The Confidence Ripple

Inference for the Mean Response

A single "best-fit" line often looks more certain than it actually is. The line is just one possible reality—the true average is a range. Today, we use the `RegressionInference` tool to look under the hood of the relationship between **gestation** (weeks) and **weight** (grams).

1. Loading the Chapter 12 Materials

Load the Chapter 12 materials and check the structure of `BabyData1` using the following code:

Coding Corner: Toolbox Initialization

```
# Load materials and explore the data structure
load(url("https://statypus.org/files/StatypusCh12.RData"))
str(BabyData1)
```

2. The Mathematical Blueprint (Transcription)

Transcribe the blueprints for the standard errors found in **Definition 12.5** of your text to ensure the underlying logic is clear before plotting.

Standard Error of $\hat{y}|_{x=x_0}$:
The "Mean" Shiver

Standard Error of $y|_{x=x_0}$:
The "Individual" Chaos

Reality Check: The +1 Difference

Notice that these formulas are nearly identical, but the "Individual" formula has a +1 inside the square root. Consider the math: why is it impossible for the error of a single prediction (y) to ever be smaller than the error of the average estimate ($\hat{y}$)?

3. Mapping the Ripple

We have recovered **Page 20** of a statypus' journal (attached to this lab), but the primary data visualization was lost in transit. We will use the `RegressionInference` tool to reconstruct the missing figure and fill in the record.

Coding Corner: Visualizing the Mean

```
# Run the tool and observe the red "shiver"
RegressionInference(BabyData1$gestation, BabyData1$weight)
```

On the attached journal page, use a **regular pencil** to lightly sketch the points and the regression line based on your screen output. Then, use a **red colored pencil** to shade in the confidence bands.

Crucial: Make sure your red bands clearly show the "flaring" curvature at the edges of the plot.

4. Consulting the Text

Now that you have physically traced the shape, open *R is for Statypus* directly to **Section 12.2** (Confidence Intervals for the Mean Response) to understand the geometry of the plot.

1. **The Definition:** In plain English, what does that red shaded region represent? (What are we 95% confident is trapped inside those red bands?)

2. **The Pivot Point:** Section 12.2 explains why the bands flare. At what approximate value for gestation ($\bar{x}$) is our model most "certain" about the average birth weight?

3. **The Shiver:** Why does our uncertainty about the *average* increase as we move further away from that pivot point?

5. The Power of the Function

Reality Check: Manual Estimation

On the journal page, find the 38-week mark on the x-axis. Using your red colored pencil, draw a **vertical line segment** that connects the bottom red band to the top red band.

You can use the `x0` argument to **show a specific confidence interval** on the plot and see the exact values for the intervals. Run the following code and use it to answer the questions under **Observations**.

Coding Corner: The Precise Pin

```
# Use the x0 argument to see exactly 38 weeks
RegressionInference(BabyData1$gestation, BabyData1$weight, x0 = 38)
```

Observations:

- Predicted mean weight (`fit`) at 38 weeks: _____
- Precise 95% interval for that mean: (_____ , _____)

Coding Corner: Advanced Control

By default, the tool calculates a 95% confidence level. However, if your research requires a higher degree of certainty, the tool accepts a `conf.level` argument.

Statypus Insight: Reflection & Synthesis

Turn this sheet over. On the blank back of this page, provide a brief written reflection (3–5 sentences) on the following:

- How do the confidence intervals at 38 and 42 weeks compare?
- How does the vertical bar on your computer screen compare to your sketch?
- Why does the "shiver" of the mean create an hourglass shape rather than parallel lines?
- What is the practical interpretation of the hourglass geometry of the curved red bands?

and that is why I will never again trust an overly caffeinated kangaroo with a slide rule.

Section 12: Linear Dynamics

The following observations concern the geometric variance of mean response estimates. We expect to see significant shiver for extreme values of the `gestation` variable, but will have to actually analyze the data to be sure.

Field Record: The Hourglass Geometry

Instructions: Trace the mean ripple using standard protocol (RED). Note the curvature flaring. Technical precision in the shading of the confidence bands is required for valid inference.

Reference: Figure 12.2 – Data points redacted. Mark $\bar{x}$ and the 38-week interval.

Supplementary Log Entry:

I am once again questioning the data entry methods used in Bill's preliminary clinical trials. Bill's tendency to round to the nearest kilogram is frankly an insult to the precision required for Project GOSSIP. I don't think Bill's electroreception is all that sound for a supposed statistics expert. If he continues to treat the scale as a "suggestion," I will be forced to request a transfer to the **Dolphin Pond Laboratory**.

Section 13: Multiple Realities

While Section 12 deals with the relationship between two variables, the GOSSIP protocol suggests that birth weight is rarely a product of gestation alone. In the next module, we will expand our model to include secondary predictors, specifically focusing on the way that multiple independent