The Precision Metric: The `qt()` Function

1. Research & Documentation

In Section 10.2, we used the t-score as a post-calculation check to see if our data was "weird." Now, we are flipping the script. As a Lead Engineer, you must define your **Precision Metric** (t^*) *before* you can calculate a Confidence Interval.

Technical Requirements: The `qt()` Function

Locate Section 10.3.1 in your text and record the technical requirements below:

The real name of t^* is:

Argument 1 (`p`):

Argument 2 (`df`):

2. The Symmetry Sketch

A 95% Confidence Interval leaves 5% of the "risk" in the tails. Because the t-distribution is symmetric, that risk is split evenly.

Calculation: The Symmetric Safety Net

Task: Sketch a t-distribution curve below. Shade the **top 2.5%** and the **bottom 2.5%**. Mark the t^* boundaries on the x-axis and label the middle 95% area as your "Safety Net".

3. Calculating the Multiplier

Use your R console to find the t^* (critical value) for the following audit scenarios. This value acts as the "multiplier" for your Standard Error.

Coding Corner: The Multiplier Audit

Scenario A: The Small Audit ($n = 10$)
Code: `qt(p = 0.975, df = 9)`
Result (t^*):

Scenario B: The Industrial Audit ($n = 100$)
Code: `qt(p = 0.975, df = 99)`
Result (t^*):

Scenario C: The High-Stakes Audit (99% Confidence, $n = 10$)
Code: `qt(p = 0.995, df = 9)`
Result (t^*):

Scenario D: The Precision Audit (99% Confidence, $n = 100$)
Code:
Result (t^*):

4. Lead Engineer's Reflection

Reflection: The Tug-of-War (n vs. Confidence)

Review your results from Part 3 and analyze how the t^* multiplier reacts to your decisions.

1. **The Cost of Certainty:** Compare Scenario A to Scenario C. When you demand more confidence (99% vs 95%) without increasing your sample size, what happened to your t^* multiplier?

2. **The Reward of Data:** Compare Scenario C to Scenario D. Even though both audits require 99% confidence, how does having a larger sample size ($n = 100$ vs $n = 10$) "reward" the Engineer in terms of the t^* multiplier?

3. **The Engineer's Choice:** If you are a Lead Engineer tasked with a high-stakes safety audit, which of the four scenarios (A-D) provides the most "precise" results (the narrowest t^* Safety Net)? Justify your choice.

Reflection: The Hero Check

Imagine a report states a 95% confidence interval is **4.2 to 5.8**. As the Lead Engineer, you know the sample mean sit exactly in the center. **Task:** Draw a number line below. Place $\bar{x}$ at the center and mark the boundaries. Draw an arrow showing how your t^* multiplier acts as the "stretcher" that moves the boundaries away from the mean.

Statypus Insight: Automation is Coming

In the next lab, we will discover the single function that automates this entire report calculation for us. Stay tuned.