

Game of Missing Digit

This program is actually a simulation of a game played between two friends.

Let's say there are two friends Leila and Sheila. Leila tells Sheila that she is a detective who can trace missing numbers.

Leila asks Sheila to write down any string of numbers without showing you the result. (For example, Sheila writes 714329167.)

Next, Leila asks Sheila to add a zero to the right.

(New number would be 7143291670)

Next, she asks Sheila to subtract her first number.

($7143291670 - 714329167 = 6428962503$)

Finally Leila tells Sheila to remove any digit except 0 from the number she is left with. (Sheila eliminates 4. Her remaining number will be 628962503.)

Leila now states that if Sheila will show her just her remaining number, she will tell Sheila what digit she eliminated – that she will find the missing digit.

Trick:

Here is how Leila finds the missing digit. First, she adds the digits in the remaining number Sheila gives her. She keeps adding until she is left with a single digit.

In the above example:

- Adding all digits in 628962503 gives 41.
- Add all digits in 41 gives 5.

If this single digit is 9, that's the answer. Otherwise, Leila subtracts this digit from 9 to get the missing digit.

Explore the game:

If you want to play with my final program to get a feel for this game, click the link given at the end of the article. Try not to peek at the scripts yet, since we want to design them ourselves below.

1. Click on the "Green flag" and watch the game.
2. Pick between interactive and animation modes. In "interactive" mode you play the role of Sheila. In "animation" mode you just watch the simulated game.

Scratch and CS Concepts Used

When we design this program, we will make use of the following Scratch and CS concepts. Learn these concepts if you don't know them before proceeding further.

Main concepts:

- Algorithms
- Conditions: YES/NO questions
- Conditionals (If-Else)
- Conditionals (IF)
- Data types – numbers
- Data types – strings
- Data types – String operations (join, letter, length of)
- Data types – string traversal
- Events
- Looping – simple (repeat, forever)
- Looping – nested
- Looping – conditional
- Procedures – custom
- Random numbers
- Relational operators (<, >, =)
- Sequence
- Synchronization using broadcasting
- User input – text
- Variables
- Variables - local/global scope

High Level Design

In the animation mode, the program involves a conversation between two sprites which can be implemented using broadcasting. Leila would send a broadcast every time she expects Sheila to respond in some way. Sheila would receive each such broadcast and perform the expected action.

Since Leila is not supposed to know the numbers Sheila is working on, Sheila must use variables with "local scope", i.e. her variables must be private (created "for this sprite only").

Let's consider each exchange of the conversation as a feature idea and go through the entire conversation.

In the interactive mode, the user plays the role of Sheila and does all the calculations.

Feature Idea # 1: Pick a large number

Leila asks Sheila to pick a large number.

Design:

Sheila uses the "pick random" operator and saves the result in a private variable "n1".

Feature Idea # 2: Add zero

Leila asks Sheila to attach a 0 at the end.

Design:

Sheila uses the "join" operator, or multiplies n1 by 10 and saves the result in a private variable "n2".

Feature Idea # 3: Subtract

Leila asks Sheila to subtract the original number from this larger number.

Design:

Sheila subtracts n2 from n1 and saves the result in a private variable "n3".

Feature Idea # 4: Remove any digit

Leila tells Sheila to remove any digit except 0 from the number she is left with.

Step 1: *Pick a non-zero digit from n3 at random.*

Design:

We can use "repeat until" and call "pick random" until a non-zero digit is picked from n3.

Step 2: *Remove the non-zero digit from n3 and save the result in a private variable "n4".*

Design:

Using an example would help here. Let's say $n_3 = 60174615$ and the selected digit is 1. In this case there are two "1"s and we will pick the first. We need to remove 1 and save 6074615 into n_4 .

This can be achieved by the following algorithm:

String 1 = string to the left of "1" excluding "1" of course. (In this example: 60)

String 2 = string to the right of "1" excluding "1". (In this example: 74615).

Join string 1 and 2 and save the result in n_4 . (In this example $n_4 = 6074615$).

Use "string traversal" to achieve all steps above.

Feature Idea # 5: Show

Leila now states that if Sheila will show her just her remaining number, she will tell Sheila what digit she removed.

Design:

So far, all numbers of Sheila are being stored in private variables. This time, Sheila will copy n_4 to a global variable "N".

Feature Idea # 6: Guess

Leila should now be able to guess the missing digit by looking at the number N.

Design:

Here is how you find the missing digit. First, add the digits in the remaining number.

Keep adding until you are left with a single digit.

Let's say the remaining number is 628962503.

- Adding all digits in 628962503 gives 41.
- Add all digits in 41 gives 5.

Subtract this digit from 9. That will give you the missing number.

To add up all digits, we can use the standard "string traversal" algorithm. But, we need to repeat this process until we get a single digit. "Repeat until" can come to rescue here.

Feature Idea # 7: Interactive mode

In the interactive mode, the user plays the role of Sheila.

Step 1: Provide the option to run the program in "interactive" and "animation" modes.

Design:

This is a simple matter of providing two click-buttons which are shown at the beginning of the program. If "interactive" is clicked, Leila talks with the user, if "animation" is clicked, she talks with Sheila as before.

Step 2: Convert the script that computes the missing digit into a custom block since the same code is run for both modes.

Design:

This is a simple matter of creating a custom block called FindDigit.

Save as Program Version "Final"

Congratulations! You have completed all the main features of the game. Compare your program with my program at the link below.

<https://scratch.mit.edu/projects/356352199/>

How to play the game:

1. Click on the "Green flag".
2. Pick between interactive and animation modes. In "interactive" mode you play the role of Sheila. In "animation" mode you just watch the simulated game.

Author: Abhay B. Joshi (abjoshi@yahoo.com)

Last updated: 28 December 2019