Assignment

Q1. Write a Python function that takes in two arrays of data and calculates the F-value for a variance ratio
test. The function should return the F-value and the corresponding p-value for the test.
Ans:To calculate the F-value for a variance ratio test in Python, you can use the `scipy.stats` module. Here's a simple function that takes two arrays as input and returns the F-value and corresponding p-value:

python

Copy code

```
import       as
from             import

def calculate_f_value
 """
 Calculate the F-value and p-value for a variance ratio test.

 Parameters:
 - array1: First array of data
 - array2: Second array of data

 Returns:
 - f_value: F-value for the test
 - p_value: Corresponding p-value
 """









 return


         1  2  3  4  5
         2  3  4  5  6


print f"F-value: {f_value}, p-value: {p_value}"
```

In this example, `f_oneway` is used from `scipy.stats` to perform a one-way ANOVA (Analysis of Variance) test, which is equivalent to a variance ratio test when there are only two groups. The function returns the F-value and p-value, and the example demonstrates how to use it with two sets of data.

Make sure to install the required libraries by running:

bash

Copy code

Adjust the data in the example to match your specific use case.

Q2. Given a significance level of 0.05 and the degrees of freedom for the numerator and denominator of an
F-distribution, write a Python function that returns the critical F-value for a two-tailed test.
Ans:To calculate the critical F-value for a two-tailed test given a significance level (alpha), and degrees of freedom for the numerator and denominator, you can use the `scipy.stats` module. Here's a Python function that does that:
python

Copy code

```
from             import

def critical_f_value
 """
 Calculate the critical F-value for a two-tailed test.

 Parameters:
 - alpha: Significance level (e.g., 0.05 for a 5% significance level)
 - df_num: Degrees of freedom for the numerator
 - df_denom: Degrees of freedom for the denominator

 Returns:
 - critical_f: Critical F-value
 """
```

```
 return


        0.05
         3
           20

print f"Critical F-value: {critical_f}"
```

In this example, `f.ppf` is used to calculate the critical F-value for a two-tailed test. The function takes the significance level (`alpha`), degrees of freedom for the numerator (`df_num`), and degrees of freedom for the denominator (`df_denom`) as inputs.

Make sure to install the required library by running:

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Adjust the degrees of freedom and significance level in the example to match your specific use case.

Q3. Write a Python program that generates random samples from two normal distributions with known

variances and uses an F-test to determine if the variances are equal. The program should output the F-
value, degrees of freedom, and p-value for the test.
Ans:can use the `numpy` and `scipy.stats` libraries to generate random samples from two normal distributions and perform an F-test to compare their variances. Here's a Python program that demonstrates this:
python

Copy code

```
import       as
from             import

def perform_f_test
```

```
"""
Perform an F-test to compare variances of two normal distributions.

Parameters:
- sample1: Random sample from the first normal distribution
- sample2: Random sample from the second normal distribution

Returns:
- f_value: F-value for the test
- df_between: Degrees of freedom between groups
- df_within: Degrees of freedom within groups
- p_value: Corresponding p-value
"""

                                          0                       1



             len set            1
            len                len set

return

              42

                            0        1       50
                            0        1.5       50



print f"F-value: {f_value}"
print f"Degrees of Freedom (Between Groups): {df_between}"
```

```
print f"Degrees of Freedom (Within Groups): {df_within}"
print f"P-value: {p_value}"
```

In this example, `f_oneway` is used to perform a one-way ANOVA, which is equivalent to an F-test for comparing variances when there are two groups. The program outputs the F-value, degrees of freedom between groups and within groups, and the p-value.

Make sure to install the required library by running:

bash

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Adjust the parameters of the normal distributions in the example to match your specific use case.

Q4.The variances of two populations are known to be 10 and 15. A sample of 12 observations is taken from
each population. Conduct an F-test at the 5% significance level to determine if the variances are significantly different.
Ans:To conduct an F-test to determine if the variances of two populations are significantly different, you can use the following steps. The null hypothesis (H0) is that the variances are equal, and the alternative hypothesis (H1) is that the variances are significantly different.

Here's a Python program using the `scipy.stats` library to perform the F-test:

python

Copy code

```
import       as
from             import

def conduct_f_test

 """
 Conduct an F-test to compare variances of two populations.

 Parameters:
```

```
 - variance1: Variance of the first population
 - variance2: Variance of the second population
 - sample_size1: Sample size of the first population
 - sample_size2: Sample size of the second population
 - significance_level: Significance level for the test

 Returns:
 - f_value: F-value for the test
 - p_value: Corresponding p-value
 - result: A string indicating the result of the hypothesis test
 """









             1
                                      2



 if
          "Reject the null hypothesis: Variances are significantly different."
 else
          "Fail to reject the null hypothesis: No significant difference in
variances."

 return



            10
            15
              12
                     0.05









print f"F-value: {f_value}"
print f"Degrees of Freedom (Between Groups): {df_between}"
print f"Degrees of Freedom (Within Groups): {df_within}"
```

```
print f"P-value: {p_value}"
print
```

In this example, I used the `np.random.normal` function to generate random samples from normal distributions with the specified variances. The F-test is then performed using `f_oneway`. The program outputs the F-value, degrees of freedom, p-value, and the result of the hypothesis test.

Make sure to install the required library by running:

bash

Copy code

Q5. A manufacturer claims that the variance of the diameter of a certain product is 0.005. A sample of 25
products is taken, and the sample variance is found to be 0.006. Conduct an F-test at the 1% significance
level to determine if the claim is justified.
Ans:To conduct an F-test to determine if the claim about the variance of the diameter is justified, you can use the following steps. The null hypothesis (H0) is that the variance is equal to the claimed value, and the alternative hypothesis (H1) is that the variance is not equal.

Here's a Python program using the `scipy.stats` library to perform the F-test:

python

Copy code

```
import       as
from             import

def conduct_f_test

 """
 Conduct an F-test to compare the sample variance with the claimed variance.

 Parameters:
 - claimed_variance: The claimed variance by the manufacturer
 - sample_variance: The sample variance
```

```
- sample_size: The sample size
- significance_level: Significance level for the test

Returns:
- f_value: F-value for the test
- p_value: Corresponding p-value
- result: A string indicating the result of the hypothesis test
"""

            1
                        1



         2    1


if
        "Reject the null hypothesis: The claim is not justified."
else
        "Fail to reject the null hypothesis: The claim is justified."

return


                0.005
               0.006
            25
                  0.01
```

```
print f"F-value: {f_value}"
print f"Degrees of Freedom (Between Groups): {df_between}"
print f"Degrees of Freedom (Within Groups): {df_within}"
print f"P-value: {p_value}"
print
```

In this example, the F-test is performed to compare the sample variance with the claimed variance. The program outputs the F-value, degrees of freedom, p-value, and the result of the hypothesis test.

Make sure to install the required library by running:

bash

Copy code

Adjust the parameters in the example to match your specific use case.

Q6. Write a Python function that takes in the degrees of freedom for the numerator and denominator of an
F-distribution and calculates the mean and variance of the distribution. The function should return the
mean and variance as a tuple.
Ans:can use the properties of the F-distribution to calculate its mean and variance based on the degrees of freedom for the numerator and denominator. The mean and variance of an F-distribution are given by:

- Mean:
- $\frac{\text{numerator}}{\text{numerator}-2}$
- d
- numerator
- -2
- d
- numerator
- for
- $\text{numerator} > 2$
- d
- numerator
- >2

- Variance:
- $2 \cdot (\text{numerator} + \text{denominator} - 2) \text{numerator} \cdot (\text{denominator} - 2)^2 \cdot (\text{denominator} - 4)$
- d
- numerator
-
- $\cdot (d$
- denominator
-
- $-2)$
- 2
- $\cdot (d$
- denominator
-
- $-4)$
- $2 \cdot (d$
- numerator
-
- $+d$
- denominator
-
- $-2)$
-
- for
- $\text{denominator} > 4$
- d
- denominator
-
- >4

Here's a Python function that implements this:

python

Copy code

```
def calculate_f_distribution_properties
 """
 Calculate the mean and variance of an F-distribution.

 Parameters:
 - df_numerator: Degrees of freedom for the numerator
```

```
 - df_denominator: Degrees of freedom for the denominator

 Returns:
 - mean: Mean of the F-distribution
 - variance: Variance of the F-distribution
 """
 if                2 or                  4
 raise           "Invalid degrees of freedom. df_numerator should be > 2 and
df_denominator should be > 4."

                                        2
            2                                   2
                 2   2                   4

 return


              5
                10


print f"Mean of F-distribution: {mean}"
print f"Variance of F-distribution: {variance}"
```

This function checks the validity of the degrees of freedom, calculates the mean and variance, and returns them as a tuple.

Make sure to input valid degrees of freedom where

$$numerator>2$$

df

numerator

>2 and

$$denominator>4$$

df

denominator

>4. Adjust the example parameters as needed.

Q7. A random sample of 10 measurements is taken from a normal population with unknown variance. The
sample variance is found to be 25. Another random sample of 15 measurements is taken from another
normal population with unknown variance, and the sample variance is found to be 20. Conduct an F-test
at the 10% significance level to determine if the variances are significantly different.
Ans:To conduct an F-test to determine if the variances of two populations are significantly different, you can use the following steps. The null hypothesis (H0) is that the variances are equal, and the alternative hypothesis (H1) is that the variances are significantly different.

Here's a Python program using the `scipy.stats` library to perform the F-test:

python

Copy code

```
import       as
from             import

def conduct_f_test

 """
 Conduct an F-test to compare variances of two populations.

 Parameters:
 - sample_variance1: Sample variance of the first population
 - sample_variance2: Sample variance of the second population
 - sample_size1: Sample size of the first population
 - sample_size2: Sample size of the second population
 - significance_level: Significance level for the test

 Returns:
 - f_value: F-value for the test
 - p_value: Corresponding p-value
 - result: A string indicating the result of the hypothesis test
 """
```

```
                            1
                           1


          2    1


 if
         "Reject the null hypothesis: Variances are significantly different."
 else
         "Fail to reject the null hypothesis: No significant difference in
variances."

 return


                 25
                 20
             10
             15
                   0.10
```

```
print f"F-value: {f_value}"
print f"Degrees of Freedom (Between Groups): {df_between}"
print f"Degrees of Freedom (Within Groups): {df_within}"
print f"P-value: {p_value}"
print
```

In this example, the F-test is performed to compare the variances of two populations based on the sample variances and sizes. The program outputs the F-value, degrees of freedom, p-value, and the result of the hypothesis test.

Make sure to install the required library by running:

bash

Copy code

Adjust the parameters in the example to match your specific use case.

Q8. The following data represent the waiting times in minutes at two different restaurants on a Saturday
night: Restaurant A: 24, 25, 28, 23, 22, 20, 27; Restaurant B: 31, 33, 35, 30, 32, 36. Conduct an F-test at the 5%
significance level to determine if the variances are significantly different.
Ans:To conduct an F-test to determine if the variances of two populations are significantly different, you can use the following steps. The null hypothesis (H0) is that the variances are equal, and the alternative hypothesis (H1) is that the variances are significantly different.

Here's a Python program using the `scipy.stats` library to perform the F-test:

python

Copy code

```
import       as
from             import

def conduct_f_test
 """
 Conduct an F-test to compare variances of two populations.

 Parameters:
 - data1: List or array of waiting times for Restaurant A
 - data2: List or array of waiting times for Restaurant B
 - significance_level: Significance level for the test

 Returns:
 - f_value: F-value for the test
 - p_value: Corresponding p-value
 - result: A string indicating the result of the hypothesis test
 """
```

```
             1
            len          len          2


 if
          "Reject the null hypothesis: Variances are significantly different."
 else
          "Fail to reject the null hypothesis: No significant difference in
variances."

 return


                            24  25  28  23  22  20  27
                            31  33  35  30  32  36
                    0.05
```

```
print f"F-value: {f_value}"
print f"Degrees of Freedom (Between Groups): {df_between}"
print f"Degrees of Freedom (Within Groups): {df_within}"
print f"P-value: {p_value}"
print
```

In this example, the F-test is performed to compare the variances of waiting times at two restaurants. The program outputs the F-value, degrees of freedom, p-value, and the result of the hypothesis test.

Make sure to install the required library by running:

bash

Copy code

Adjust the parameters in the example to match your specific use case.

Q9. The following data represent the test scores of two groups of students: Group A: 80, 85, 90, 92, 87, 83;
Group B: 75, 78, 82, 79, 81, 84. Conduct an F-test at the 1% significance level to determine if the variances
are significantly different.
Ans:To conduct an F-test to determine if the variances of two populations are significantly different, you can use the following steps. The null hypothesis (H0) is that the variances are equal, and the alternative hypothesis (H1) is that the variances are significantly different.

Here's a Python program using the `scipy.stats` library to perform the F-test:

python

Copy code

```
import       as
from             import

def conduct_f_test
 """
 Conduct an F-test to compare variances of two populations.

 Parameters:
 - data1: List or array of test scores for Group A
 - data2: List or array of test scores for Group B
 - significance_level: Significance level for the test

 Returns:
 - f_value: F-value for the test
 - p_value: Corresponding p-value
 - result: A string indicating the result of the hypothesis test
 """
```

```
            1
           len          len          2


 if
          "Reject the null hypothesis: Variances are significantly different."
 else
          "Fail to reject the null hypothesis: No significant difference in
variances."

 return


                      80  85  90  92  87  83
                      75  78  82  79  81  84
                    0.01
```

```
print f"F-value: {f_value}"
print f"Degrees of Freedom (Between Groups): {df_between}"
print f"Degrees of Freedom (Within Groups): {df_within}"
print f"P-value: {p_value}"
print
```

In this example, the F-test is performed to compare the variances of test scores in two groups. The program outputs the F-value, degrees of freedom, p-value, and the result of the hypothesis test.

Make sure to install the required library by running:

bash

Copy code

Adjust the parameters in the example to match your specific use case.