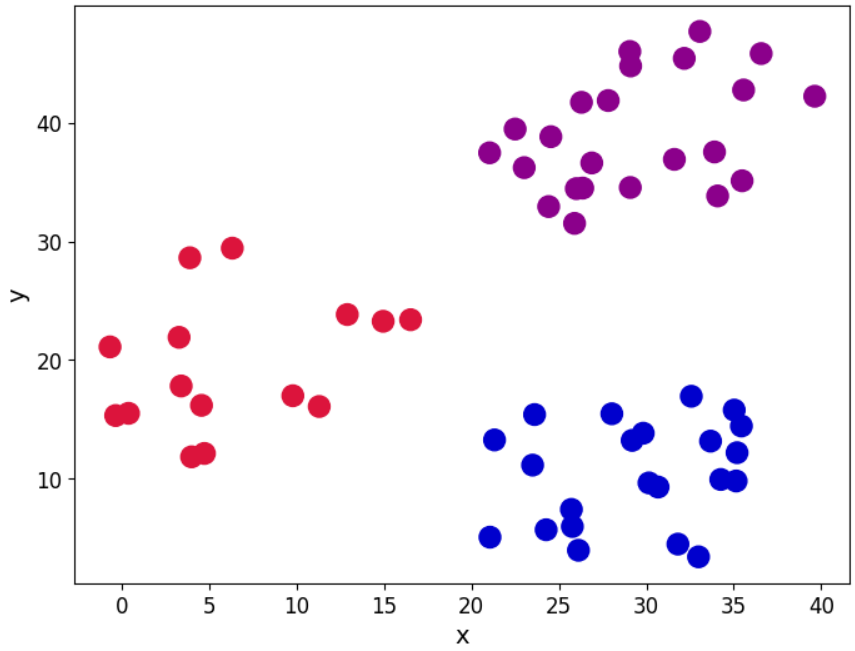
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from matplotlib.colors import ListedColormap
%matplotlib inline
blobs = pd.read_csv('/content/kmeans_blobs.csv')
colnames = list(blobs.columns[1:-1])
blobs.head()
```

	ID	x	y	cluster
0	0	24.412	32.932	2
1	1	35.190	12.189	1
2	2	26.288	41.718	2
3	3	0.376	15.506	0
4	4	26.116	3.963	1

Next steps: View recommended plots

```
customcmap = ListedColormap(["crimson", "mediumblue", "darkmagenta"])
fig, ax = plt.subplots(figsize=(8, 6))
plt.scatter(x=blobs['x'], y=blobs['y'], s=150,
c=blobs['cluster'].astype('category'),
cmap = customcmap)
ax.set_xlabel(r'x', fontsize=14)
ax.set_ylabel(r'y', fontsize=14)
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)
plt.show()
```




```
def initiate_centroids(k, dset):
    '''
    Select k data points as centroids
    k: number of centroids
    dset: pandas dataframe
    '''
    centroids = dset.sample(k)
    return centroids
np.random.seed(42)
k=3
df = blobs[['x','y']]
centroids = initiate_centroids(k, df)
centroids
```

	x	y
0	24.412	32.932
5	25.893	31.515
36	26.878	36.609

Next steps: View recommended plots

```
def rsserr(a,b):
    '''
    Calculate the root of sum of squared errors.
    a and b are numpy arrays
    '''
    return np.square(np.sum((a-b)**2))


for i, centroid in enumerate(range(centroids.shape[0])):
    err = rsserr(centroids.iloc[centroid,:], df.iloc[36,:])
    print('Error for centroid {0}: {1:.2f}'.format(i, err))
```

```
Error for centroid 0: 384.22
Error for centroid 1: 724.64
Error for centroid 2: 0.00
```

```
def centroid_assignation(dset, centroids):
    '''
    Given a dataframe `dset` and a set of `centroids`, we assign each
    data point in `dset` to a centroid.
    - dset: pandas dataframe with observations
    - centroids: pandas dataframe with centroids
    '''
    k = centroids.shape[0]
    n = dset.shape[0]
    assignation = []
    assign_errors = []

    for obs in range(n):
        # Estimate error
        all_errors = np.array([])
        for centroid in range(k):
            err = rsserr(centroids.iloc[centroid, :], dset.iloc[obs,:])
            all_errors = np.append(all_errors, err)

        # Get the nearest centroid and the error
        nearest_centroid = np.where(all_errors==np.amin(all_errors))[0].tolist()[0]
        nearest_centroid_error = np.amin(all_errors)

        # Add values to corresponding lists
        assignation.append(nearest_centroid)
        assign_errors.append(nearest_centroid_error)

    return assignation, assign_errors



df['centroid'], df['error'] = centroid_assignation(df, centroids)
df.head()
```

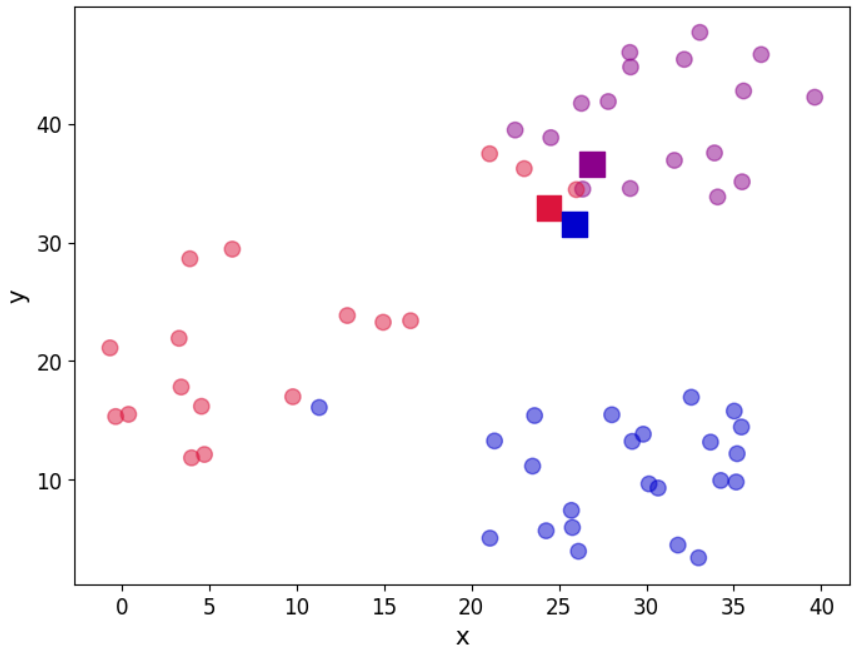
```
<ipython-input-8-e891e7f5dc1a>:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/s
  df['centroid'], df['error'] = centroid_assignation(df, centroids)
```

	x	y	centroid	error
0	24.412	32.932	0	0.000000
1	35.190	12.189	1	211534.211314
2	26.288	41.718	2	699.601495
3	0.376	15.506	0	776856.744109
4	26.116	3.963	1	576327.599678

Next steps: View recommended plots

```
fig, ax = plt.subplots(figsize=(8, 6))
plt.scatter(df.iloc[:,0], df.iloc[:,1], marker = 'o',
            c=df['centroid'].astype('category'),
            cmap = customcmap, s=80, alpha=0.5)
plt.scatter(centroids.iloc[:,0], centroids.iloc[:,1],
            marker = 's', s=200, c=[0, 1, 2],
            cmap = customcmap)
ax.set_xlabel(r'x', fontsize=14)
ax.set_ylabel(r'y', fontsize=14)
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)
plt.show()
```




```
print("The total error is {0:.2f}".format(df['error'].sum()))
```

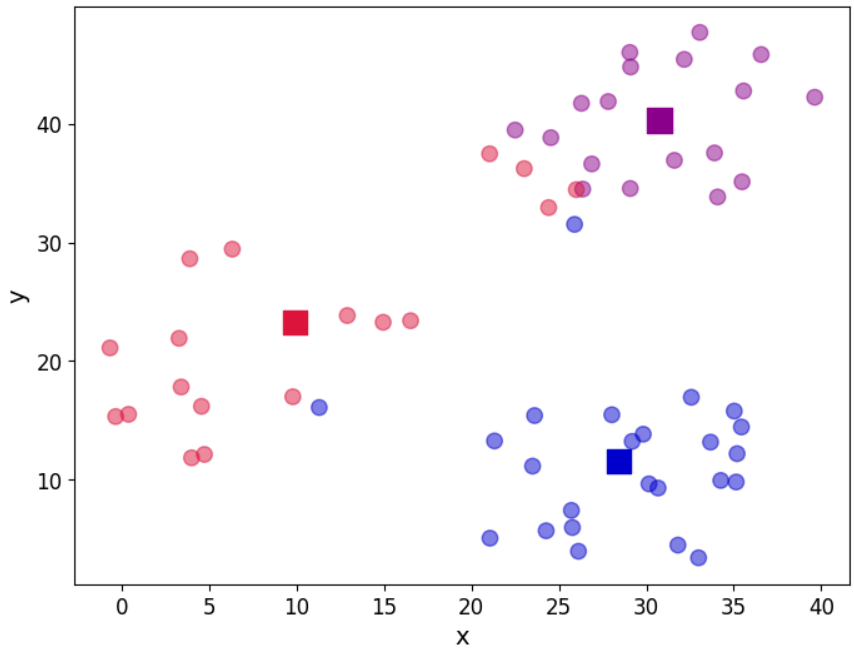
```
The total error is 11927659.01
```

```
centroids = df.groupby('centroid').agg('mean').loc[:, colnames].reset_index(drop = True)
centroids
```

	x	y
0	9.889444	23.242611
1	28.435750	11.546250
2	30.759333	40.311167

Next steps: View recommended plots

```
fig, ax = plt.subplots(figsize=(8, 6))
plt.scatter(df.iloc[:,0], df.iloc[:,1], marker = 'o',
            c=df['centroid'].astype('category'),
            cmap = customcmap, s=80, alpha=0.5)
plt.scatter(centroids.iloc[:,0], centroids.iloc[:,1],
            marker = 's', s=200,
            c=[0, 1, 2], cmap = customcmap)
ax.set_xlabel(r'x', fontsize=14)
ax.set_ylabel(r'y', fontsize=14)
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)
plt.show()
```




```
def kmeans(dset, k=2, tol=1e-4):
    '''
    K-means implementation for a
    `dset`: DataFrame with observations
    `k`: number of clusters, default k=2
    `tol`: tolerance=1E-4
    '''
    # Let us work in a copy, so we don't mess with the original
    working_dset = dset.copy()

    # We define some variables to hold the error, the
    # stopping signal and a counter for the iterations
    err = []
    goahead = True
    j = 0

    # Step 2: Initiate clusters by defining centroids
    centroids = initiate_centroids(k, dset)

    while goahead:
        # Step 3 and 4 - Assign centroids and calculate error
        working_dset['centroid'], j_err = centroid_assignation(working_dset, centroids)
        err.append(sum(j_err))

        # Step 5 - Update centroid position
        centroids = working_dset.groupby('centroid').agg('mean').reset_index(drop=True)

        # Step 6 - Restart the iteration
        if j > 0:
            # Is the error less than a tolerance (1E-4)
            if err[j-1] - err[j] <= tol:
                goahead = False

        j += 1
        working_dset['centroid'], j_err = centroid_assignation(working_dset, centroids)
        centroids = working_dset.groupby('centroid').agg('mean').reset_index(drop=True)

    return working_dset['centroid'], j_err, centroids


np.random.seed(42)
df['centroid'], df['error'], centroids = kmeans(df[['x','y']], 3)
df.head()
```

	x	y	centroid	error
0	24.412	32.932	2	3767.568743
1	35.190	12.189	1	1399.889001
2	26.288	41.718	2	262.961097
3	0.376	15.506	0	2683.086425
4	26.116	3.963	1	2723.650198

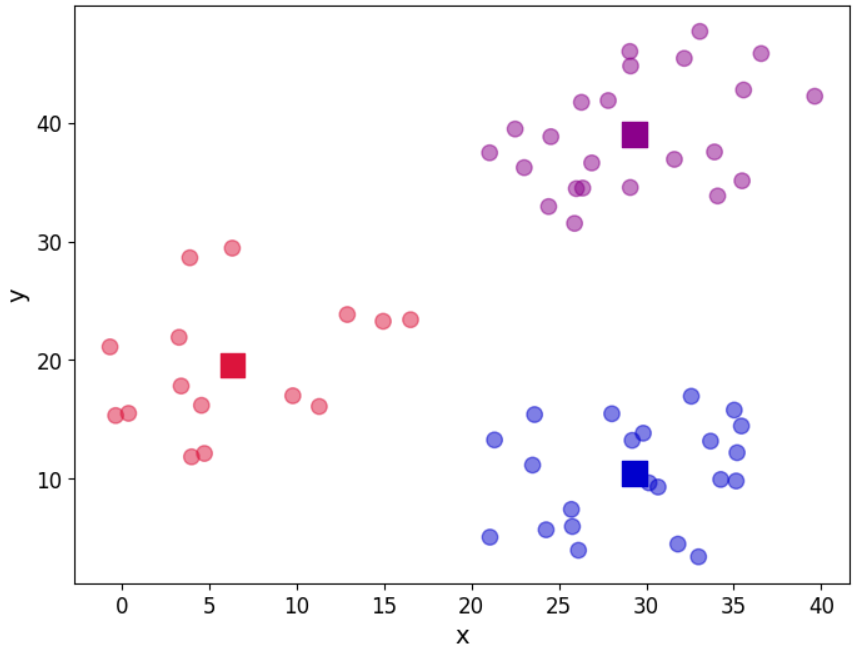
Next steps: View recommended plots

```
centroids
```

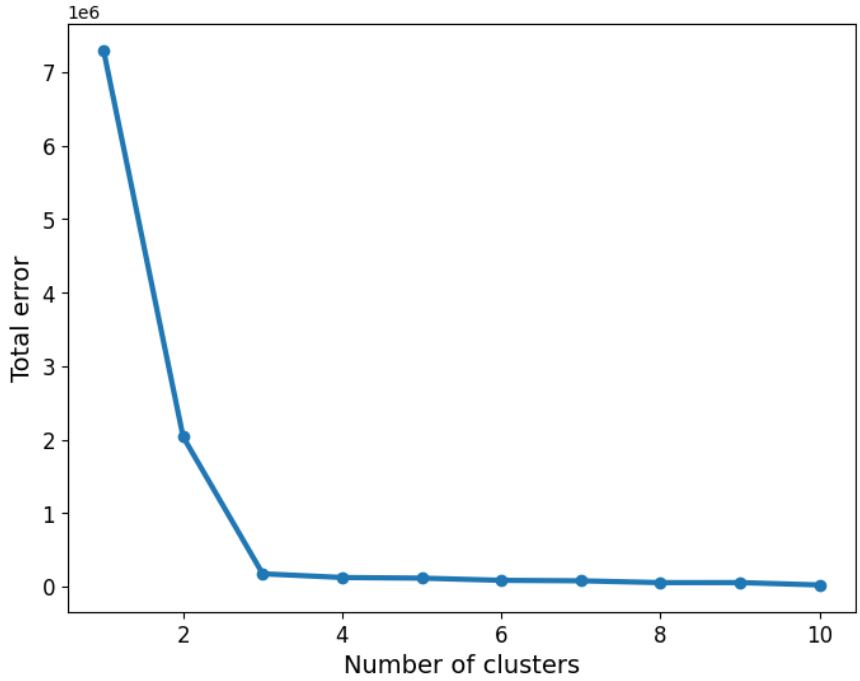
	x	y
0	6.322867	19.559800
1	29.330864	10.432409
2	29.304957	39.050783

Next steps: View recommended plots

```
fig, ax = plt.subplots(figsize=(8, 6))
plt.scatter(df.iloc[:,0], df.iloc[:,1], marker = 'o',
            c=df['centroid'].astype('category'),
            cmap = customcmap, s=80, alpha=0.5)
plt.scatter(centroids.iloc[:,0], centroids.iloc[:,1],
            marker = 's', s=200, c=[0, 1, 2],
            cmap = customcmap)
ax.set_xlabel(r'x', fontsize=14)
ax.set_ylabel(r'y', fontsize=14)
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)
plt.show()
```



```
err_total = []
n = 10
df_elbow = blobs[['x','y']]
for i in range(n):
    _, my_errs, _ = kmeans(df_elbow, i+1)
    err_total.append(sum(my_errs))
fig, ax = plt.subplots(figsize=(8, 6))
plt.plot(range(1,n+1), err_total, linewidth=3, marker='o')
ax.set_xlabel(r'Number of clusters', fontsize=14)
ax.set_ylabel(r'Total error', fontsize=14)
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)
plt.show()
```




```
from sklearn.cluster import KMeans
from sklearn import datasets
from sklearn.utils import shuffle
# import some data to play with
iris = datasets.load_iris()
X = iris.data
y = iris.target
names = iris.feature_names
X, y = shuffle(X, y, random_state=42)
```

```
model = KMeans(n_clusters=3, random_state=42)
iris_kmeans = model.fit(X)
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:870: FutureWarning: The default value of `n_init` wil
  warnings.warn(
```

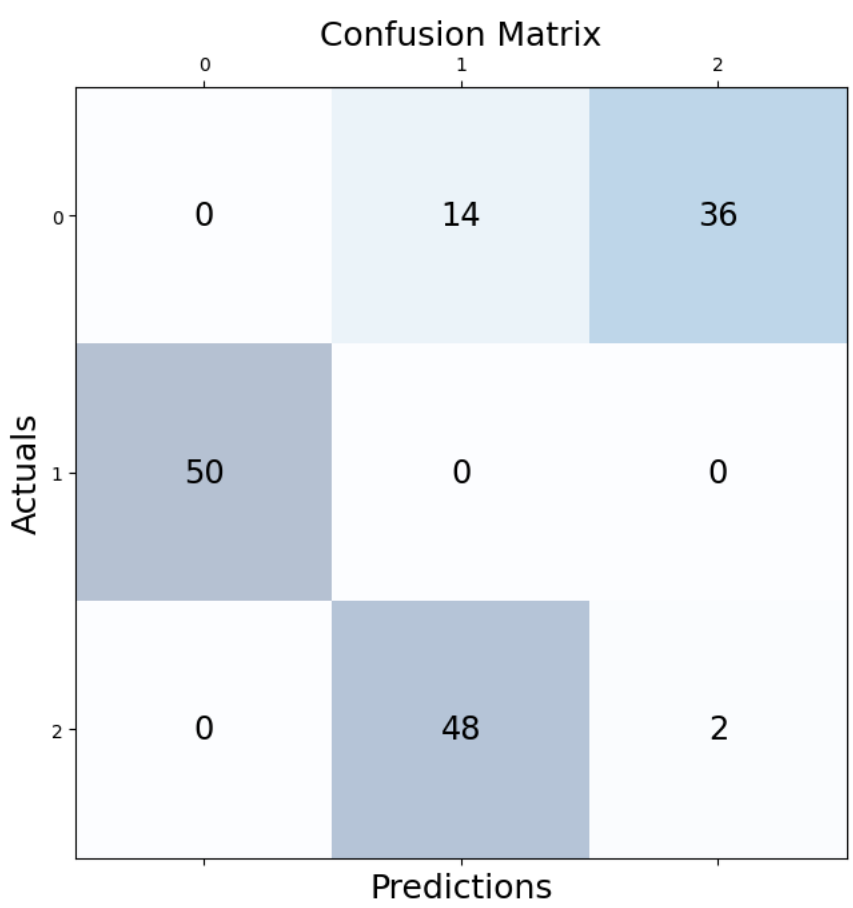
```
iris_kmeans.labels_
```

```
array([1, 0, 2, 1, 1, 0, 1, 2, 1, 1, 2, 0, 0, 0, 0, 1, 2, 1, 1, 2, 0, 1,
       0, 2, 2, 2, 2, 2, 0, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 1, 0,
       0, 1, 1, 2, 1, 2, 1, 2, 1, 0, 2, 1, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0,
       1, 2, 0, 1, 1, 0, 1, 1, 1, 1, 2, 1, 0, 1, 2, 0, 0, 1, 2, 0, 1, 0,
       0, 1, 1, 2, 1, 2, 2, 1, 0, 0, 1, 2, 0, 0, 0, 1, 2, 0, 2, 2, 0, 1,
       1, 1, 1, 2, 0, 2, 1, 2, 1, 1, 1, 0, 1, 1, 0, 1, 2, 2, 0, 1, 2, 2,
       0, 2, 0, 2, 2, 2, 1, 2, 1, 1, 1, 1, 0, 1, 1, 0, 1, 2], dtype=int32)
```

```
y = np.choose(y, [1, 2, 0]).astype(int)
y
```

```
array([2, 1, 0, 2, 2, 1, 2, 0, 2, 2, 0, 1, 1, 1, 1, 2, 0, 2, 2, 0, 1, 0,
       1, 0, 0, 0, 0, 0, 1, 1, 1, 1, 2, 1, 1, 0, 2, 1, 1, 1, 0, 2, 2, 1,
       1, 2, 0, 0, 2, 0, 2, 0, 2, 1, 0, 2, 1, 1, 1, 2, 0, 1, 1, 1, 2, 1,
       2, 0, 1, 2, 0, 1, 0, 0, 2, 2, 0, 2, 1, 2, 0, 1, 1, 2, 2, 1, 0, 1,
       1, 2, 2, 0, 2, 0, 0, 2, 1, 1, 0, 0, 1, 1, 1, 2, 0, 1, 0, 0, 1, 2,
       2, 0, 2, 0, 1, 0, 2, 0, 2, 2, 2, 1, 2, 2, 1, 2, 0, 0, 1, 2, 0, 0,
       1, 0, 1, 2, 0, 0, 2, 0, 2, 2, 0, 0, 1, 2, 0, 1, 2, 0])
```

```
from sklearn.metrics import confusion_matrix
conf_matrix=confusion_matrix(y, iris_kmeans.labels_)
fig, ax = plt.subplots(figsize=(7.5, 7.5))
ax.matshow(conf_matrix, cmap=plt.cm.Blues, alpha=0.3)
for i in range(conf_matrix.shape[0]):
    for j in range(conf_matrix.shape[1]):
        ax.text(x=j, y=i,s=conf_matrix[i, j], va='center',
                ha='center', size='xx-large')
plt.xlabel('Predictions', fontsize=18)
plt.ylabel('Actuals', fontsize=18)
plt.title('Confusion Matrix', fontsize=18)
plt.show()
```




```
iris_kmeans.cluster_centers_
```

```
array([[5.006     , 3.428     , 1.462     , 0.246     ],
       [5.9016129 , 2.7483871 , 4.39354839, 1.43387097],
       [6.85      , 3.07368421, 5.74210526, 2.07105263]])
```

```
fig = plt.figure(figsize=(20, 10))

# First subplot for K-Means Clusters
ax1 = fig.add_subplot(1, 2, 1, projection='3d')
ax1.scatter(X[:, 3], X[:, 0], X[:, 2],
            c=iris_kmeans.labels_.astype(float),
            edgecolor="k", s=150, cmap=customcmap)
ax1.view_init(20, -50)
ax1.set_xlabel(names[3], fontsize=12)
ax1.set_ylabel(names[0], fontsize=12)
ax1.set_zlabel(names[2], fontsize=12)
ax1.set_title("K-Means Clusters for the Iris Dataset", fontsize=12)

# Second subplot for Actual Labels
ax2 = fig.add_subplot(1, 2, 2, projection='3d')
for label, name in enumerate(['virginica', 'setosa', 'versicolor']):
    ax2.text3D(X[y == label, 3].mean(),
               X[y == label, 0].mean(),
               X[y == label, 2].mean() + 2,
               name,
               horizontalalignment="center",
               bbox=dict(alpha=0.2, edgecolor="w", facecolor="w"))
ax2.scatter(X[:, 3], X[:, 0], X[:, 2],
            c=y, edgecolor="k", s=150,
            cmap=customcmap)
ax2.view_init(20, -50)
ax2.set_xlabel(names[3], fontsize=12)
ax2.set_ylabel(names[0], fontsize=12)
ax2.set_zlabel(names[2], fontsize=12)
ax2.set_title("Actual Labels for the Iris Dataset", fontsize=12)
```