PHYS_356_notebook

February 21, 2018

1 Problem 1

1.1 (a)

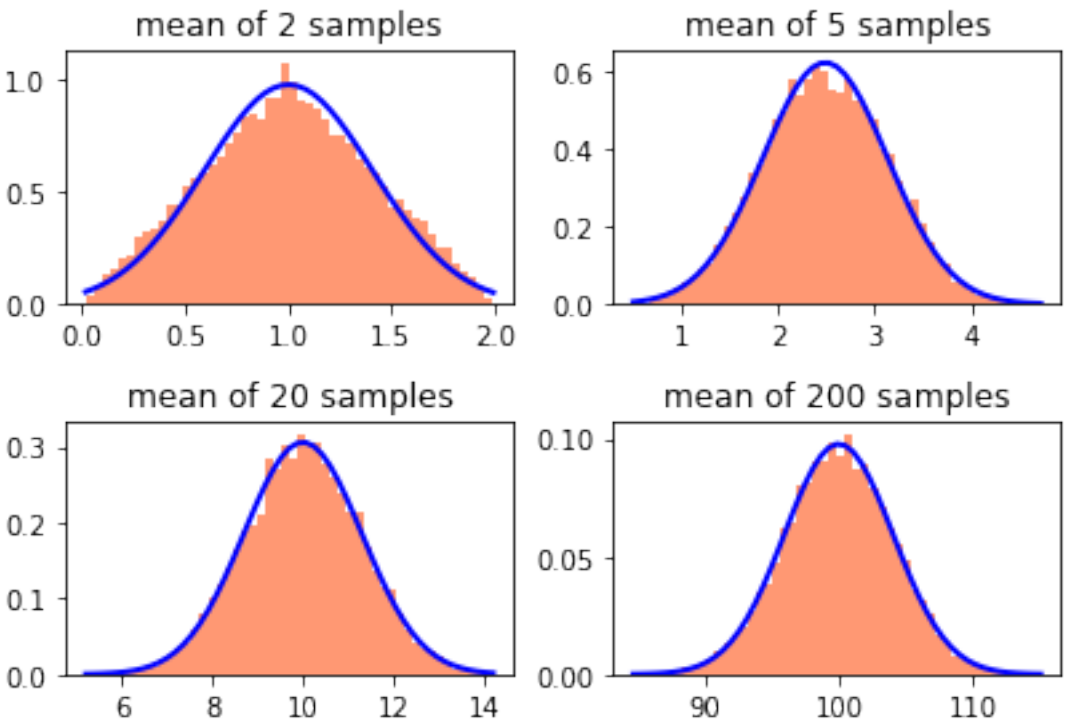
Show the distribution of mean values of N random variables obtained from a uniform distribution for increasing numbers of N (i.e., N = 2, 5, 20, 200) and compare each distribution with a Gaussian with the same mean and variance as the obtained distribution.

```
In [1]: import numpy as np
        from matplotlib import pyplot as plt
        from matplotlib import mlab
        import math
```

```
In [46]: def gaussian(x, mu, sig):
             return np.exp(-np.power(x - mu, 2.) / (2 * np.power(sig, 2.)))

         # Number of samples for each trial
         samples = [2, 5, 20, 200]
         numBins = 50
         trials = 10**4

         for i, N in enumerate(samples):
             plt.subplot(2,2,i+1)
             plt.tight_layout()
             means = []
             for i in range(trials):
                 dist = np.random.uniform(0,1,N)
                 means.append(sum(dist))
             mean = np.mean(means)
             variance = np.var(means)
             count, bins, ignored = plt.hist(means, numBins, normed = True, color = "coral", al
             plt.plot(bins, mlab.normpdf(bins, mean, np.sqrt(variance)), color = "blue", linewi
             plt.title("mean of " + str(N) + " samples")
         plt.savefig("1a.png", dpi=300)
```



1.2 (b)

Do the same as (a) but using the distribution in problem 4 of problem set 1, with a = 2.

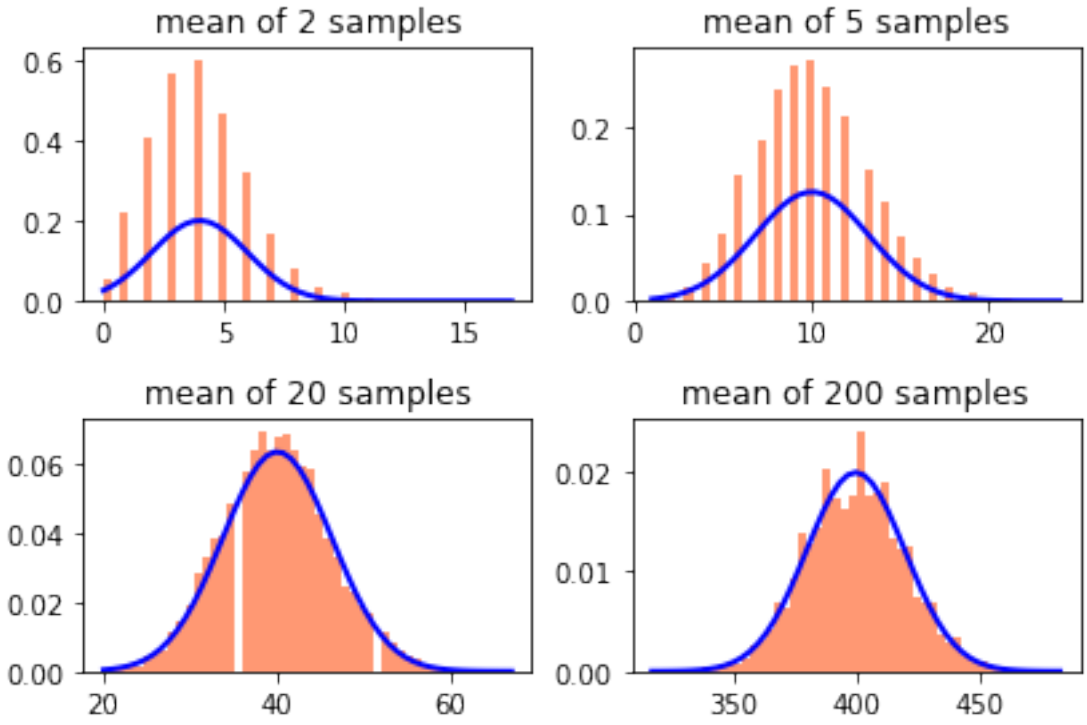
```
In [62]: # Number of samples for each trial
         samples = [2, 5, 20, 200]
         numBins = 50

         trials = 10**4

         # Poisson Parameters
         a = 2

         for i, N in enumerate(samples):
             plt.subplot(2,2,i+1)
             plt.tight_layout()
             means = []
             for i in range(trials):
                 dist = np.random.poisson(a,N)
                 means.append(sum(dist))
             mean = np.mean(means)
             variance = np.var(means)
             count, bins, ignored = plt.hist(means, numBins, normed = True, color = "coral", al
```

```
        plt.plot(bins, mlab.normpdf(bins, mean, np.sqrt(variance)), color = "blue", linew
        plt.title("mean of " + str(N) + " samples")
    plt.savefig("1b.png", dpi=300)
```

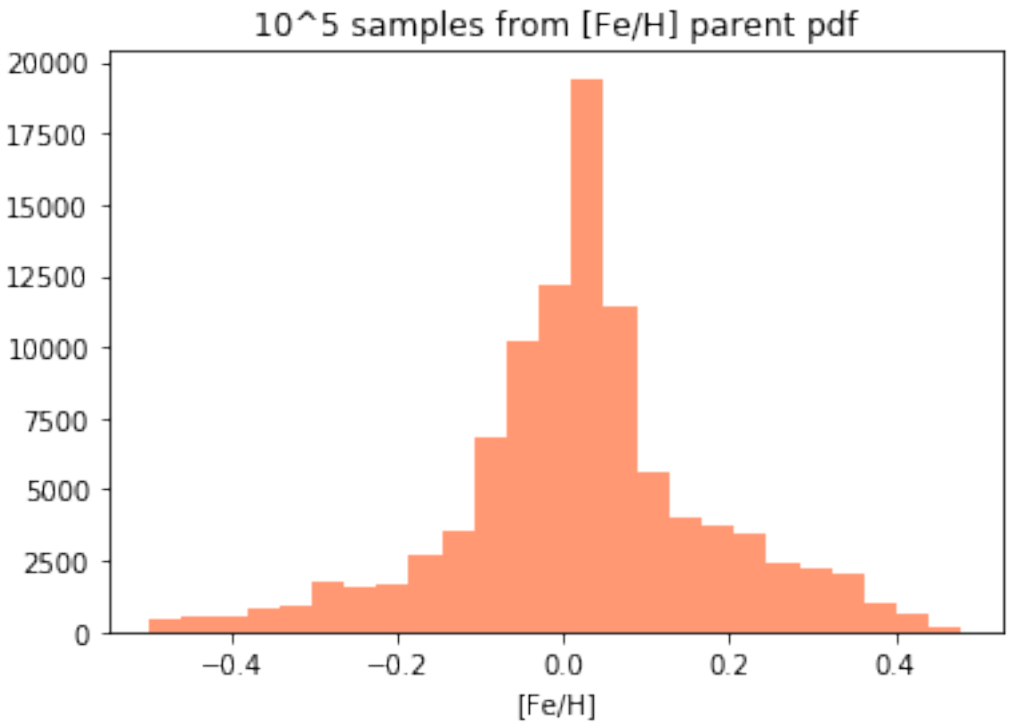


2 Problem 2

```
In [13]: # Load data from exoplanets.org, strip first entry (header)
         FeH_data = np.genfromtxt("FeH.csv", delimiter=',')
         FeH_data = FeH_data[1:]

         # # Get 10^5 samples
         numSamples = 10**5
         distribution = np.random.choice(FeH_data, numSamples)

         plt.hist(distribution, 25, color="coral", alpha = 0.8)
         plt.xlabel('[Fe/H]')
         plt.title('10^5 samples from [Fe/H] parent pdf')
         plt.savefig("2.png", dpi=300)
```



3 Problem 3

3.1 (d)

Use python to plot the data and the regression line you found in 1c.

```
In [15]: # Samples
         x = [1,3,5]
         y = [8,2,1]

         avg_x = np.average(x)
         avg_y = np.average(y)

         cov = 0
         for i in range(3):
             cov += (x[i] - avg_x)*(y[i]-avg_y)/3

         a = cov/np.var(x)
         b = avg_y - a*avg_x
```

```
In [50]: plt.scatter(x, y, marker='o', color="coral")
         t = np.arange(0.5, 5.5, 0.1)
         plt.plot(t, a*t+b)
         plt.title(r'MLE: $\hat{a} \approx -1.75,\quad \hat{b} \approx 8.92$')
```

```
plt.xlabel('X')
plt.ylabel('Y')
plt.savefig("3d.png", dpi=300)
```