

Designing Monte Carlo Simulations Using TI-Nspire™ Technology

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Overview of Presentation

- Use in our curriculum
- A Few Definitions
 - Simulation, random, random variable, string, trial, pseudo-random, randseed
- What is a Monte Carlo simulation?
- Activities
 - Sum of two fair six-sided dice
 - Blue-eyed babies problem
 - Airplane overbooking
 - Baseball hitting streak

Use in Our Curriculum

- A lesson for a few days in a Precalculus/ Statistics course
 - *Functions, Statistics and Trigonometry* 3rd ed.
University of Chicago School Mathematics Project
- For average sophomores, juniors, seniors
- Lesson 06-07 (beginning of semester 2)

Monte Carlo Method



- Use of repeated trials to produce relative frequencies to estimate probabilities
- Three basic steps:
 1. Determine how the situation will be modeled.
 2. Define what constitutes a trial and what will be recorded.
 3. Specify the number of trials that will be run and how the estimated answer will be obtained.

Who Uses Monte Carlo Simulations?

- **An important tool for decision-making**
- **General Motors, Procter and Gamble, and Eli Lilly:** to estimate both the average return and the riskiness of new products.
- **Sears:** to determine how many units of each product line should be ordered from suppliers — for example, how many pairs of Dockers should be ordered this year.

Who Uses Monte Carlo Simulations?

- **Wall Street firms:** to price complex financial derivatives and determine the *Value at RISK (VAR)* of their investment portfolios.
- **Financial planners:** to determine optimal investment strategies for their clients' retirement.

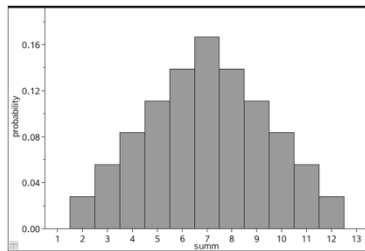
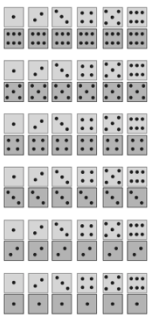
A Simple Example: Sum of Two Fair Six-sided Dice

- What is the probability of getting a sum of 2? 3?... 12?



- This is an example of designing a simulation for a problem for which we already know the probabilities or they can be easily calculated.

Sum of 2 Dice Outcomes



Ideas for Monte Carlo Simulation of Sum of 2 Six-sided Dice

1. .
2. .
3. .

Format of Simulation of Sum of 2 Dice

- **FORMAT 1:** View results one at a time on the home screen
 - On a calculator screen, generate one string at a time, and keep a tally of each value.

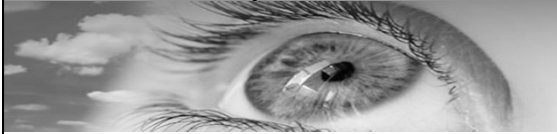
Format of Simulation of Sum of 2 Dice

- **FORMAT 2:** View results in a spreadsheet
 - In a spreadsheet, generate rows of strings and their sums using commands in columns.
 - Count each result by sight by scrolling the column.
 - Use a histogram to find each count.
 - Use counting command: Countif(list,value)

Format of Simulation of Sum of 2 Dice

- **FORMAT 3:** "Blindly" view results in a single command
 - Use a counting command on a calculator screen.

A Try-On-Your-Own Example: Blue & Brown Eyes



- Two brown-eyed parents can have a blue-eyed child if they each carry a recessive gene for blue eyes. Assume that in these cases, the probability of blue eyes is $1/4$ and the probability of brown eyes is $3/4$. Design a simulation to estimate the probability of having exactly one of three children with blue eyes.

Ideas for a Monte Carlo Simulation?

1. .

2. .

3. .

Airline Overbooking



Try this one on your own or with a partner.

- Suppose that 24 tickets are sold for a small plane and that the probability of arrival for each passenger is 90%. Use a simulation to estimate:
 - how many of the 24 passengers will show up.

Ideas for Airline Overbooking Part a)

1. .

2. .

3. .

Airline Overbooking Part b)

Try this one on your own or with a partner.

- Suppose that 24 tickets are sold for a small plane and that the probability of arrival for each passenger is 90%. Use a simulation to estimate:
b) **how many tickets should be sold in order to fill all 24 seats.**



Ideas for Airline Overbooking Part b)

1. .

2. .

3. .

Baseball Hitting Streak Problem

Try this one on your own or with a partner.



- Suppose that a baseball player has a batting average of 0.300. Use your calculator to simulate his next 100 official at-bats, recording whether he gets a hit or not. What is the longest streak of hits that he gets in your simulation?

Ideas for Baseball Hitting Streak Problem

1. .
2. .
3. .

Benefits of Doing Monte Carlo Simulations Using Technology

THANK YOU!

Download Powerpoint, handout, and .tns files from:

- gbsweb.glenbrook225.org/gbs/kkerr/simtalk.zip
