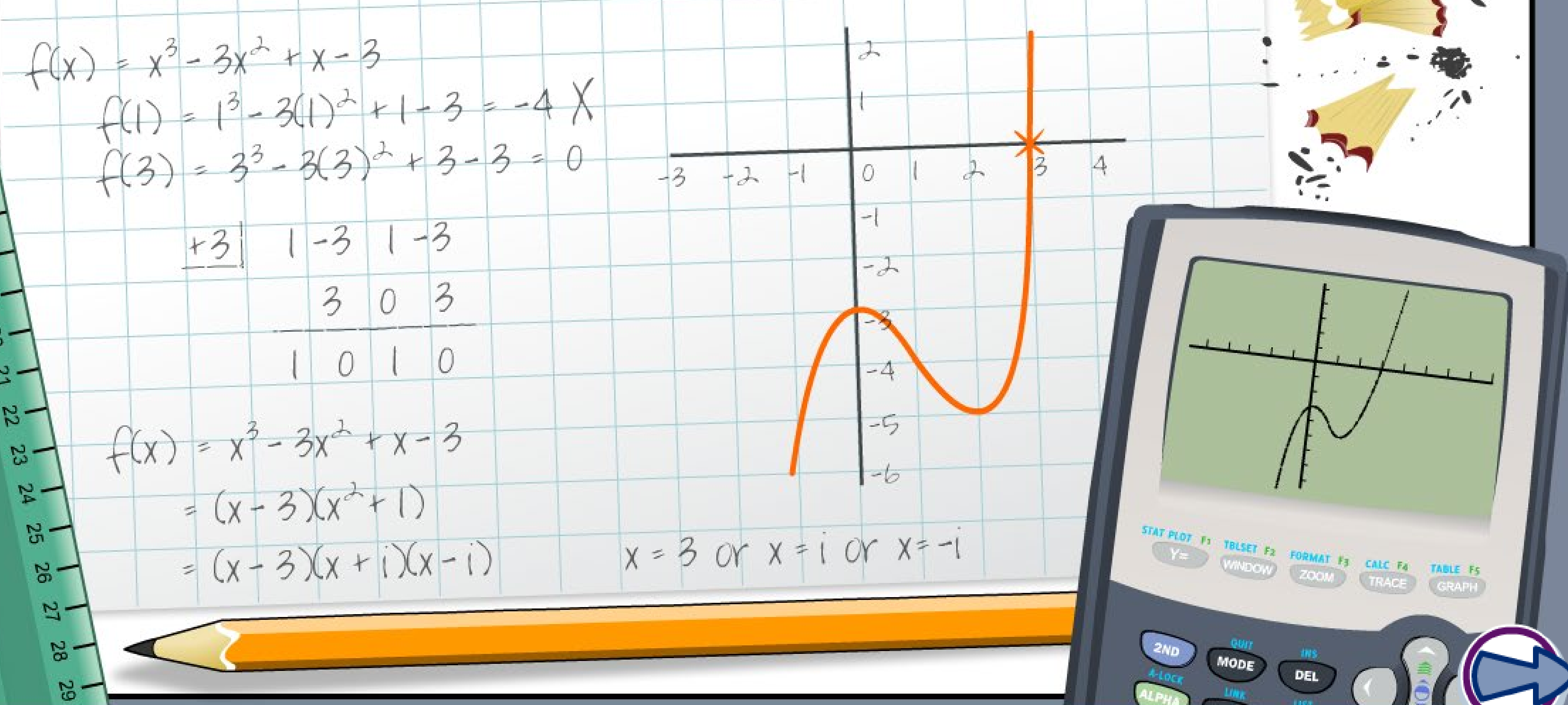
Simulation Models



Information

Common core icons

This icon indicates a slide where the Standards for Mathematical Practice are being developed. Details of these are given in the Notes field.

MODELING

Slides containing examples of mathematical modeling are marked with this stamp.

This icon indicates an opportunity for discussion or group work.

The **Standards for Mathematical Practice** outlined in the Common Core State Standards for Mathematics describe varieties of expertise that mathematics educators at all levels should seek to develop in their students.

These are:

1) Make sense of problems and persevere in solving them.

2) Reason abstractly and quantitatively.

3) Construct viable arguments and critique the reasoning of others.

4) Model with mathematics.

5) Use appropriate tools strategically.

6) Attend to precision.

7) Look for and make use of structure.

8) Look for and express regularity in repeated reasoning.

This icon indicates that the slide contains activities created in Flash. These activities are not editable.

This icon indicates teacher's notes in the Notes field.

Random numbers

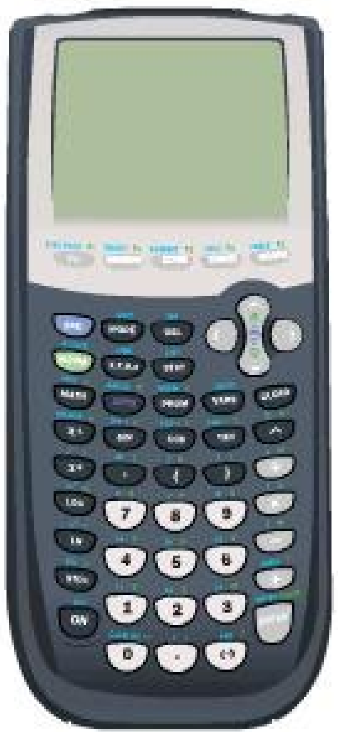
Random numbers are numbers that are distributed over a certain range and are unpredictable.

Some places where can you get random numbers are:

- computers
- graphing calculators
- books of random numbers
- random number tables
- the internet.

Random numbers are useful in modeling real-world situations that involve chance.

Generating random numbers on a graphing calculator



Most graphing calculators can generate random numbers from different distributions. Press on a type of random number to learn how to generate them using a calculator.

uniform random integer

binomial distribution

normal distribution

Assuming a couple has 5 children, what is the probability they have exactly 2 girls?

This problem can be solved using probability: **0.3125**

This scenario is simple enough that it can be solved using probability. However, not all problems are so simple.

A **simulation** is a way to model the outcomes of a scenario.

It is particularly useful when the scenario is too complicated to calculate the probability directly.

It is also useful for verifying results.

Simulation terminology

Assuming a couple has 5 children, what is the probability they have exactly 2 girls?

a **component** is a basic event in the sequence of random outcomes: **having a child**

a **trial** is the sequence of events under consideration: **having 5 children**

a **response variable** is the result of a trial: **whether or not there are exactly 2 girls**

Verifying results

The scenario where a couple has 5 children is simulated below. What is the probability they have 2 girls from this simulation? Use the table provided.

100 random numbers that are: 0 (boy) or 1 (girl) with equal probabilities.

0 0 1 0 0	1 0 1 1 1	0 0 0 0 0	1 1 0 1 0
1 1 0 0 0 ✓	1 0 0 1 1	0 1 1 1 1	1 0 0 1 0 ✓
1 0 1 1 0	1 0 0 1 1	0 0 0 1 1 ✓	1 1 1 1 0
0 0 0 0 1	0 1 1 0 1	1 1 1 1 1	1 1 0 1 0
0 0 0 1 1 ✓	0 1 1 1 1	1 0 1 0 0 ✓	1 1 1 1 0

no. of girls	0	1	2	3	4	5	total
no. of trials							0
exp. prob.							0

Repeat the experiment for another 20 trials.
Is the experimental probability still 0.25?

no. of girls	0	1	2	3	4	5	total
no. of trials							0
exp. prob.							0

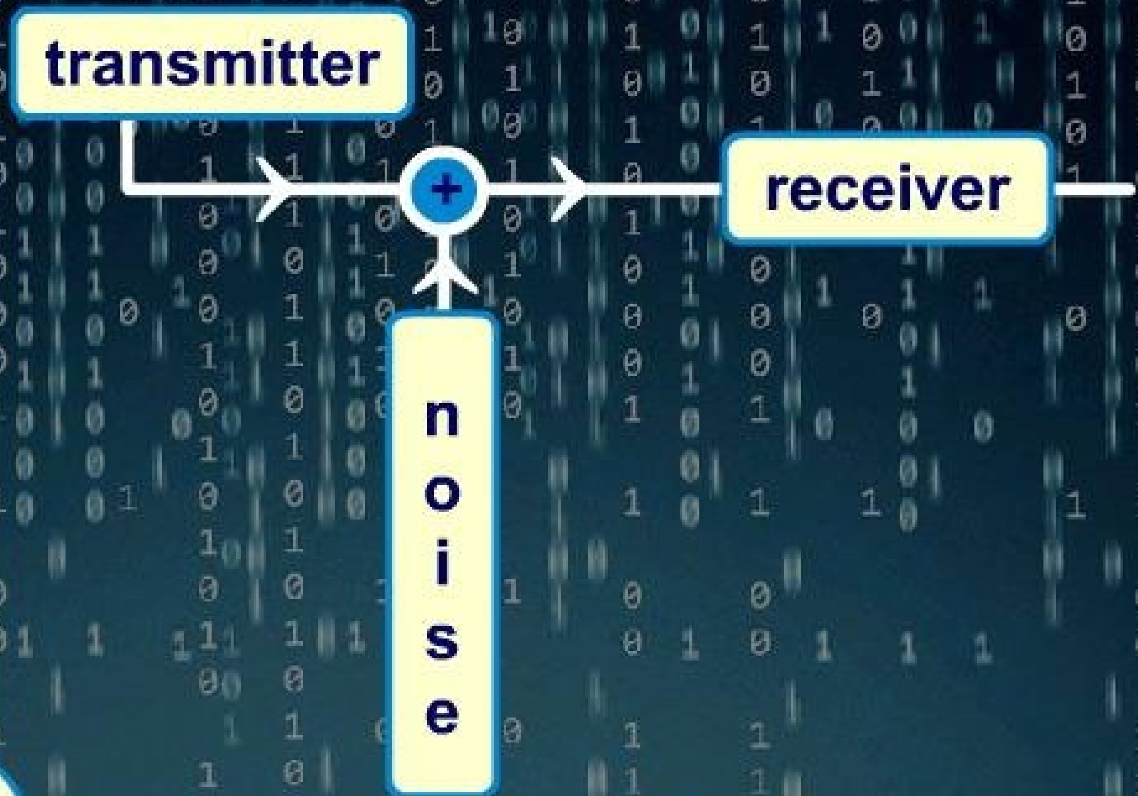
Now try with 500 trials. Does this support the theoretical probability of 0.3125?

Bit errors in a communication channel

Start by pressing on the buttons at the right to learn more about the parts of a communication system.

Then press on the buttons below to learn to simulate it.

1 2 3 4 5



Margin of error

The **margin of error** is a measure of the likelihood that the sample data represents the population accurately.

The margin of error of a sample depends on the sample size, n, and the proportion of the sample, p.

$$ME = 1.96\sqrt{\frac{p(1-p)}{n}}$$

With a large sample size, the margin of error decreases and the sample statistic becomes more accurate due to the law of large numbers.

Margin of error example

Use a random number generator to simulate a yes-or-no survey with different probabilities of "yes" and different sample sizes and then enter the results in the table below. The margin of error is calculated automatically.

p	yes	no	total	margin of error
			0	
			0	
			0	
			0	

What happens to the margin of error as the number of "yes" answers or the sample size changes?

Simulate two treatments

In a large scale study of carpal tunnel patients, every 4 in 5 patients who had surgery showed improvement in 6 months, but only every 3 in 5 patients who received wrist splints improved. Using this data, how can you simulate both treatments?

One way is to generate two sets of 50 random integers between 0 and 4: randInt(0, 4, 50).

- Surgery: 0 is no improvement; 1 through 4 is an improvement.
- Wrist splints: 0 or 1 is no improvement; 2, 3, or 4 is improvement.

Another way is to generate a 0 or a 1 as a binomial random variable where 0 means no improvement and 1 means improvement.

- In surgery the probability of a 1 is 0.8: randBin(1, 0.8, 50).
- In wrist splints the probability of a 1 is 0.6: randBin(1, 0.6, 50).

Simulation of surgery

Use the simulations to compare the margin of errors.

Using the results of the simulations, complete the tables below. The margin of error is calculated automatically.

splint	yes	no	total	margin of error
no. responses			0	

surgery	yes	no	total	margin of error
no. responses			0	

How do their margins of error differ? Do they stay the same if the simulations are repeated?