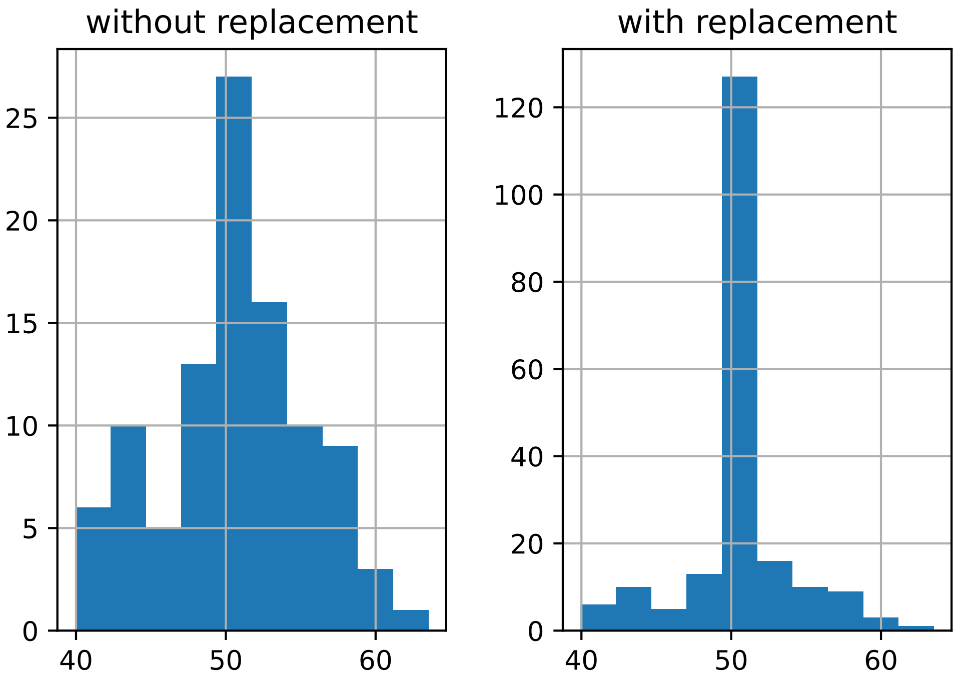
In [63]:

```
# replacing with median values
col_a_median = deepcopy(df["A"])
median = df["A"].median()
col_a_median = col_a_median.fillna(median)
median_df = pd.DataFrame({"without replacement":df["A"],"with replacement":col_a_median})

median_df.hist()
```

Out[63]:

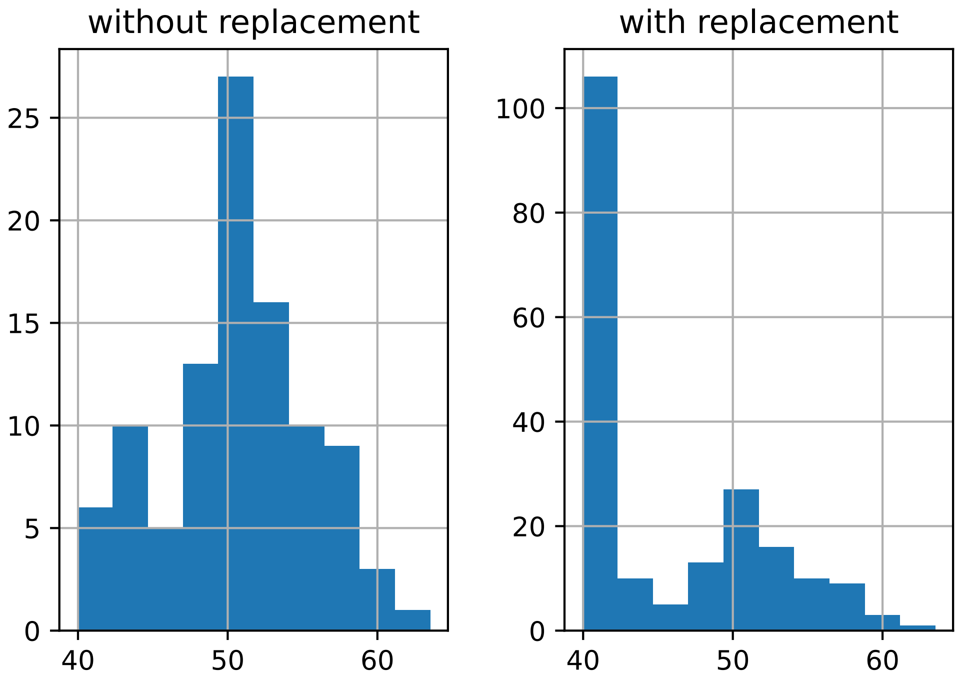
```
array([[<AxesSubplot:title={'center':'without replacement'}>,
        <AxesSubplot:title={'center':'with replacement'}>]], dtype=object)
```



```
In [64]: # replacing with mode values
         col_a_mode = deepcopy(df["A"])
         mode = df["A"].mode()[0]
         col_a_mode = col_a_mode.fillna(mode)
         mode_df = pd.DataFrame({"without replacement":df["A"],"with replacement":col_a_mode})

         mode_df.hist()
```

```
Out[64]: array([[<AxesSubplot:title={'center':'without replacement'}>,
                 <AxesSubplot:title={'center':'with replacement'}>]], dtype=object)
```



In [65]:

```
# filling missing values using mean by replacing 2 known values to None and then calculating RMSE
col_a = deepcopy(df["A"])
col_a[0] = col_a[1] = None

col_a = col_a.fillna(col_a.mean())

rmse = 0
for i in range(2):
    rmse += (col_a[i] - df["A"][i])**2

rmse **= 0.5
rmse /= 2
print(f'Original Values: {df["A"][0]} {df["A"][1]}')
print(f'Generated Values: {col_a[0]} {col_a[1]}')
print(f"RMSE After Mean Replacement for First 2 values : {rmse}")
```

```
Original Values: 48.91692627 47.69272613
Generated Values: 50.67962923000001 50.67962923000001
RMSE After Mean Replacement for First 2 values : 1.7341216691730785
```

In [66]:

```
# filling missing values using mean by replacing 2 known values to None and then calculating RMSE
col_a = deepcopy(df["A"])

for i in range(12):
    col_a[i] = None
col_a = col_a.fillna(col_a.mean())

rmse = 0
for i in range(12):
    rmse += (col_a[i] - df["A"][i])**2

rmse **= 0.5
rmse /= 2
print(f'Original Values')
for i in range(12):
    print(f'df["A"][{i}] : {df["A"][i]}')
print(f'Generated Values')
for i in range(12):
    print(f'col_a[{i}] : {col_a[i]}')
print(f"RMSE After Mean Replacement for First 12 values : {rmse}")
```

```
Original Values
df["A"][0] : 48.91692627
df["A"][1] : 47.69272613
df["A"][2] : 48.6295795
df["A"][3] : 58.5440342
df["A"][4] : 44.82133762
df["A"][5] : 47.69350376
df["A"][6] : 43.95443412
df["A"][7] : 52.84905452
df["A"][8] : 47.93471606
df["A"][9] : 63.53148348
df["A"][10] : 49.80409903
df["A"][11] : 52.18302422
Generated Values
col_a[0] : 50.64384543215909
col_a[1] : 50.64384543215909
col_a[2] : 50.64384543215909
col_a[3] : 50.64384543215909
col_a[4] : 50.64384543215909
col_a[5] : 50.64384543215909
col_a[6] : 50.64384543215909
col_a[7] : 50.64384543215909
col_a[8] : 50.64384543215909
```

```
col_a[9] : 50.643845432159O9
col_a[10] : 50.64384543215909
col_a[11] : 50.64384543215909
RMSE After Mean Replacement for First 12 values : 9.312407456436615
```

4. Perform Noise identification, Outlier detection using histogram and try to remove the outliers and check the statistical characteristics again.

In [67]:

```
new_df = deepcopy(df)
skewed_cols = ["D","Left Skew"]
for col in new_df.columns:
    if col in skewed_cols:
        new_df[col] = new_df[col].fillna(new_df[col].median())
    else:
        new_df[col] = new_df[col].fillna(new_df[col].mean())
```

In [68]:

```
record_count = len(new_df)
bin_size = math.ceil(record_count**0.5)

print(f"No. of Records : {record_count}")
print(f"Bin Size for Histograms : {bin_size}")
```

```
No. of Records : 200
Bin Size for Histograms : 15
```

In [69]:

```
# hbos = Histogram Based Outlier Score
hbos = HBOS(n_bins=bin_size)

hbos.fit(new_df)
output = hbos.decision_function(new_df)


new_df["Anomaly"] = hbos.predict(new_df)

# Records that are possible Anomalies
new_df[new_df["Anomaly"] == 1]
```

Out[69]:

	A	B	C	D	Left Skew	Multimodal	IQ20	IQ100	Anomaly
1	47.692726	68.175751	30.174288	47.825783	18.2	49.244001	107.418864	93.806158	1

	A	B	C	D	Left Skew	Multimodal	IQ20	IQ100	Anomaly
2	48.629579	61.753451	43.641583	59.699370	14.6	37.780203	95.006312	135.339681	1
3	58.544034	69.783507	53.738745	45.704638	21.2	56.827208	96.522192	100.772632	1
4	44.821338	70.730153	67.829659	44.254419	24.5	54.513731	108.878563	91.600053	1
5	47.693504	63.002345	58.796386	58.919273	24.9	47.876070	108.488800	105.969921	1
6	43.954434	54.451451	63.025524	44.086329	27.4	48.755803	109.344148	93.866104	1
8	47.934716	74.690423	31.758708	47.967768	24.2	58.907958	84.488598	110.123194	1
9	63.531483	75.704799	23.780607	48.368597	20.6	58.405534	83.672763	128.924255	1
11	52.183024	72.933634	71.122767	53.595887	19.1	50.776997	104.137603	130.364024	1
15	50.250865	59.395780	90.095257	47.120198	12.0	40.333273	100.275924	86.800080	1
17	49.713332	68.800339	46.285660	56.155408	6.4	41.295937	130.399002	81.836038	1
18	57.192464	61.795063	63.979316	50.885967	10.7	54.745351	109.176063	97.667278	1
19	48.523342	77.080420	65.328652	50.948824	17.2	51.976363	78.284920	96.144068	1
30	47.454810	59.156253	47.151747	61.030881	29.3	46.939871	102.132401	117.147695	1
32	53.822451	75.121428	72.528756	42.137098	29.5	55.233160	102.132401	91.333411	1
46	41.600699	61.827355	68.671110	56.311178	12.1	48.138371	102.132401	99.063733	1
52	47.993737	71.104455	72.533235	46.889732	1.0	43.779643	102.132401	90.410677	1
56	43.547346	67.971160	57.840796	53.886415	9.0	58.293881	102.132401	92.119592	1
63	49.316954	63.120633	59.262267	44.061115	11.1	59.764552	102.132401	116.885690	1
73	40.623255	64.444796	45.286507	54.943578	16.8	45.162762	102.132401	123.992293	1

In [70]:

```
new_df = new_df[new_df.Anomaly != 1]
new_df = new_df.drop("Anomaly",axis = 1)
# mean, median, mode, variance for all columns
print(f"Mean\n{new_df.mean()}")
print("")
print(f"Median\n{new_df.median()}")
print("")
print(f"Variance\n{new_df.var()}")
```

```
Mean
A              50.785570
B              65.376997
C              50.207973
D              49.883500
Left Skew      21.233889
Multimodal     60.767580
IQ20          102.196998
IQ100         102.782607
dtype: float64

Median
A              50.632133
B              65.544513
C              50.851334
D              49.726685
Left Skew      21.500000
Multimodal     63.607973
IQ20          102.132401
IQ100         102.925179
dtype: float64

Variance
A              10.536062
B               9.677995
C              97.030257
D              11.597258
Left Skew      17.788063
Multimodal    131.986012
IQ20           12.676367
IQ100         100.891334
dtype: float64
```