About

This notebook illustrates the Central Limit Theorem (CLT) in action, using two large samples: the first from the standard uniform distribution, the second from a Poisson distribution.

A histogram of the actual sampling distribution of the mean is plotted alongside the approximated sampling distribution of the mean (as set out by the CLT).

Background

The **Central Limit Theorem** states that

> If $X_1, X_2 \ldots, X_n$ are n independent random observations from a population with mean μ and finite variance σ^2, then for large n, the distribution of their mean $\overline{X}_n$ is approximately normal with mean μ and variance σ^2/n, such that:
>
> $$\overline{X}_n \approx N\left(\mu, \frac{\sigma^2}{n}\right).$$
>
> Reference: *M248 Handbook, pp.12.*

Imports

The function `clt()` can be read here. The header and docstring have been included at the bottom of the document.

```
import scipy.stats as stats
from util.clt import clt
```

Illustration 1

This uses samples generated from the **standard uniform distribution,** $U(0, 1)$.

```
clt(a_dist=stats.uniform(loc=0, scale=1),
    n=30,
    N=10000,
    bins=50)
```

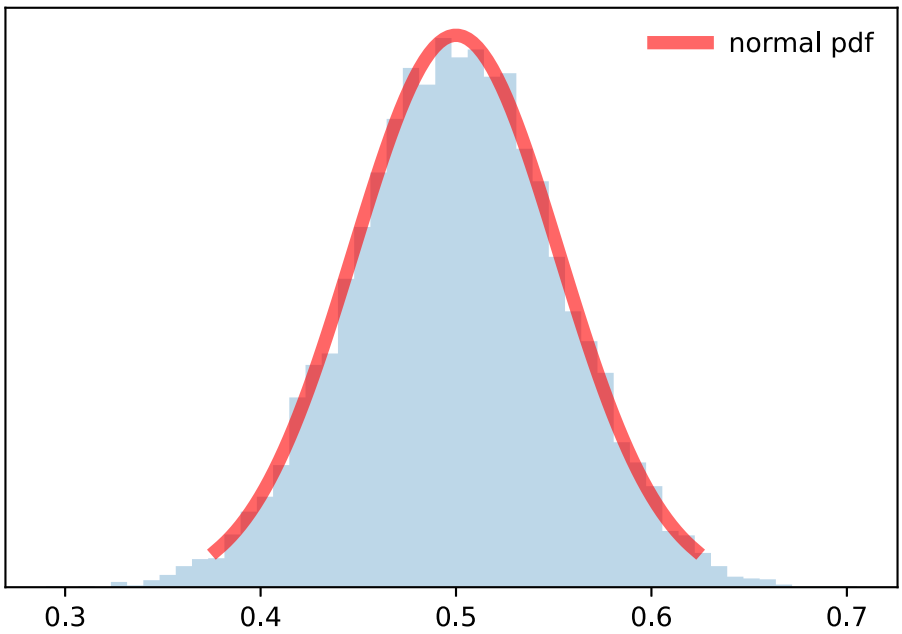
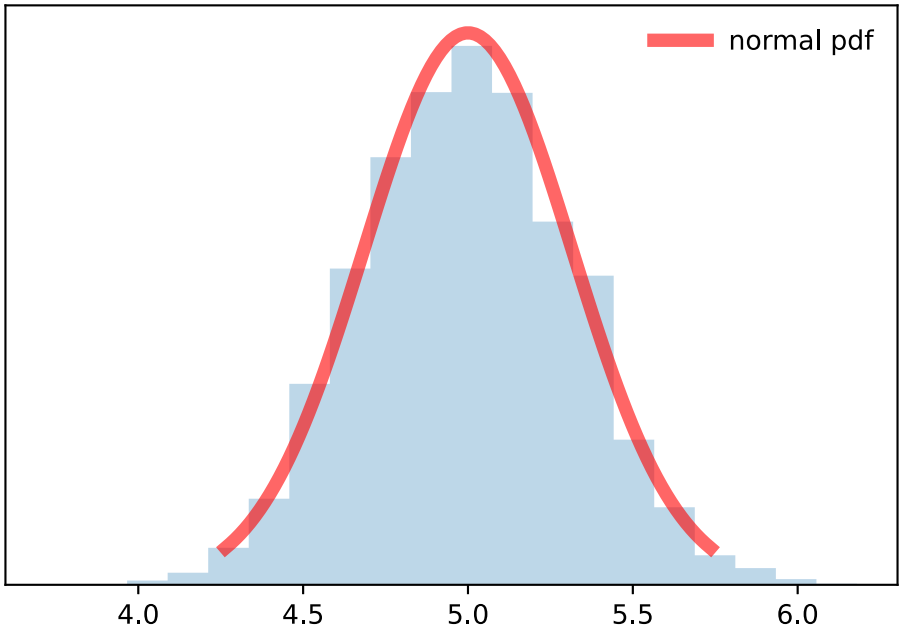


Illustration 2

This uses samples generated from the **Poisson distribution,** $\text{Poisson}(5)$.

```
clt(a_dist=stats.poisson(mu=5),
    n=50,
    N=10000,
    bins=20)
```



Function

This is a transclusion of the function `clt()` imports, header, and docstring, for illustration purposes.

```
import matplotlib.pyplot as plt
import numpy as np
from scipy.stats import norm


def clt(a_dist: object, n: int, N: int, bins: int) -> None:
    '''
    Generates N random samples of size n from the distribution a_dist.
    Calulate's each sample's mean, and plots the sampling
    distribution of the mean as a histogram.

    The approximate sampling distribution of the mean (by the CLT) uses
    parameters a_dist.mean(), and the standard error a_dist.var()/n.

    The parameter bins controls the number of bins used in the
    histogram.
    Changing this parameter will make the histogram less accurate,
    but improves the plot's fidelity for discrete distributions.
```