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MATH-ICT EUROPE

Erasmus+ KA219 Project

PROGRAMMING OF MATHEMATICAL PROBLEMS
USING THE SCRATCH PROGRAM

MODULE 2




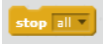
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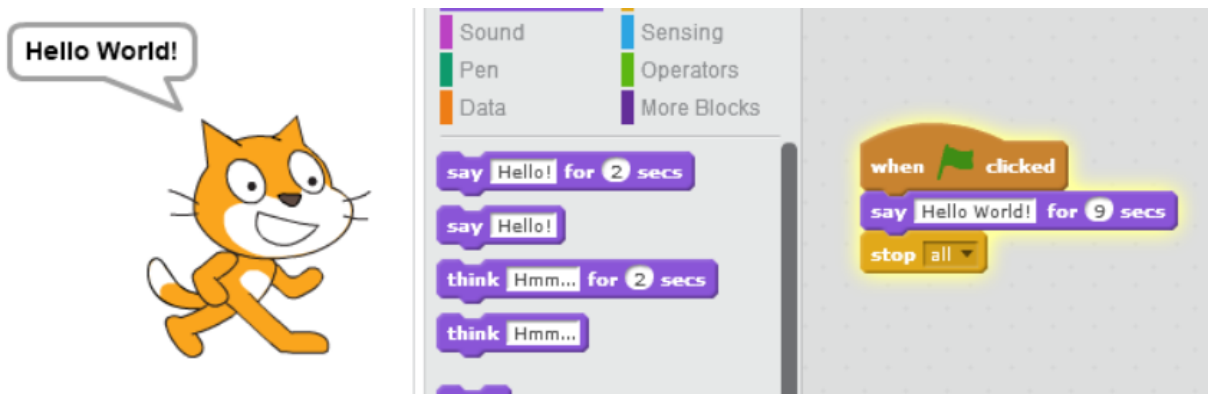
PROGRAMMING WITH SCRATCH

When programming with Scratch we will use two code blocks. We will use this  code block for Start from “Events” menu and this  code block for Stop for “Control Menu”

Display on Screen


We use two code blocks for display on screen. These codes are  or  inside of “Looks” menu. We determine the length of time that with this  code block should stay on the screen.

In the example below, We print for 9 seconds "Hello World!".

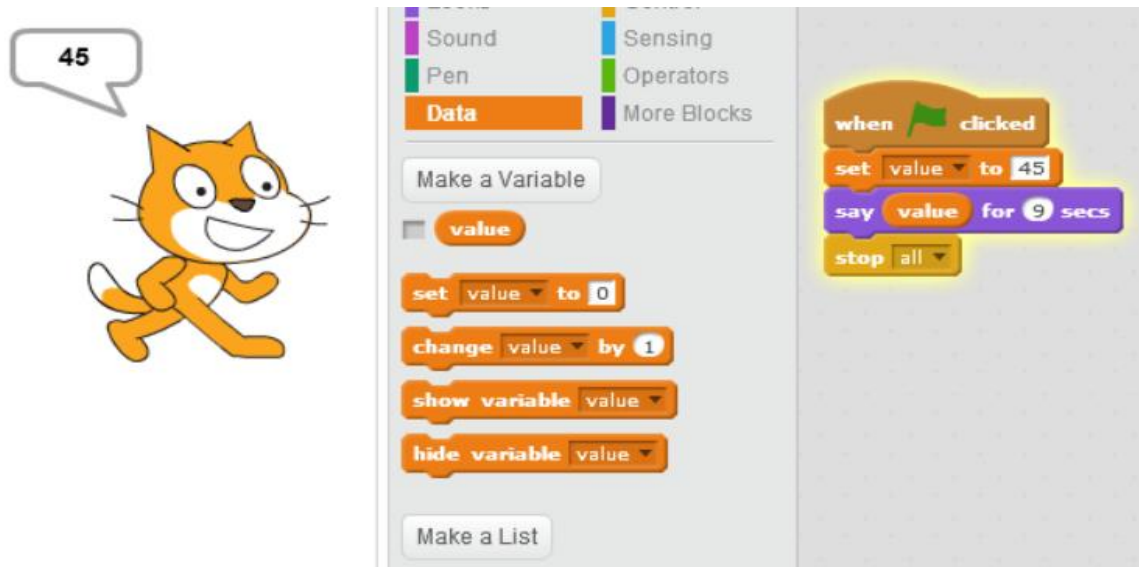


Variables

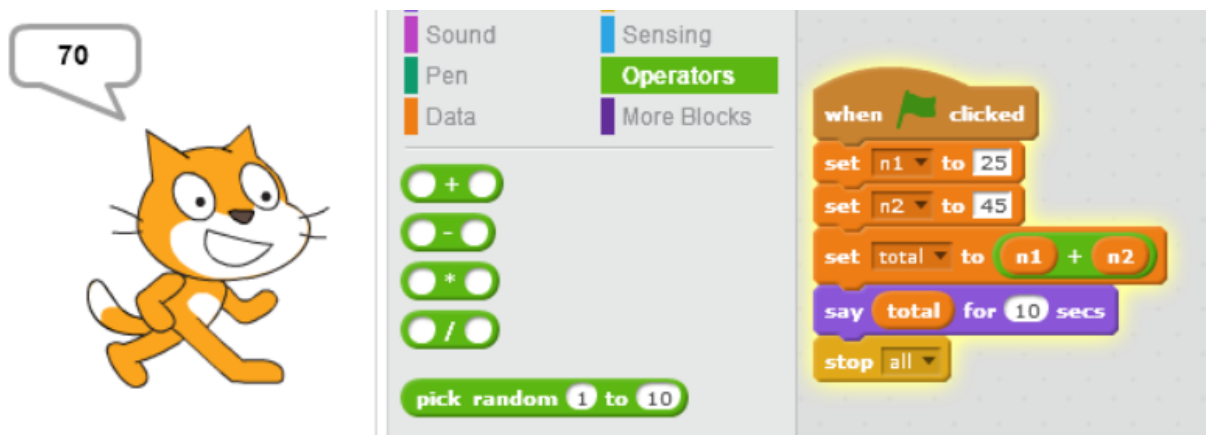
We will use a single variable type when programming with Scratch. Variable types like the other programming languages are not available on Scratch. To create a variable, go to the Make Variable menu from the Data menu and create a variable by specifying the name of our variable. We use this

 code block to assign a variable value.

Example: Make a variable named "Value". Create the program that assigns the number 45 to the variable and displays it on the screen.



Example: Create a program that gives the sum of 25 to 45 and displays the sum on the screen.



In this program, we created the sum of n1 and n2 variables using the "Operators" menu code block.

Example: Find the average of 98 and 27.



Example: Find the average of numbers 18, 36, 45.

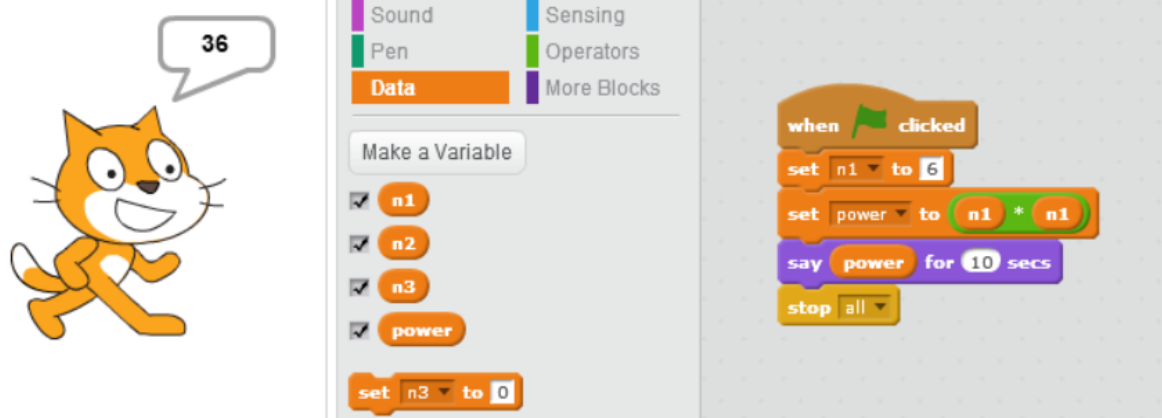


The Scratch script shows the following steps:

- when green flag clicked
- set n1 to 18
- set n2 to 36
- set n3 to 45
- set power to $(n1 + n2 + n3) / 3$
- say power for 10 secs
- stop all

The variable 'power' is shown with a value of 33 in a speech bubble next to the Scratch cat.

Example: Create a program that calculates square and cube of six.



The Scratch script shows the following steps:

- when green flag clicked
- set n1 to 6
- set power to $n1 * n1$
- say power for 10 secs
- stop all

The variable 'power' is shown with a value of 36 in a speech bubble next to the Scratch cat.



The Scratch script shows the following steps:

- when green flag clicked
- set n1 to 6
- set power to $n1 * n1 * n1$
- say power for 10 secs
- stop all

The variable 'power' is shown with a value of 216 in a speech bubble next to the Scratch cat.

Value assignment to variable from output

We can use `ask Enter a value and wait` and `answer` code blocks with variable from Sensing menu for value assignment to variable from outside. In the following example, the n1 variable is assigned a value of 45.

The Scratch interface shows a cat character with a speech bubble saying "Enter a value :". A variable monitor for `n1` shows the value 45. Below the cat is a text input field containing "45". The script area contains the following code:

```

when green flag clicked
  ask Enter a value: and wait
  set n1 to answer
  stop all
  
```

The Data area shows the variable `n1` is checked and set to 45. Other variables `n2`, `n3`, and `power` are not checked.

Example: Write a program that gives the sum of two numbers entered from the outside.

The Scratch interface shows a cat character with a speech bubble saying "Enter 1st value :". Variable monitors for `n1` (49), `n2` (61), and `total` (110) are visible. Below the cat is a text input field containing "49". The script area contains the following code:

```

when green flag clicked
  ask Enter 1st value: and wait
  set n1 to answer
  ask Enter 2nd value: and wait
  set n2 to answer
  set total to n1 + n2
  say total for 8 secs
  stop all
  
```

The Data area shows variables `n1`, `n2`, and `total` are checked. `total` is set to 110.

Example: Find avarege of three numbers entered from the outside.

The Scratch interface shows a cat character with variable monitors for `n1` (52), `n2` (43), `n3` (25), and `avarege` (40). The script area contains the following code:

```

when green flag clicked
  ask Enter 1st value: and wait
  set n1 to answer
  ask Enter 2nd value: and wait
  set n2 to answer
  ask Enter 3rd value: and wait
  set n3 to answer
  set avarege to (n1 + n2 + n3) / 3
  say avarege for 8 secs
  stop all
  
```

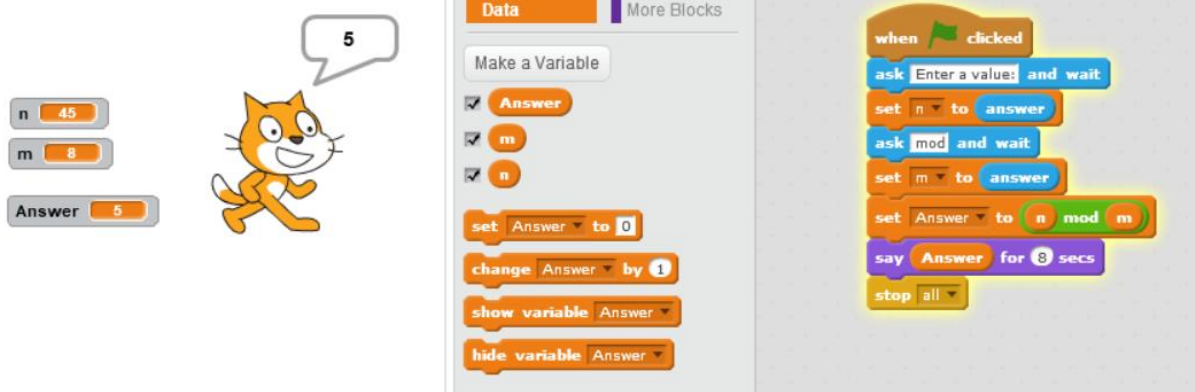
The Data area shows variables `avarege`, `n1`, `n2`, and `n3` are checked. `avarege` is set to 40.

Example: Create a program that computes the area and perimeter of the square from which the edge value are assigned from outside.

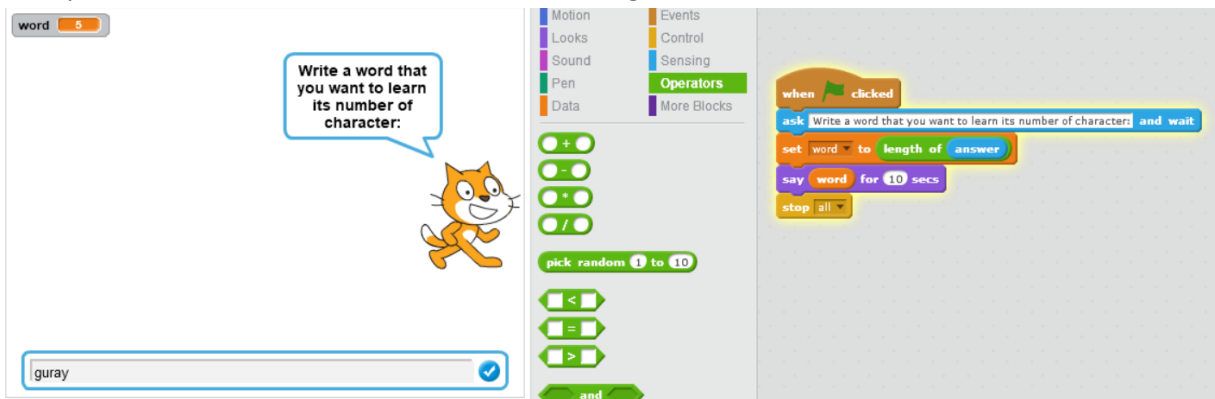
Example: Create a program that computes the perimeter and area of the rectangle from which the edge values are assigned from outside.

Example: Create a program that computes the perimeter and area of the circle from which the radius values are assigned from outside.

Example: Create a program that computes the desired mode of an assigned value from outside.

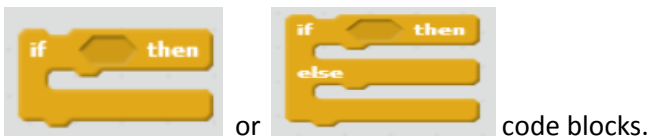


Example: The code block that finds the character length of the word

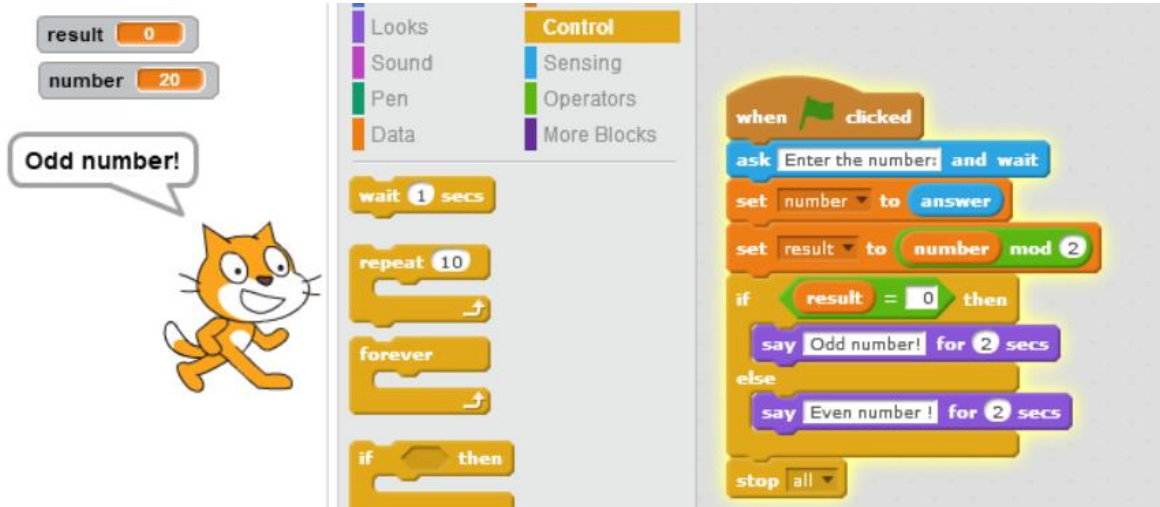


Conditional Expressions

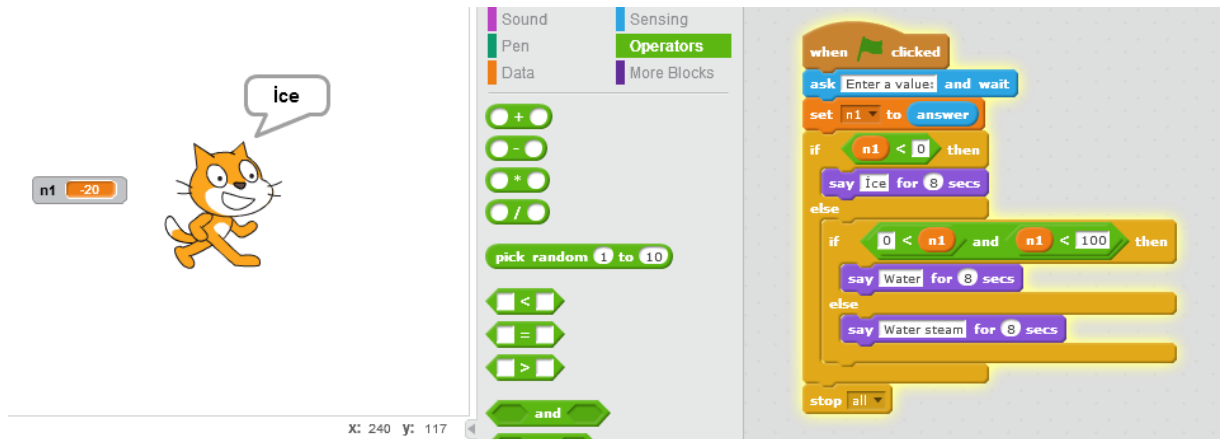
You can find Conditional Expressions at Control menu. And you can use



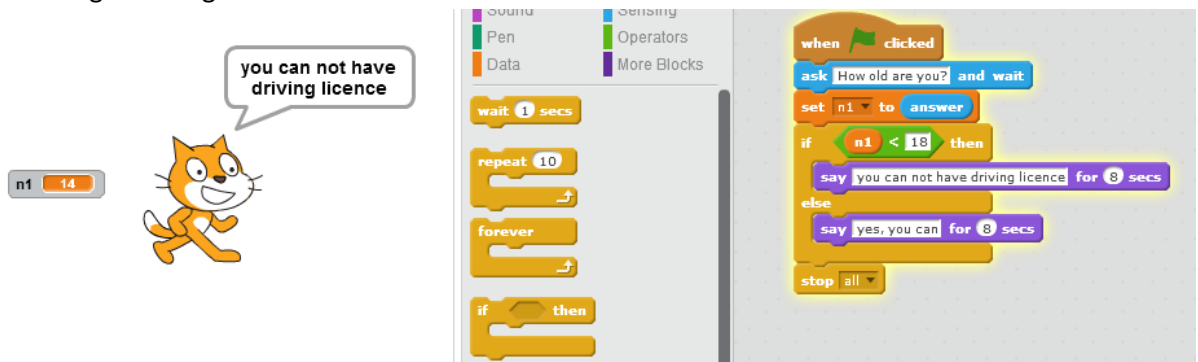
Example: Create a program that displays on the screen that odd or even numbers according to the value entered from the outside.



Example: Create a program that displays the physical state of the water on the screen according to the temperature value entered from the outside.



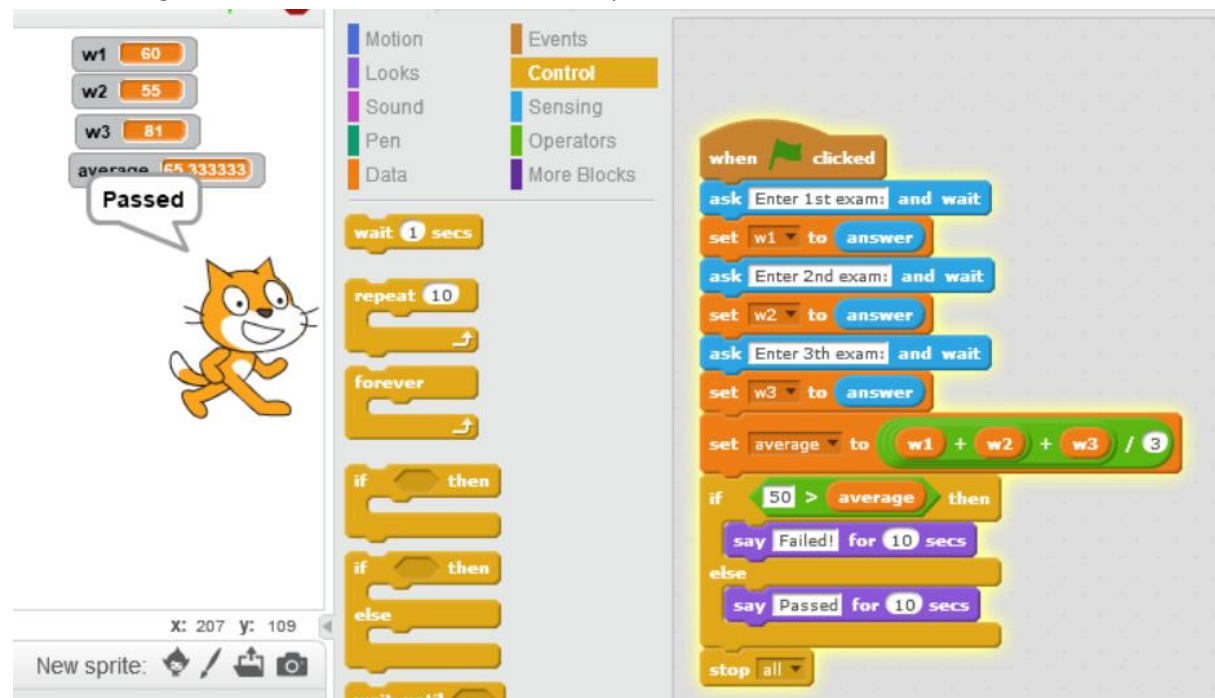
Example: Create a program that displays on the screen that it can or can not have a driving license according to the age entered from outside.



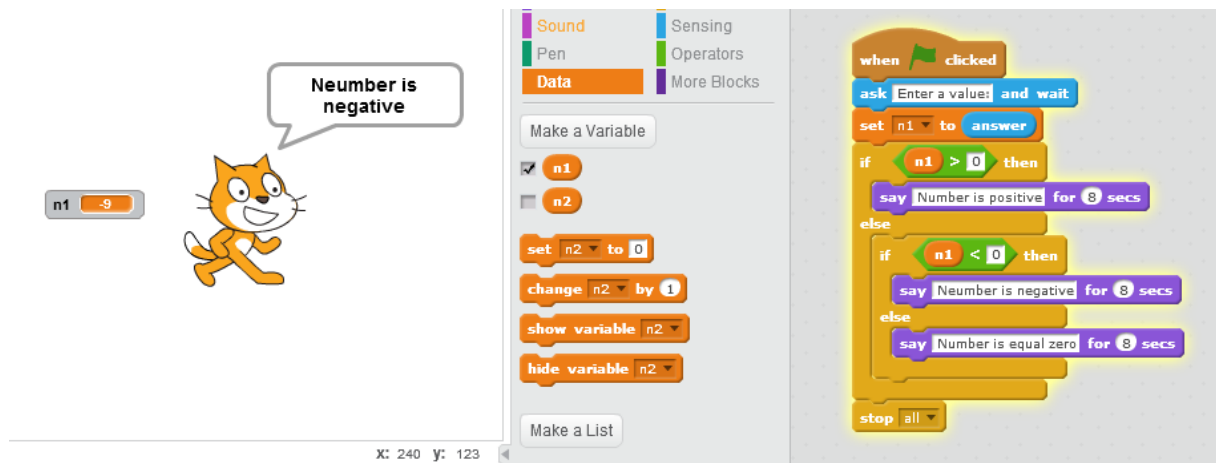
Example: Create a program that displays the two numbers entered from outside that are bigger, smaller, or equal.



Example: Write a program that finds the average of three exams grades and displays on the screen "if the average is less than 50" "failed", if it is not "passed"



Example: Create a program that displays an assigned number from outside as positive, negative, or zero on the screen.



Loops:

You can use  or  code blocks on Control menu.

Example: Increase the numbers one by one starting from 1 and display on the screen up to 50.



Example: Create a program that finds the sum of numbers 1 through 10.

The Scratch interface shows a cat character with a speech bubble containing the number 55. On the left, there are two variable monitors: 'i' with a value of 11 and 's' with a value of 55. The code area contains the following blocks:

- when green flag clicked
- set i to 0
- repeat until i > 10
 - set s to s + i
 - change i by 1
- say s for 8 secs
- stop all

Example: Create a program that finds the sum of even natural numbers for a value to be entered from the outside

The Scratch interface shows a cat character with a speech bubble containing the number 110. On the left, there are four variable monitors: 'n' (20), 's' (110), 'i' (22), and another 'n' (20). The code area contains the following blocks:

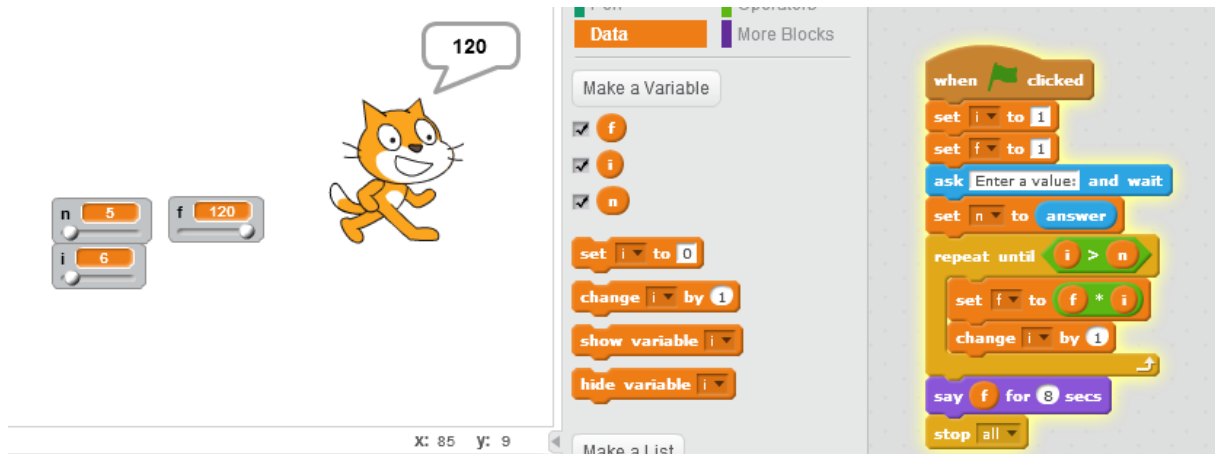
- when green flag clicked
- ask Enter a even number and wait
- set n to answer
- repeat until i > n
 - set s to s + i
 - change i by 2
- say s for 8 secs
- stop all

Example: Create a program that finds the sum of odd natural numbers for a value to be entered from the outside

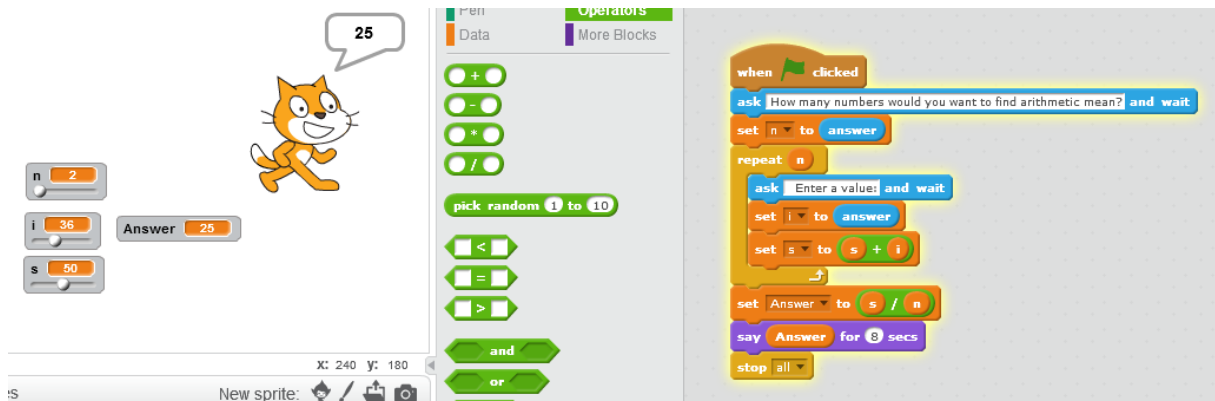
The Scratch interface shows a cat character with a speech bubble containing the number 81. On the left, there are four variable monitors: 'n' (17), 's' (81), 'i' (19), and another 'n' (17). The code area contains the following blocks:

- when green flag clicked
- ask Enter a odd number and wait
- set n to answer
- set i to 1
- repeat until i > n
 - set s to s + i
 - change i by 2
- say s for 8 secs
- stop all

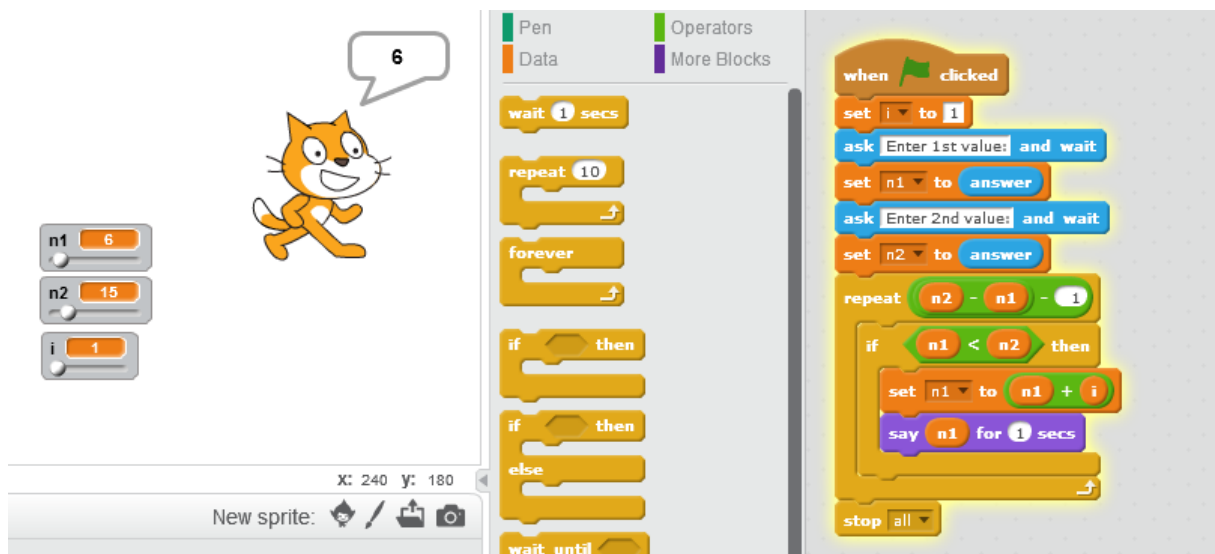
Example: Create a program that finds the factorials of number's for a value to be entered from the outside



Example: Create a program that computes the average of the N piece numbers that are assigned from the outside.



Example: Create a program that displays the numbers on the screen between two numbers that are assigned from the outside.



EXAMPLES

Q1: We want to pour half of the water in a cylinder. How many degrees of angle should the cylinder make with the floor? You determine the radius and height of the cylinder.

($V_s = 2\pi rh$, r =radius, h =height *for calculate the angle use the arctan function)

The image shows a Scratch project for Q1. On the left, the variable monitor displays: $r = 4$, $h = 100$, $\pi = 3.14$, and $\text{angle} = 4.573921$. The code blocks are as follows:

- when green flag clicked
- ask determine radius and wait
- set r to answer
- ask determine height and wait
- set h to answer
- set angle to atan of $2 * r / h$
- say for pour half of water for 2 secs
- say angle for 2 secs
- say it must be tilted for 2 secs
- stop all

The stage shows the Scratch cat sprite at coordinates X: -240, Y: 19.

Q2: If you open a 1 euro account in a generous bank that given the customers 100% interest rate on January 1, how much money do you have in 31 December?

PS1: Calculate based on compound interest.

PS2: Compound interest formula: $A(1 + \frac{r}{n})^n$ A: Capital, r : Interest rate, n : Calculation period

The image shows a Scratch project for Q2. On the left, the variable monitor displays: $n = 1$, $\text{result} = 1.153978$, $i = 0$, and $\text{Sprite: y} = 71607761$. The code blocks are as follows:

- when green flag clicked
- delete all of x
- set n to 1
- set result to 1
- set i to 0
- set y to 1
- ask Calculation period and wait
- repeat until y > answer
- set result to $\text{result} * (1 + i / \text{answer})$
- change y by 1
- repeat until i > 18
- add letter i of result to x
- change i by 1
- stop all

The stage shows the Scratch cat sprite at coordinates X: 193, Y: 127.

Q3: Create the program that calculates π according to the sum rule given below.

PS: If you give the maximum value of n , the result will be closer to π

$$\pi = 4 \sum_{k=0}^n \frac{(-1)^k}{2k+1}$$

The image shows a Scratch code editor with a sprite named 'pi' and a list of 20 items. The code is as follows:

```

when green flag clicked
  set k to 0
  set sum to 0
  set a to -1
  set b to 0
  set j to 1
  delete all of pi
  ask How many terms do you want? and wait
  repeat until k > answer
    set a to a * -1
    set b to 2 * k + 1
    set sum to sum + 4 * a / b
    change k by 1
  repeat until j > 18
    add letter j of sum to pi
    change j by 1
  stop all
  
```

The sprite 'pi' has a list of 20 items: 3, ., 1, 4, 1, 5, 9, 2, 6, 5, 3, 5, 8, 9, 7, 9, 4, 7, 8, 4.

Q4: By using Maclaurin series create a program that calculates e^x the according to desired value of x .

$$e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \dots + \frac{x^n}{n!}$$

The image shows a Scratch code editor with the following components:

- Stage:** A list of 12 items representing the digits of e: 2, ., 7, 1, 8, 2, 8, 1, 8, 2, 8, 4. The length is 25.
- Code Area:**
 - When Green Flag Clicked:**
 - delete all of e
 - ask determine value of x and wait
 - set x to answer
 - set donominator to 1
 - set sum to 1
 - set donominator to 1
 - set n to 1
 - set j to 1
 - ask How many terms do you want? and wait
 - repeat until n > answer:
 - set donominator to donominator * x
 - set donominator to donominator * n
 - change n by 1
 - set sum to sum + donominator / donominator
 - repeat until j > 25:
 - add letter j of sum to e
 - change j by 1
 - stop all

Q5: Create a program that calculates the desired value according to the Maclaurin series of cosine function.

$$\cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \dots + \frac{x^n}{n!}$$

The image shows a Scratch code editor with the following components:

- Stage:** A new sprite.
- Code Area:**
 - When I Start as a Done:**
 - ask Determine the radyan value and wait
 - set x to answer
 - set sign to 1
 - set nominator to 1
 - set donominator to 1
 - set sum to 1
 - ask How many terms do you want? and wait
 - set n to 1
 - repeat until n > answer:
 - if n mod 2 = 0 then:
 - set donominator to donominator * n
 - set sign to -1 * sign
 - set nominator to nominator * x
 - set sum to sum + sign * nominator / donominator
 - else:
 - set donominator to donominator * n
 - set nominator to nominator * x
 - change n by 1
 - stop all

Q6: Create a program that calculates the desired value according to the Maclaurin series of sine function.

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \dots + \frac{x^{2n-1}}{(2n-1)!}$$

The image shows a Scratch code editor with the following components:

- Sprite Area:** A cat sprite is visible on the left.
- Variable Monitor:** A monitor for the variable 'sin(x)' is shown with a list of values from 1 to 15. The values are: 1: -, 2: 0, 3: ., 4: 7, 5: 5, 6: 6, 7: 8, 8: 0, 9: 2, 10: 4, 11: 9, 12: 5, 13: 3, 14: 0, 15: 7. The length of the list is 18.
- Data & Blocks Panel:**
 - Make a Variable:** Variables 'donominator', 'j', 'n', 'sign', 'sum', and 'x' are checked.
 - Make a List:** Variable 'sin(x)' is checked.
- Script Area:**
 - when clicked: delete all of sin(x), set sum to 0, set nominator to 1, set donominator to 1, set n to 1, set sign to -1, set j to 1.
 - ask determine radyan value and wait.
 - set x to answer.
 - ask how many terms do you want and wait.
 - repeat until n > answer:
 - set donominator to donominator * n
 - if n mod 2 = 1 then:
 - set sign to sign * -1
 - set nominator to nominator * x
 - set sum to sum + sign * nominator / donominator
 - else:
 - set nominator to nominator * x
 - change n by 1
 - repeat until j > 18:
 - add letter j of sum to sin(x)
 - change j by 1
 - stop all