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Algebra
Unit 3 Line Master 10a

Writing Code to Simulate a Coin Toss

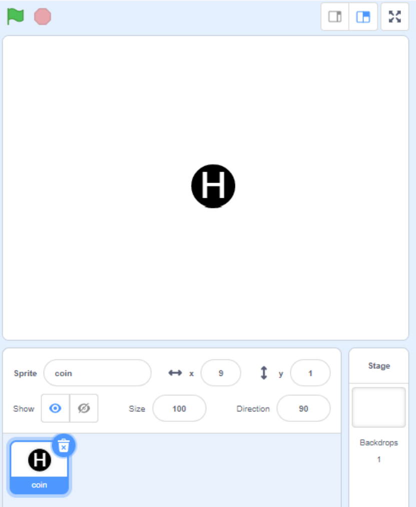
Let’s explore probability through coding by creating a coin toss simulator application in Scratch.

Start with an existing Scratch application that has a **coin** sprite with two costumes ready to go: one for heads and one for tails. Click on this link.

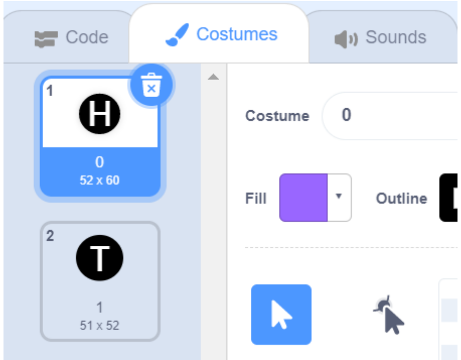
https://scratch.mit.edu/projects/692982103/editor

If you have a Scratch login, save the project in your Scratch account by selecting **Remix** at the top of the screen. A login is not required to work with the code, but you will not be able to save your changes without it.

1. You can see this application already has a **coin** sprite. If you select the **Costumes** tab (the middle tab on the top left), you will see that the costume that has “H” for heads has **0** for its name and the other costume has a “T” for tails and has **1** for its name.



Sprite coin x 9 y 1
Size 100 Direction 90
coin



1 H 0 52 x 60
2 T 1 51 x 52
Costume 0

Return to the code, by clicking on the **Code** tab.

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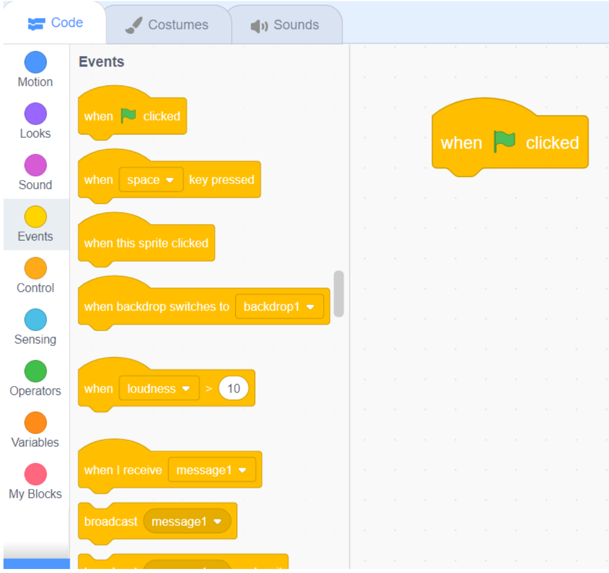
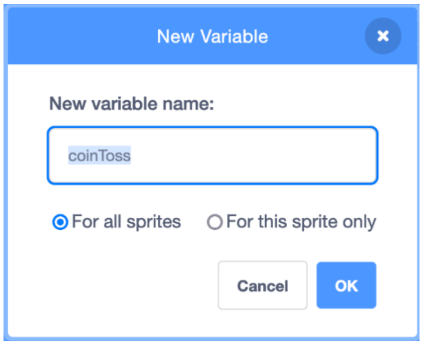
2. Start writing the code for the coin toss.
Under **Events**, select the **when green flag clicked** block and drag it to the code editing area as shown.



3. Create a variable to hold a random number between 0 and 1. Later in the code, if the random number is 0, you will display the coin in its heads costume and if the random number is 1, you will display the coin in its tails costume.

To make a variable, under **Variables**, select **Make a Variable**. Name the variable **coinToss** and select **OK**.


New Variable

New variable name: coinToss

● For all sprites ○ For this sprite only

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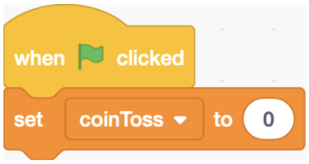
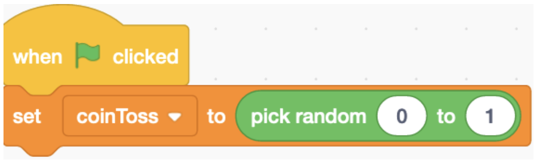
4. Under **Variables**, select the **set** block and ensure **coinToss** is selected from the pulldown menu. Place it underneath the **when green flag clicked** block.



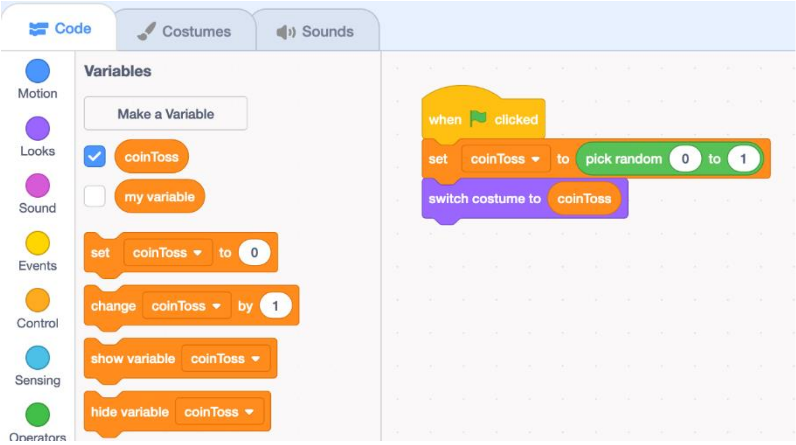
```
when ⚑ clicked
set coinToss ▾ to 0
```

5. Set the **coinToss** variable to a random number between 0 and 1. To do this, go to **Operators** and drag the **pick random** block into the **set coinToss** block as shown. Change the number range to **0** to **1**.



```
when ⚑ clicked
set coinToss ▾ to pick random 0 to 1
```

6. Now, switch the **coin** costume to display the H **coin** costume if the random number picked is 0, and T if the random number picked is 1. Under **Looks**, select the **switch costume to** block and drag it beneath the **set** block.
   Because the costumes have already been labelled as **0** and **1** in the **Costumes** tab, you just need to use the **coinToss** variable block from under **Variables** and place it into the **switch costume to** block, since the **coinToss** variable will either be set to 0 or 1.



```
when ⚑ clicked
set coinToss ▾ to pick random 0 to 1
switch costume to coinToss
```

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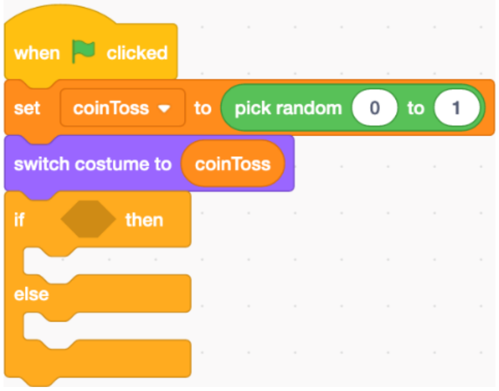
Writing Code to Simulate a Coin Toss (cont'd)

7. You need a way to keep track of whether heads or tails is tossed. To do this, you need two additional variables. Under **Variables**, select **Make a Variable** and name it **totalHeads**. Make a second variable called **totalTails**.

***conditional statement*: A type of coding instruction used to compare values and make decisions. A conditional statement tells a program to execute an action only if a certain condition is true or false. It is often represented as an if-then or if-then-else statement.

You will use a *conditional statement* to determine if you need to increase the **totalHeads** variable by 1 because heads is tossed, or to increase the **totalTails** variable by 1 because tails is tossed. Follow Steps 8 to 11 to code the statement.

8. Under **Control**, select the **if-then-else** block and place it beneath the **switch costume to** block.

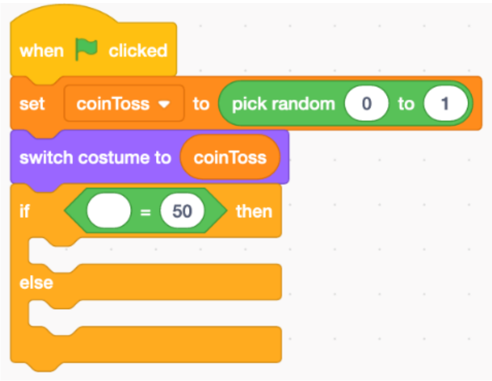


```
when ⚑ clicked
set coinToss ▾ to pick random 0 to 1
switch costume to coinToss
if ⬡ then

else

```

9. Inside the **if-then-else** block, you need a comparison operator to check if something is true or not. Under **Operators**, select the **equal** (=) comparison operator and place it inside the first part of the **if-then-else** block.



```
when ⚑ clicked
set coinToss ▾ to pick random 0 to 1
switch costume to coinToss
if ( ) = 50 then

else

```

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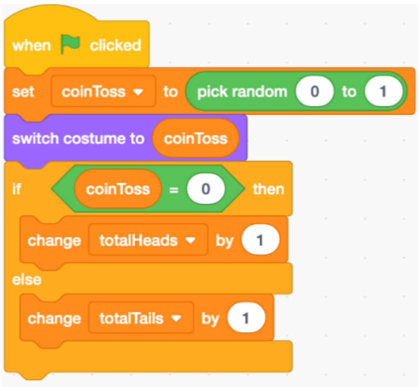
Writing Code to Simulate a Coin Toss (cont'd)

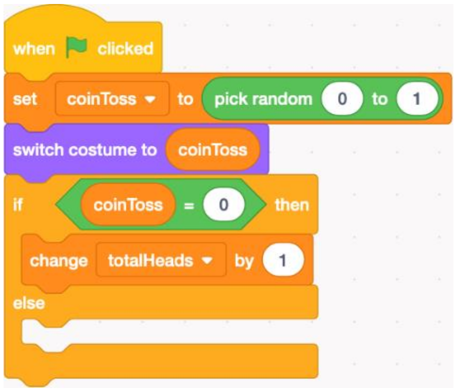
10. You want the program to check if heads was tossed and, if it was, increase the **totalHeads** variable by 1 as a way of keeping track of the total number of heads tossed.



```
when ⚑ clicked
set coinToss ▾ to pick random 0 to 1
switch costume to coinToss
if coinToss = 0 then
    change totalHeads ▾ by 1
else
    change totalTails ▾ by 1
```

Under **Variables**, select the **coinToss** block and place it inside the **equals (=)** operator. Change the second part of the **equals** (=) operator to **0**, rather than 50.

Next, select a **change** block from **variables** and place it below the first portion of the **if-then-else** block. Ensure the **totalHeads** variable is selected from the pulldown menu and that the number **1** is displayed in the **change** block so that each time a head is tossed, the **totalHeads** variable will increase by 1.



```
when ⚑ clicked
set coinToss ▾ to pick random 0 to 1
switch costume to coinToss
if coinToss = 0 then
    change totalHeads ▾ by 1
else
```

11. If heads is not tossed, that means tails must have been tossed. Place a **change** block inside the **else** portion of the conditional. Ensure the **totalTails** variable is selected in the pulldown menu and that the number **1** is displayed in the **change** block so that each time tails is tossed, the **totalTails** variable will increase by 1.

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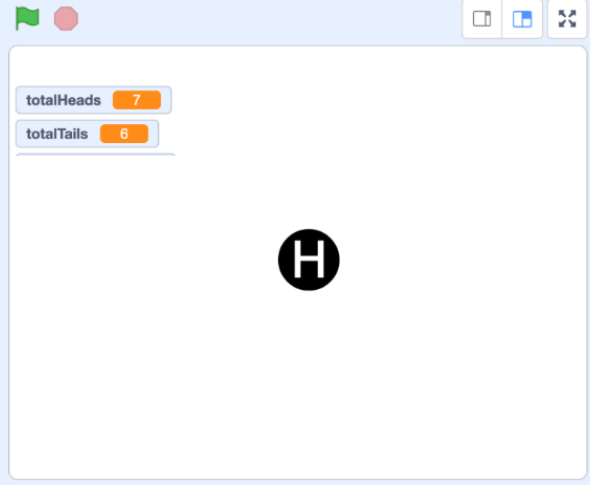
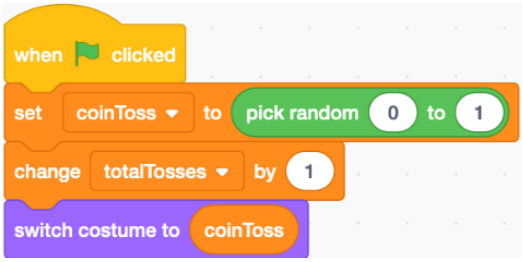
12. Click on the green flag above the stage to execute the code. Do this many times. The values of three variables are displayed on the stage. The coin should switch to an H or a T depending on the random number that is picked. Each time an H appears, the **totalHeads** variable increases by 1. Each time a T appears, the **totalTails** variable increases by 1.
If these things don't happen, check your code to make sure it matches what is shown in the images at each step.

Your stage should look similar to this but with different numbers of heads and tails.


totalHeads 7
totalTails 6

13. Add a variable to keep track of the total number of tosses. Under **Variables**, select **Make a Variable** and call it **totalTosses**. Each time the green flag is clicked, you'd like the **totalTosses** variable to increase by 1. Insert a **change** block below first **set** block in the code and ensure the **totalTosses** variable is selected from the pulldown menu. To insert a block, drag it to where you want it to appear and let go.


```
when [flag] clicked
set coinToss to pick random 0 to 1
change totalTosses by 1
switch costume to coinToss
```

The first 4 blocks in your code should look like what is shown above.

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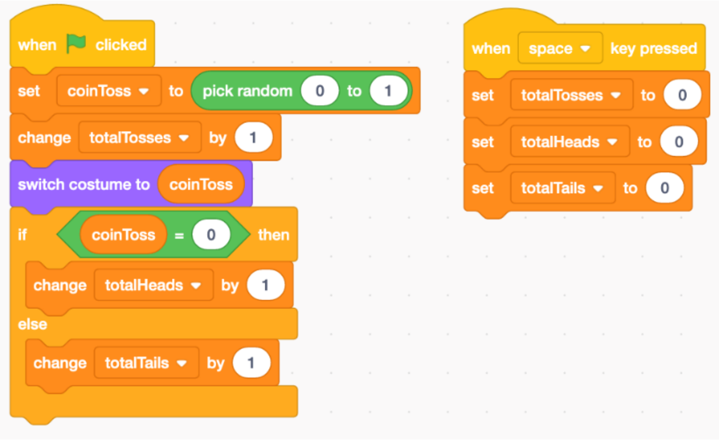
14. Finally, add code to reset all of the variables to 0 when the user presses the spacebar. Under **Events**, select **when space key pressed**, and place it in the code editing window.

    Under **Variables,** select three **set** blocks and place them beneath the **when space key pressed** block.
    Select **totalTosses** from the pulldown menu for the first one, **totalHeads** for the second one, and **totalTails** for the third one.

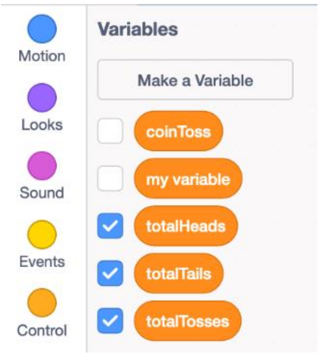


```
when [flag] clicked
set coinToss to pick random 0 to 1
change totalTosses by 1
switch costume to coinToss
if coinToss = 0 then
    change totalHeads by 1
else
    change totalTails by 1

when space key pressed
set totalTosses to 0
set totalHeads to 0
set totalTails to 0
```

15. Before you run your program again, make sure only certain variables are displayed on the stage.

    Under **Variables**, deselect the checkbox for **coinToss**. Only the three variables with the checkboxes selected will be displayed.



□ coinToss
□ my variable
☑ totalHeads
☑ totalTails
☑ totalTosses

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Writing Code to Simulate a Coin Toss (cont’d)

16. Execute the code several times and then press the space bar.
    Did the variable values reset back to 0?
    If not, look carefully through the code to make sure you have everything correct and haven’t missed a step.
    We call this process “debugging”.

theoretical probability: when all outcomes are equally likely, the number of favourable outcomes for an event divided by the total number of outcomes

experimental probability: the number of favourable outcomes in an experiment divided by the total number of trials

17. When we toss a fair coin many times, theoretical probability tells us that we can expect to get half heads and half tails.

    a) Reset the variables. Then click on the green flag 10 times.
    How many of the 10 tosses are heads? How many are tails?
    How close is this experimental result to what theoretical probability would lead you to expect?

    b) Combine your results with 4 other pairs. How many of the 50 tosses are heads? How many are tails?

    c) Suppose you could toss a fair coin 10 000 times.
    What would theoretical probability lead you to expect might happen? What do you think might happen?