**E**stimation **A**nd **C**onfidence **I**ntervals

**a. Building 99% Confidence Interval Using Sample Standard Deviation**

Given data : 1.13, 1.55, 1.43, 0.92, 1.25, 1.36, 1.32, 0.85, 1.07, 1.48, 1.20, 1.33, 1.18, 1.22, 1.29 *Step 1:*

Insert the data into the Jupyter notebook by using the library Pandas

* import pandas as pd
* data = pd.Series([1.13, 1.55, 1.43, 0.92, 1.25, 1.36, 1.32, 0.85, 1.07, 1.48, 1.20, 1.33, 1.18, 1.22, 1.29]) data

*Step 2:*

Calculate the sample mean and sample standard deviation

* import numpy as np
* from scipy import stats
* x bar = np.mean(data)
* s = np.std(data, ddof=1) # ddof=1 for sample standard deviation

*Step 3*:

Determine the sample size and Degrees of Freedom.

* n = len(data)
* df = n - 1

*Step 4:*

Setting Confidence level

* confidence level = 0.99

*Step 5:*

Find the critical value from the t-distribution for the given confidence level and degrees of freedom

t-distribution is used instead of the normal distribution because we are estimating the population mean from a small sample (n<30) and do not know the population standard deviation. The t-distribution accounts for the additional uncertainty in the estimate of the standard deviation.

* t score = stats.t.ppf(1 - (1 – confidence level) / 2, df)

*Step 6:*

Calculate the margin of error :

* margin of error = t score \* (s / np.sqrt(n))

*Step 7:*

Constructing the confidence interval:

* confidence interval = (x bar – margin of error, x bar + margin of error)
* print("99% Confidence Interval using Simple Standard Deviation:”, confidence interval)

*Result:*

* 99% Confidence Interval using Sample Standard Deviation: (1.090197338451367, 1.3871359948819662)

*Conclusion:*

The 99% confidence interval for the mean number of characters printed before the print-head fails is (1.090,1.388). This means we are 99% confident that the true population mean lies within this interval.

**b. Building 99% Confidence Interval Using Known Population Standard Deviation**

Given data : 1.13, 1.55, 1.43, 0.92, 1.25, 1.36, 1.32, 0.85, 1.07, 1.48, 1.20, 1.33, 1.18, 1.22, 1.29 Population standard deviation=0.2

*Step 1:*

Insert the data into the Jupyter notebook by using the library Pandas

* import pandas as pd
* data = pd.Series([1.13, 1.55, 1.43, 0.92, 1.25, 1.36, 1.32, 0.85, 1.07, 1.48, 1.20, 1.33, 1.18, 1.22, 1.29]) data

*Step 2:*

Calculate the sample mean

* x\_bar = np.mean(data)

*Step 3*:

Determine the sample size

* n = len(data)

*Step 4:*

Setting Confidence level

* confidence level = 0.99

*Step 5:*

Find the critical value from the z-distribution for the given confidence level

* z\_score = stats.norm.ppf(1 - (1 - confidence\_level) / 2)

*Step 6:*

Calculate the margin of error :

* margin of error = z\_score \* (sigma / np.sqrt(n))

*Step 7:*

Constructing the confidence interval:

* confidence interval = (x bar – margin of error, x bar + margin of error)
* print("99% Confidence Interval using Simple Standard Deviation:”, confidence interval)

*Result:*

* 99% Confidence Interval using Sample Standard Deviation: (1.1056514133957607, 1.3716819199375725)

*Conclusion:*

The 99% confidence interval for the mean number of characters printed before the print-head fails, using the known population standard deviation of 0.2 million characters, is (1.1056, 1.3716). This means we are 99% confident that the true population mean lies within this interval.