1. By running the python code included in file *Question1.lbai5.py*, we get the output as following:

```
count    1000.00000
mean       76.71500
std        13.16355
min        37.00000
25%        68.00000
50%        77.00000
75%        87.00000
max       100.00000
Name: Midterm, dtype: float64
------------------------------------------
Mode:[77 83]
------------------------------------------
Variance:173.279054054
```

This result indicate that

a. Max = 100, Min = 37

b. Q1 = 68, median = 77, Q3 = 87

c. mean = 76.715

d. mode1 = 77 and mode2 = 83

e. empirical variance = 173.279

2. By running the python code included in file *Question2.lbai5.py*, we get the output as following:

```
Original empirical variance: 173.279054054
Normalized empirical variance: 1.001001001
------------------------------------------
Normalized 90:1.00922621869
------------------------------------------
Pearson's Correlation Coefficient:
         Midterm    Final
Midterm 1.000000 0.544425
Final   0.544425 1.000000
------------------------------------------
Covariance:
          Midterm      Final
Midterm 173.279054  78.254194
Final    78.254194 119.232176
```

    a. Original empirical variance > Normalized empirical variance

    b. Normalized 90 = 1.009

    c. Pearson's Correlation Coefficient = 0.544

    d. Covariance = 78.254

3. a.
$$\text{Jaccard Coefficient} = \frac{q}{q+r+s} = \frac{58}{58+120+2} = 0.322$$

    b. By running the python code included in file *Question3.lbai5.py*, we get the output as following:

```
b.
Norm-1:6152.0
Norm-2:715.327896842
Norm-infty:170.0
--------------------------
c.
Cosine similarity:[[ 0.84140403]]
--------------------------
d.
K-L Divergence:0.207080937332
```

This result indicate that

    1. When $h = 1$, dist = 6152.0

    2. When $h = 2$, dist = 715.328

    3. When $h = \infty$, dist = 170.0

    c. Cosine similarity = 0.841

    d. K-L Divergence = 0.207

4. By running the python code included in file *Question4.lbai5.py*, we get the output as following:

```
chisquare: 2468.183
```

This result indicate that $\chi^2 = 2468.183$