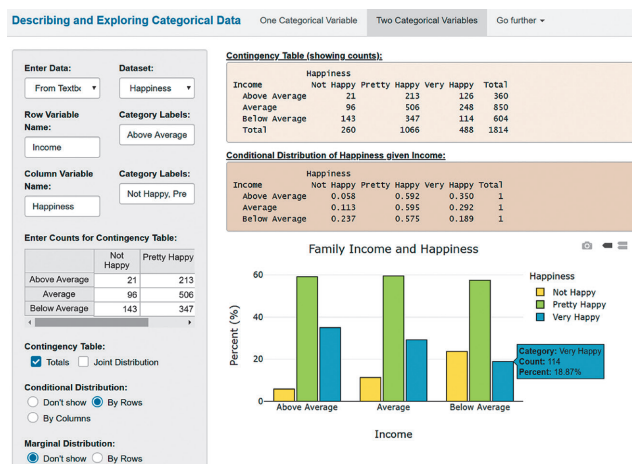


An Introduction to the Web Apps

The website ArtofStat.com links to several web-based apps that run in any browser. These apps allow students to carry out statistical analyses using real data and engage with statistical concepts interactively. The apps can be used to obtain graphs and summary statistics for exploratory data analysis, fit linear regression models and create residual plots, or visualize statistical distributions such as the normal distribution. The apps are especially valuable for teaching and understand sampling distributions through simulations. They can further guide students through all steps of inference based on one or two sample categorical or quantitative data. Finally, these apps can carry out computer intensive inferential methods such as the bootstrap or the permutation approach. As the following overview shows, each app is tailored to a specific task.

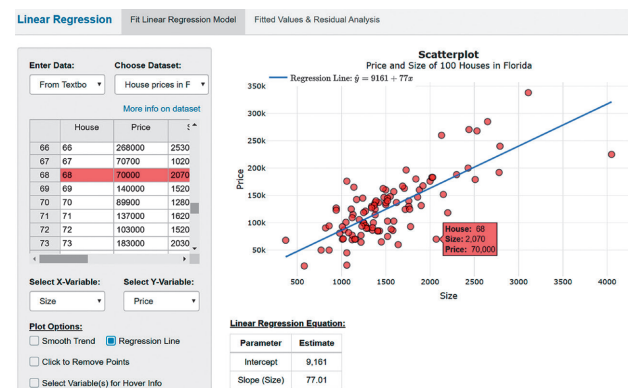
- The **Explore Categorical Data** and **Explore Quantitative Data** apps provide basic summary statistics and graphs (bar graphs, pie charts, histograms, box plots, dot plots), both for data from a single sample or for comparing two samples. Graphs can be downloaded.



Screenshot from the *Explore Categorical Data* app

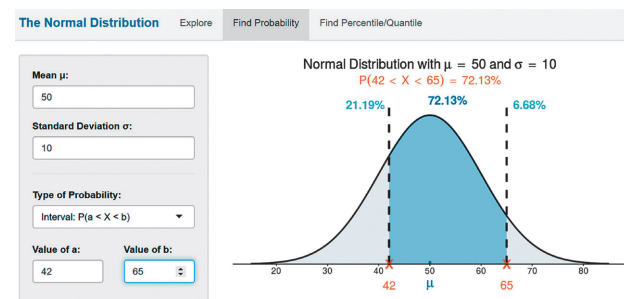
- The **Times Series** app plots a simple time series and can add a smooth or linear trend.
- The **Random Numbers** app generates random numbers (with or without replacement) and simulates flipping (potentially biased) coins.
- The **Mean vs. Median** app allows users to add or delete points by clicking in a graph and observing the effect of outliers or skew on these two statistics.
- The **Scatterplots & Correlation** and the **Explore Linear Regression** apps allow users to add or delete points from a scatterplot and observe how the correlation coefficient or the regression line are affected. The **Guess the Correlation** app lets users guess the correlation for

randomly generated data sets. The **Fit Linear Regression** app provides summary statistics, an interactive scatterplot, a smooth trend line, the regression line, predictions, and a residual analysis. Options include confidence and prediction intervals. Users can upload their own data. The **Multivariate Relationships** app explores graphically and statistically how the relationship between two quantitative variables is affected when adjusting for a third variable.



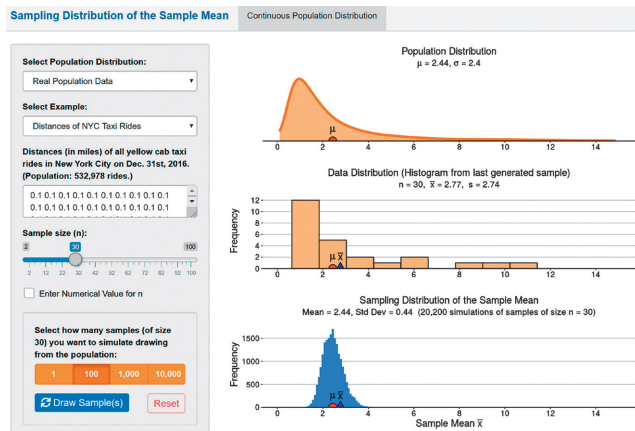
Screenshot from the *Linear Regression* app

- The **Binomial, Normal, t, Chi-Squared, and F Distribution** apps provide an interactive graph of the distribution and how it changes for different parameter values. Each app easily finds percentile values and lower, upper, or interval probabilities, clearly marking them on the graph of the distribution.



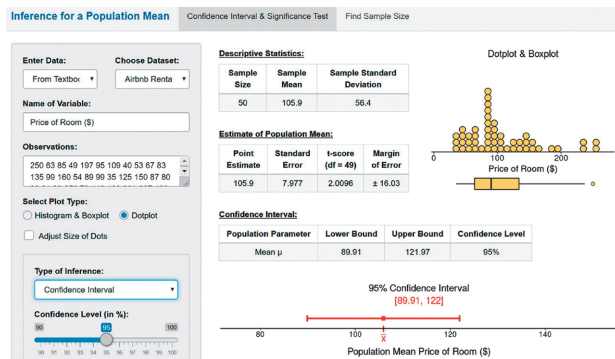
Screenshot from the *Normal Distribution* app

- The three **Sampling Distribution** apps generate sampling distributions of the sample proportion or the sample mean (for both continuous and discrete populations). Sliders for the sample size or population parameters help with discovering and exploring the Central Limit Theorem interactively. In addition to the uniform, skewed, bell-shaped, or bimodal population distributions, several real population data sets (such as the distances traveled by all taxis rides in NYC on Dec. 31) are preloaded.



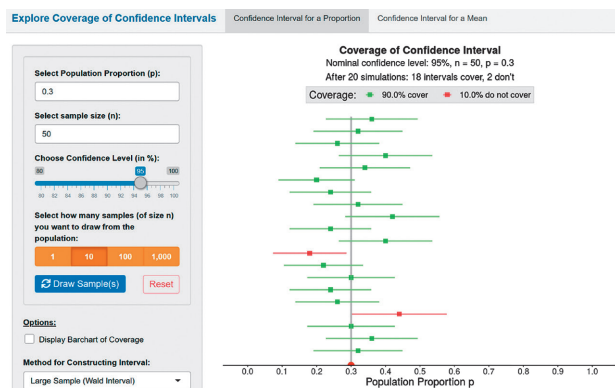
Screenshot from the *Sampling Distribution for the Sample Mean* app

- The **Inference for a Proportion** and the **Inference for a Mean** apps carry out statistical inference. They provide graphs and summary statistics from the observed data to check assumptions, and they compute margin of errors, confidence intervals, test statistics, and P-values, displaying them graphically.



Screenshot from the *Inference for a Population Mean* app

- The **Explore Coverage** app uses simulation to demonstrate the concept of the confidence coefficient, both for confidence intervals for the proportion and for the mean. Different sliders for true population parameters, the sample size, or the confidence coefficient show their effect on the coverage and width of confidence intervals. The **Errors and Power** app visually explores and provides Type I and Type II errors and power under various settings.



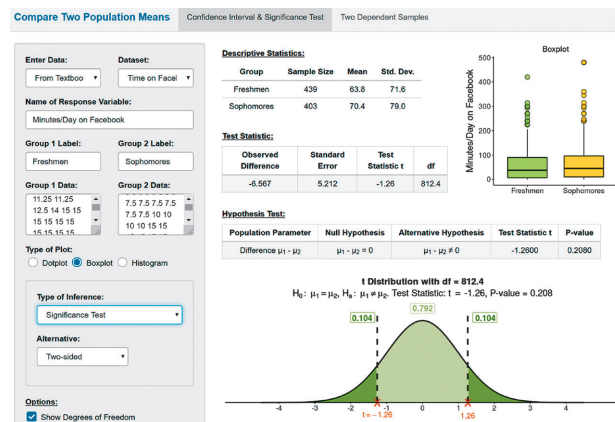
Screenshot from the *Explore Coverage* app

- The **Bootstrap for One Sample** app illustrates the idea behind the bootstrap and provides bootstrap percentile confidence intervals for the mean, median, or standard deviation.



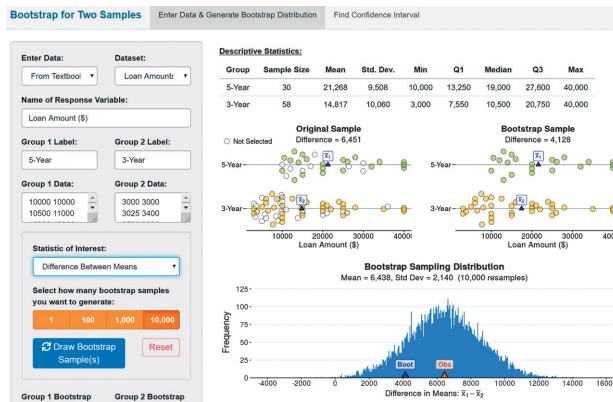
Screenshot from the *Bootstrap for One Sample* app

- The **Compare Two Proportions** and **Compare Two Means** apps provide inference based on data from two independent or dependent samples. They show graphs and summary statistics for data preloaded from the textbook or entered by the user and compute confidence intervals or P-values for the difference between two proportions or means. All results are illustrated graphically. Users can provide their own data in a variety of ways, including as summary statistics.



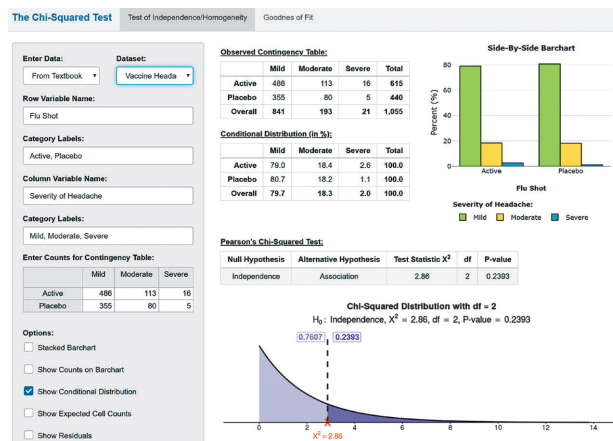
Screenshot from the *Compare Two Means* app

- The **Bootstrap for Two Samples** app illustrates how the bootstrap distribution is built via resampling and provides bootstrap percentile confidence intervals for the difference in means or medians. The **Scatterplots & Correlation** app provides resampling inference for the correlation coefficient. The **Permutation Test** app illustrates and carries out the permutation test comparing two groups with a quantitative response.



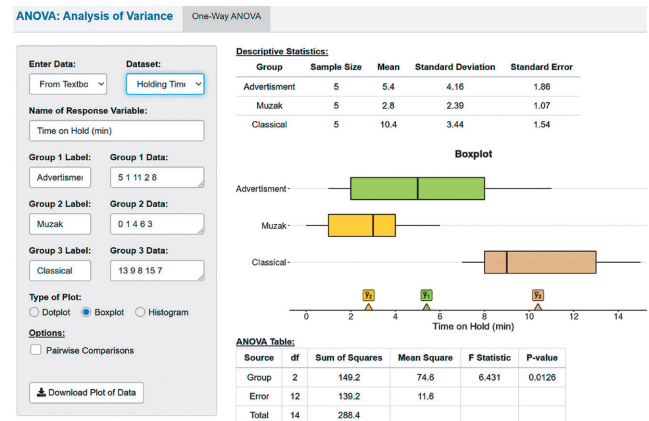
Screenshot from the *Bootstrap for Two Samples* app

- The **Chi-Squared Test** app provides the chi-squared test for independence. Results are illustrated using graphs, and users can enter data as contingency tables. The corresponding permutation test is available in the **Permutation Test for Independence (Categ. Data)** app and for 2×2 tables in the **Fisher's Exact Test** app.



Screenshot from the *Chi-Squared Test* app

- The **ANOVA (One-Way)** app compares several means and provides simultaneous confidence intervals for multiple comparisons. The **Wilcoxon Test** and the **Kruskal-Wallis Test** apps for nonparametric statistics provide the analogs to the two-sample t test and ANOVA, both for independent and dependent samples.



Screenshot from the *ANOVA (One-Way)* app

- The **Multiple Linear Regression** app fits linear models with several explanatory variables, and the **Logistic Regression** app fits a simple logistic regression model, complete with graphical output.