F Distribution

and

P Value

What is **F Distribution**?

The F-distribution is a probability distribution used in hypothesis testing to determine the equality of variances from normally distributed populations.

The F distribution has the following properties:

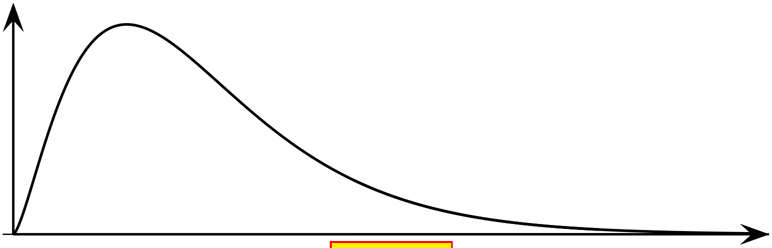
- The density curve is not symmetric.
- The density curve is not bell-shaped.
- The density curve is skewed to the right.
- The total area under the density curve is 1.
- It comes with two different degrees of freedom.

- The two degrees of freedom are referred to as

  numerator degrees of freedom (Ndf) and

  denominator degrees of freedom (Ddf).

Here is how the F distribution curve look like.



$Ndf > 2$

Where does **F Distribution** curve peak?

- When $0 < Ndf < 2$, the F distribution curve $\to \infty$ as $F \to 0$.
- When $Ndf = 2$, the F distribution curve begins at $(0, 1)$ and decreasing from there.
- When $Ndf > 2$, the F distribution curve has a peak point at

$$F = \frac{(Ndf - 2) \cdot Ddf}{Ndf \cdot (Ddf + 2)}$$

Example:

Find the F value where F distribution curve peak with $Ndf = 5$ and $Ddf = 8$.

Solution:

We simply plug in the given Ndf and Ddf in the equation and simplify.

$$F = \frac{(Ndf - 2) \cdot Ddf}{Ndf \cdot (Ddf + 2)} = \frac{(5 - 2) \cdot 8}{5 \cdot (8 + 2)}$$

$$= \frac{24}{50} = 0.48$$

The peak value of the F distribution curve with the given information takes place at the F value of 0.48.

Probability with F Distribution using TI:

2ND , **VARS** , **↓** , **Fcdf**

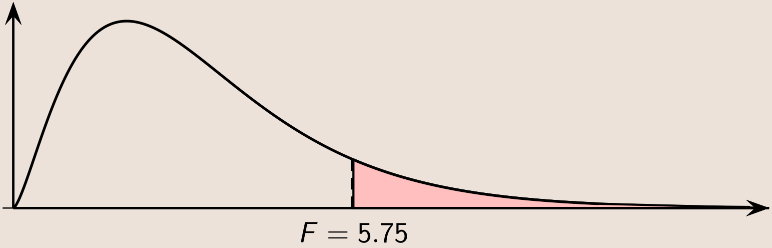
Probability Type	TI Command
$P(F < a)$	Fcdf$(0, a, Ndf, Ddf)$
$P(F > b)$	Fcdf$(b, E99, Ndf, Ddf)$
$P(a < F < b)$	Fcdf(a, b, Ndf, Ddf)
$P(F < a \text{ or } F > b)$	1-Fcdf(a, b, Ndf, Ddf)

Example:

Find $P(F > 5.75)$, $Ndf = 4$, and $Ddf = 10$. Round to 3-decimal places.

Solution:

We start by drawing the F distribution curve, then shade and label accordingly.



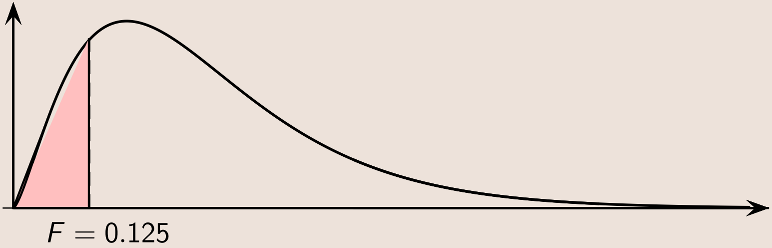
Now we can use the TI command,
$P(F > 5.75) = Fcdf(5.75, E99, 4, 10) \approx 0.011.$

Example:

Find $P(F < 0.125)$, with $Ndf = 3$, and $Ddf = 12$. Round to 3-decimal places.

Solution:

We start by drawing the F distribution curve, then shade and label accordingly.



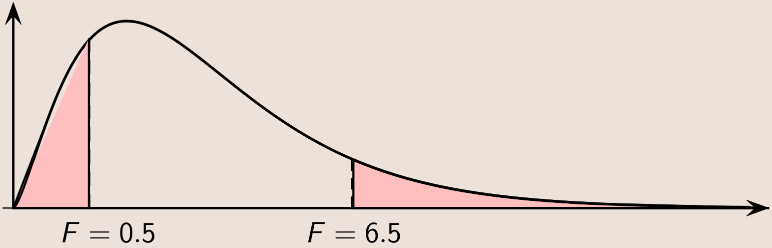
Now we can use the TI command,
$P(F < 0.125) = Fcdf(0, 0.125, 3, 12) \approx 0.056.$

Example:

Find $P(F < 0.5 \text{ or } F > 6.5)$, with $Ndf = 8$, and $Ddf = 8$. Round to 3-decimal places.

Solution:

We start by drawing the F distribution curve, then shade and label accordingly.



Now we can use the TI command,
$P(F < 0.5 \text{ or } F > 6.5) = 1 - Fcdf(0.5, 6.5, 8, 8) \approx 0.181.$

What is **P Value**?

Assuming H_0 is valid

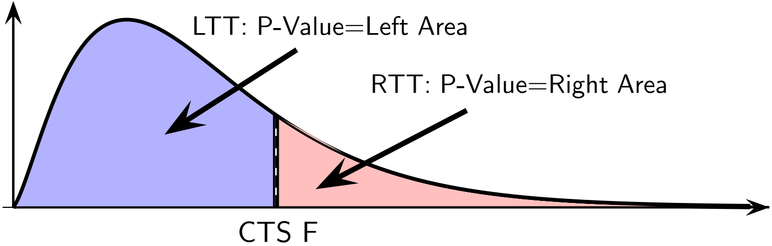
It is the probability that the observed data support the null hypothesis.

A low p-value provides evidence against the null hypothesis, often resulting in rejecting the null hypothesis.

A high p-value suggests the observed data are consistent with the null hypothesis, often resulting in fail to reject the null hypotheis.

The p-value suggests the smallest level of significance α for which the null hypothesis H_0 would be rejected and
the alternative hypothesis H_1 would be supported.

P Value & CTS F :



For the **TTT**, Find the area on both sides of F

then $P - Value = 2 \cdot$ **Smaller Area**.

P Value & CTS F with TI:

2ND , **VARS** , **↓** , **Fcdf**

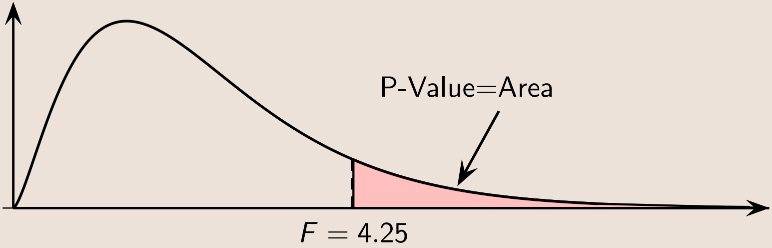
Testing Type	TI Command
Right-Tail Test	Fcdf($CTS, E99, Ndf, Ddf$)
Left-Tail Test	Fcdf($0, CTS, Ndf, Ddf$)
Two-Tail Test	• Find the area on both sides of F • Multiply the smaller area by 2

Example:

Find the corresponding P-Value for a Right-Tail Test with $CTS\ F = 4.25$, $Ndf = 5$, and $Ddf = 9$. Round to 3-decimal places.

Solution:

We start by drawing the F distribution curve, then shade and label accordingly.



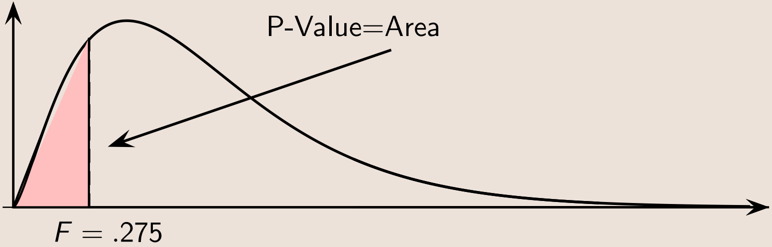
Now we can use the TI command,
$P - Value = Fcdf(4.25, E99, 5, 9) \approx 0.029$.

Example:

Find the corresponding P-Value for a Left-Tail Test with $CTS\ F = 0.275$, $Ndf = 8$, and $Ddf = 10$. Round to 3-decimal places.

Solution:

We start by drawing the F distribution curve, then shade and label accordingly.



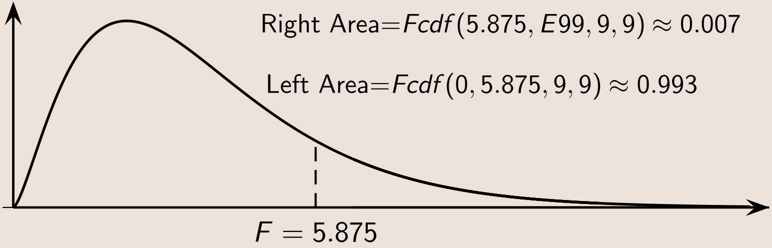
Now we can use the TI command,
$P - Value = Fcdf(0, .275, 8, 10) \approx 0.040$.

Example:

Find the corresponding P-Value for a Two-Tail Test with $CTS\ F = 5.875$, $Ndf = 9$, and $Ddf = 9$. Round to 3-decimal places.

Solution:

We start by drawing the F distribution curve and clearly label.



Since it is a **TTT**,

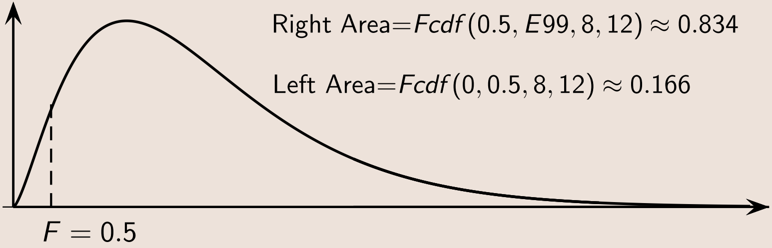
$P - Value = 2 \cdot$ **Smaller Area** $\approx 2 \cdot 0.007 \approx 0.014$

Example:

Find the corresponding P-Value for a Two-Tail Test with $CTS\ F = 0.5$, $Ndf = 8$, and $Ddf = 12$.

Solution:

We start by drawing the F distribution curve and clearly label.



Since it is a **TTT**,

$P - Value = 2 \cdot$ **Smaller Area** $\approx 2 \cdot 0.166 \approx 0.332$