

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 sys as sys
from math import sqrt

def calculate_f_value(array1, array2):
    """
    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
    """
    n1 = len(array1)
    n2 = len(array2)
    mean1 = sum(array1) / n1
    mean2 = sum(array2) / n2
    var1 = sum((x - mean1) ** 2 for x in array1) / (n1 - 1)
    var2 = sum((x - mean2) ** 2 for x in array2) / (n2 - 1)
    f_value = var1 / var2
    p_value = 1 - stats.f.cdf(f_value, n1 - 1, n2 - 1)

    return f_value, p_value

# Example usage
array1 = [1, 2, 3, 4, 5]
array2 = [2, 3, 4, 5, 6]

f_value, p_value = calculate_f_value(array1, array2)

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 scipy.stats import f

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:

```
bash
```

Copy code

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
"""

```

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```

```
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

Copy code

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 (H_0) is that the variances are equal, and the alternative hypothesis (H_1) 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 sys as sys
from scipy import stats

def conduct_f_test(x, y):
    """
    Conduct an F-test to compare variances of two populations.

    Parameters:
    x: list of values for population 1
    y: list of values for population 2
    """
```

- 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 (H_0) is that the variance is equal to the claimed value, and the alternative hypothesis (H_1) 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 sys as sys
from scipy import stats

def conduct_f_test(claimed_variance, sample_variance):
    """
    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:
- $\frac{d_2 \text{numerator}}{d_2 \text{numerator} - 2}$
- d
- numerator
-
- -2
- d
- numerator
-
-
- for
- $\frac{d_2 \text{numerator}}{d_2 \text{numerator} - 2}$
- d
- numerator
-
- >2

- Variance:
- $2 \cdot \left(\frac{\text{numerator}}{\text{denominator}} + \frac{\text{denominator} - 2}{\text{numerator}} \cdot \left(\frac{\text{denominator} - 2}{\text{denominator}} \right)^2 \cdot \left(\frac{\text{denominator} - 4}{\text{denominator}} \right) \right)$
- d
- numerator
-
- $\cdot \left(\frac{d}{\text{denominator}} \right)$
- denominator
-
- $-2)$
- 2
- $\cdot \left(\frac{d}{\text{denominator}} \right)$
- denominator
-
- $-4)$
- $2 \cdot \left(\frac{d}{\text{numerator}} \right)$
- numerator
-
- $+d$
- denominator
-
- $-2)$
-
- for
- $\frac{\text{denominator}}{d} > 4$
- 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 df_numerator < 2 or df_denominator < 4:
    raise ValueError("Invalid degrees of freedom. df_numerator should be > 2 and df_denominator should be > 4.")
```

```
return
```

```
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

df_numerator > 2

df

numerator

>2 and

df_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 (H_0) is that the variances are equal, and the alternative hypothesis (H_1) 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 sys as sys
from math import sqrt

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 (H_0) is that the variances are equal, and the alternative hypothesis (H_1) 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 sys
from scipy import stats

def conduct_f_test(data1, data2, significance_level):
    """
    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 sys as sys
from typing import List, Tuple, Union

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
    """
    data1: List[Union[int, float]] = []
    data2: List[Union[int, float]] = []
    significance_level: float = 0.01

    # Calculate the F-value and p-value using scipy.stats
    f_value, p_value = stats.f_test(data1, data2)

    # Determine the result of the hypothesis test
    if p_value < significance_level:
        result = "Reject H0: The variances are significantly different."
    else:
        result = "Fail to reject H0: The variances are not significantly different."

    return f_value, p_value, result
```



```

        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.