χ^2 Distribution

&

P–Value

What is **P–Value**?

Assuming H_0 is valid

P–Value is the probability of observing results at least as extreme as the ones we have actually observed.

In simple language, **P–Value** is the probability how odd or unusual the result would be if everything were just random.

How do we calculate the **P–Value**?

Calculating p-value strictly depends on the statistical test, but the core idea is always the same.

What does **P–Value** suggest?

A low p-value suggests 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 hypothesis.

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

P–Value & CTS χ^2 with TI:

2ND , **VARS** , $\downarrow$, χ^2**cdf**

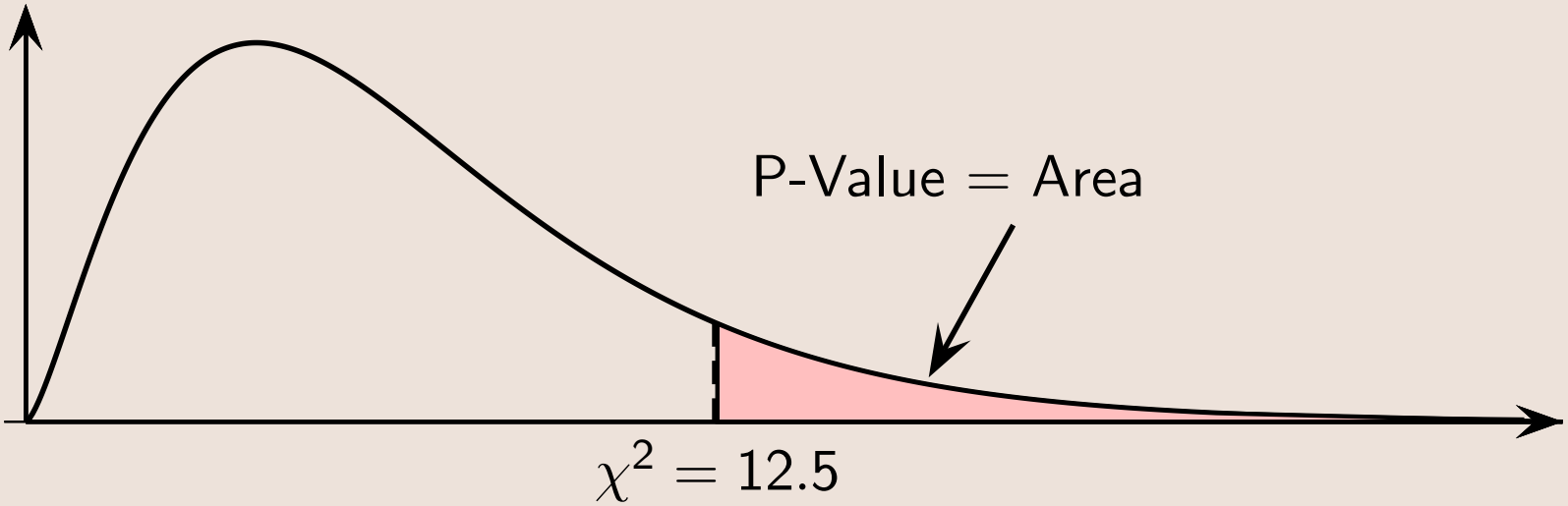
Testing Type	TI Command
Right-Tail Test	$\chi^2 cdf(CTS, E99, df)$
Left-Tail Test	$\chi^2 cdf(0, CTS, df)$
Two -Tail Test	• Find the area on both sides of CTS χ^2
	• Multiply the smaller area by 2

Example:

Find the corresponding P-Value for a Right-Tail Test with $CTS\,\chi^2 = 12.5$ and $df = 9$. Round to 3-decimal places.

Solution:

We start by drawing the χ^2 distribution density curve, then label and shade accordingly.



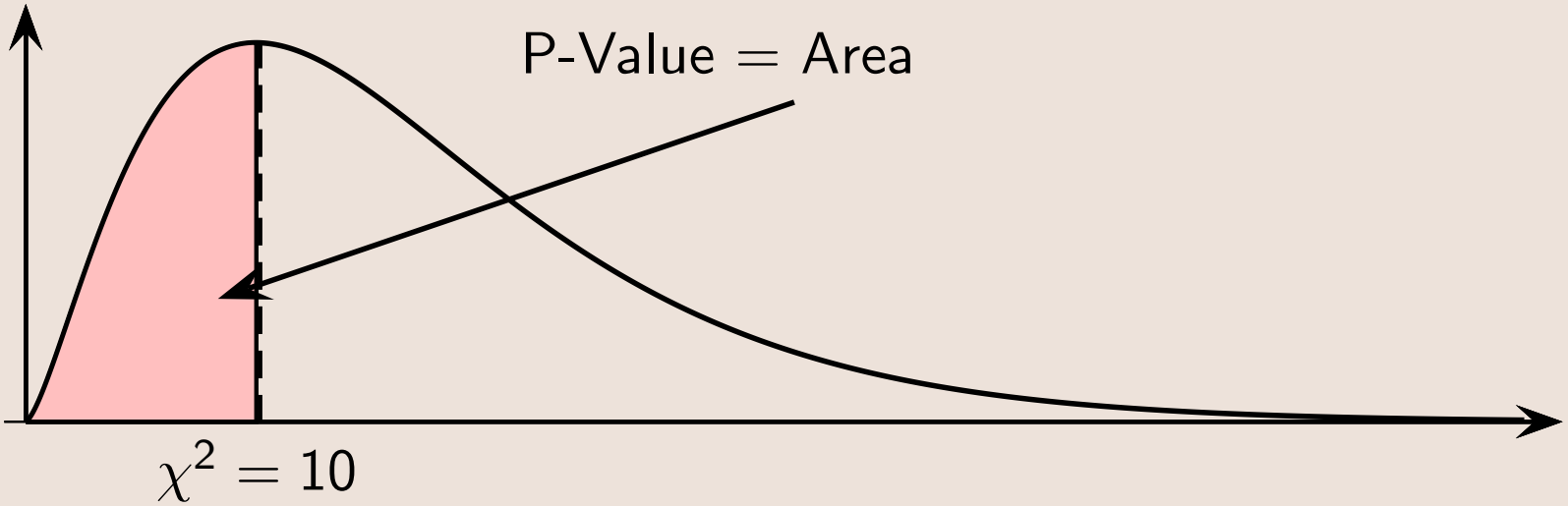
Now we can use the TI command,
$P - Value = \chi^2 cdf\,(12.5, E99, 9) \approx 0.187$.

Example:

Find the corresponding P-Value for a Left-Tail Test with $CTS\ \chi^2 = 10$ with $df = 12$. Round to 3-decimal places.

Solution:

We start by drawing the χ^2 distribution density curve, then label and shade accordingly.



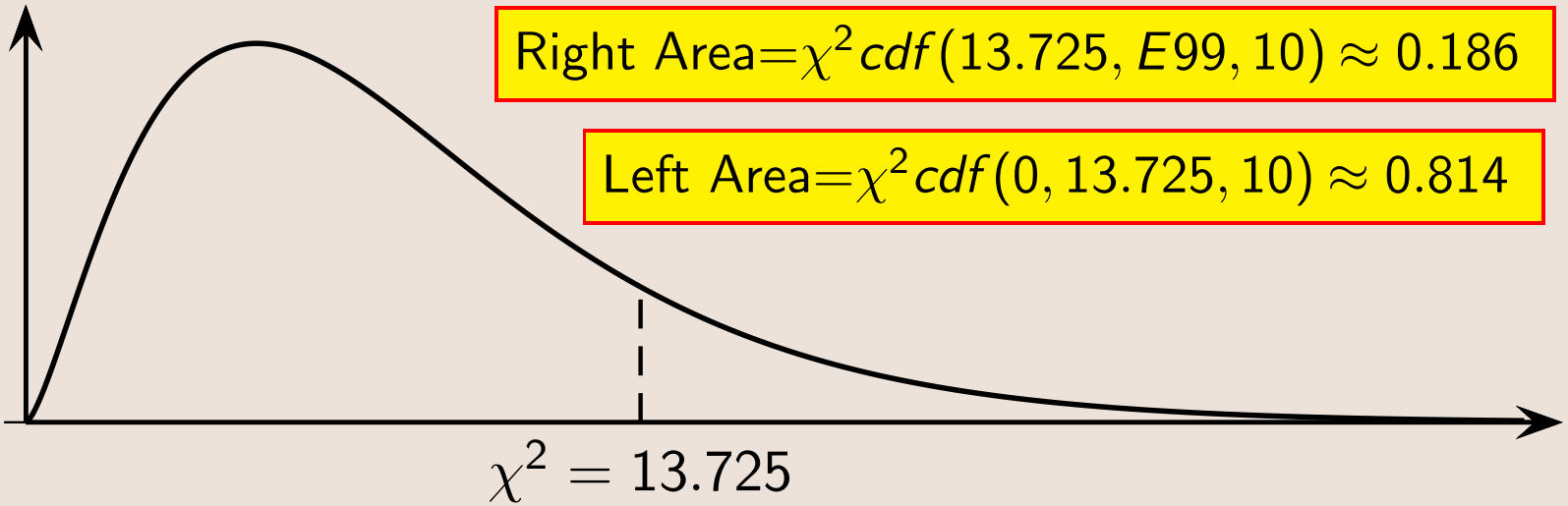
Now we can use the TI command,
$P - Value = \chi^2 cdf\,(0, 10, 12) \approx 0.384$.

Example:

Find the corresponding P-Value for a Two-Tail Test with $CTS\ \chi^2 = 13.725$ with $df = 10$. Round to 3-decimal places.

Solution:

We start by drawing the χ^2 distribution density curve.



Now we can use the TI command,

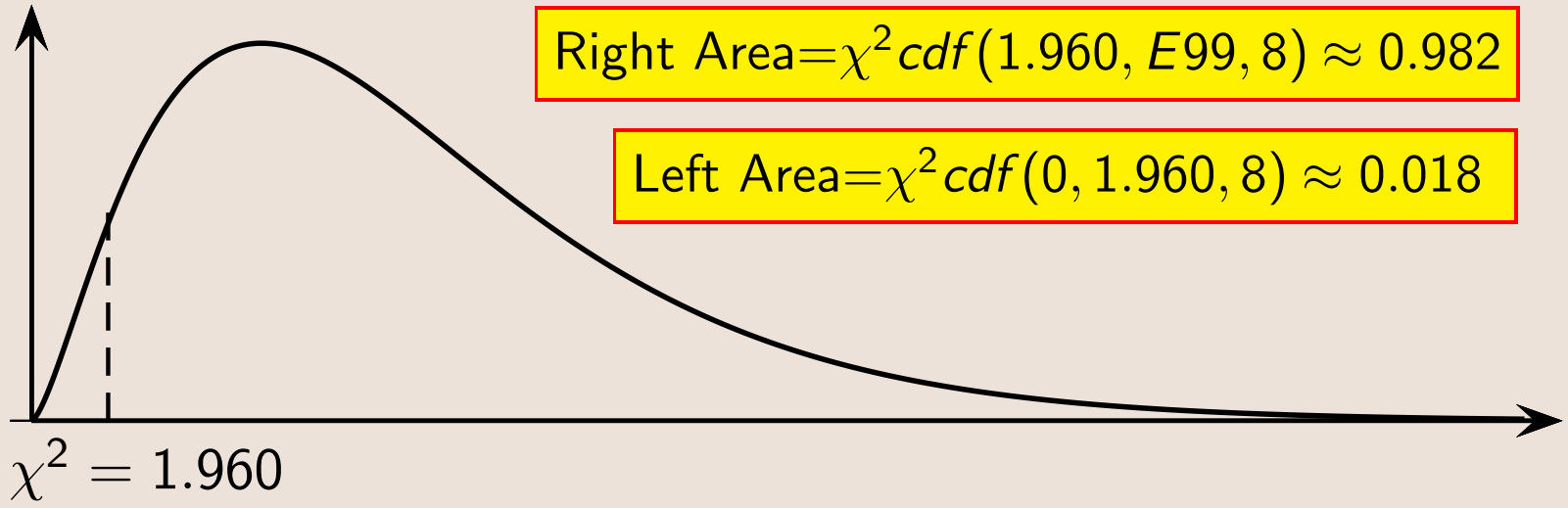
$P - Value = 2 \cdot$ **Smaller Area** $\approx 2 \cdot 0.186 \approx 0.372$

Example:

Find the corresponding P-Value for a Two-Tail Test with $CTS\ \chi^2 = 1.960$ with $df = 8$.

Solution:

We start by drawing the χ^2 distribution density curve.



Now we can use the TI command,

$P - Value = 2 \cdot$ **Smaller Area** $\approx 2 \cdot 0.018 \approx 0.036$

Example:

Using the result from the last example, suggest value for the significance level α such that

1. H_0 is supported
2. H_0 is rejected

Solution:

From last example, the p–value was 0.036,

1. For H_0 to be supported, we need $p - value > \alpha$.

   Choose $\alpha = 0.02$

2. H_0 to be rejected, we need $p - value \leq \alpha$.

   Choose $\alpha = 0.04$