LA03_Ex2_KDE

April 28, 2018

```
In [1]: import numpy as np
        import matplotlib.pyplot as plt
        import scipy as sp
        from scipy import stats
        from sklearn.neighbors import KernelDensity
        from statsmodels.nonparametric.kde import KDEUnivariate
        from statsmodels.nonparametric.kernel_density import KDEMultivariate
```

1 Task1

Compare the outcomes of different implementations of KDEs.

There are several options available for computing KDE in Python. - SciPy: gaussian_kde. - Statsmodels: KDEUnivariate and KDEMultivariate. - Scikit-learn: KernelDensity.

1.1 1.1. Generate synthethic data and plot them

Generate synthetic dataset the distribution of which can be presented as a combination of three Gausian distributions with the following parameters: μ_1=1, σ_1=1 and μ_2=8, σ_2=2 and μ_2=14, σ_2=1.5. Generate 1000 samples from the distribution.

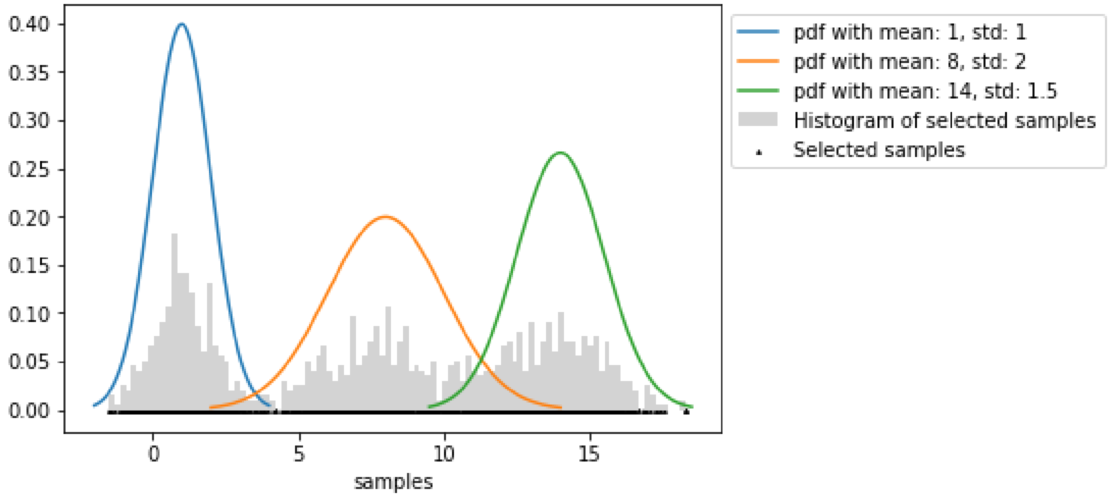
Plot the pdf of this distribution and the generated samples.

```
In [2]: """
        source:
        https://stackoverflow.com/questions/14189937/separate-mixture-of-gaussians-in-python
        https://docs.scipy.org/doc/numpy/reference/generated/numpy.random.choice.html
        """
        mean_std = [[1,1],[8,2],[14,1.5]]
        mix=np.array([])
        for mean,std in mean_std:
            x = np.linspace(mean-3*std,mean+3*std,1000)
            plt.plot(x,plt.mlab.normpdf(x,mean,std),
                     label="pdf with mean: "+str(mean)+", std: "+str(std))
            mix= np.concatenate((mix,np.random.normal(mean,std,1000)))


        samples = np.random.choice(mix, 1000)
        samples_x = np.full(samples.shape,-0.001)
```

```
plt.hist(samples, bins=samples.size//10, normed=True,
         label="Histogram of selected samples",color='lightgrey')

plt.scatter(samples,samples_x,c='k',marker='^',s=3,
            label="Selected samples")
plt.xlabel('samples')
plt.legend(bbox_to_anchor = (1,1),loc= 2)
plt.show()
```

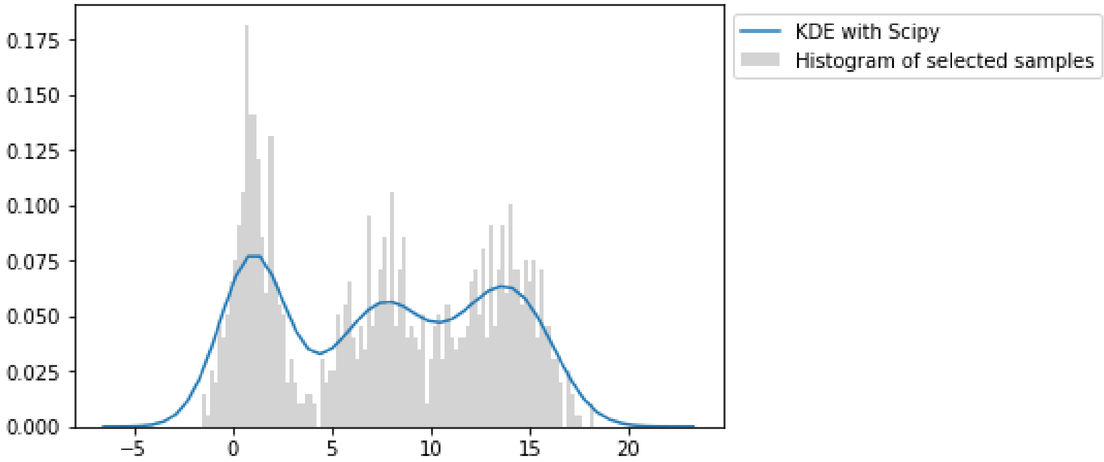


1.2 1.2. Use the generated samples to perform

1.2.1 1.2.1. KDE with Scipy

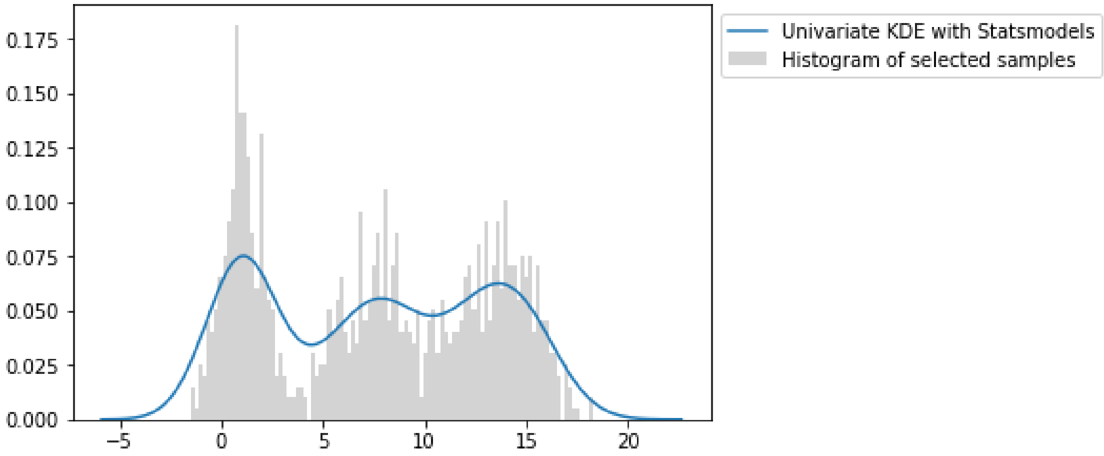
```
In [3]: x = np.linspace(np.min(samples)-5,np.max(samples)+5)
```

```
In [4]: scipy_kde=stats.gaussian_kde(samples)
        plt.plot(x,scipy_kde.evaluate(x),label = 'KDE with Scipy')
        plt.hist(samples, bins=samples.size//10, normed=True,
                 label="Histogram of selected samples",color='lightgrey')
        plt.legend(bbox_to_anchor = (1,1),loc= 2)
        plt.show()
```



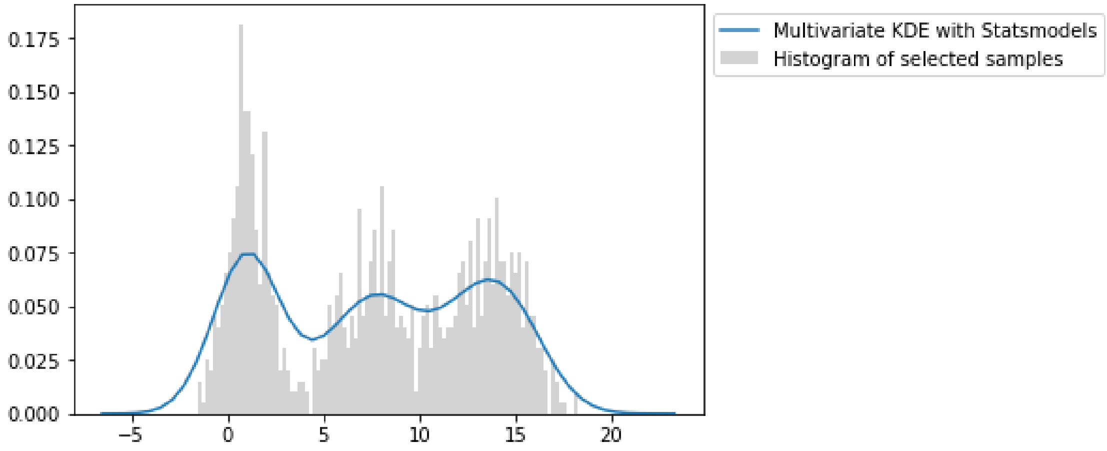
1.2.2 1.2.2. Univariate KDE with Statsmodels

```
In [5]: """
        source:
        http://www.statsmodels.org/dev/examples/notebooks/generated/kernel_density.html
        """
        statsmod_univariate_kde = KDEUnivariate(samples)
        statsmod_univariate_kde.fit()
        plt.hist(samples, bins=samples.size//10, normed=True,
                 label="Histogram of selected samples",color='lightgrey')
        plt.plot(statsmod_univariate_kde.support, statsmod_univariate_kde.density,
                 label= 'Univariate KDE with Statsmodels')
        plt.legend(bbox_to_anchor = (1,1),loc= 2)
        plt.show()
```



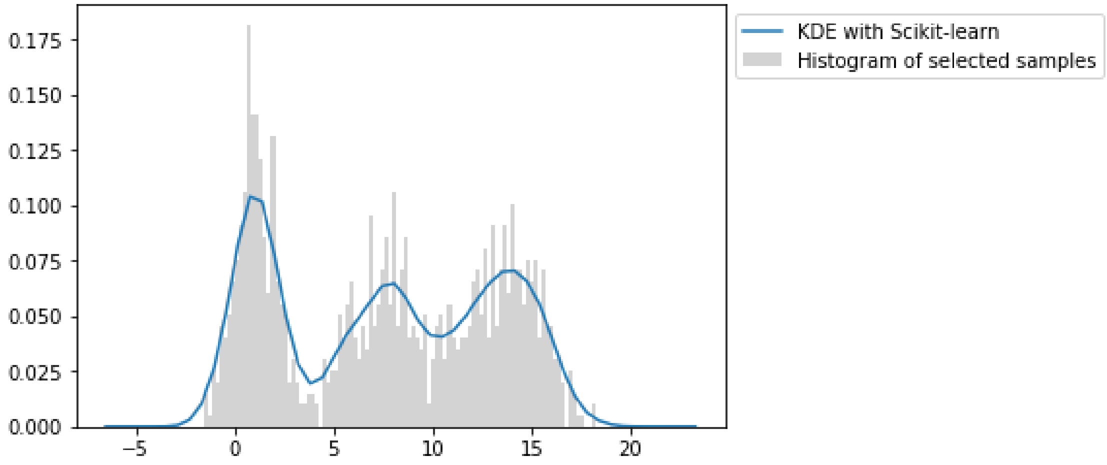
1.2.3 1.2.3. Multivariate KDE with Statsmodels

```
In [6]: statsmod_multivariate_kde = KDEMultivariate(samples, var_type= 'c')
        plt.hist(samples, bins=samples.size//10, normed=True,
                 label="Histogram of selected samples",color='lightgrey')
        plt.plot(x, statsmod_multivariate_kde.pdf(x),
                 label= 'Multivariate KDE with Statsmodels')
        plt.legend(bbox_to_anchor = (1,1),loc= 2)
        plt.show()
```



1.2.4 1.2.4. KDE with Scikit-learn

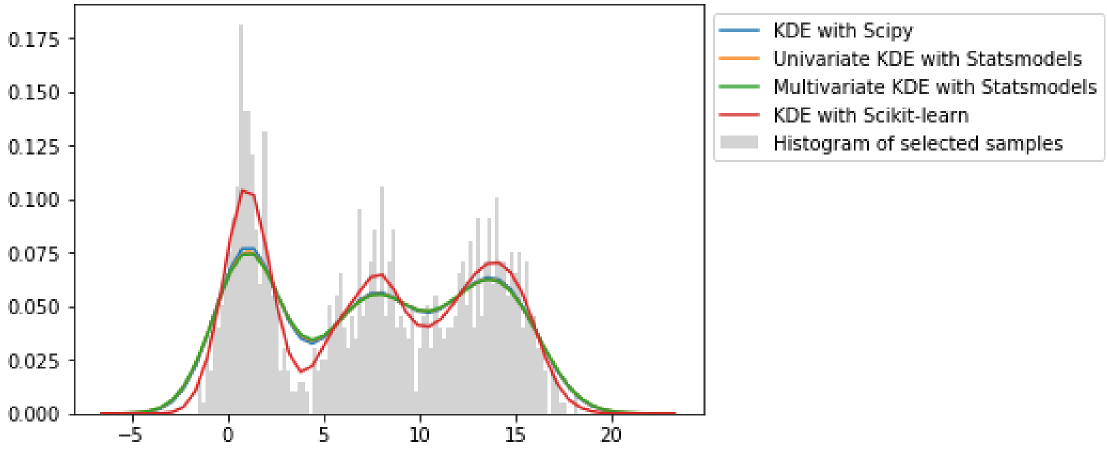
```
In [7]: """
        Source:
        http://scikit-learn.org/stable/auto_examples/neighbors/plot_kde_1d.html
        """
        scikitlearn_kde = KernelDensity(kernel='gaussian',
                                        bandwidth=0.75).fit(samples[:, np.newaxis])
        plt.hist(samples, bins=samples.size//10, normed=True,
                 label="Histogram of selected samples",color='lightgrey')
        plt.plot(x, np.exp(scikitlearn_kde.score_samples(x[:,np.newaxis])),
                 label= 'KDE with Scikit-learn')
        plt.legend(bbox_to_anchor = (1,1),loc= 2)
        plt.show()
```



1.3 1.3 Plot all four distributions on one figure.

```
In [8]: plt.hist(samples, bins=samples.size//10, normed=True,
                 label="Histogram of selected samples",color='lightgrey')
        plt.plot(x,scipy_kde.evaluate(x),label = 'KDE with Scipy')
        plt.plot(statsmod_univariate_kde.support, statsmod_univariate_kde.density,
                 label= 'Univariate KDE with Statsmodels')
        plt.plot(x, statsmod_multivariate_kde.pdf(x),
                 label= 'Multivariate KDE with Statsmodels')
        plt.plot(x, np.exp(scikitlearn_kde.score_samples(x[:,np.newaxis])),
                 label= 'KDE with Scikit-learn')

        plt.legend(loc=2,bbox_to_anchor=(1,1))
        plt.show()
```


KDE with Scipy
Univariate KDE with Statsmodels
Multivariate KDE with Statsmodels
KDE with Scikit-learn
Histogram of selected samples