

# ***How Do You Use Statistical Reasoning to Formulate Convincing Conclusions?***

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Thursday, April 18, 2013

# Statistical Studies

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Statistical reasoning is needed throughout the process:

- **Formulating** a question (or questions) that clarifies the problem and can be addressed with data
- **Designing** and **employing** a plan for collecting data.
- **Analyzing** and **summarizing** the data.
- **Interpreting** the results from the analysis, and answering the question on the basis of the data.

*Guidelines for Assessment and Instruction in Statistics Education*  
(Franklin et al., 2007)

# Formulating Statistical Questions

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What are natural questions related to stacking pennies using dominant and non-dominant hands?



# CCSSM High School Statistics

## Making Inferences and Justifying Conclusions, S-IC

**Make inferences and justify conclusions from sample surveys, experiments, and observational studies**

3. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

# Volunteers Methods

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- Describe your protocol (rules) for stacking pennies.

# Common Core State Standards for Mathematics

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“Technology plays an important role in statistics and probability by making it possible to generate plots, functional models, and correlation coefficients, and simulate many possible outcomes in a short amount of time.” (p. 55)

# CCSSM Mathematical Practice

## Use Appropriate Tools Strategically

Use Mathematically proficient **students consider the available tools when solving a mathematical problem.** These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a **statistical package**, or dynamic geometry software. Proficient students are **sufficiently familiar with tools** appropriate for their grade or course **to make sound decisions** about when each of these tools might be helpful. . . . They are able to use these tools **to explore and deepen their understanding of concepts.**

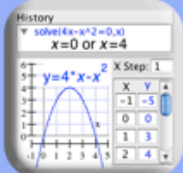
# Public-domain Core Math Tools

Core Math Tools

Info Select an App: Quick Access


### Algebra & Functions

#### CAS



Produce tables and graphs of functions, manipulate symbolic expressions, and solve equations and inequalities

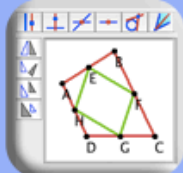
#### Spreadsheet



Use familiar spreadsheet functions, insert class data or data from other sources, and employ data transformations.


### Geometry & Trigonometry

#### Synthetic



Construct, measure, manipulate, transform, and animate geometric figures


#### Coordinate



Construct, measure, manipulate, transform, and animate geometric figures in a coordinate plane


### Statistics & Probability

#### Data Analysis



Graphically display and analyze univariate and bivariate data

#### Simulation



Create and run simulations of probabilistic situations

**General Purpose Tools**

CAS, Spreadsheet, Interactive Geometry, Data Analysis and Simulation

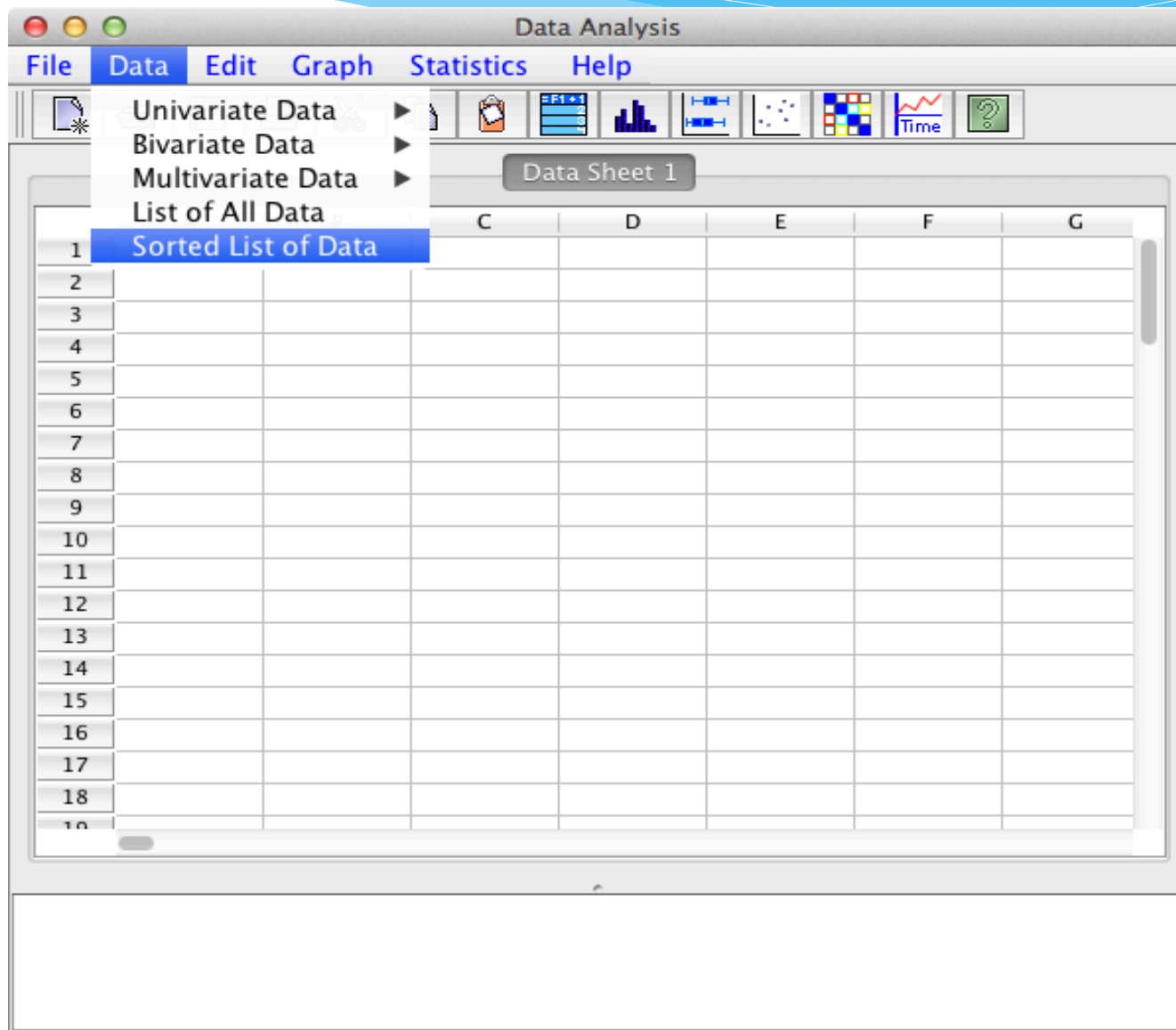
**Custom Apps** →

Focused exploration of specific topics such as triangle congruence conditions, sampling distributions, and linear programming

**Advanced Apps** →

Tools for exploring post-CCSSM topics including vertex-edge graphs, contour diagrams, difference quotients, and cryptography





# CCSSM High School Statistics

## Interpreting Categorical and Quantitative Data, S-ID

**Summarize, represent, and interpret data on a single count or measurement variable**

1. Represent data with plots on the real number line (dot plots, histograms, and box plots).
2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.

# Statistical Significance

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How do you decide whether the difference in the mean responses for stacking pennies happened by chance or was due to the choice of dominate or non-dominate hand?

# CCSSM High School Statistics

## Making Inferences and Justifying Conclusions, S-IC

**Make inferences and justify conclusions from sample surveys, experiments, and observational studies**

5. Use data from a randomized experiment to compare two treatments; **use simulations to decide if differences between parameters are significant.**

# CCSSM High School Statistics

## Making Inferences and Justifying Conclusions, S-IC

**Make inferences and justify conclusions from sample surveys, experiments, and observational studies**

5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between **parameters** are significant.

### Clarification

5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between **sample statistics (usually sample means or sample proportions)** are significant.

## Randomization Test

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- Suppose that each subject will respond the same way no matter which treatment he or she gets. Call this the *null hypothesis*.
- Randomly divide the available subjects into the two treatment groups, give the treatments, and record the responses.
- Generate a *randomization* distribution that shows the difference in the mean response from many different possible randomizations of the subjects to the treatments, still assuming that the null hypothesis is true.
- Decide if the difference from the actual experiment would be extreme (a rare event) if the null hypothesis is true.
- If not, you cannot reject the null hypothesis. If so, you can reject the null hypothesis and conclude that the treatments did make a difference in the mean response.

# CCSSM High School Statistics

## Interpreting Categorical and Quantitative Data, S-ID

**Summarize, represent, and interpret data on two categorical and quantitative variables**

6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
  - a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.
  - b. Informally assess the fit of a function by plotting and analyzing residuals.
  - c. Fit a linear function for a scatter plot that suggests a linear association.

# CCSSM High School Statistics

## Interpreting Categorical and Quantitative Data, S-ID

### **Interpret linear models**

7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.
8. Compute (using technology) and interpret the correlation coefficient of a linear fit.



## Additional Resources

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- **Core Math Tools** is freely available from [www.nctm.org/coremathtools/](http://www.nctm.org/coremathtools/)
- **CPMP-Tools** is freely available from [www.wmich.edu/cpmp/CPMP-Tools/](http://www.wmich.edu/cpmp/CPMP-Tools/)
- Sample lesson materials for your classroom: <http://www.wmich.edu/cpmp/2nd/unitsamples/c3u1intro.html>

# Thank you

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