In [1]:
```
import pandas as pd
import numpy as np
```

In [2]:
```
import sklearn.discriminant_analysis
sklearn.discriminant_analysis.__file__
```

Out[2]:
```
'/Users/wendellwang/Developer/ML/lib/python3.9/site-packages/sklearn/discriminant_analysis.py'
```

In [3]:
```
db = pd.read_csv('insect.txt',
                 header=None,
                 names=['Y', 'X1', 'X2', 'X3'],
                 sep=' ')
db.head()
```

Out[3]:

	Y	X1	X2	X3
0	a	191	131	53
1	a	185	134	50
2	a	200	137	52
3	a	173	127	50
4	a	171	128	49

In [12]:
```
from scipy.stats import bartlett
```

In [134…
```
stat, p = bartlett(db['X1'], db['X2'], db['X3'])
```

In [135…
```
p
```

Out[135…
```
1.0685193072965499e-12
```

In [136…
```
stat
```

Out[136…
```
55.12949450156246
```

In [137…
```
[np.var(x, ddof=1) for x in [db['X1'], db['X2'], db['X3']]]
```

Out[137…
```
[441.9236842105263, 85.83157894736841, 7.694736842105264]
```

In [157…
```
from sklearn.discriminant_analysis import LinearDiscriminantAnalysis as LDA
```

In [158…
```
model = LDA(store_covariance=True)
```

In [159…
```
Y = np.array(db['Y'])
X = np.array(db[['X1', 'X2', 'X3']])
```

In [160…
```
model.fit(X,Y)
```

Out[160…
```
LinearDiscriminantAnalysis(store_covariance=True)
```

In [161…
```
print(model.predict([[191, 131, 53]]))
```

```
['a']
```

Due to the limitations of sklearn, we were not able to get the linear discriminant functions for the two species separately. We could only get the coefficients and intercept of the final result $(\hat{d_b^L}(x) - \hat{d_a^L}(x))$

In [165…
```
model.coef_
```

Out[165…
```
array([[ 0.67922537, -0.40785906, -2.70428038]])
```

In [166…
```
model.intercept_
```

Out[166…
```
array([54.09784031])
```

So, as the code above shown, the linear discriminant function of $(\hat{d_b^L}(x) - \hat{d_a^L}(x))$ is

$$(\hat{d_b^L}(x) - \hat{d_a^L}(x)) = 54.098 + 0.679x_1 - 0.408x_2 - 2.704x_3$$

which also matches the substraction result from the website https://online.stat.psu.edu/stat505/lesson/10/10.4

$$\hat{d_a^L}(x) = -247.276 - 1.417x_1 + 1.520x_2 + 10.954x_3$$

$$\hat{d_b^L}(x) = -193.178 - 0.738x_1 + 1.113x_2 + 8.250x_3$$