# Lesson 12 – Loops

* What are Loops?
* Do While
* Do Until
* For – Next
* Algorithms with loops

What students should know

**4h**

Repetitive structures are one of the most basic functions of a programming language. A loop in a computer program is a directive that repeats until a specified condition is reached. In a repeat structure, the loop the specified condition is tested on each iteration of the loop. If the answer to the “loop until” requires action, the code in the body of the loop executes. The test condition is evaluated over and over again until no further action is required, this should be when the “stop looping” test condition is met. Every time the question is asked it is called repetition or iteration..

A computer programmer who has to use the same lines of code multiple times in a program can use a loop to save time, space, ease of programming.

**Remember**

Repeats have to end at some point or it's a programming error. A repetition that never ends is called an endless loop. In this case the computer is trapped in a perpetual repetition of the same functions without "awareness" of vanity!



In B4X there are four repeat **commands**: For, Do While, Do Until, for Each.

## The Do While command

Suppose you would like to display on the screen with the command Log() numbers from 1 to 5 below each other. The code you should write would produce this output in the log panel:

Log(1)

Log(2)

Log(3)

Log(4)

Log(5)

You realize that if you had to keep printing numbers then you would have to continue writing Log() commands for as many numbers as you need.

The command Do While is stated as follows:

Picture Command Do While

**Do While** *Condition*

Commands

...

**Loop**

**As long as** the condition is true

Execute the Commands

...

**Go back to condition.**

In the example with the five numbers and using Do While the code is written:

**Private** i as Int = 1

**Do While** *i <=*  *5*

**Log**(i)

i = i + 1

**Loop**

Variable **i** counts how many times the loop will run.

The Condition also examines whether the contents of the counter exceeded the limit set by the developer, i.e. 5, and if this happens, the repetition stops.

Before the loop iteration end, the repeat counter is increased by +1. This value is also called Step.

The step can be positive or negative, but it can never be 0 because then the repetition would run forever.

**Remember**

When the counter starts at a value less than the final value then the **step must** be **positive.**

When the counter starts from a value greater than the final value then the **step must** be **negative.**



Examples of the command Do While.

**Example 1**

Show all integers from 100 to 1



**Private** i as **Int** = 100

**Do** While *i >= 1*

**Log**(i)

i = i - 1

**Loop**

In the example the repeat counter starts at a large value (100) and ends at a small (0) before the repetition is complete. Attention in this case to the **Step** is **Negative** (-1).

**Example 2**

Show all even numbers from 1 to 100



**Private** i as **Int** = 1

**Do While** *i*  *<= 100*

**If** I mod 2 = 0 **then**

**Log**(i)

**End if**

i = i + 1

**Loop**

**Private** i as **Int** = 2

**Do While** *I <= 100*

**Log**(i)

i = i + 2

**Loop**

Here are two solutions presented the first uses a command if in loop to check whether the number is even and only then executes the command Log. In the second algorithm has changed the **starting and step values** of the i in 2 and the **Step** increases by 2 which creates a faster algorithm to run.

**Example 3 – Sum Algorithm**

Make a program that for ten numbers entered, the program calculates their sum. These numbers are considered to range between -100 and 100



The function will be used for the purposes of the example. It is used as follows:

**Remember**

The **Rnd command (First Value, Last Value)** returns a number between the First (inclusive) and Last (exclusive) value.

e.g. A = Rnd(1, 10) returns a number between 1 and 9 in variable A



**Private** I  **As**  **Int** = 1

**Private** A **as Int**

**Private** intSum  **as Int** = 0

**Do While** *i*  *<= 10*

A = **Rnd**(-100, 101)

intSum = intSum + A

i = i + 1

**Loop**

**Private** I  **As**  **Int** = 1

**Private** A **as Int**

**Private** intCounter  **as Int** = 0

**Do While** *i*  *<= 10*

A = **Rnd**(-1000, 1001)

**If** A < 0 **then**

intCounter = intCounter + 1

**End If**

i = i + 1

**Loop**

**Example 4** **– Algorithm Count.**

Make a program that for ten numbers entered, the program end calculates the number of negatives. These numbers are considered to range between -1000 and 1000



**Private** I  **As**  **Int** = 1

**Private** A **as Int**

**Private** intMax, intMin  **as Int**

A = **Rnd**(-1000, 1001)

intMax = A

intMin = A

**Do While** *i*  *<=*  *9*

A = **Rnd**(-100, 100)

**If** intMax < A **then**

intMax = A

**End If**

**If** intMin > A **then**

intMin = A

**End If**

i = i + 1

**Loop**

1. First read a number outside the while.
2. Set as the starting value in the intMax and intMin variable the first number since there is no one else to compare.
3. For each new number it is checked   
   if it is less than intMin then intMin replaced by A   
   if the new A is greater than intMax the intMax is replaced with the new A.

**Example 5 - Maximum Algorithm - Minimum**

Make a program that for ten numbers entered the program counts the largest and smallest numbers. These numbers are considered to range between -1000 and 1000



## Loops with unknown repeats.

Often in programming we do not know from the beginning the number of repetitions. This usually happens when the repeat depends on the value taken from user or on values calculated during the repeat.

**Example 6 – Non-specific number of repetitions**

Create a program that constantly reads numbers and calculates the Averages of the even values. The program stops when a number less than 0 is entered.



1. The condition checks whether the total has not reached the limit of 200.
2. A number is read and then program calculates the sum. Condition checked again by Do While.

**Private** A **as Int**

**Private** intSum  **as Int**  **= 0**

**Do While** i*ntSum <= 200*

*A = Rnd(-100, 100)*

intSum = intSum + A

**Loop**

**Example 7 – Non-specific number of repetitions**

Create a program that reads numbers and calculates their sum. The program stops when the sum exceeds 200.



1. First read a number outside the replay.
2. The DoWhile condition checks whether the number A is within the limits.
3. A new number is read before the end of the iteration.

**Private** A **as Int**

**Private** intCount  **as Int**  **= 0**

A = **Rnd**(-100, 100)

**Do While** *A*  *>*  *0*

**If** A mod 2 = 0 **then**

intCount = intCount + 1

**End If**

A = Rnd(-100, 100)

**Loop**

## The Do Until command.

The operation of the Do Until is like the Do While. The only difference is the condition which controls when a repetition will end as opposed to the Do While which controls how long it will work. In both cases the check shall be carried out at the beginning, in which case the code shall not be executed if the Condition is False.

**Remember**

The condition of Do Until is the denial of Do While.



**Private** i as **Int** = 100

**Do Until**  *i*  *<*  *1*

**Log**(i)

i = i - 1

**Loop**

**Example 1**

Show all numbers from 100 to 1



**Private** i as **Int** = 1

**Do Until**  *I*  *> 100*

**If** I mod 2 = 0 **then**

**Log**(i)

**End if**

i = i + 1

**Loop**

**Private** i as **Int** = 2

**Do Until** i  *>*  *100*

**Log**(i)

i = i + 2

**Loop**

**Example 2**

Show all even numbers from 1 to 100



**Private** I  **As**  **Int** = 1

**Private** A **as Int**

**Private** intSum  **as Int** = 0

**Do Until**  *I*  *>*  *10*

A = **Rnd**(-100, 100)

intSum = intSum + A

i = i + 1

**Loop**

**Example 3 – Sum Algorithm**

Make a program that for ten numbers entered, the program calculates their sum. These numbers are considered to range between -100 and 100.



**Example 4** **– Algorithm Count**

Make a program that for ten numbers entered, the program calculates the number of negatives. These numbers are considered to range between -1000 and 1000.



**Private** i  **as**  **Int** = 1

**Private** A **as Int**

**Private** intCounter  **as Int** = 0

**Do Until**  *i*  *>*  *10*

A = **Rnd**(-1000, 1001)

**If** A < 0 **then**

intCounter = intCounter + 1

**End If**

i = i + 1

**Loop**

**Private** I  **As**  **Int** = 1

**Private** A **as Int**

**Private** intMax, intMin  **as Int**

A = **Rnd**(-1000, 1001)

intMax = A

intMin = A

**Do Until**  *I*  *>*  *9*

A = **Rnd**(-1000, 1001)

**If** intMax < A **then**

intMax = A

**End If**

**If** intMin > A **then**

intMin = A

**End If**

i = i + 1

**Loop**

**Example 5** **- Maximum Algorithm - Minimum**

Make a program that for ten numbers entered, the program counts the largest and smallest numbers. These numbers are considered to range between -1000 and 1000.



**Private** A **as Int**

**Private** intCount  **as Int**  **= 0**

A = **Rnd**(-100, 100)

**Do Until**  *A*  *<*  *0*

**If** A mod 2 = 0 **then**

intCount = intCount + 1

**End If**

A = Rnd(-100, 100)

**Loop**

**Example 6 – Non-specific number of repetitions**

Create a program that constantly reads numbers and calculates the Averages of the even. The program stops when a number less than 0 is entered.



**Example 7 – Non-specific number of repetitions**

Create a program that reads numbers and calculates their sum. The program stops when the sum exceeds 200.



**Private** A **as Int**

**Private** intSum  **as Int**  **= 0**

**Do Until**  *intSum*  *>*  *200*

*A = Rnd(-100, 100)*

intSum = intSum + A

**Loop**

## For Loop

The for loop is probably the simplest repeat command.

**for** i = n1  **to**  n2  **Step**  n3

Commands

...

**Next**

Where:

i the Counter variable

n1 the initial value of the Counter

n2 the final value

n3 step of repetition

* At the beginning of repetition, variable ‘i’ accepts n1.
* Executes commands within the repetition.
* At the end of the repetition the value of ‘i’ increases or decreases by n3
* Check if ‘i’ has exceeded the final value n2.
  + if the step is positive and ‘i’ is less than or equal to the final value then the repeat runs again
  + If the step is negative and ‘i’ is greater than or equal to the final value, then the repeat runs again.

**Remember**

In relation to **Do While** and **Do Until** the **For** command:

* Does not need to initialize the counter.
* Does not need to set the step change operation.
* It is always for measurable repeats (however, you can use the exit command to get out of it at any time).



### Examples of For loops

**Private** I **As** **Int**

**For** i = 100 **to** 1 **step** -1

**Log**(i)

**Next**

**Example 1**

Show all numbers from 100 to 1



**Example 2**

Show all even numbers from 1 to 100



**Private** I  **As**  **Int**

**For** i = 1  **to**  100

**If i**  **mod 2 = 0 then**

**Log**(i)

**End If**

**Next**

## Exercises

1. Write a program that reads an integer K between 1 and 200 and calculates the sum of 1+2+3+...+K.
2. Write a program in which the user enters numbers and calculate the average of the above numbers. The program ends by entering zero.
3. A consumer wants to buy games for gifts to 10 children and also wants their total price not to exceed 200€. Make a program to:
   1. Enter the cost of the game (random number between 10-50, command Rnd(10, 51) )
   2. Calculate the total cost of games purchased so far,
   3. Check if the money has run out.
   4. Finally show the total cost of the games and their number.
4. A leap year (also known as an intercalary year or bissextile year) is a calendar year that contains an additional day (or, in the case of a lunisolar calendar, a month) added to keep the calendar year synchronized with the astronomical year or seasonal year. A year is a leap year when:

if (year is not divisible by 4) then (it is a common year)

else if (year is not divisible by 100) then (it is a leap year)

else if (year is not divisible by 400) then (it is a common year)

else (it is a leap year)

Make a program that shows the leap years between 1900 and 2100

(<https://en.wikipedia.org/wiki/Leap_year>)

1. Build a program with the help of the turtle that creates polygons with a number of angles that the user enters in an appropriate field. The program will include a design start button and a screen clearing button that when pressed clears the screen and places the turtle in center of screen.
2. Draw the following shapes with the turtle:





