stats

November 16, 2022

0.1 Tarek El-Hajjaoui, 11/15/2022, Stats 200AP

[47]:
```
import numpy as np
import matplotlib.pyplot as plt
from scipy.stats import norm, multivariate_normal, probplot
from mpl_toolkits.mplot3d import Axes3D
```

[48]:
```
# Y1   N(80, 10^2)
y1_mu = 80
y1_sigma = 10
y1 = np.random.normal(y1_mu, y1_sigma, 1000)
```

[49]:
```
np.mean(y1), np.sqrt(np.var(y1))
```

[49]:
```
(80.05291637914031, 10.006395350742721)
```

[50]:
```
# Y2   N(83, 10^2)
y2_mu = 83
y2_sigma = 10
y2 = np.random.normal(y2_mu, y2_sigma, 1000)
```

[51]:
```
np.mean(y2), np.sqrt(np.var(y2))
```

[51]:
```
(82.8854172147184, 10.263753316698011)
```

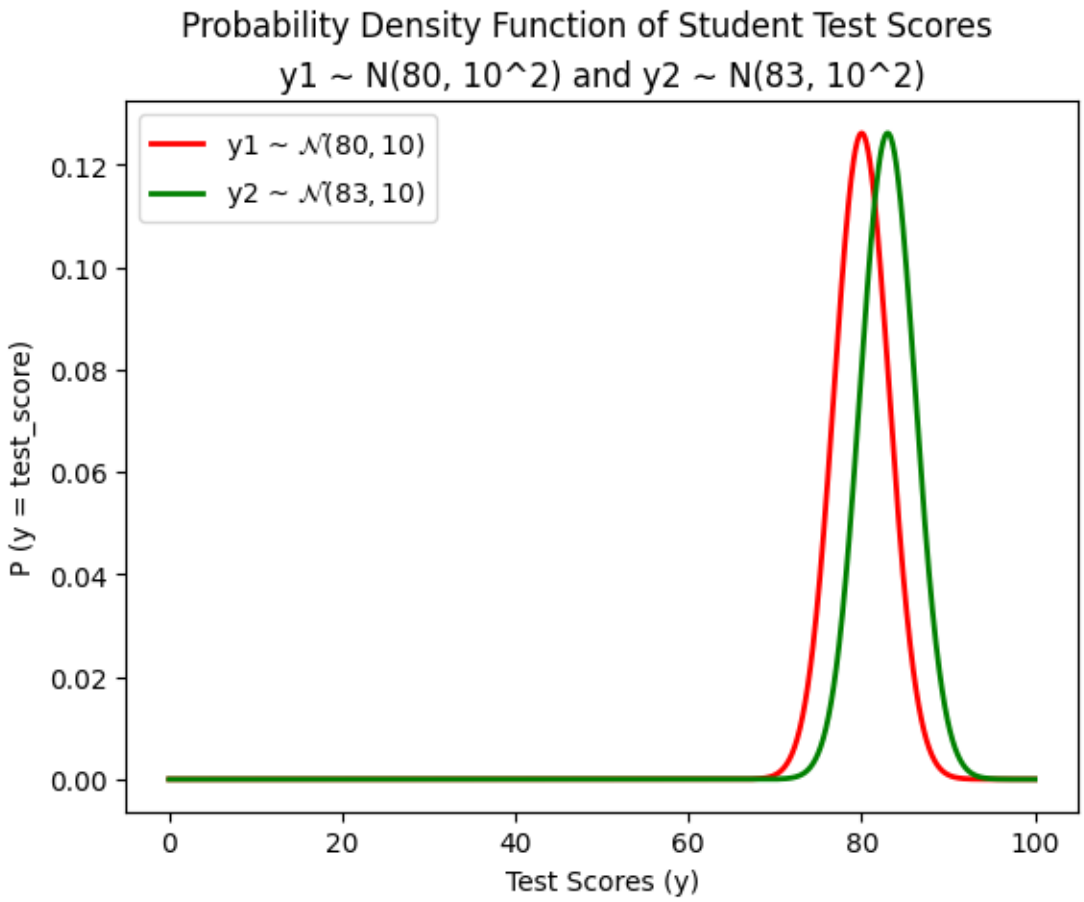
[52]:
```
def univariate_normal_pdf(y, mu, sigma):
    """pdf of the univariate normal distribution."""
    return ((1. / np.sqrt(2 * np.pi * sigma)) *
            np.exp(-(y - mu)**2 / (2 * sigma)))
```

[53]:
```
def plot_distributions(y1_mu, y1_sigma,
                       y2_mu, y2_sigma,
                       suptitle, title, y1_ax,
                       y2_ax, y1_label, y2_label,
                       lower_limit, upper_limit, pop_size):

    x = np.linspace(lower_limit, upper_limit, num=pop_size)
```

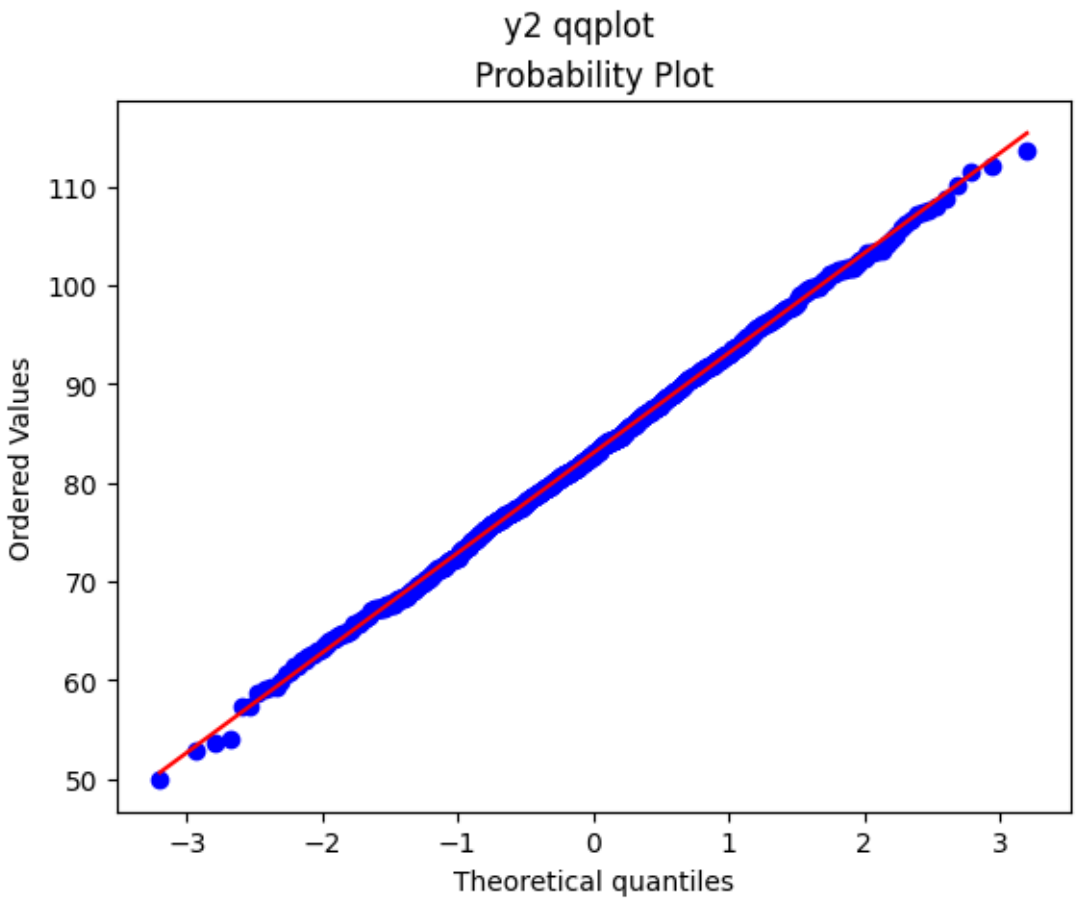
```
    plt.plot(x, univariate_normal_pdf(x, y1_mu, y1_sigma), linewidth=2,␣
↪color='r', label=y1_label)
    plt.plot(x, univariate_normal_pdf(x, y2_mu, y2_sigma), linewidth=2,␣
↪color='g', label=y2_label)
    plt.suptitle(suptitle)
    plt.title(title)
    plt.xlabel(y1_ax)
    plt.ylabel(y2_ax)
    plt.legend(loc='upper left')
    plt.show()
```

[54]:
```
plot_distributions(y1_mu=y1_mu, y1_sigma=y1_sigma, y2_mu=y2_mu,␣
↪y2_sigma=y2_sigma,
                   suptitle="Probability Density Function of Student Test␣
↪Scores",
                   title="y1   N(80, 10^2) and y2   N(83, 10^2)", y1_ax="Test␣
↪Scores (y)",
                   y2_ax="P (y = test_score)", y1_label="y1 ~ $\mathcal{N}(80,␣
↪10)$",
                   y2_label="y2 ~ $\mathcal{N}(83, 10)$", lower_limit=0,␣
↪upper_limit=100, pop_size=1000)
```

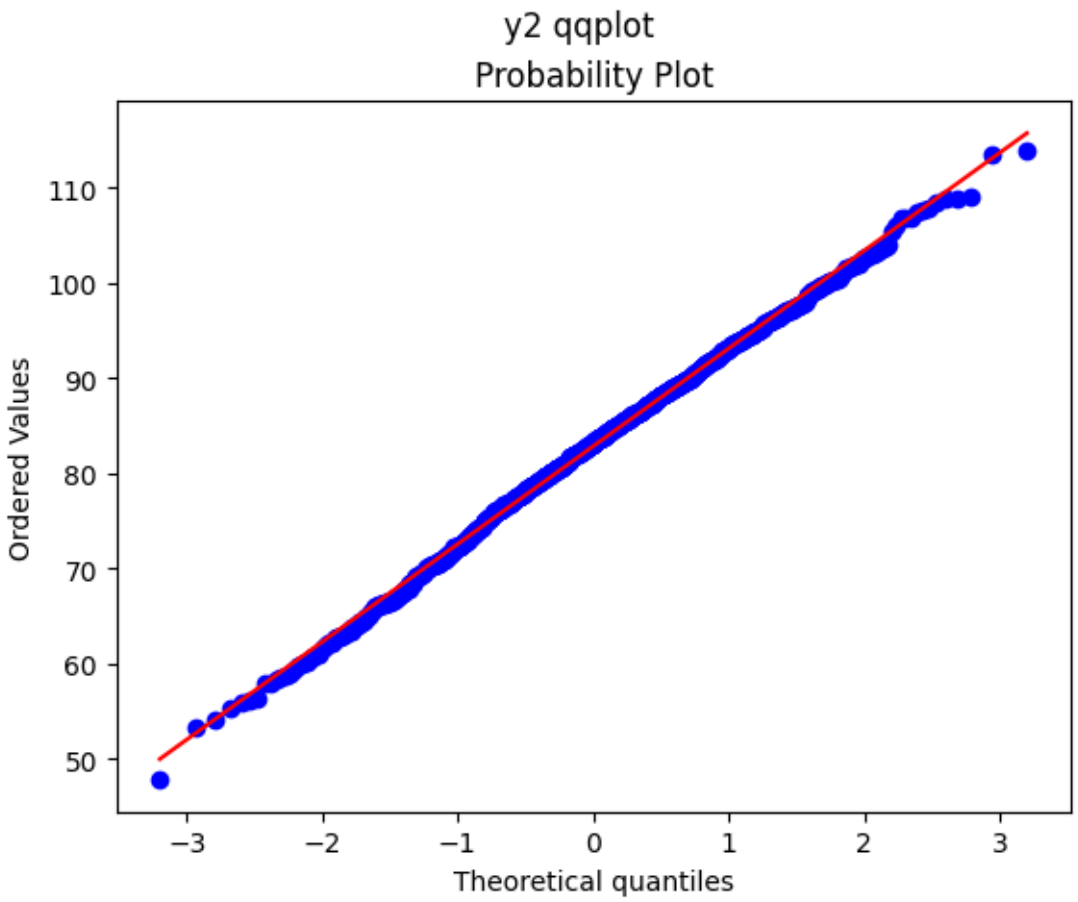


[55]:
```
def qqplot(y, suptitle):
    fig = plt.figure()
    plt.suptitle(suptitle)
    ax = fig.add_subplot(111)
    res = probplot(y, dist='norm', plot=ax)
```

[56]:
```
qqplot(y1, suptitle="y1 qqplot")
```



[57]:
```
qqplot(y2, suptitle="y2 qqplot")
```



0.1.1 E[(0.4)y1 +(0.4)y2 + (0.2)max{ y1,y2 }]

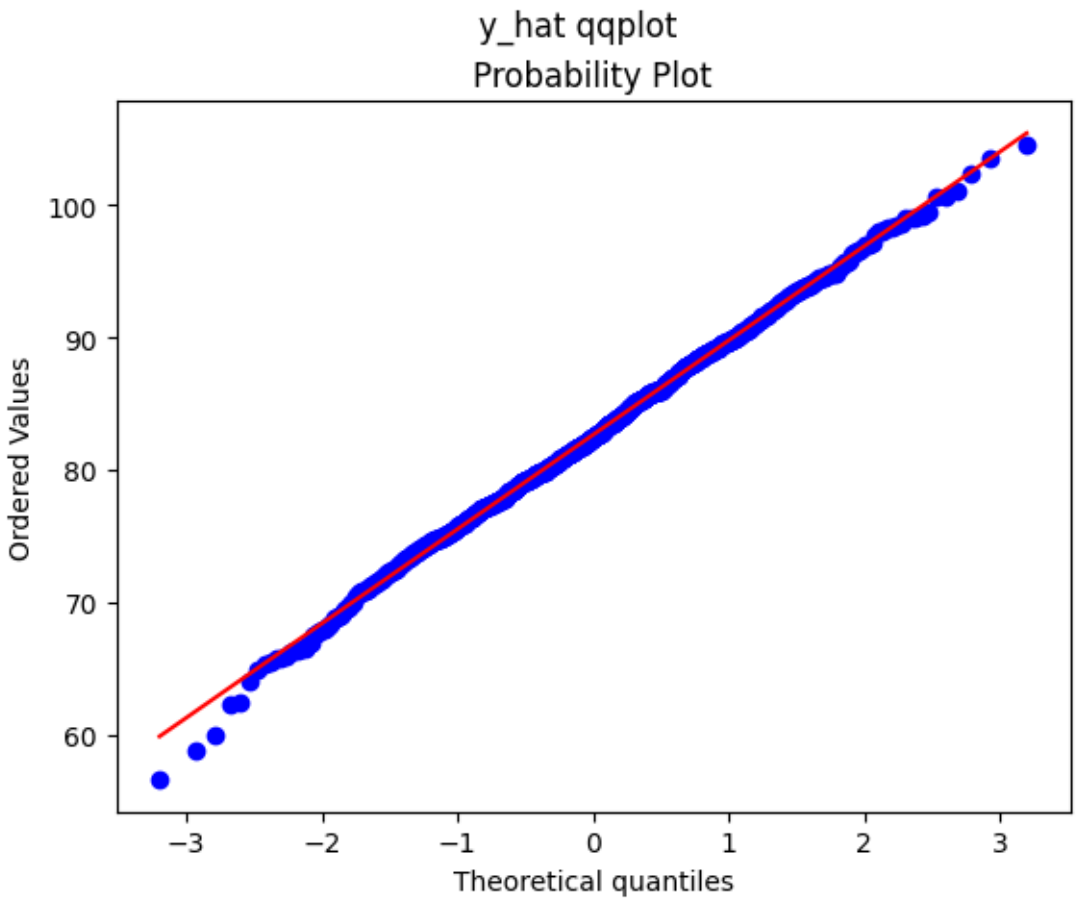
[58]:
```
def expected_value(y1, y2, y1_weight, y2_weight, y_max_weight):
        return (y1_weight * np.mean(y1)) + (y2_weight * np.mean(y2)) +␣
↪(y_max_weight * np.mean(np.max([y1, y2])))
```

[59]:
```
y_hat = np.array([expected_value(y1[i], y2[i], 0.4, 0.4, 0.2) for i in␣
↪range(1000)])
```

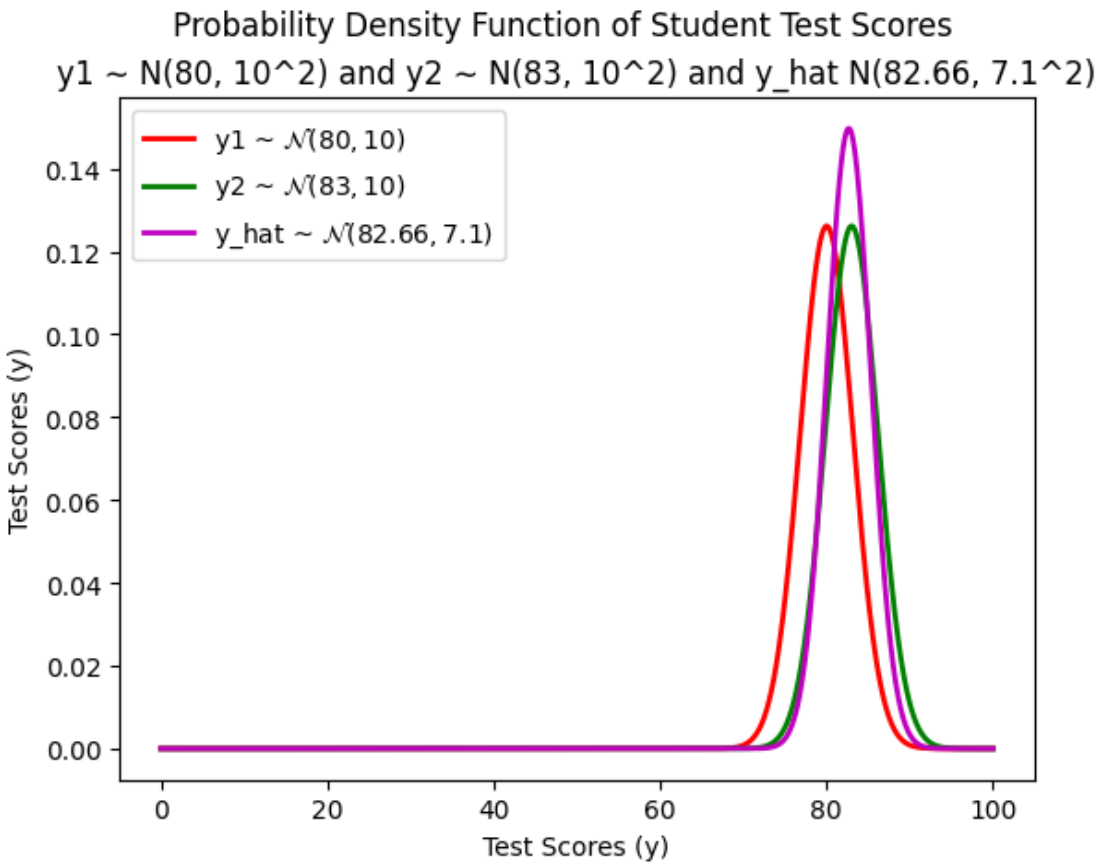
[60]:
```
y_hat_mu, y_hat_sigma = round(np.mean(y_hat),2), round(np.sqrt(np.var(y_hat)),␣
↪2)
y_hat_mu, y_hat_sigma
```

[60]: (82.66, 7.1)

[61]:
```
qqplot(y_hat, suptitle="y_hat qqplot")
```



[62]:
```
    x = np.linspace(0, 100, num=1000)
    plt.plot(x, univariate_normal_pdf(x, y1_mu, y1_sigma), linewidth=2,␣
↪color='r', label="y1 ~ $\mathcal{N}(80, 10)$")
    plt.plot(x, univariate_normal_pdf(x, y2_mu, y2_sigma), linewidth=2,␣
↪color='g', label="y2 ~ $\mathcal{N}(83, 10)$")
    plt.plot(x, univariate_normal_pdf(x, y_hat_mu, y_hat_sigma), linewidth=2,␣
↪color='m', label=f"y_hat ~ $\mathcal{{N}}({y_hat_mu}, {y_hat_sigma})$")
    plt.suptitle("Probability Density Function of Student Test Scores")
    plt.title(f"y1   N(80, 10^2) and y2   N(83, 10^2) and y_hat N({y_hat_mu},␣
↪{y_hat_sigma}^2)")
    plt.xlabel("Test Scores (y)")
    plt.ylabel("Test Scores (y)")
    plt.legend(loc='upper left')
    plt.show()
```



0.1.2 Sources

- matplotlib normal - https://numpy.org/doc/stable/reference/random/generated/numpy.random.normal.htm
- matplotlib hist - https://matplotlib.org/stable/api/_as_gen/matplotlib.pyplot.hist.html
- expected value in Python - https://www.statology.org/expected-value-in-python/
- univariate normal pdf - https://peterroelants.github.io/posts/multivariate-normal-primer/
  #### Furture reference for 3d plots
- https://matplotlib.org/2.0.2/mpl_toolkits/mplot3d/tutorial.html
- https://stackoverflow.com/questions/67095247/gca-and-latest-version-of-matplotlib
- https://stackoverflow.com/questions/38698277/plot-normal-distribution-in-3d

[ ]: