# Clustering using K-Means

In [0]:

```
import pandas as pd
import numpy as np
from scipy.spatial import distance
```

## Loading Data

In [0]:

```
from sklearn.datasets import load_iris
data = load_iris()
df = pd.DataFrame(data["data"])
df["target"] = data.target

#### get stratified Dataset from orginal data
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(df[df.columns.difference(['target'
])], df["target"], stratify=df["target"], \
                                                    test_size=90, random_state=28)
x_train.shape, x_test.shape , y_train.shape , y_test.shape
# store it in a dataframe 'df'
df = pd.DataFrame(x_train)
# maintain a list of all points
data= []
for index in range(df.shape[0]):
    data.append(tuple(df.iloc[index]))
```

In [283]:

```
display(df.head())
print('sample format of data : ')
data[:5]
```

| | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| **31** | 5.4 | 3.4 | 1.5 | 0.4 |
| **80** | 5.5 | 2.4 | 3.8 | 1.1 |
| **92** | 5.8 | 2.6 | 4.0 | 1.2 |
| **109** | 7.2 | 3.6 | 6.1 | 2.5 |
| **64** | 5.6 | 2.9 | 3.6 | 1.3 |

```
sample format of data :
```

Out[283]:

```
[(5.4, 3.4, 1.5, 0.4),
 (5.5, 2.4, 3.8, 1.1),
 (5.8, 2.6, 4.0, 1.2),
 (7.2, 3.6, 6.1, 2.5),
 (5.6, 2.9, 3.6, 1.3)]
```

## Steps for K-Means Algorithm:

**1)** Initialize 'k' centroids by picking randomly/choosively from data.

**2)** Assign data points to their corresponding clusters, based on the distance between centroids and each data point.

**3)** Shift/Re-initialize the centroids Ci, to the center of its cluster.

**4)** Repeat the steps 2 and 3 untill the centroids aren't moving any more.

## Implementation

In [0]:

```
class Distance:
    """
    This class 'Distance' has methods, calculates distance metrics like "euclidean", "m
anhattan", "cosine", "minkowski"
    These methods be called by creating object like Distance().euclidean_distance(point
1, point2)
    Inputs: point1, point2.
    Output: return distance b/w points.
    """
    def __init__(self):
        pass
    def euclidean_distance(self, point1, point2):
        return distance.euclidean(point1, point2)
    def manhattan_distance(self, point1, point2):
        return distance.cityblock(point1, point2)
    def cosine_distance(self, point1, point2):
        return distance.cosine(point1, point2)
    def minkowski_distance(self, point1, point2):
        return distance.minkowski(point1, point2)
```

In [0]:

```
def initialize_centroids(data, n_clusters=3):
    """
    Input: Data points, n_clusters
    Output: Dictionary of size 'n_clusters, Where key='centroid' and value="[] empty li
st".
    """
    length = len(data)
    clusters={}
    for index in np.random.randint(0, length, size=(1,n_clusters))[0]:
        clusters[data[index]] = []
    return clusters

def assign_points_to_centroids(data, clusters, distance_metric="euclidean"):
    """
    Input: Data points, Clusters(dict with key=centroid, val=[points......]) , distance
_metric=['euclidean','cosine','manhattan','minkowski'].
    Output: Dictionary, Where key='centroid' and value="list of points that're close to
that centroid".
    """
    if distance_metric=="euclidean":
        dist_obj= Distance().euclidean_distance
    elif distance_metric=="cosine":
        dist_obj= Distance().cosine_distance
    elif distance_metric=="manhattan":
        dist_obj= Distance().manhattan_distance
    elif distance_metric=="minkowski":
        dist_obj= Distance().minkowski_distance

    centroids = list(clusters.keys())
    for point in data:
        close_centroid = ()
        min_dist = float("inf")
        if point not in centroids:
            for centroid in centroids:
                curr_dist = dist_obj(point,centroid)
                if curr_dist < min_dist:
                    min_dist = curr_dist
                    close_centroid = centroid
            clusters[close_centroid].append(point)
    return clusters

def update_centroids(clusters):
    """
    Input: Clusters(dict with key=centroid, val=[points......])
    Output: Dictionary, Where key='updated centroid' and value="[]"(empty list)
            Also returns whether to stop converging (or) not.
    """
    new_clusters={}
    for centroid in clusters:
        # finding mean of those points
        new_clusters[ tuple(np.mean(clusters[centroid], axis=0)) ] = []
    return new_clusters
```

## pseudo code for K-Means

initialize_centroids(args)

while max_iter:

> > assign_points_to_centroids(args)
> >
> > update_centroids(args)

assign_points_to_centroids(args)

In [0]:

```
# Input parameter
n_clusters = 3
max_iter=300

clusters = initialize_centroids(data, n_clusters)
for i in range(max_iter=300):
    clusters = assign_points_to_centroids(data, clusters)
    clusters = update_centroids(clusters)
clusters = assign_points_to_centroids(data, clusters)
```

In [274]:

```
print("No of points in each cluster :", [len(clusters[i]) for i in clusters])
```

```
No of points in each cluster : [20, 14, 26]
```

## Visualization - Scatter plots

For visualization purpose, considered only two dimensions.

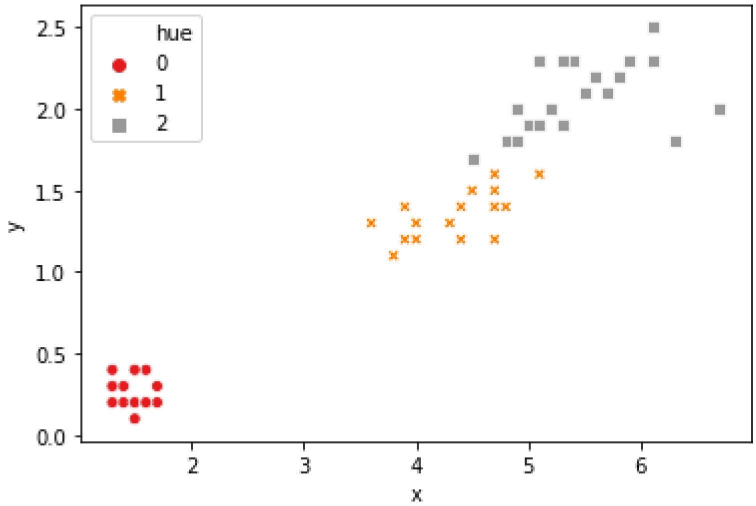
### Orginal Data

In [250]:

```
#@title
import matplotlib.pyplot as plt
import seaborn as sns

tdf = pd.DataFrame()
tdf["x"] = df.iloc[:,2]
tdf["y"] = df.iloc[:,3]
tdf["hue"] = y_train

ax = sns.scatterplot(x="x", y="y", hue="hue", data =tdf, style="hue", palette="Set1")
plt.show()
```



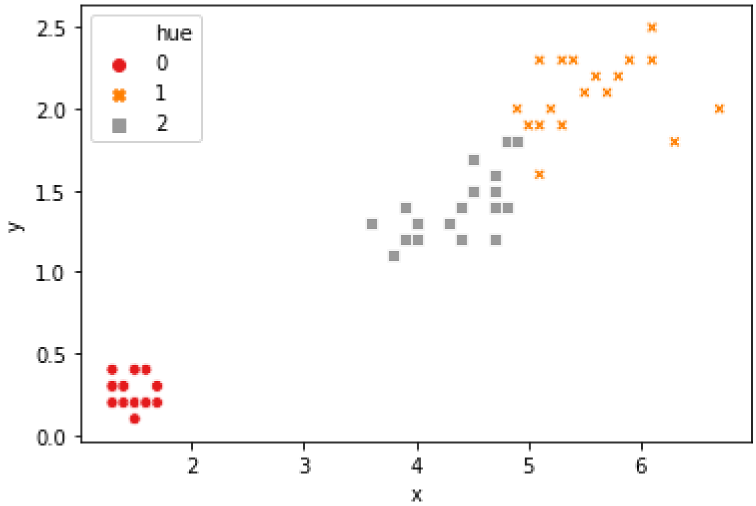

### sklearn's K-Means clustering

In [251]:

```
#@title
from sklearn.cluster import KMeans
clustering = KMeans(n_clusters=3).fit(df.iloc[:,2:])
clustering.labels_

mdf = pd.DataFrame()
mdf["x"] = df.iloc[:,2]
mdf["y"] = df.iloc[:,3]
mdf["hue"] = clustering.labels_

ax = sns.scatterplot(x="x", y="y", hue="hue", data =mdf, style="hue", palette="Set1")
plt.show()
```




### Scratch Code K-Means algorithm

The point in the midst of each cluster is a 'Centroid' of that cluster.

In [271]:

```
#@title
lst = []
excess_x=[]
excess_y=[]
cnt=0
xtra=10
for key in clusters:
  for i in clusters[key]:
    i=list(i)
    i.append(cnt)
    lst.append(i)
  lst.append(key+(xtra,))
  xtra+=1
  cnt+=1
adf = pd.DataFrame(np.array(lst))
rdf= pd.DataFrame()
rdf["x"] = adf.iloc[:,2]
rdf["y"] = adf.iloc[:,3]
rdf["hue"] = adf.iloc[:,-1]

ax = sns.scatterplot(x="x", y="y", hue="hue", data =rdf, style="hue", palette="Set1")
```