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Programming in



For beginners!

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Chapter 1. History and introduction to NIL

I suppose there is not much of a “history” when it comes to NIL, as the language was very young on the moment this document was written.

For years I've been programming in many languages now, and when it comes to scripting level languages, Lua has always been the language I used most. Its simplicity and easiness to learn and set things up, and the many engines supporting Lua was the main reason for this.

Lua did always had a few downsides for me. When writing short addons (for which Lua was originally intended), Lua's complete open approach on matters is its greatest asset. However as writing long projects in Lua with over thousands lines of codes for one single script isn't that exceptional anymore in Lua, the downsides of this open approach come to light. A Lua program can become a mess quite easily. Now the nightmare is not as bad as C where either a total crash or “Segmentation Fault” is all you get, and maybe tons of memory being “leaked” are very serious issues. However in C you are not likely to spend weeks on debugging because you misspelled one variable name, due to the obligation to declare your variables.

Now inspired by languages such as TypeScript which was meant to enhance JavaScript, I was certain something like that had to be possible with Lua as well. Some quick concepts came to mind soon, and eventually I decided to put it into code, and the NIL project was born. NIL still has the simplicity of Lua in many ways, and yet gives you some more obligations, which allows you to avoid the issues I mentioned above. Also Lua lacks “official” support for some things I deem vital in a programming language, however they were acceptable as Lua allows you to “cheat” those in, but the ways to do it were not exactly “clean” in my opinion. NIL also offers some more clean ways to do this. NIL does not execute any code by itself, it will translate itself into Lua, Lua will after that compile and execute the code.

Now I wrote this guide with beginners in mind. So the level I take in mind is that you didn't code before. If you did code in other languages, good for you, then this guide can still be helpful, but as I wanted to cover all levels of coders as much as possible I had to take the “worst” (don't take it personally) kind as the standard. One minimal thing I must ask for is that you are able to use command line interfaces. If you are on Windows, then basic knowledge of either the standard command prompt (cmd) or PowerShell will do. When you are on Linux, BSD or Mac, you will need to know how the terminal works, and how to use shell/bash commands, or at least the very basics of those. Having minimal knowledge of these kinds of interfaces are pretty important in general if you wanna code.

Pretty important note for Windows users, NIL works best if you have a text format that uses only LF and not CRLF of line endings. Most DECENT text editors (Notepad is NOT a DECENT tool for this) have support for this, but may not use this by default. The current version of NIL has no support for source files containing non-ASCII characters.

Chapter 2. QuickNIL and “Hello World”

Before you get on the roll, make sure you have an editor ready to type your code in. I used Geany myself, but Notepad++ or Atom or well, basically anything that is not the standard Notepad will do (Note to MacUsers. TextEdit won't do either as that is NOT a plain text editor and will go for RTF documents by default and is therefore unusable for this purpose).

Before we start, I want you to know that Dennis Ritchie the man who invented the C programming language did say: “The only way to learn a new programming language is by writing programs in it”. I live by those words, and I already did before I knew Ritchie said them.

That is why I want you to download [QuickNIL](#)! QuickNIL is a quick program set up to prototype in NIL, so you can test out what NIL can do. The functionality of QuickNIL is not that much, but it's enough to demonstrate what NIL can do. If you are not well-versed with C# or VisualStudio, then don't bother to download the source code of QuickNIL and to compile it yourself, as that may only give you headaches. Go to the “Releases” tab in stead, and there you can download a zip file containing a fully functional version of QuickNIL.

Mac and Linux users can run this application, despite it being an .exe file, but they will require to install either Mono or Wine first, although for QuickNIL, Mono might be the better choice.

Now to test if QuickNIL works. This is done by writing the traditional program... “Hello World”.

- i. Create a folder where you want to put in all your NIL test projects.
- ii. Although normally considered bad practice, we'll go the easy way and extract the contents of the QuickNIL zip into this same folder
- iii. Now open your favorite editor and make a source containing the code “print('Hello World')”
- iv. Save this in your NIL test folder and name it “Hello.nil”
- v. Open the command line interface and use the “cd” command to go to the test folder
- vi. Type “QuickNIL Hello.nil” (Linux and Mac users should type “mono QuickNIL.exe Hello.nil”
- vii. If the text “Hello World” appears as a reply from QuickNIL, then congratulations, then you are ready to get on the road.

So far I may not have been helpful on NIL itself. I have only explained how to get started on the first lessons. Let's now get on the first lesson itself, and maybe the “Hello World” program you just wrote is the best way to go here.

```
print('Hello World')
```

The word “print” is a function. I will go into the deep of functions at a later time, but for now let's just say that a function is a kind of instruction. A task. A command. This may not be entirely true, but

for now this will do. “print” means “print onto the screen” in NIL. And then between the (and the) you must tell NIL *what* to print onto the screen. In this case that was 'Hello World'. This is what we call a string. Now strings can be done in NIL with both single and double quotation marks, as long as you are consequent in using the same quotation in ending the string as the one you start it with. A string is a series of characters, in official definition. In a more simple wording it means just text of any kind.

For NIL it's most prudent to start every instruction on a new line. Especially in the early versions of NIL you can prevent a lot of trouble with that. I will now get into some more instructions. Like this:

```
print('My name is Jeroen P. Broks')  
print('I developed the NIL language')  
print('And I am now teaching you how to use it yourself')
```

I think it's pretty clear what this code does.

Now “print” will be a very important instruction for the course of these lessons, so try to play around with it some more like I did above. Save your code and try out in QuickNIL to see what the code does.

Chapter 3. An introduction to variables

Variables are very important in technically all programming languages. Think of variables as a drawer in which you put something, and which you can get out of your drawer later.

For the course of this chapter a variable can contain either a string or a number (there are more purposes variables, but forget about that for now, as I will come back to that later).

NIL does require you to declare variables before you can use them. You can just do this by telling NIL what the variable has to contain... that is a string or a number, and then you got to name the variable. You can do that like this:

```
number age
string name
```

So we have now declared two variables. The variable age can be used to store a number, and the variable name can be used to store strings. Alternatively you can type “int age” in stead of “number age”, which doesn't make too much difference in NIL, and which has actually be put in to make it easier on C coders who are used to use “int” to store (integer) numbers in.

Now what good is having variables? Well, as long as you only declare them, but don't put any data into them, NIL will put default values in. In the case of a number that will be 0 (zero) and in the case of a string, it will just be an empty string. So let's define them. When defining a variable you put something into these variables. Like this:

```
age = 44
name = 'Jeroen'
```

Cool, now the variable 'age' contains number 44 and the variable name contains the string 'Jeroen'. A way to check this is by simply using “print”. Like this:

```
print(name,age)
```

Run this all in QuickNIL and you'll see this:

```
Jeroen 44
```

It's obvious what just happened. You assigned the variables and print shows what they contain. Now that's nice a name, with somebody's age (mine on the moment I wrote the original version of this chapter), but can't we make this is bit fancier? You can.... You can concatenate the contents of variables. Concatenate means you join strings together into one string. NIL will in this case handle numbers as if they were strings.

```
print('My name is '..name..' and I am '..age..' years old')
```

In NIL you can concatenate by using “..” between the strings and numbers. So this will display the text “My name is Jeroen and I am 44 years old”. Would you now assign different values to name and age, the outcome of this command will change as well. For example, if you put in 50 in age and put 'Hans' in name, then the print command will say “My name is Hans and I am 50 years old”.

Now variables are named “variables” for a reason. The value they contain can change. You can simply do that by assigning new data to them just as you did before.

Let's write the program above anew, to demonstrate

```
number age
string name
age = 44
name = 'Jeroen'
print('I am '..name..' and I am '..age..' years old')
age = 50
name = 'Hans'
print('I am '..name..' and I am '..age..' years old')
```

Please note, you do not have to declare the variables again. You already did so, so NIL knows they are there. Defining them however can be done as many times as you want.

Now lastly for this chapter, I wanna show you this code:

```
number age
string name
age = 44
name = 'Jeroen'
print('I am '..name..' and I am '..age..' years old')
age++
print('I am '..name..' and I am '..age..' years old')
```

Now the output will be this:

```
I am Jeroen and I am 44 years old
I am Jeroen and I am 45 years old
```

You can guess what happened. The “++” instruction increased the age variable by one. Alternatively you can use “--” to decrease it by one. Now more mathematical possibilities are there with numeric variables. Frankly NIL translates “age++” as “age = age + 1”. More about that in the next chapter.

Chapter 4. Mathematics in NIL

This chapter will be boring if you've ever coded before in either Pascal, C, BASIC, Lua, Python, or whatever language you can think of, as NIL is not so much different from any of these when it comes to mathematics. For those new to programming in general it will be wise to take note of this chapter.

Mathematics is very extremely dominant in coding, no matter which language you use. After all, a computer is to this very day, not so much more than an evolved calculator. Even the simplest programs are more mathematics than anything else. Therefore good understanding of expressions and formulas is of vital importance. As a matter of fact. All programming languages are supposed to be what we call turing-complete. The term was named after [Alan Turing](#), and one of the most important demands to be turing-complete is that a language is able (no matter how complex you have to go to make it happen) to solve any mathematical problem. This is not *entirely* correct, but it's what it comes down to in simple words.

Let's show you some examples of how to do math in NIL.

First of all you can send the outcome of a mathematical formula to a function, which can do something with it. As up until now we only discussed “print”, that can then look like this:

```
print(3+5)
```

Since $3+5=8$, this will get you 8 as output. Subtraction works the same way:

```
print(5-3)
```

Well, as you know $5-3=2$, so this will be your output.

Now you can take this even further, as you can also store the outcome of mathematical problems into variables. Like this:

```
number a
a = 12 + 15
print(a)
```

Well, of course since NIL wants all variables declared first, the “number a” command did do that, and then $a = 12 + 15$, will store the outcome of $12+15$ (which happens to be 27) in a, so the output should be 27.

Now where it really gets more interesting, is when you can calculate with variables in stead of numbers.

```
number a = 22
number b = 15
print( a + b )
```

Now what I showed here, may be new to you, but in NIL you can declare and define a variable in once, however you can only do this with straight numbers (or strings in case of a string) and not with mathematical issues. Knowing this does save writing time. Well, breaking down this code is easy. 22 was assigned into a, and number 15 was stored into b. That means that “a+b” is “22+15” respectively, right. Since $22+15=37$, that should be the output of this code.

And yes, the outcome of a mathematical formula can also be stored into another variable.

```
number a = 15
number b = 22
number c
c = a + b
print(c)
```

A few notes are in order. Since `c` is to contain the outcome of a mathematical formula and not a straight number, you cannot define it in the declaration (at least not in the current version of NIL), so that's why you'll need a separate line for this.

Assignment #1:

The only way to learn a new programming language is by writing programs in it, so time for some practice. Write a program in NIL that will show the outcome of:

```
5 + 4
15 - 4
16 + 7
```

In the first version, the program only has to show the results of these formulas.

Make a second version, in which no numbers are used in the formulas but variables only, so make sure all variables contain the correct numbers.

Now I only demonstrated `+` and `-`, and frankly, odd as it may seem this is all you need to write a Turing complete program, since `5x7` is actually handled by the computer as `7+7+7+7+7`, but you don't wanna write that all out, do you? Do you? Well you don't have to. Here are the basic operators, you'll probably use most in coding, and which are also very common in loads of programming languages.

<code>+</code>	plus
<code>-</code>	minus
<code>*</code>	multiply
<code>/</code>	divide
<code>^</code>	empower (not very common in most languages but NIL supports this)
<code>%</code>	modulo (in some languages (like BASIC and most of its variants) written as “mod”)

These symbols might differ from what you are used to see from the symbols used in your mathematics school books, aren't they. It is basically because some things are simply not writable in code, and some symbols can have different meanings in code. For example, there is no way a programming language can tell if “`x`” is the multiplication symbol, or if its a variable named “`x`”, and thus the use for the asterisk “`*`”.

So to sum it up a bit

code	human math
$2 + 3$	$2 + 3$
$3 - 2$	$3 - 2$
$2 * 3$	2×3
$3 / 6$	$3 : 6$
3^2	3^2

I left out the %, or modulo as I have never heard of a human way to write this out. Modulo is the rest value of a division formula. For example, 5:3 will not end up in an integer since 5 is not dividable by 3. You will (if we forget about decimals) get 1 rest 2, and that makes 2 the modulo value, so 5%3 will result into 2.

A note about ^ for empowering (in case you plan to learn other languages as well). This only works in NIL because this is also the notation its underlying language Lua uses for this. Most variants of BASIC use this symbol too. Most languages do not support ^, but have other ways to do this. (If you wanna learn Pascal in particular you gotta be aware of this, as in Pascal ^ means pointer, but that is really nerdy stuff we won't get into now).

Except for ^ and % nearly all programming languages use the same symbols for mathematical calculations. % is sometimes replaced by “mod” and “^” is sometimes not supported at all, and that is really it. Knowing these will get you further in whatever language you want to learn.

Also note that in most languages (some exceptions are there) * and / take priority over + and -. You can put calculations between (and) to make sure the computer does these first, just like in normal mathematics.

Assignment #2:

Now write a program with the number variables “productprice”, “numproducts”

Make the system calculate the total price a customer would in total if they bought a certain number of products and put that into a variable named “totalprice”. Let's start with 60 as price (dollars or euros or whatever is irrelevant), and 20 as number of products, and the program must (of course) print this to the screen. (If you can make the computer turn this into a sentence with concatenation).

Assignment #2a:

And if you think you are tough, let's up the stakes a little, once you have the total price, let's assume that 17% VAT has to be paid over the total price, and make the computer display that.

Chapter 5. The first introduction to functions

5.1 void

Functions are one of the most important things to master. NIL is set up to be able to act as a procedural programming language. This means that you can (and technically should) put your code in functions only (wherever possible).

I already told you that “print” is a function. As you go programming in NIL more and more, you'll find out there are many, many more functions available to you for which “print” is only one. These functions have been pre-programmed for you, in order to provide basic functionality.

In this chapter I'm gonna tell you how to make these functions yourself. Which is actually quite easy. Allow me to show one of the simplest examples we can think of!

```
void Hello()  
    print('Hello world')  
end
```

Now that looks pretty easy, doesn't it? Now if you run this script in QuickNIL you will see no output. That is only natural, as QuickNIL did create the function, but since that was all it was instructed to do, it will end immediately after that. In order for a function to operate it must be called.

Add this line at the bottom of your code:

```
Hello()
```

And if you run your script in QuickNIL now, you'll see “Hello world” appear.

Now let's break this down. What is that word “void”, for starters? Well “void” is a datatype, just like “number” and “string”. In NIL “void” can however only be used for functions and it means that the function will not return a value. Now this sounds pretty obscure, but I'll get into the deep of that later. For now let's assume all functions to be “void” only, to make things easier on the shorter run. With () you tell NIL the identifier you just declared is a function, but the fun doesn't end there, but more about that later. Then on the lines to come you tell NIL what the function should do and the “end” instruction ends the function. So any code coming after that is no longer part of that function. There is more to the “end” command than just that, but for now, let's assume this is its only function.

Now you can have some fun with these:

```
print('I know a great program its name is:')  
Hello()  
print('All all it does is print:')  
Hello()
```

You will when you run this program see that whenever the instruction “Hello()” appears NIL will put “Hello world” onto the screen.

Let's now make functions a bit more fancier. I already told you that “print” is a function, but you've seen that you can send some data to the function, so that print knows WHAT to put onto the screen. I hear you wonder, can I do that too?

OF COURSE YOU CAN! And this is actually where working with functions gets interesting.

```
void Sum(number a, number b)
    print(a+b)
end
Sum(5, 6)
```

Now before you try out this code, a quick pop-quiz. What do you think, this function will show you on the screen, and why?

If you think it will show 11, because 5 gets assigned into variable a, and 6 to variable b, making the “print” command effectively show the result of 5+6 (which happens to be 11), you are correct, as that is EXACTLY what happens.

Let's break this down, step by step.

- i. Once again “void” served to create a function which does not return a value
- ii. “Sum” will be the name of the function.
- iii. Between the (and) I now declared variables a and b as number variables. These variables are known as “parameters”. They are used to store the data that the function calls give the function. The data itself is called “arguments”. The terms are quite often mixed up, but this is the correct way of using the names (my own coding instructor was very strict on that one).
- iv. Of course, once the function started the variables can be used as normal variables, and thus the print instruction will just calculate the sum, as instructed.
- v. The “end” command ends the function.
- vi. And the “Sum” command calls the function in order for it to do its job.

Important note: The variables “a” and “b” are only living inside this Sum function here, and outside the Sum function they cannot be used. We can also call them “locals”, meaning they only live in a certain portion of your program. I'll break that down in later chapters, but for now it's enough to know that variables declared as parameters can only be used in the function they belong to.

Functions are important to understand, and that you start to learn how to create and use them in an as early stage of programming lessons as possible. First of all, they can save you a lot of work. Since many programs tend to have to do the same job over and over, only with different data, it would be insane to have to write the same lines of code all the time, with a function you can do that only once, and repeat it as many times you need. They also make your program cleaner and easier to read, and in case of bugs (a “bug” means your program behaves strangely because you made mistakes while writing your code), it can also be easier when you can find the function where it goes wrong easily.

5.2 Functions which return a value

Well I already told you before that “void” is strictly used for functions which do not return a value. Now we will discuss functions that will return values. Let's use our Sum function from the last section, but let's now use it as a function returning the sum, instead of putting it on screen.

```
number Sum(number a, number b)
    return a + b
end
print(Sum(7,3))
number d
d = Sum(23,44)
print(d)
```

Here we can see a way to create a function returning a value, and also two ways to use such a function. Please note, if you just write Sum(12,234), you will see nothing. Why not? Because Sum itself does no longer contain a print instruction, and as thus, nothing will be printed that way. When a function returns a value you can immediately use it or decide to store it. The “print” example shows how you can immediately use a returned value. The returned value can also be assigned to a variable.

Now note, that as the function is no longer a non-value-returning function we no longer use “void”, but the type of the value which should be returned. In this case a number.

Now we can also make the function return a string, just as easily.

```
string Hello(string n)
    return 'Hello, '..n
end
```

Well, this is demonstrating how to return strings.

Assignment #1:

Create a program in NIL which contains a function which will calculate the average of three numbers given as parameters, and return the result.

Now make the program print the result of the numbers 6, 7 and 8 onto the screen.

Chapter 6. Boolean expressions

Understanding Booleans and how to use them is pretty important in programming in general. The term “boolean” comes from George Boole (1815-1864).

Boolean expression can technically have two outcomes. True or false. In coding booleans are most of all used to do conditional coding. In this chapter I will limit myself to working with boolean as a data type, which you can use for variables and functions, and how to use boolean expressions with the “if” command.

6.1 The “if” command

The “if” command can be easily explained as “if something is the case then do this or else do that”.

The “if” command is present in many programming languages, including but not limited to C, C++, Pascal, BASIC, php, Java, C#, JavaScript and NIL. The way the command works is, or rather it's intension is always the same. It's a few details that can be different. Of course, since this guide is about NIL, I'll limit myself to how NIL does it.

```
number a = 5
if a % 3 == 0
    print(a..' can be divided by 3')
end
```

Now this looks easy enough, right?

As I explained before '%' means modulo, and the modulo is the rest value after dividing with two integers. This means that if a number can be divided by an other number, in the case of this example 3, the rest value, and thus the modulo is always 0.

So to translate the “if” line above in human language it says: “if the modulo for 'a' and 3 is 0, then perform the next commands”.

Now all lines coming after the “if” line will be executed until the “end” command is found. We've seen that before, the “end” command. A lot of commands in NIL will affect a group of commands. We call this a scope. All scopes normally end with “end”... There are exceptions, though.

Now if you run the code above in QuickNIL you won't see anything happening at all. Why not? Because NIL was instructed only to perform that print-line if the a modulo 3 was 0. Since 5 cannot be divided by 3, the module is not 0. In fact, in this case the modulo is 2, and thus the print-line has been ignored. Now change the number of a into 6, and run the code in QuickNIL, and now you *will* see that QuickNIL will respond by saying “6 can be divided by 3”.

Let's break this down a bit further so you get more understanding of this.

The “if” command requires a boolean expression or value. “a % 3 == 0” is a boolean expression. If a % 3 does contain value 0, the expression will be “true” otherwise it will be “false”. Technically speaking if you type “if true” then the commands coming after the “if” until the “end” will ALWAYS be executed and if you type “if false” they will NEVER be executed. Sounds logical, doesn't it?



Now I hear you ask my two = marks and not one? The answer to that one is a bit of a nerdy one. In the C programming language you can define variables in an if statement. Then if you'd say “if (a=4)” you are telling C to assign 4 into variable a, and say 'true' if successful and 'false' if that failed. By saying “if (a==4)” you are actually telling not to assign any value, but to check if a is actually containing value 4. Let's forget all that, since we are not talking about the C language, and NIL (and many other modern programming languages) do not support this practice, since I now showed one of the reasons why a C program can easily turn into an incomprehensible mess, and will therefore refuse to process the code if you type a single '=', in order to protect the coder against himself. NIL too has no support for this practice, but in order to prevent confusion between C and Lua (on which NIL operates, and most Lua coders, use C to provide the APIs on which Lua runs) the “==” was kept in place, and as a result NIL uses it too.

Now we don't want the program to do nothing at all when a number is not dividable by 3, but to tell the user in stead that the number is not dividable. Can that be done? Of course!

```
number a = 5
if a % 3 == 0
    print(a..' can be divided by 3')
else
    print(a..' cannot be divided by 3')
end
```

Now “else” ends the original “if” scope and starts a new “else” scope. The “if” scope will execute if a is dividable by 3 and skip the else scope. If a is not dividable by 3 then the if scope will be skipped and the else scope will be executed in stead.

When it comes to explaining “if” I also got another one for you. The “elseif” statement.

```
number a = 5
if a % 3 == 0
    print(a..' can be divided by 3')
elseif a % 5 == 0
    print(a..' cannot by divided by 3, but it can be divided by 5')
else
    print(a..' cannot be divided by 3')
end
```

Now this one is nice to break down. When the statement in the “if” is true, it executes the “if” statement, and it will skip the elseif and the else statements and their respective scopes completely. This also means that if a contains number 15, then it will only tell you that it is dividable by 3, but not that it's also dividable by 5, even though that is true. It simply isn't checked. Once the “if” statement is false then “elseif” is being checked. So 5, 10, 20 and 25 will be checked by elseif. It goes without saying that 30 will not be, since it's dividable by 3. If both the if and the elseif are false, then else comes into play. You can by the way add as many elseif commands into one “if” as you want.

```

number a = 5
if a % 3 == 0
    print(a..' can be divided by 3')
elseif a % 5 == 0
    print(a..' cannot be divided by 3, but it can be divided by 5')
elseif a % 4 == 0
    print(a..' is not dividable by 3 or 5, but it is by 4')
else
    print(a..' cannot be divided by 3')
end

```

There is no real limit to this, although it is recommendable not to use too many elseif commands, but that is solely a recommendation and not a law.

6.2 Booleans as variable values or function returns

Yeah, this is possible. You can save the outcome of a boolean into a variable or to have it returned by a function.

```

number a = 5
bool evennumber
evennumber = a % 2 == 0
if evennumber
    print(a..' is an even number')
else
    print(a..' is an odd number')
end

```

Now this seems pretty awkward, doesn't it? Well first of all by typing “bool evennumber” we created a boolean variable named “evennumber”. When not defined it will contain “false” by default. Now the variable is defined like we define any other variables, with the variable name and the “=” symbol, and now the result of `a%2==0` is stored into the variable.

Since 5 is not dividable by 2, and thus this modulo will end up with 1, the outcome is “false” and that is stored in the “evennumber” variable. Since the outcome is false, the “if” statement will therefore go to the “else” scope and perform the code noted there, and thus this program will claim 5 to be an odd number.

Now it should be easy to guess what to do create functions returning boolean values.

```

bool Even(number b)
    return b % 2 == 0
end
number a=5
if Even(a)
    print(a..' is an even number')
else
    print(a..' is an odd number')
end

```


This way of coding is one of the big advantages of using a procedural programming language.

6.2 More than just “==”

To make things easy I've up until now omitted any boolean expression that did not contain “==”, but the truth is you can do so much more. The most used 'operators' used for boolean comparing are:

==	equals to
!=	does not equal to (can also be written as ~=)
>	greater than
<	smaller than
>=	greater than or equal
<=	smaller than or equal

Now you can do a lot more can't we?

```
number a = 5
if a % 3 != 0
    print(a..' cannot be divided by 3')
else
    print(a..' can be divided by 3')
end
```

Now this shows how we can work things out, eh? Let's do a few more:

```
number a = 5
if a > 3
    print(a.." is greater than 3")
elseif a < 3
    print(a.." is smaller than 3")
end
```

Now here we have a nice example of how to work.

6.3 “not”, “and”, “or”

These are three keywords which are handy to use in boolean expressions. Let's sort them out, shall we?

```
number a = 5
if a==3 or a==5
    print('Hello')
else
    print('Hi')
end
```

If variable a contains either 3 or 5, then “Hello” will be put on screen, in any other situation it will say “hi”. “or” means either one or the other must be true or both. Well, that is what it comes down to.



The truth is that the computer stops checking on the word “or” if the expression so far is already “true”. After all since either one or the other or both must be true, the outcome of the second expression no longer matters. This does save time. It's important you make note of this, as many professional coders, “abuse” this fact greatly to save themselves a lot of code, or to get things done in a very quick way by the computer.

Now let's get into the “and” word. I think you can guess what it does:

```
number a = 5
number b = 6
if a==5 and b==6
  print('Yo!')
else
  print('Hi')
end
```

Yes, both a has to be 5 and b has to be 6 in order for the computer to say “Yo!” otherwise it will always say “Hi”.



Now the same dirty trick as with “or” also applies here. “and” makes the computer stop checking the rest of the expression if it already got “false” for a result. After all since everything mentioned with “and” must be true, the rest of the expression no longer matters. This too can be “abused” in professional coding. I may make a few notes of those later.

Lastly the “not” keyword, wants the opposite outcome of what is checked for. If you check for `a==5` in combination with “not” then you don't want a to be 5 in order to return true.

```
number a = 5
if not a==5
  print('I do not have 5')
end
```

Now this keyword does look a little bit useless, doesn't it? Why not use “a!=5” in stead? This is because we've now only worked with simple boolean expressions. Boolean expressions can be very extremely large sometimes and then “not” can help in some ways. Like this:

```
number a = 5
if not (a==5 or a==3)
    print('Sing a song!')
end
```

Now “a” may be neither 5 nor 3 in order to prompt “Sing a song!”

Larger and by far more complex combinations are possible here. Also when working with boolean variables or functions then not may also look cleaner

```
if not Even(5)
    print('the number is not even')
end
```

This looks cleaner than

```
if Even(5)==false
    print('the number is not even')
end
```

Although both lines have the same effect, the second variant is not very common. You will encounter a lot of situations if you really get into coding where “not” is a better way to go.

6.4 Assignment

I will now get into the assignment. Copy the next code:

```
void MyFunc(number a)
end
MyFunc(1)
MyFunc(2)
MyFunc(3)
MyFunc(4)
MyFunc(5)
MyFunc(6)
MyFunc(7)
MyFunc(8)
MyFunc(9)
MyFunc(10)
MyFunc(11)
MyFunc(12)
MyFunc(13)
MyFunc(14)
MyFunc(15)
MyFunc(16)
MyFunc(17)
MyFunc(18)
MyFunc(19)
MyFunc(20)
```

Now the “void MyFunc” will be your work function in which all the code you need to write needs to be written (and in the answers appendix I will also limit myself to that code). Now I want you to perform these tasks:

1. If the parameter 'a' in the function is a number dividable by 3, the function should put “whoosh” onto the screen, and in any other situations it should just print the number itself.
2. If the parameter 'a' in the function is a number dividable by 3 it should put “woosh” on the screen, and if it's dividable by 5 it should put “hey” on the screen. In any other case it should put the number on the screen. (and yes if a number can be divided by both 3 and 5, it should say both “woosh” as “hey”).
3. Let's get into this one, and this one is really tricky. Don't be ashamed if you can't do it. If the parameter of the function is dividable by 3 the computer must say “woosh”. If the parameter is dividable by 5 the computer must say “hey”. If the number is dividable by both 3 and 5, the computer should say neither “woosh” nor “hey”, but say “blitz!” in stead.

The way in which you write the code is up to you, but all the code I want you to write should only live inside the void MyFunc() function. They say that if you can do this all, you are well on the way to become a professional coder.

Chapter 7. Loops

Perhaps if you took a look at my code in the assignment of the last chapter you may have laughed very hard for the reason I typed the same command with a different number 20 times. That was indeed pretty stupid, and the only reason I did so was because I didn't yet handle the object of loops.

Loops allow you to repeat one command, or a group of commands to be executed multiple times. There is no limit in how often you can repeat stuff, and that makes stuff pretty dangerous. Not constructing a loop well can cause it to repeat stuff forever. In that case we speak of an “infinite loop”. They can be pretty evil, and strike you bad, so you should always be sure, you only have infinite loops if you really need them, and therefore what your code well.

NIL currently supports three commands for looping. “for”, “repeat” and “while”.

7.1 The “for” loop

There are two kinds of for loops. The regular “for” and “for each”. Before I can get to “for each” I will first have to explain arrays and OOP kinds of programming, but since we didn't handle that stuff yet, I'll leave “for each” for what it is, and I'll go into the deep of that later, and I'll limit myself to the regular for-loop.

Now let's show you a basic for-loop

```
for i = 1,10
    print('Hello')
end
```

If you run this program in QuickNIL it will put the word “Hello” onto the screen ten times. Of course, you may be wondering how this works exactly.

The “for” command is just for starting the loop. The variable “i” will in this case be declared as a “variant” variable. In NIL “variant” means that the variable can contain any kind of value, this the case of basic for loops that's always numbers (in “for each” loops this can be any kind of value). The value 1 will be assigned to the variable “i”. Then it executes all commands within its scope and when reaching the “end” the variable “i” is increased by 1, the the loop repeats until “i” would become higher then 10, and then the loop stops.

Now that you know this, it should be easy to guess (without trying this in QuickNIL) what this code would do:

```
for i = 1,10
    print(i)
end
```

Think hard! Yup, this would show you the numbers 1 till 10. Basically the for loop can be seen as this:

for <index variable> = <count from>,<count until>,<step>

The “step” value is quite often not typed, and if missing it will be assumed to be 1. But it can also be 2:

```

for i = 1,10,2
    print(i)
end

```

Now variable “i” will not be increased by 1, but by 2, and as a result you'll see all odd numbers from 1 till 9. After all, the loop stops as soon as “i” exceeds 10, but since $9 + 2 \neq 10$ the number 10 itself will be skipped, just like all other even numbers.

Sometimes you may need “for” to count backwards. If that is so you just need to put in the highest number first, and the lowest last and set the step value to -1

```

for i = 10,1,-1
    print(i)
end

```

If you run this code you will see the numbers 1 till 10, but now counting down instead of counting up.

Understanding basic “for” loops is of vital importance, as they are used a lot in solving many programming issues. The index values (in the case of the programs above, that's the variable “i”) can be used in the same manner as any other variable, however it only lives within this for-loop, and I strongly recommend NOT to assign any data to it, as it can spook your code up.

Assignment #1:

In the first program I want you to write a program that shows the multiplication table of 4. Please note concatenation with strings and mathematical formulas is possible like this: `print('1 + 1 = ' . (1+1))`

To do this I do require you to use a for-loop without setting the step value (therefore making it 1)

Assignment #2:

This time, we'll do it a little bit different. Make a program, which shows all numbers dividable by 4 from 1 till 100 (so 0 and negative numbers don't count). And I won't allow you this time to use multiplication.

7.2 The “while” loop

The “while” loop is a nice feature to work with. When you got proper understanding of how “if” works, then using while is actually pretty similar. In most programming languages “while” means “as long as the given boolean expression is true, execute the next command/commands”.

```

number a
while a!=20
    a = math.random(1,20)
    print(a)
end

```

Now `math.random` is a pseudo-random-number generator. It is impossible for a computer to completely generate numbers at random, but pseudo-random-number generators are what often comes closest to this. The working of the code is now simple. As long as variable “a” does not contain the value 20, the loop should repeat. So whatever numbers are output, you'll see that once 20 comes, the loop stops.

Please note, as this is very important. When you assign the number 20 to “a” prior to the while loop, the entire loop isn't executed at all. The statement at the start was already false after all.

7.3 The “repeat” loop

The repeat loop is pretty similar to the while loop, however there are a few differences to be noted, and they are quite important too.

```
number a
repeat
    a = math.random(1,20)
    print(a)
until a==20
```

Now if you run this program through QuickNIL the result you see is probably the same as with the “while”-variant of this program, but don't be fooled, as some important differences are there.

1. First of all, where while repeats the loop as long as the boolean expression is true, the repeat loop does this UNTIL the expression is true. So unlike while a false outcome will repeat the loop, and a true outcome will end it.
2. Second, if you now assign 20 to “a” prior to the loop you will see the loop still activates and runs, where in the while variant that wouldn't happen. This is because the check is done at the end of the scope instead of the start. This guarantees that the commands in the repeat scope are always executed at least once.

It is also good to note that here we've found one of the few exceptions to the rule that all scopes end with the “end” command, as this one ends with “until”. This is because “until” can only come at the end of the scope, so placing an extra “end” would therefore be obsolete.

Alternatively in NIL you can also end “repeat” loops with “forever” which will forcefully create an infinite loop. I said it before, you must always be careful as infinite loops can be evil, but there are times they are the best approach to certain things.

7.4 “break”

When you want to loop you gotta break. Or at least know how to break. All loops can be forcefully ended with the “break” keyword (which includes the “for each” loop which I'll discuss later).

```
number s = 1
number e = 30
number b = 6
for i=s,e,3
    print(i)
    if i==b
        break
    end
end
print('Bye')
```

This loop will start at 1 and keep adding 3 until 30 has been exceeded. Now if the variable “i” would ever be 6 in this process, the break will be immediately terminated, and the print('Bye') command will be executed as the first command after the loop. Now with the configuration above it will never happen that break is called, since “i” will never be 6. This will change if you now set s to value 0. Then 6 *will* happen, and thus the loop will then be terminated despite “i” not yet having exceeded 30 (not even being close to that).

Now break instructions are particularly popular in loops which have deliberately been set to be infinite, making it easier to terminate them some time if certain conditions are met.

Chapter 8. Macros

Macros are a pretty nifty feature in NIL. They are very extremely harmful, but you should use them with care. Macros can contain anything, both code as data. When defined the NIL translator will first replace any macros it can find, and after that it translates.

```
#macro _HW_ Hello World
print('_HW_')
```

Well, maybe this is the simplest kind of program imaginable using a macro. First of all note the hastag with which the '#macro' instruction is prefixed. This is because “#macro” is neither a keyword nor a function, but a pre-processor command. NIL will handle those prior to any translation action. There are more of those, but not relevant in this chapter.

The program above will output “Hello World”, but what does actually happen. The first word after the “#macro” command is the name of the macro, and everything that comes next on the same line is the macro. This means that whenever NIL sees “_HW_” it will first substitute it with “Hello World” and once that's done the translation goes on as normal.

Now I hear you wonder, why would I need those crappy things? Yeah, why? Well I tell you why. NIL uses Lua and Lua has no support for constants. Any value can be changed. This is pretty dangerous and can lead to bugs. Macros can, once defined not be changed anymore, and are therefore safer to use in loads of situations.

The very thing a coder should prevent is what we call “magic numbers”. The best code is code where magic numbers are non-existent, actually. However, when setting up things you will inevitably come in situations where tons of numbers play a role. For example if you set up a game with your own user interface. You may need to adept text and objects based on how big you set things. If you just put in numbers in your code, and come to the conclusion that the outcome is wrong, you may need to change everything. I wouldn't like to go down that road. Now if you set these:

```
#macro _win_x_ 4
#macro _win_y_ 5
#macro _win_width_ 200
#macro _win_height_ 100
```

And make your calculations from those four macros you never need to change tons of code. Just change your macros and you're set, and the entire code changes with these automatically, in some sort of way.

Macros can do even more though. You can also use them to make a more neat set-up all parts of your program can call from:

```
#macro _project_ My application
#macro _author_ Jeroen P. Broks
#macro _version_ 1.0.0
```

Now all parts of the NIL program can show these.

Macros can even be used to put in code:

```
#macro _hello_ print('Hello World')  
_hello_
```

Yup, this will result into “Hello World” appearing on screen. Of course you can wonder why using a macro when a function would suffice. Let's use a function in stead then:

```
void hello()  
    print('Hello World')  
end  
Hello()
```

The macro version would only produce “print('Hello World')” as Lua translation, while the function variant creates 4 lines of code, in which a function which only calls print('Hello World') is created and executed. This is a waste of RAM (a needless extra function) and overhead (a needless call to a function. 2 function calls, where 1 sufficed). If you have more of those one-line snippets of code you need a lot, but which are not really complicated, and not taking any arguments, a macro can be the better option. In my “Secrets of Dyrt.NET” game, I've used macros a lot for color changing. I only have to write “__white” and NIL replaces it with the function call “Color(255,255,255)”. It's laziness I know, but for me convenient.

You may wonder why I've been prefixing and/or suffixing my macros with underscores. This is there is one weakness in macros. They override everything, even keywords. These underscores can prevent that reckless macro creation ruins some code.

I believe that among C coders it's a kind of convention to write all macros in caps lock. For NIL I don't want to follow that convention (creates dirty and hard to read code), but I'll leave it up to the community to follow this rule for NIL or not.



Note to C/C++ coders who are trying NIL. The macro support is NOT as sophisticated as in C and C++. In C I've actually seen addition of new kinds of loop commands accepting parameters like “#define MYFOR(ffrom,fto) for(int i=ffrom;i<=fto;++i)” and things like that. Unfortunately NIL has no support for this setup, and neither am I planning to implement that. It's just text being replaced with something else, and nothing more than that. If Lua did support constants I probably wouldn't even have bothered adding macros at all....

Chapter 9. Tables

Tables are a Lua standard feature, and yes NIL can therefore use them too. For the good of this chapter I'll go into two uses for tables. Using them as arrays and as “maps” or “dictionaries”. Officially they can be used for a lot more BUT THE ONLY REASON I SAY THAT IS BECAUSE THERE ARE A LOT OF KNOW-IT-ALLS WHO'D ACCUSE ME OF BRINGING UNTRUTHS FOR NOT SAYING THAT, so if you actually CARE about learning to code, forget that statement completely and don't even try to remember I had to say that.

Arrays and dictionaries are basically variables that can hold multiple values. An index or key has then to be added to tell NIL which value you want.

So far definitions. Definitions are completely useless pieces of trash, since you probably didn't understand what I just said, and if you did understand, you didn't need that definition in the first place.

Since NIL, and its host Lua, are set up as scripting languages, they have a rather free approach to maps and arrays (unlike compiler based languages such as C/C++/Pascal/and loads of other languages).

Like any other variables, tables have to be declared. Well declaring a table is easy

```
table MyTableVariable
```

Doing that will declare the table variable “MyTableVariable” and assign an empty table to it, as well. And let's now get to business in using tables.

9.1 Arrays

Arrays actually form a series of numbered values. I said “numbered” not number values, as these values can be any value at all. Numbers, strings, boolean, anything you can think of actually. And you can easily assign values like this

```
table MyArray
MyArray[1] = 'Jeroen'
MyArray[2] = 'Peter'
MyArray[3] = 'Eric'
MyArray[4] = 'Richard'
MyArray[5] = 'Sophie'
MyArray[6] = 'Hillary'
MyArray[7] = 'Nikki'
MyArray[8] = 'Sally'
MyArray[9] = 'Cindy'
print(MyArray[9])
```

Now this looks easy, eh? Not that much different from what you are used to see except from the numbers given between [and]. Right? And you may have guessed, this program will output “Cindy”. Well, let's do a bit magic here.

```
for i=1,9
    print(MyArray[i])
end
```

Well, I suppose NOW we are talking business, right? Now this will allow you a lot of stuff to do. The number between the [and] is called an “index”. In Lua (and therefore also in NIL) arrays start to

count from 1 (this contrary to many other languages such a C/C++/C#/Pascal/Go/well nearly all languages which start with 0, so be alert) and then onward. In Lua/NIL there is no (official) limit to how far you can go... Eventually your memory can be full though. In an array it's very important that all numbers follow each other up. So 1,2,3,4,5,6 is allowed. 1,3,4,5,6,8,9 is not. This because some numbers are missing. NIL won't strictly mind that, at least it won't throw an error, but it's simply not done, and some array-based functionality will get buggy.

Now the nice part of arrays is that you can easily get their length. This is done by prefixing the array with a #. Please note a line may never begin with a # as NIL will then use pre-processor directives instead, but anywhere else in a line this will tell you how many elements an array has. And with that some random access is possible. And let's take “random” literally ;)

```
table MyArray
MyArray[1] = 'Jeroen'
MyArray[2] = 'Peter'
MyArray[3] = 'Eric'
MyArray[4] = 'Richard'
MyArray[5] = 'Sophie'
MyArray[6] = 'Hillary'
MyArray[7] = 'Nikki'
MyArray[8] = 'Sally'
MyArray[9] = 'Cindy'
for i=1,20
    number r
    r = math.random(1,#MyArray)
    print(MyArray[r])
end
```

Now this program will just list 20 random names out of the 9 put in this array. Since MyArray is has 9 values, #MyArray will contain the number value 9. If you would add 3 more values on indexes 10, 11 and 12 respectively, then #MyArray will contain value 12.

Assignment #1:

Create a program with an array, containing five major cities in the United States, and make them appear in reversed order as you numbered them in your array. If you still know how to count backwards with a for-loop, this should be easy. :)

9.2 Maps/Dictionaries

Whether this is a map or a dictionary depends on the programming language you use. In C++ and Go it's called a map, and in C# it's called a dictionaries, but frankly they are two names for the same thing. In contrast for an array, where only numbers should be used between [and], and they should always be a kind of “chain”, in maps you can use anything. Numbers, strings. Anything goes. Instead of indexes between the [and], we now speak of keys. And we can now do something like this:

```

table Capital
Capital['USA'] = 'Washington D.C.'
Capital['the Netherlands'] = 'Amsterdam'
Capital['Germany'] = 'Berlin'
Capital['Denmark'] = 'Copenhagen'
Now this looks cool doesn't it? And yes, you can also use variables as keys
string key='USA'
print(Capital[key])

```

This will added to the code above put “Washington D.C.” on the screen. Please note that #Capital will always contain value 0 in this case. This will listing out impossible, right? Wrong! I will get to that in the next section.

9.3 “for each” with pairs and ipairs

There are several “official” names for this phenomenon, but if you speak of “for each” nearly all coders know what you mean. The term comes from the fact that many languages use the keywords “for” and “each” in combination. Like in BlitzBasic and its variants Blitz3D and BlitzPlus. Some languages, like C# for example use the keyword “foreach” for this process... yes, I'm for real (unfortunately).

Lua, on which NIL is based, doesn't use the word “each”, and neither does NIL (by default that is), but that doesn't mean the process doesn't exist here.

Lua has two basic functions that NIL can use as well, to perform a “for each”. “ipairs” and “pairs”. The “ipairs” function is for arrays only, and pairs can be used for both arrays and maps. (Don't accuse me of telling untruth due to possible adeptions with metatables. This in an INSTRUCTION guide and not a CONFUSION guide! So leave stuff that is not yet relevant out of this. If you don't know what I'm talking about, this forget I placed this note! Yeah, I've had to do with coding “pros” (read: trolls) on guides I wrote earlier, and that obligates me to place these confusing messages to take away their fun to bash stuff down for no reason!)

In section 9.1, I used a classic for-loop in order to demonstrate how to show all elements in an array. But we can also use a for each loop with ipairs in stead.

```
// Let's define the table!
table MyArray
MyArray[1] = 'Jeroen'
MyArray[2] = 'Peter'
MyArray[3] = 'Eric'
MyArray[4] = 'Richard'
MyArray[5] = 'Sophie'
MyArray[6] = 'Hillary'
MyArray[7] = 'Nikki'
MyArray[8] = 'Sally'
MyArray[9] = 'Cindy'
// Classic for-loop
for i=1,#MyArray
    print(MyArray[i])
end
// ipairs for each loop variant #1
for i,v in ipairs(MyArray)
    print(MyArray[i])
end
// ipairs for each loop variant #2
for i,v in ipairs(MyArray)
    print(v)
end
```

Now all three loop commands will produce the same output, so three times you will see all names in order.

Perhaps you can puzzle out how what happens. And if not let's break it down.

“for i,v in ipairs(MyArray)”. Well the “for” command just tells we are going to start the loop, so nothing new here.

Now “i” and “v” are variables declared to live inside this for-loop. Now “ipairs” will put all index numbers in the first variable, which I now named “i”, and all values in the second variable, in this case “v”, and will so go through this entire array and stop the loop when all array indexes have been properly processed. Please note that if you'd now create MyArray[20]='Michael' that ipairs will ignore it, since the indexes 10 till 20 do not exist, so index 9 is considered the end of the array.

This being said ipairs is therefore considered useless in map based tables. So instead we can use pairs for any table that is not an array.

```
table Capital
Capital['USA'] = 'Washington D.C.'
Capital['the Netherlands'] = 'Amsterdam'
Capital['Germany'] = 'Berlin'
Capital['Denmark'] = 'Copenhagen'
for k,v in pairs(Capital)
    print('The capital of '..k..' is '..v..'.')
end
```

Now this looks pretty similar to what we could produce with ipairs. The big difference is that pairs will work with any kind of key. However, here's the rub. Copy this program and run it in QuickNIL and you'll probably see what I and if not, then well, add some more countries with their respective capitals and sooner or later you'll see it. This was the output I got, but it may differ from yours:

```
The capital of USA is Washington D.C..
The capital of Germany is Berlin.
The capital of Denmark is Copenhagen.
The capital of the Netherlands is Amsterdam.
```

Yeah, why is the Netherlands listed last, when it was listed second in my code? This has to do with how NILs host, which is Lua, manages the memory within tables, and NIL just takes that over. The order in which pairs() lists can be any order at all. I just tried this script myself several times as I wrote this, and I can confirm the order was different on every single run. This makes pairs pretty unreliable

when the order is important. For the time being there's nothing you can do about. When you are more well versed in NIL or its underlying system Lua, you can write alternatives for pairs and ipairs in order to cope with this problem, but as this is something for higher level coders, you'll have to (at least for the time being) grin and bear it. It's better than nothing, after all. In some later versions of this guide, I may add some appendices, in which a function that can solve this problem will be presented ;)

Assignment #2:

Make a program that has a map based table in which the keys are the names of animals, and the values are the sound they make. Put in ten animals. Then make NIL list them all out. The order in which they appear doesn't matter. Make the output for all animals appear as this:

The <animal> says <sound>.

This is the basis of how to use tables in NIL (and also in Lua). Tables have a lot more functionality than just this, but that is something to be discussed in later lessons.

Chapter 10. Classes in NIL

asasa

Appendix: Assignment answers

Important notices:

- a) You'll learn nothing by just copying my code. Always try this our yourself first, and then look at my code to compare
- b) A golden rule in coding is that there are multiple ways to get to the same solution of a problem your code has to solve. I'm only giving you one solution, that doesn't mean there are other (sometimes even better) solutions.
- c) I will always try to limit myself to the stuff already discussed. If you know better ways containing things not discussed at that point of the lesson... cool, but don't bother me with it with an issue ticket, as I'll dismiss it!

Chapter 4, assignment #1:

```
// part 1
print(5 + 4)
print(15 - 4)
print(16 + 7)
```

```
// part 2
number a = 5
number b = 4
number c = 15
number d = 16
number e = 7
print(a+b)
print(c-b)
print(d+e)
```

Chapter 4, assignment #2:

```
// Assignment 2:
number productprice = 60
number numproducts = 20
number totalprice
totalprice = productprice * numproducts
print("Customer bought "..numproducts.." of the product which costs
"..productprice.." each, which makes a total of "..totalprice)

// Assignment 2a:
number vat
vat = totalprice * (0.17)
number totalwithvat
totalwithvat = totalprice + vat
print("With 17% VAT "..vat.." has to be added to the total price,
which makes "..totalwithvat)

// Don't bother if you get too many decimals. It will be discussed
later what you can do about that.
```

Chapter 5, assignment #1:

```
number AVG(number n1, number n2, number n3)
    return (n1+n2+n3) / 3
end
print (AVG(6,7,8))
```

Please note the output will be 7.0, and not just 7. This has to do with Lua on which NIL relies for this, will always assume the results of dividing to be non-integer numbers.

Chapter 6:

Task #1:

```
void MyFunc(number a)
    if a % 3 == 0
        print("whoosh")
    else
        print(a)
    end
end
```

Task #2:

```
void MyFunc(number a)
    if a % 3 == 0
        print("whoosh ")
    end
    if a % 5 == 0
        print("hey")
    end
    if a % 3 !=0 and a % 5 != 0
        print(a)
    end
end
```

Task #3:

```
void MyFunc(number a)
    if a % 3 ==0 and a % 5 == 0
        print("blitz!")
    elseif a % 3 == 0
        print("whoosh")
    elseif a % 5 == 0
        print("hey")
    else
        print(a)
    end
end
```

chapter 7, assignment #1:

```
for i=1,10
    print(i.." * 4 = "..(i * 4) )
end
```

chapter 7, assignment #2:

```
for i=4,100,4
    print(i)
end
```

Please note, if I'd start the for with '1' it would count 1,5,9,13,17, etc, and we do not want that, so I gotta start with the lowest number dividable by 4, which is 4 itself. Well now "i" would be increased with 4 all the time, which automatically results in only numbers dividable by 4.

chapter 9, assignment #1:

```
table cities
cities[1] = "New York"
cities[2] = "Washington D.C."
cities[3] = "San Francisco"
cities[4] = "Los Angeles"
cities[5] = "New Orleans"
for i=#cities,1,-1
    print(cities[i])
end
```

chapter 9, assignment #2:

```
table Animals

Animals["dog"] = "woof"
Animals["cat"] = "meow"
Animals["bird"] = "tweet"
Animals["lion"] = "growl"
Animals["duck"] = "quack"

Animals["chicken"] = "backcock"
Animals["cow"] = "moo"
Animals["snake"] = "hiss"
Animals["pig"] = "groink"
Animals["mouse"] = "peep"

for animal,sound in pairs(Animals)
    print("The "..animal.." says "..sound..".")
end
d
```