Title: ANOVA

Name: Wong Jin Wui

Matric Number: 23005209

Question 4

4. To examine the effects of pets and friends in stressful situations, researchers recruited 45 people to participate in an experiment. Fifteen of the subjects were randomly assigned to each of three groups to perform a stressful task alone (control group), with a good friend present, or with their dog present. Each subject's mean heart rate during the task was recorded. Test the appropriate hypotheses at the $\alpha = 0.05$ level to decide if the mean heart rate differs between the groups.

	n	*Mean*	*Std. Dev.*
Control	15	82.52	9.24
Pets	15	73.48	9.97
Friends	15	91.325	8.34

In [36]:
```
from scipy.stats import f
```

In [60]:
```
n = 15
means = [82.52, 73.48, 91.325]
stds = [9.24, 9.97, 8.34]
```

In [62]:
```
# average of group means - used to find how far each group is from overall average
grand_mean = sum(means) / len(means)
```

In [64]:
```
# SSB
SSB = 0
for mean in means:
    SSB = SSB + n * (mean - grand_mean) ** 2
```

In [66]:
```
# SSW
SSW = 0
for std in stds:
    SSW = SSW + (n - 1) * (std ** 2)
```

In [68]:
```
dfb = len(means) - 1
dfw = n * len(means) - len(means)
```

In [70]:
```
MSB = SSB / dfb
MSW = SSW / dfw
```

In [72]:
```
# F-statistic
F = MSB / MSW
```

In [74]:
```
p = 1 - f.cdf(F, dfb, dfw)
```

In [79]:
```
print (f"F = {F:.2f}")
print(f"p = {p:.6f}")
```

```
F = 14.09
p = 0.000021
```

In [82]:
```
# conclusion
alpha = 0.05
if p < alpha:
    print ("Reject the null hypothesis")
else:
    print ("Fail to reject the null hypothesis")
```

```
Reject the null hypothesis
```

Question 5

5. An investigation carried out to study the toxic effects of mercury was described in the article "Comparative Responses of the Action of Different Mercury Compounds on Barley" (*International Journal of Environmental Studies* [1983]). Ten different concentrations of mercury were compared with respect to their effects on average dry weight (per 100 seven-day-old seedlings). The basic experiment was replicated 4 times for a total of 40 observations. The article reported an ANOVA F statistic of 1.895. Using a significance level of 0.05, test the hypothesis that the true mean dry weight is the same for all 10 concentration levels.

In [92]:
```
F_stat = 1.895
dfb = 9 # between
dfw = 30 # within

p = 1 - f.cdf(F_stat, dfb, dfw)
print (f"P-value = {p:.4f}")
```

```
P-value = 0.0916
```

In [98]:
```
# conclusion
alpha = 0.05
if p < alpha:
    print ("Reject the null hypothesis")
else:
    print ("Fail to reject the null hypothesis")
```

```
Fail to reject the null hypothesis
```

Question 6

6. High productivity and carbohydrate storage ability of the Jerusalem artichoke make it a promising agricultural crop. The article "Leaf Gas Exchange and Tuber Yield in Jerusalem Artichoke Cultivars" (*Field Crops Research* [1991]) reported on various plant characteristics. Consider the following data on chlorophyll concentration (in grams per square meter) for four varieties of Jerusalem artichoke:

	n	***Mean***	***Std. Dev.***
Variety 1	5	0.3	0.12
Variety 2	5	0.24	0.089
Variety 3	4	0.41	0.1
Variety 4	6	0.33	0.054

Do the data suggest that true average chlorophyll concentration depends on the variety? State and test the appropriate hypotheses at a level of 0.05.

In [104…
```
group_data = [
    [5, 0.3, 0.12], # Variety 1
    [5, 0.24, 0.089], # Variety 2
    [4, 0.41, 0.1], # Variety 3
    [6, 0.33, 0.054] # Variety 4
]
```

In [106…
```
total_n = 0
for group in group_data:
    n = group[0]
    total_n = total_n + n

print(f"Total sample size: {total_n}")
```

```
Total sample size: 20
```

In [110…
```
weighted_sum = 0
for group in group_data:
    n = group[0]
    mean = group[1]
    weighted_sum += n * mean #same as weighted_sum = weighted_sum + n

grand_mean = weighted_sum / total_n
print (f"Grand Mean: {grand_mean:.4f}")
```

```
Grand Mean: 0.3160
```

In [112…
```
SSB = 0
for group in group_data:
```

```
    n = group[0]
    mean = group[1]
    SSB += n * (mean - grand_mean) ** 2

print(f"Grand Mean: {grand_mean:.4f}")
```

```
Grand Mean: 0.3160
```

In [132…
```
SSW = 0
for group in group_data:
    n = group[0]
    std = group[2]
    SSW += (n-1) * (std ** 2)

print(f"SSW: {SSW:.4f}")
```

```
SSW: 0.1339
```

In [134…
```
k = len(group_data)
dfb = k - 1
dfw = total_n - k

print(f"dfb: {dfb}")
print(f"dfw: {dfw}")
```

```
dfb: 3
dfw: 16
```

In [136…
```
MSB = SSB / dfb
MSW = SSW / dfw
F = MSB / MSW
print(f"F-stat: {F:.4f}")
```

```
F-stat: 2.6566
```

In [144…
```
p = 1 - f.cdf(F, dfb, dfw)
print(f"p = {p:.6f}")
```

```
p = 0.083651
```

In [146…
```
# conclusion
alpha = 0.05
if p < alpha:
    print ("Reject the null hypothesis")
else:
    print ("Fail to reject the null hypothesis")
```

```
Fail to reject the null hypothesis
```