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.

Task: Open your copy of *Statypus* to **Section 10.3**. Locate the definition of the `qt()` function and record the technical requirements below:

What does "qt" stand for? _____

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.

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."

Sketch your symmetric Safety Net here.

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.

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

The Tug-of-War: Sample Size (n) vs. Confidence Level
Review your results from Part 3 and analyze how the t^* multiplier reacts to your decisions.

1. **The Cost of Certainty:** Compare Scenario A (95% / $n = 10$) to Scenario C (99% / $n = 10$). When you demand more confidence without increasing your sample size, what happened to your t^* multiplier?

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2. **The Reward of Data:** Compare Scenario C (99% / $n = 10$) to Scenario D (99% / $n = 100$). When you increased your sample size while keeping confidence the same, how does R "reward" the Engineer?

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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? Justify your choice based on the width of the t^* Safety Net.

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The Hero Check
Imagine an audit report is generated for you. It states that the 95% confidence interval for a population mean is **4.2 to 5.8**. As the Lead Engineer, you know that the sample mean ($\bar{x}$) sits exactly in the center of those boundaries.

Task: Draw a number line below. Place the mean ($\bar{x}$) at the center and mark the boundaries. Then, draw an arrow showing how your t^* multiplier acts as the "stretcher" that moves the boundaries away from the mean.

Lead Engineer Pro-Tip: *In the next lab, we will discover the single function that automates this entire report calculation for us. Stay tuned.*