

Desmos and Quarto as a Unified Approach to Teaching Inference



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Introduction

The Challenge of Teaching Inference:

Statistics teachers are all too aware of the challenge of trying to build students' intuition for the logic behind inference, while fighting time constraints and a long list of required topics. Guiding students to understand the Central Limit Theorem, how that extends to one-sample t-tests, the proper interpretation of p-values, and carry out all the steps in between is difficult. Without conceptual understanding, students often reduce inference to tedious plug-and-chug steps. While that might get them through basic homework, it leaves them behind when real comprehension is needed. That's why engaging ways to visualize inference aren't just helpful, they're essential.

A Dual-Tool Method: Desmos and Quarto

This poster presents a two-part visual strategy: using Desmos to build conceptual intuition and R's Quarto to apply that understanding to real-world data.

- Desmos helps students grasp *why* inference works through interactive visualizations.
- Quarto shows students *how* it's used, easing them into coding and data analysis in a way that feels accessible.

Together, these platforms bridge the gap between theory and practice, helping students connect classroom concepts to meaningful statistical thinking. These resources function for both in-person or online class settings, providing value to introductory high school or college courses.

Easy to Share

Both Desmos and Quarto offer the added benefit of being easy to distribute. Sharing visuals in Desmos couldn't be simpler. Just one link lets students open and interact with the visual on any device, no further steps required. If students want to save or edit a visual, creating an account is straightforward. Similarly, Quarto documents can be rendered as HTML, PDF, or Word files and easily shared with a class. PDF files are perhaps the most convenient for distribution. This accessibility makes both tools highly practical for classroom use, regardless of the teaching format.

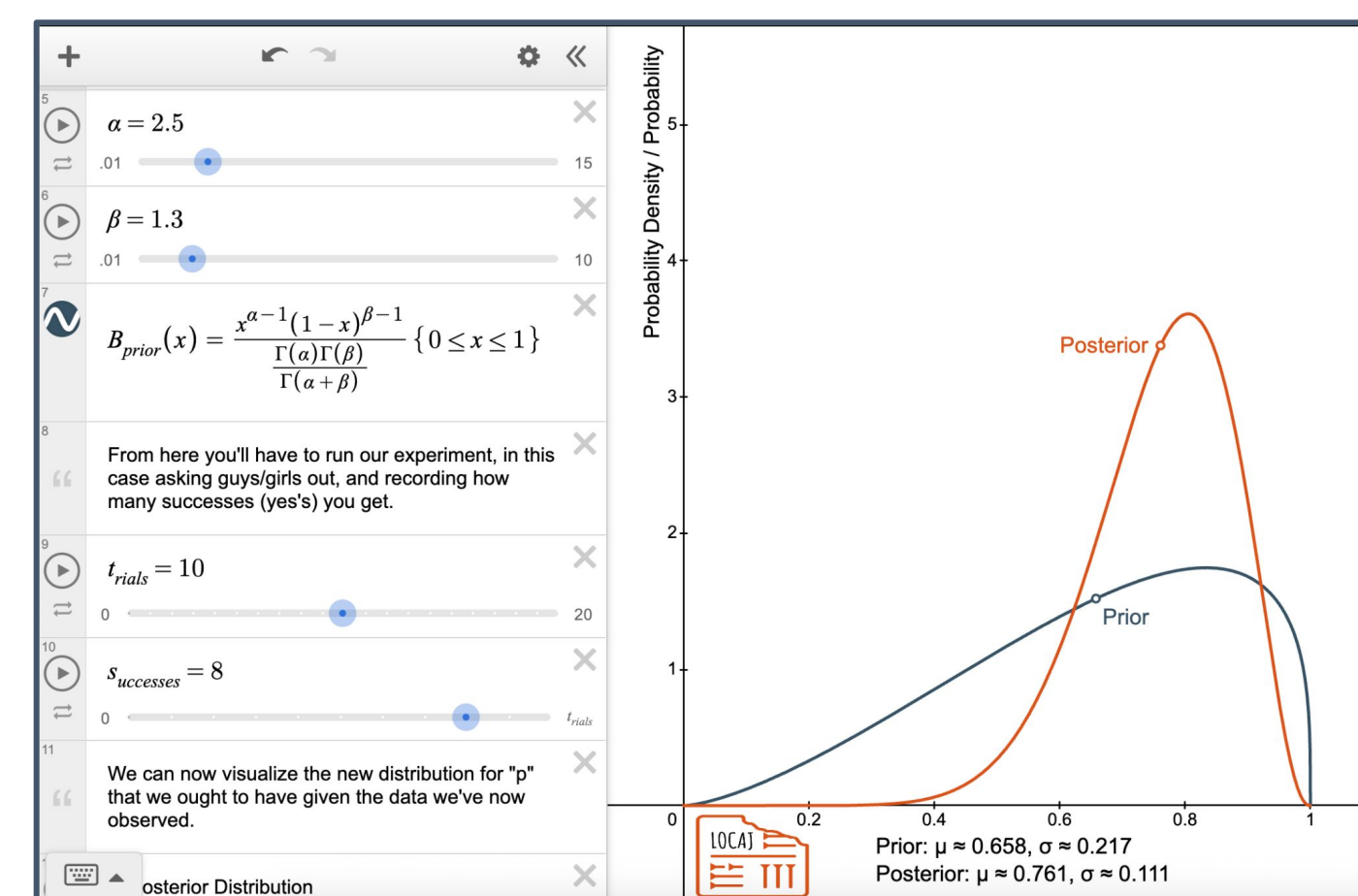
Desmos

A Secret Weapon

Though often underused by teachers, Desmos offers extensive capabilities for visualizing inference. The platform can generate frequently used PDF and PMFs, perform basic hypothesis tests, and compute summary statistics. Beyond this, Desmos can be used to create visuals for nearly any concept that would be encountered in lower-level statistics courses, including: the Central Limit Theorem, confidence intervals, hypothesis tests, ANOVA, Chi-Squared tests, bootstrapping, randomization, and even Bayesian inference.

Hidden Depths

Desmos is more versatile than many realize. In the example shown, students define a Bayesian prior using a Beta distribution, then simulate trials to generate both posterior and predictive distributions.



Two-Pronged Approach to Visualizing Inference

Dynamic Introduction in Desmos:

Inference can be challenging for students because it requires a constant shift in perspective. Using theory to make claims about unknown population values, while reasoning with only the data we actually observe.

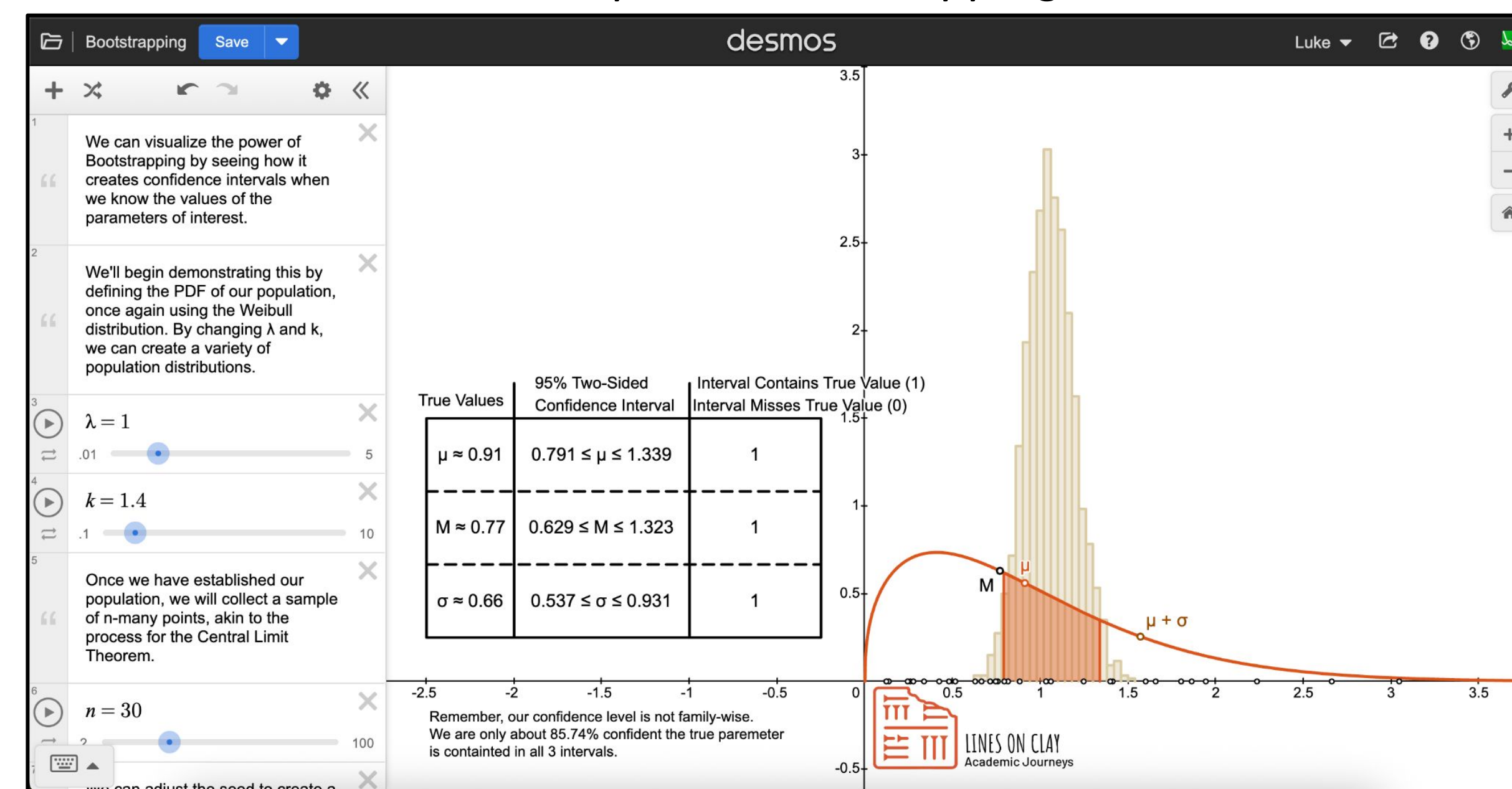
Desmos is uniquely suited to help students grasp this duality, offering dynamic, hands-on visuals that bridge theory and practice.

On the left, students walk through the full logic of bootstrapping. They define a population, view a sample, generate resamples, and form confidence intervals, all within a single interactive tool.

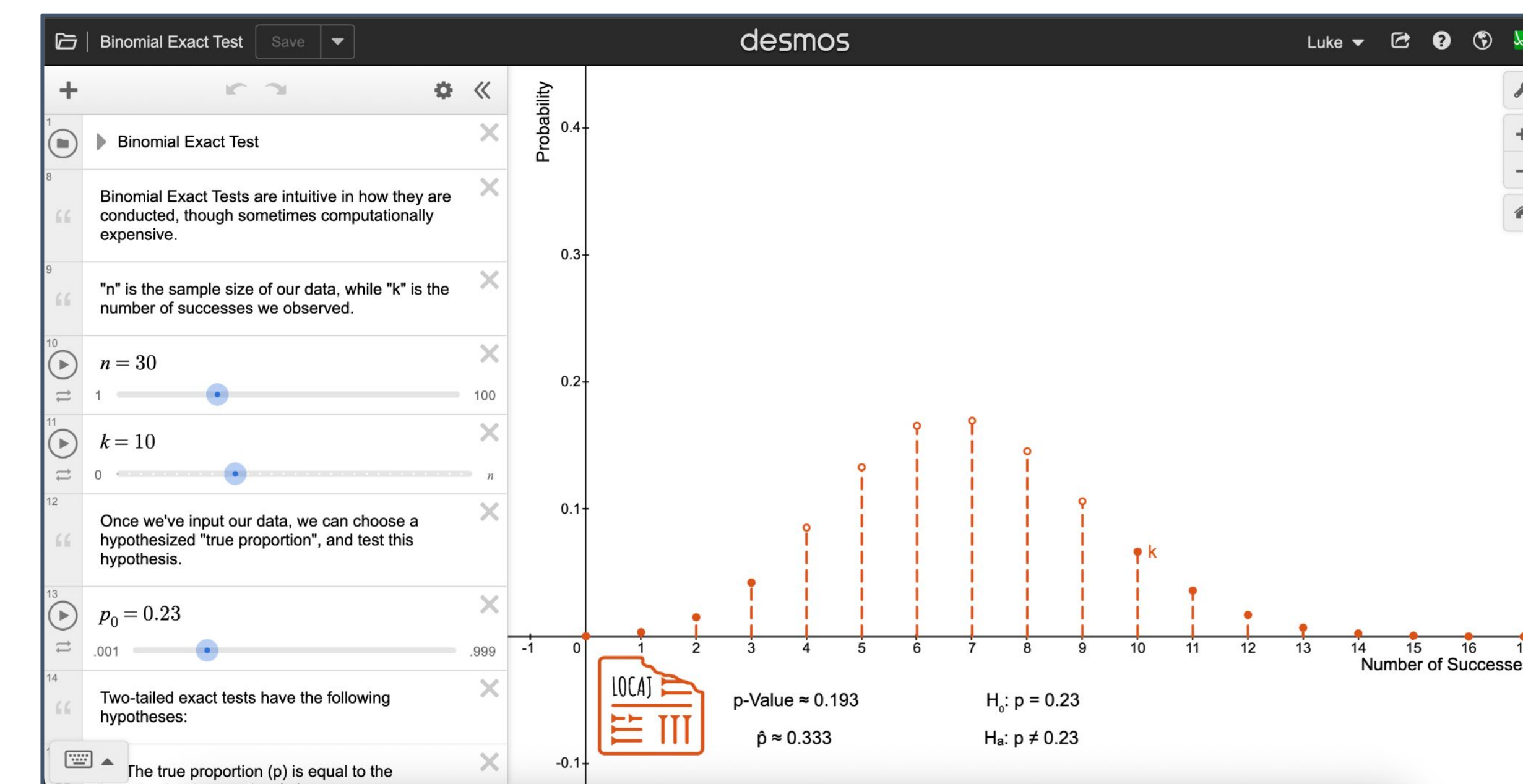
On the right, they explore a binomial exact test, visualizing the hypothesized probability distribution under H_0 and directly identifying the probability of observing specific outcomes.

These visuals make abstract reasoning tangible, intuitive, and deeply memorable.

Example 1 - Bootstrapping



Example 2 - Binomial Exact Testing



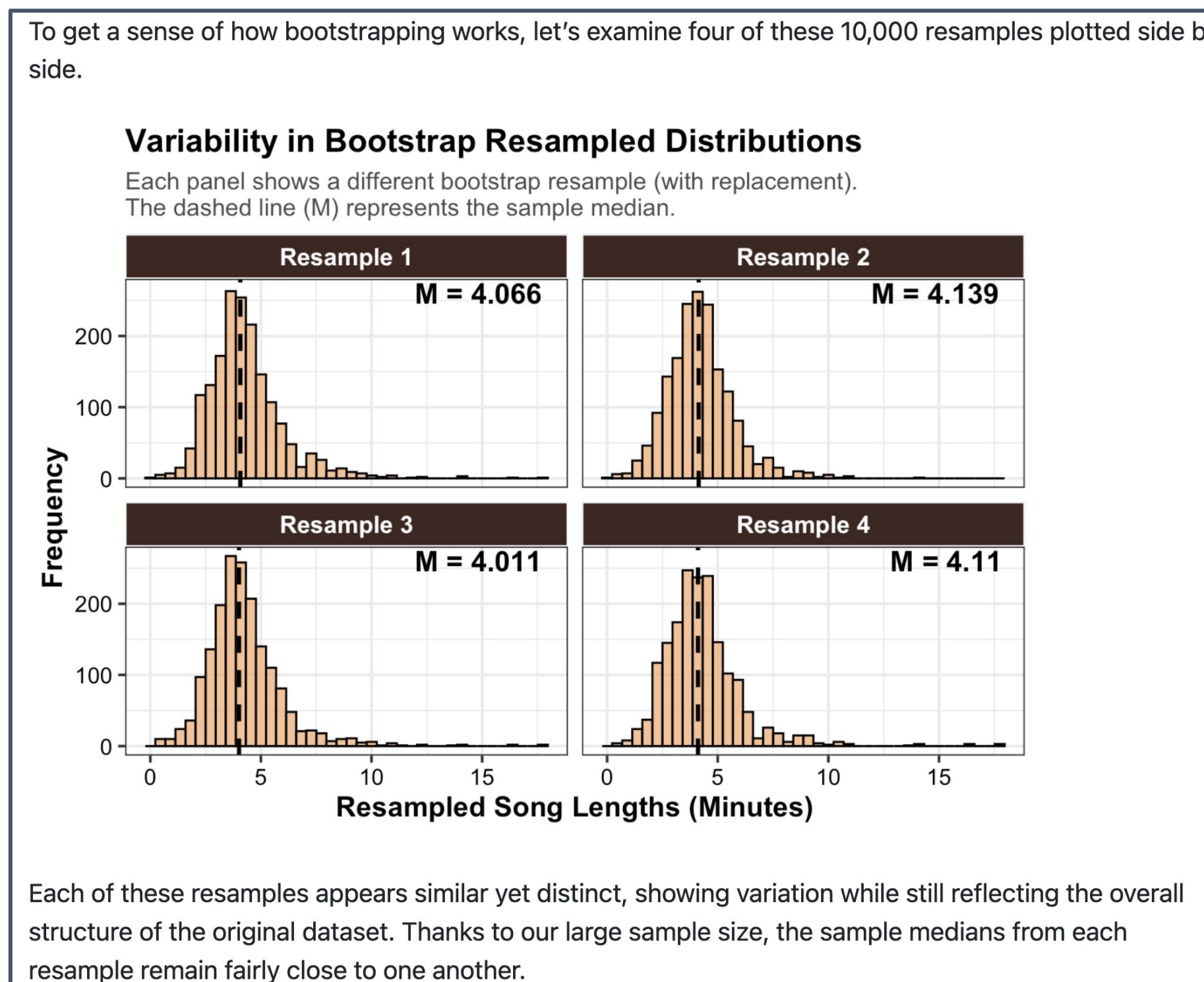
Application in Quarto:

Once students grasp the core concepts in Desmos, it's time for them to turn that understanding into action using R through Quarto.

On the left, we use data extracted from *"Exportify"* to bootstrap the true median song lengths from students' own Spotify playlists. They explore how resampled distributions vary and build confidence intervals. The only difference is this time they are working with data that matters to them, instead of a population distribution defined by an arbitrary PDF.

On the right, students analyze the built-in *"survey"* dataset to test the claim that 10% of people are left-handed, using a binomial exact test. They examine the data, assess whether it meets the test's assumptions, run the code, and interpret the results.

Each Quarto document reads like a guided walkthrough. Ideas are explained in plain language, code is embedded only when helpful, and no prior programming experience is required.



Quarto

Moving Beyond Simulation:

Quarto is one of the best tools for answering the classic student question: *"Why does this matter?"* While it doesn't have Desmos' real-time interactivity, it makes up for it by showcasing inference in real-world contexts. Like Desmos, Quarto documents are easy to distribute.

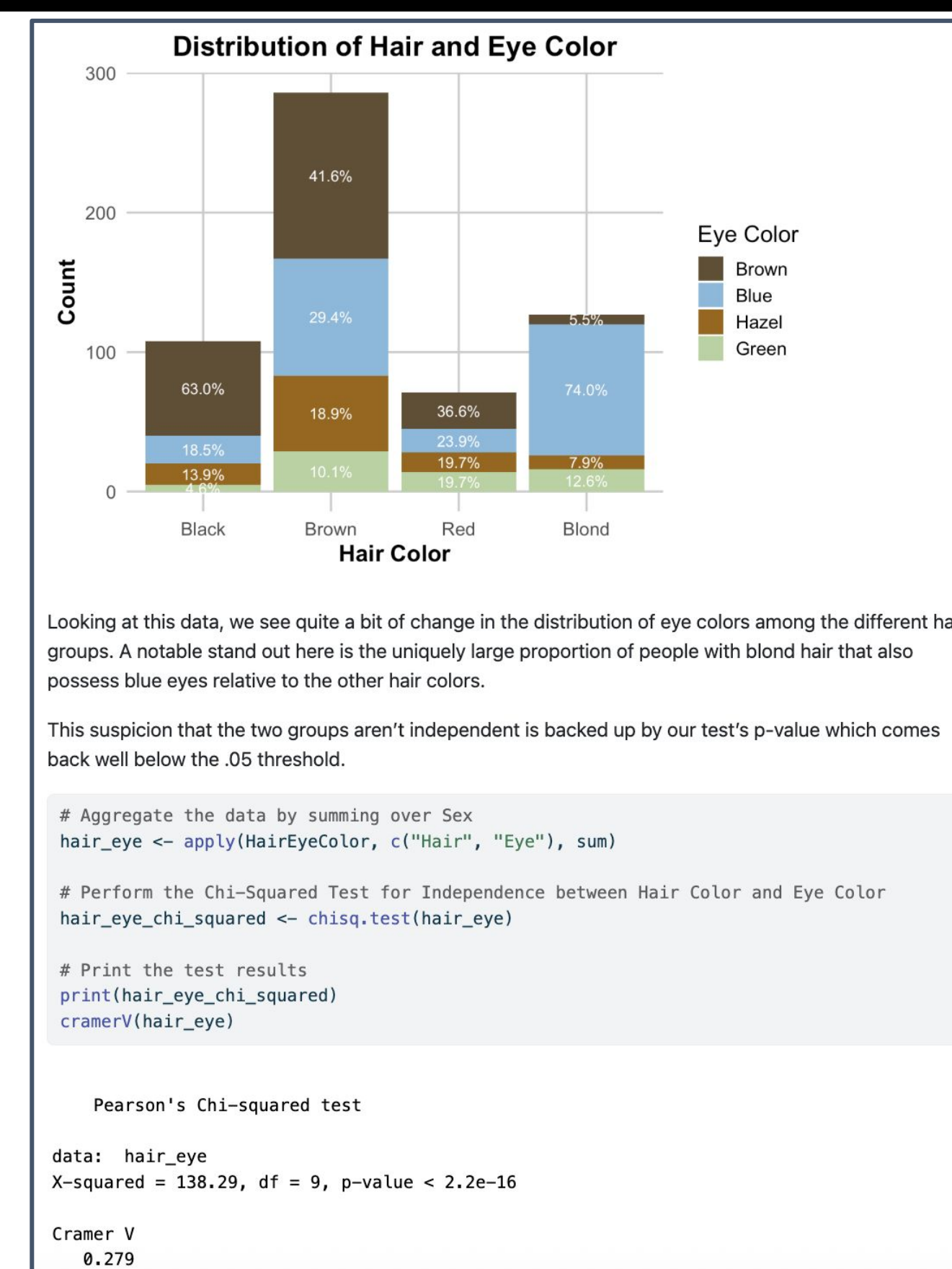
Blending Code, Text, and Insight

The example to the right illustrates Quarto's three greatest strengths.

First, it enables students to engage with professional-quality visuals generated in R without requiring them to even see the underlying code. Today, even teachers with limited R experience can use tools like GenAI to create custom plots tailored to classroom needs.

Second, Quarto documents read like pamphlets, with well-formatted text walking students through each step of analysis.

Finally, the ability to embed R code alongside its output helps demystify programming: students can copy, run, and modify clean code in small, manageable chunks rather than facing it all at once.



Desmos & Quarto – The Perfect Pair

"Two are better than one, because they have a good reward for their toil."

~ Ecclesiastes 4:9 (ESV)

As you can see, the union of Desmos and Quarto is a strategic one for student learning. Desmos is best suited for beginning the learning process. It offers an accessible entry point for exploring statistical concepts, allowing students to directly observe how each variable impacts inference. It can even serve as a calculator for certain topics when programs like R feel too intimidating. This makes Desmos ideal for helping students grasp the big ideas behind statistical theory.

That said, Desmos has its limitations: its computational power can be limiting at times, and entering real-world data must be done manually, making data-driven analysis impractical. This is where Quarto becomes the ideal companion. It harnesses the full power of R, enabling instructors to walk students through real data and generate professional-quality plots. Students can explore the logic without needing to write code themselves, while still being given access to clean, modifiable code for practice and adaptation. Students may not love statistics, but they'll no longer be able to say, *"How would I ever use this stuff?"*

Together, Desmos and Quarto yield a "good reward": a deeper, more complete learning experience. What one begins, the other completes. And in tandem, they offer more than either could alone.

Thank you for taking the time to read this presentation ~ Luke Zingg