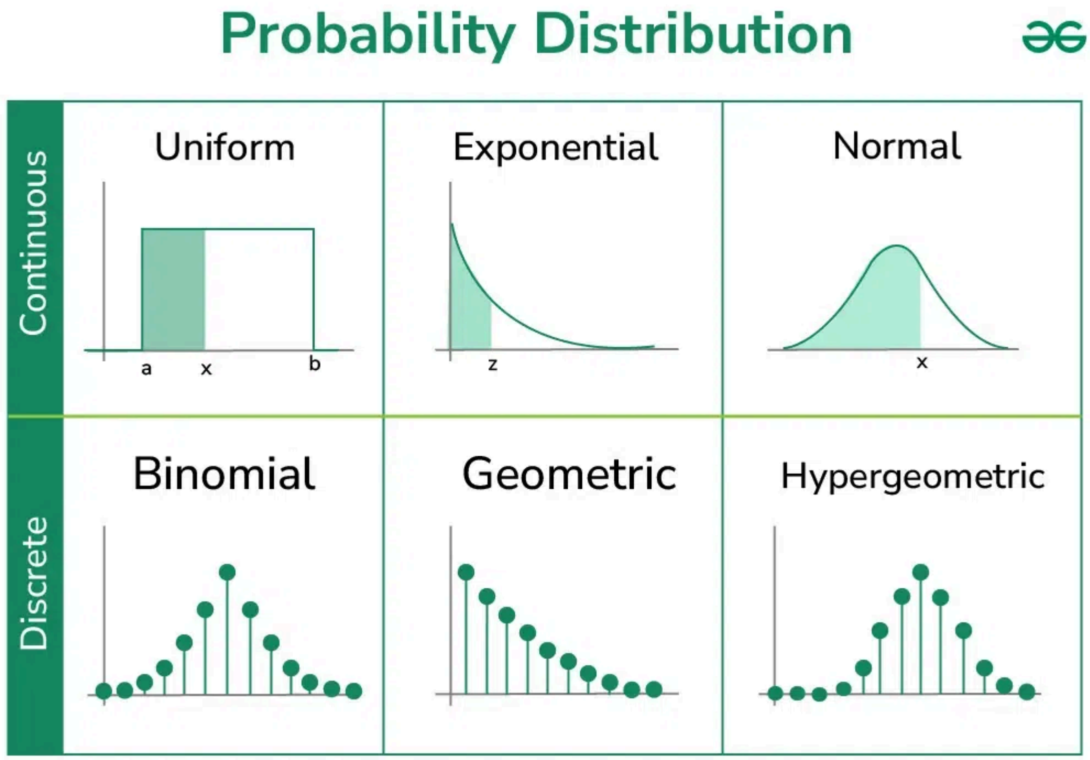


Introduction to Probability Distribution

Estimated time needed: **30** minutes

In this lab, you will familiarize yourself with the normal probability distributions and work on some exercises

Objectives

- Import Libraries
- Introduction to Probability Distributions
  - Normal Distributions
- Lab Exercises

Import Libraries

All Libraries required for this lab are listed below. The libraries pre-installed on Skills Network Labs are commented. If you run this notebook in a different environment, e.g. your desktop, you may need to uncomment and install certain libraries.

In [1]:
```
#install specific version of libraries used in lab
#! mamba install pandas==1.3.3
#! mamba install numpy=1.21.2
#! mamba install scipy=1.7.1-y
#!  mamba install matplotlib=3.4.3-y
#!  mamba install statsmodels=0.12.0-y
```

Import the libraries we need for the lab

In [2]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import scipy.stats
from math import sqrt
```

Read in the csv file from the url using the request library

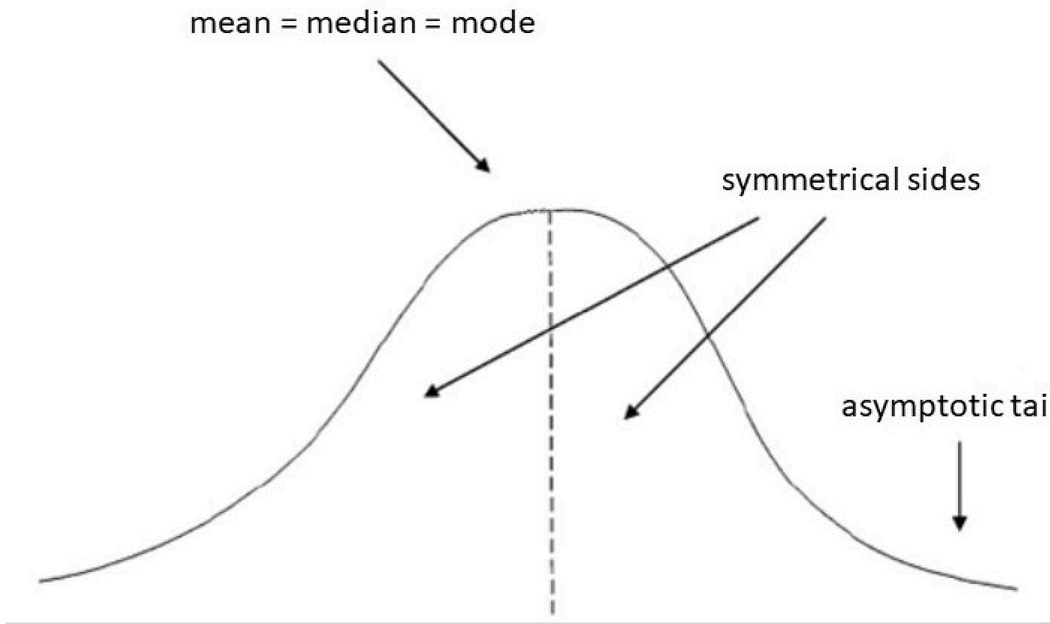
In [3]:
```
ratings_url = 'https://cf-courses-data.s3.us.cloud-object-storage.appdomain.cloud/I
ratings_df = pd.read_csv(ratings_url)
```

Introduction to Probability Distribution

In this section, you will learn how to create the plot distributions using the scipy library in python

Normal Distribution

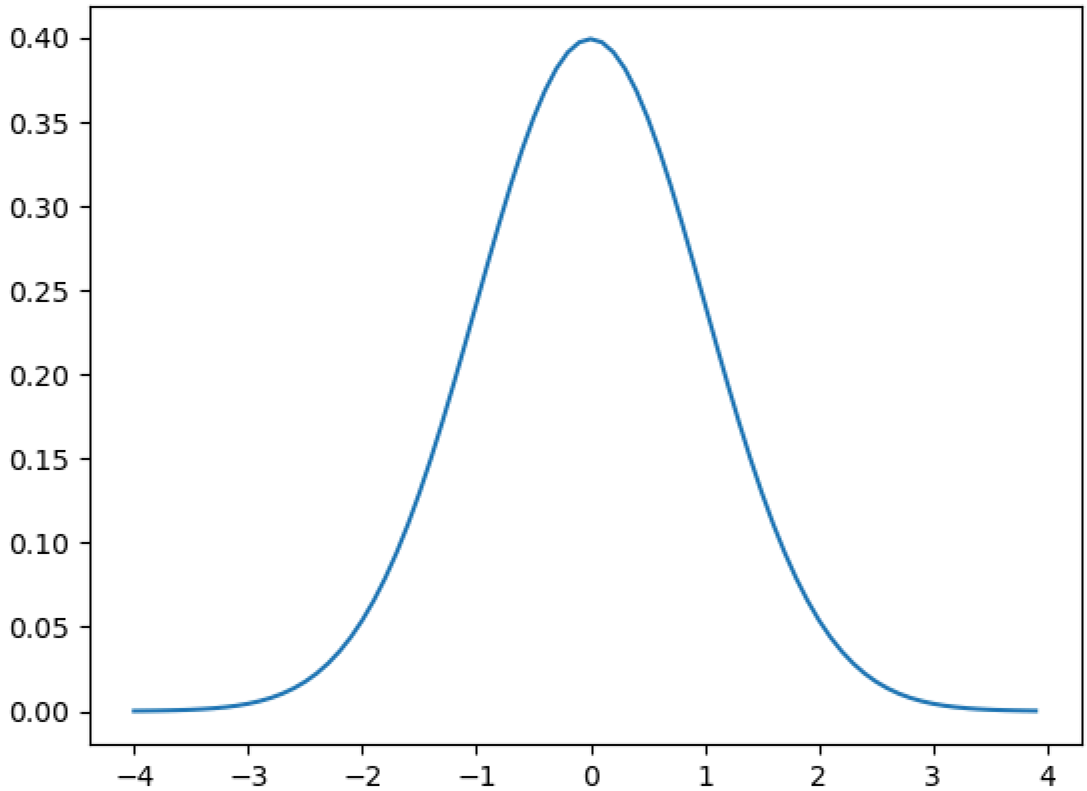
A normal distribution is a bell-shaped density curve described by its mean μ and standard deviation σ. The curve is symmetrical and centered around it's mean. A normal distribution curve looks like this:



We can visualize the curve. Import norm from scipy.stat and plot graph with matplotlib

In [4]:
```
from scipy.stats import norm

# Plot between -4 and 4 with 0.1 steps.
x_axis = np.arange(-4, 4, 0.1)
# Mean = 0, SD = 1.
plt.plot(x_axis, norm.pdf(x_axis, 0, 1))
plt.show()
```



Lab Exercises

Using the teachers' rating dataset, what is the probability of receiving an evaluation score of greater than 4.5

Find the mean and standard deviation of teachers' evaluation scores

In [5]:
```
eval_mean = round(ratings_df['eval'].mean(), 3)
eval_sd = round(ratings_df['eval'].std(), 3)
print(eval_mean, eval_sd)
```

```
3.998 0.555
```

Use the scipy.stats module. Because python only looks to the left i.e. less than, we do remove the probability from 1 to get the other side of the tail

In [6]:
```
prob0 = scipy.stats.norm.cdf((4.5 - eval_mean)/eval_sd)
print(1 - prob0)
```

```
0.1828639734596742
```

Using the teachers' rating dataset, what is the probability of receiving an evaluation score greater than 3.5 and less than 4.2

First we find the probability of getting evaluation scores less than 3.5 using the `norm.cdf` function

In [7]:

```
x1 = 3.5
prob1 = scipy.stats.norm.cdf((x1 - eval_mean)/eval_sd)
print(prob1)
```

```
0.1847801491443654
```

Then for less than 4.2

In [8]:

```
x2 = 4.2
prob2 = scipy.stats.norm.cdf((x2 - eval_mean)/eval_sd)
print(prob2)
```

```
0.642057540461896
```

The probability of a teacher receiving an evaluation score that is between 3.5 and 4.2 is:

In [9]:

```
round((prob2 - prob1)*100, 1)
```

Out[9]:

```
45.7
```

Using the two-tailed test from a normal distribution:

- A professional basketball team wants to compare its performance with that of players in a regional league.
- The pros are known to have a historic mean of 12 points per game with a standard deviation of 5.5.
- A group of 36 regional players recorded on average 10.7 points per game.
- The pro coach would like to know whether his professional team scores on average are different from that of the regional players.

State the null hypothesis

- H_0: $x = μ_1$ ("The mean point of the regional players is not different from the historic mean")
- H_1: $x ≠ μ_1$ ("The mean point of the regional players is different from the historic mean")

When the population standard deviation is given and we are asked to deal with a sub-sample, the size (n) of the sub-sample is used in the formula:

$$Z = \frac{\overline{X} - \mu}{\sigma/\sqrt{n}}$$

In [10]:
```
## because it is a two-tailed test we multiply by 2
2*round(scipy.stats.norm.cdf((10.7 - 12)/(5.5/sqrt(36))), 3)
```

Out[10]:
```
0.156
```

Conclusion: Because the p-value is greater than 0.05, we fail to reject the null hypothesis as there is no sufficient evidence to prove that the mean point of the regional players is different from the historic mean

Practice Questions

Question 1: Using the teachers' rating dataset, what is the probability of receiving an evaluation score greater than 3.3?

In [14]:
```
## insert code here

##calculate the probability less than 3.3
prob_less_than = scipy.stats.norm.cdf((3.3 - eval_mean)/eval_sd)
##then remove the probability from 1 to get the area to the right of 3.3
print(1 - prob_less_than)
```

```
0.8957422041794154
```

Question 2: Using the teachers' rating dataset, what is the probability of receiving an evaluation score between 2 and 3?

In [15]:
```
## insert code here

## find the probablity of reciving a score of less than 2
prob_less_than_2 = scipy.stats.norm.cdf((x1 - eval_mean)/eval_sd)
print(prob_less_than_2)

## find the probablity of reciving a score of less than 3
prob_less_than_3 = scipy.stats.norm.cdf((x2 - eval_mean)/eval_sd)
print(prob_less_than_3)

## remove both probabilities from each other
round((prob_less_than_3 - prob_less_than_2)*100, 1)
```

```
0.1847801491443654
0.642057540461896
```

Out[15]:
```
45.7
```

Question 3: To test the hypothesis that sleeping for at least 8 hours makes one smarter, 12 people who have slept for at least 8 hours every day for the past one year have their IQ tested.

- Here are the results: 116, 111, 101, 120, 99, 94, 106, 115, 107, 101, 110, 92

- Test using the following hypotheses: H0: μ = 100 or Ha: μ > 100

In [16]:
```
## insert code here

iqs = [116, 111, 101, 120, 99, 94, 106, 115, 107, 101, 110, 92]
sample_size = len(iqs)
degree_freedom = sample_size - 1
iq_mean = sum(iqs) / sample_size
mean_diff = [(iq - iq_mean) ** 2 for iq in iqs]
iq_std = sqrt(sum(mean_diff) / degree_freedom)
variance = iq_std ** 2
print(f"IQ mean is {iq_mean}, sd is {iq_std}, variance is {variance}")
round(1-scipy.stats.norm.cdf((iq_mean - 100)/(iq_std/sqrt(12))), 3)
```

```
IQ mean is 106.0, sd is 8.831760866327848, variance is 78.00000000000001
```

Out[16]:
```
0.009
```

Author

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In [ ]:
```

```