Welcome

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Goals

Introduce the audience to the Central Limit Theorem (CLT)

Provide examples of Applications of the the Central Limit Theorem

Prerequisites

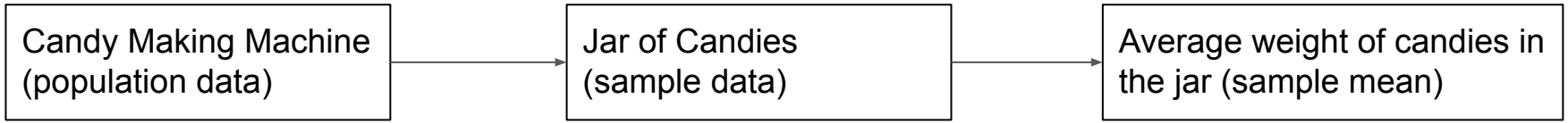
Basic Python coding skills

Why central limit theorem

Represents the most confused and misinterpreted fundamental topics in Statistics

Example: Candies

Estimating the distribution of weights of candies the machine produces



Notes:

- Number of candies in the jar = sample size
- Number of jars = number of samples

Q: What is central limit theorem

The central limit theorem states that if you have a *population* with *mean* μ and *standard deviation* σ and take a sufficiently large number random samples from the population with replacement, then the distribution of the sample means will be ***normal***.

Properties of the distribution of sample means

Mean of the *sample* means = *mean* of the *population*

Standard deviation of the *sample* means = *standard deviation* of the population / sqrt(n),
where n - sample size

Environment setup

1. Recommended docker setup:

   Run the following commands in your terminal:

   ```
   git clone https://github.com/MLWorkshops/mlinterviews.git
   cd mlinterviews
   make pull
   make docker-run
   ```

   Open in your browser the following link http://127.0.0.1:8888/?token=<.....> printed out in your terminal

2. Colab access:

   Open this link in your browser:

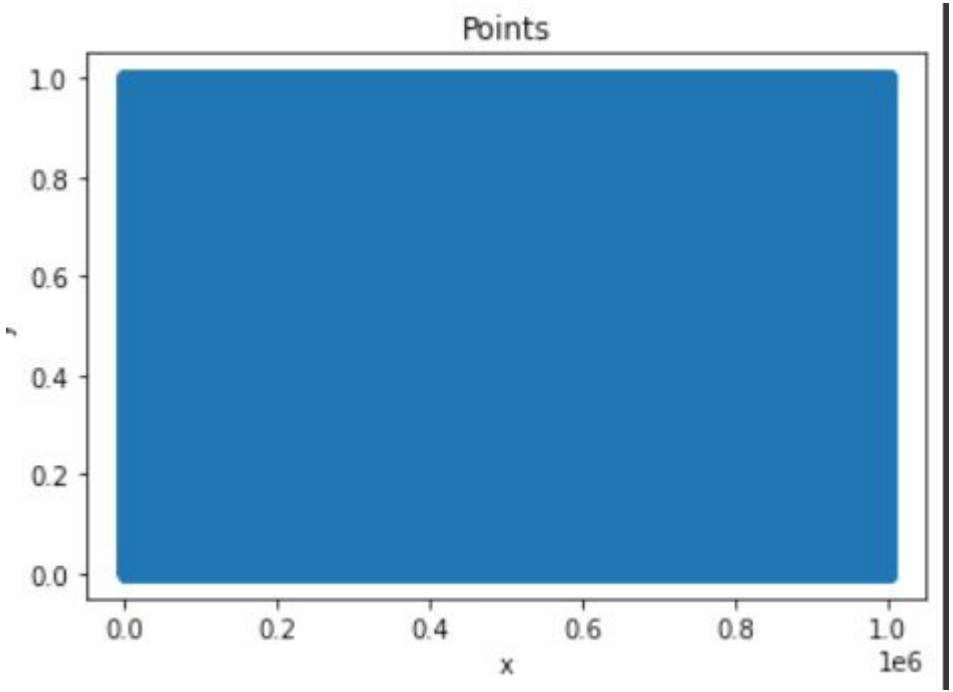
   https://colab.research.google.com/drive/1EBvCVN1JX_X-_9qkH3YpQpEYXxc9VbdY?usp=sharing

   And choose File -> Save a copy in Drive in your to be able to edit the notebook

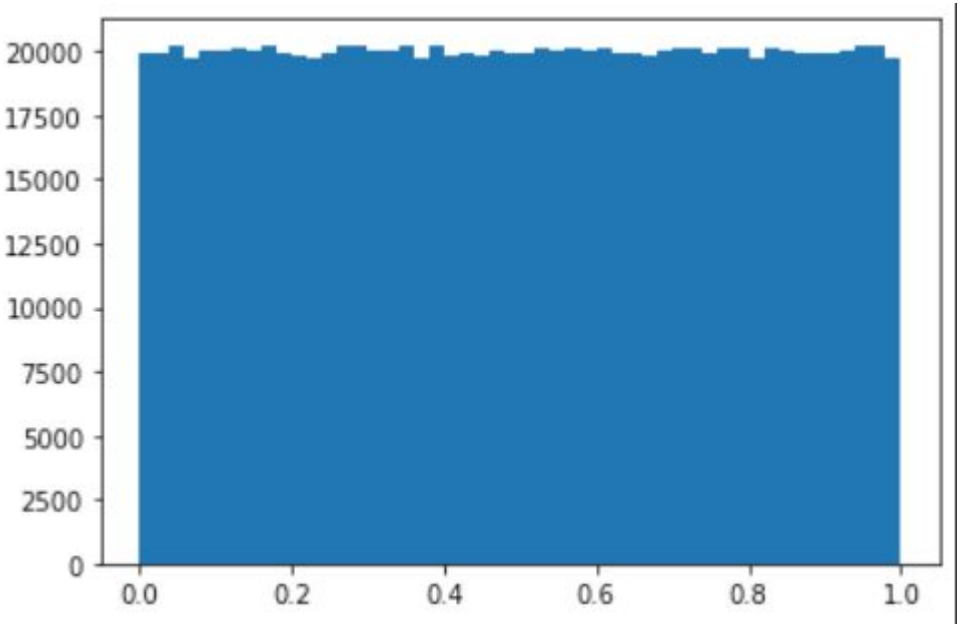
Example: quantified*

Generate population of 1MM floating point numbers uniformly distributed in the range of 0 to 1

Scatter plot of population (size of 1M)



Histogram of the population

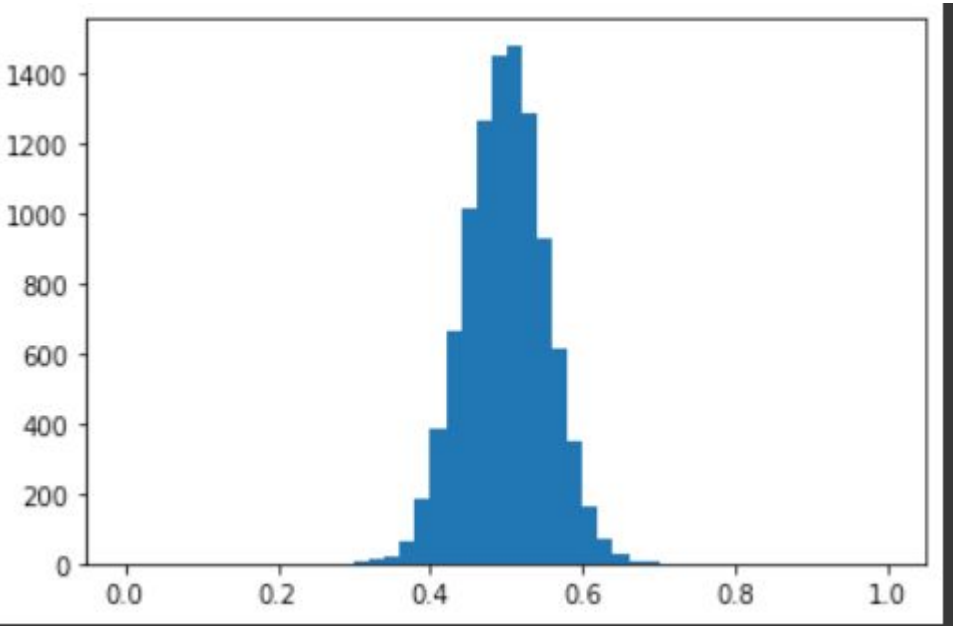


1m items
50 bins
20k = 1M/50

Q: Change the number of samples and sample size in a systematic way*

Number of samples\Sample size	1	10	30+
High	Population	Student	***Normal***
Low	Unknown	Unknown	Unknown (centered around mean)

Let’s build a distribution (histogram) of the sample means



Number of samples = 10k
Sample size = 30
Mean = 0.5 (population mean)
Standard deviation = Population Standard deviation / sqrt(30)

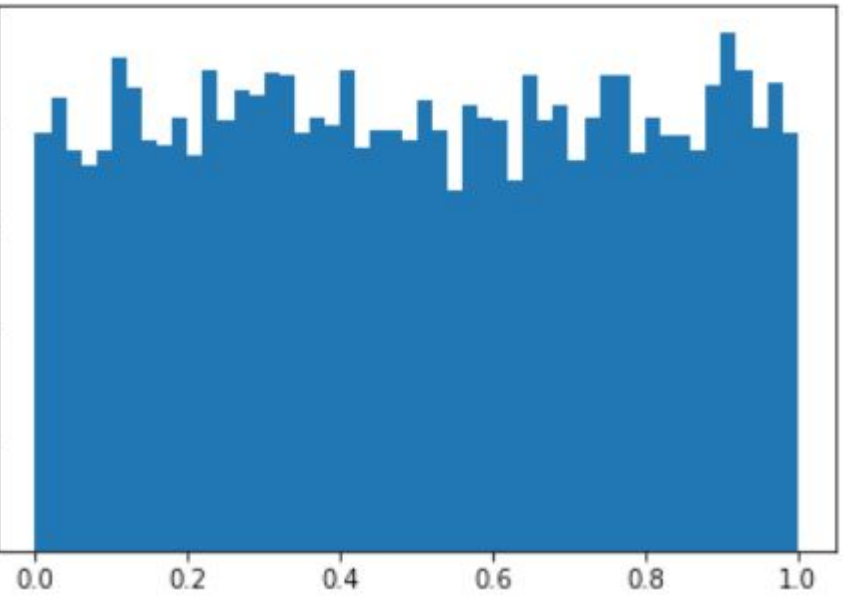
Coding Challenge*

write a function that computes a variance of a given list of values

Q: Change the number of samples and sample size in a systematic way*

Number of samples\Sample size	1	10	30+
High	***Population***	Student	Normal
Low	Unknown	Unknown	Unknown (centered around mean)

Number of samples=10k and sample size=1 (the same distribution)

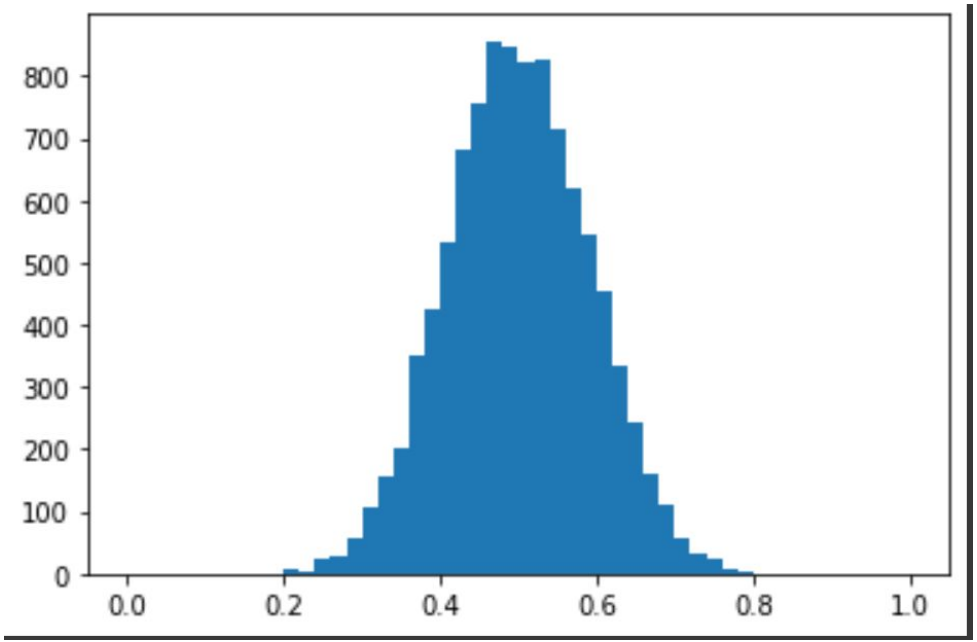


Number of samples = 10k
Sample size = 1
Mean = 0.5 (population mean)
Standard deviation = Standard deviation Variance / sqrt(1)

Q: Change the number of samples and sample size in a systematic way*

Number of samples\Sample size	1	10	30+
High	Population	***Student***	Normal
Low	Unknown	Unknown	Unknown (centered around mean)

Number of samples=10k and sample size=10 (t student)

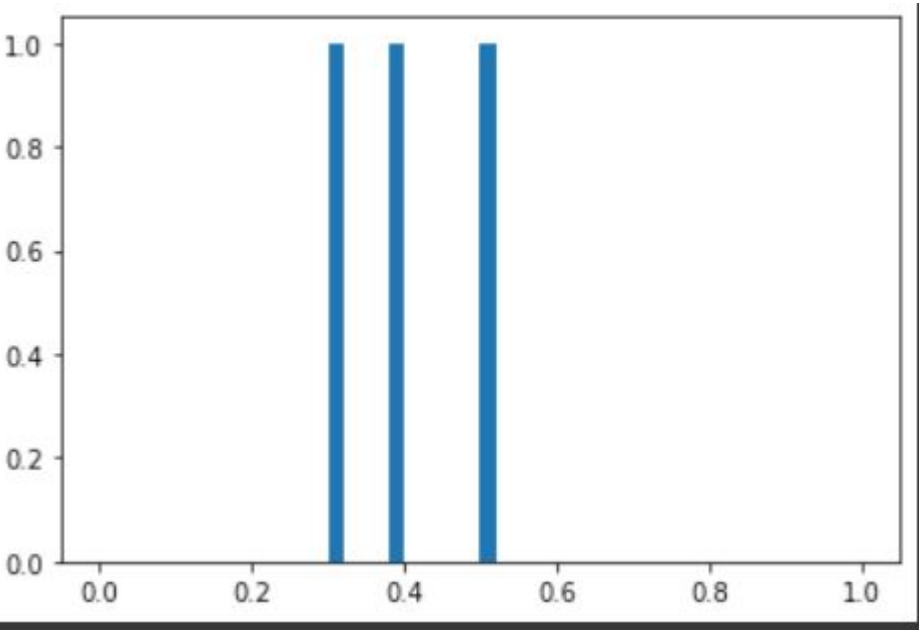


Number of samples = 10k
Sample size = 10
Mean = 0.5 (population mean)
Standard deviation = Standard deviation Variance / sqrt(10)

Q: Change the number of samples and sample size in a systematic way*

Number of samples\Sample size	1	10	30+
High	Population	Student	Normal
Low	Unknown	***Unknown***	Unknown (centered around mean)

Number of samples=3 and sample size=10 (unknown)

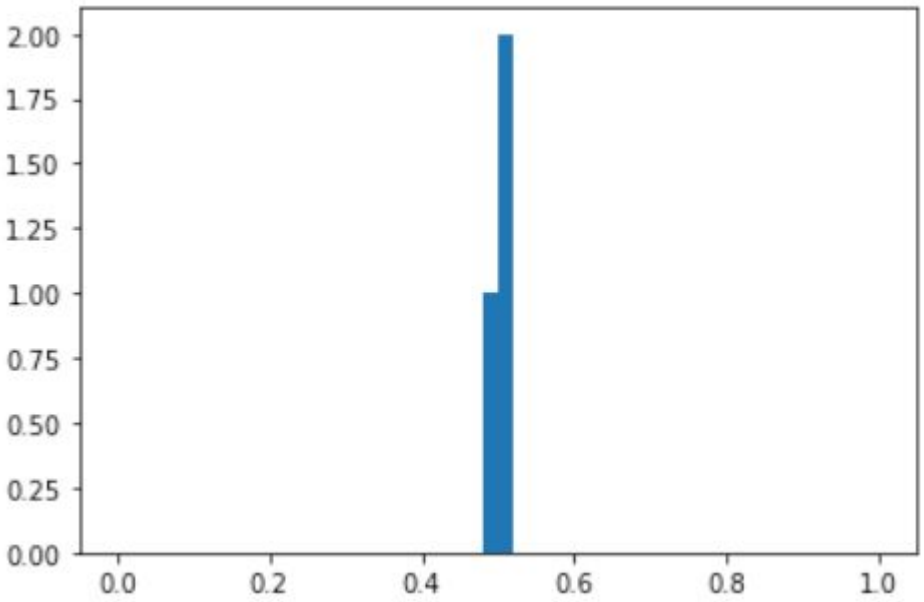


Number of samples = 3
Sample size = 10
Mean = 0.5 (population mean)
Standard deviation = Population
Standard deviation / sqrt(3)

Q: Change the number of samples and sample size in a systematic way*

Number of samples\Sample size	1	10	30+
High	Population	Student	Normal
Low	Unknown	Unknown	***Unknown (centered around mean)***

Number of samples=3 and sample size=3000 (unknown, but centered around the population mean)



Number of samples = 3
Sample size = 3000
Mean = 0.5 (population mean)
Standard deviation = Population Standard deviation / sqrt(3)

Summary

Number of samples\Sample size	1	10	30+
High	Population	Student	Normal
Low	Unknown	Unknown	Unknown (centered around mean)

Application: population distribution is normal

Measurement errors: performance profiling. Mean and Standard deviation can give us even more information about the underlying distribution.

Sample size = number of measurements

Number of samples = number of experiments

One *experiment* is comprised of multiple *measurements*

Mean of the population = Mean of sample means

*Standard deviation of the population = standard deviation of the sample means * sqrt(sample size)*

Coding Challenge*

write a function that computes a z-score for a given number assuming

that the values follow a normal distribution

z-score is is the number of standard deviations by which the value of a

raw score (i.e., an observed value or data point)

is above or below the mean value of what is being observed or measured.
[https://en.wikipedia.org/wiki/Standard_score]

Thank you for your time and attention