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A beginner's guide to:

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1. Introduction to Lua and this book

1.1 What is Lua?

Lua is a scripting language, which works completely in an interpreted environment. It has been coded in C and has been set up to be easily implemented with any program written in C. It's been used for many kinds of application. For example for creating addons for utilities, and most of all for games.

Lua was designed by Roberto Ierusalimschy, Waldemar Celes and Luiz Henrique de Figueiredo in a university in Rio de Janeiro in Brazil, and is completely free. It was named after the moon as "lua" means "moon" in Portuguese. Despite Lua itself being set up in C, you don't need any knowledge of C in order to use it, due to language quite often being implemented in tools in which you may need it.

Lua is very extremely symplistic in its syntax and general setup, making it very easy to learn and understand, even when you never touched a programming language before. Still Lua has a kind of low-level approach and is despite being interpreted quite fast. Since it's specifically designed to work in a C environment, it's very popular in the professional industry and knowing the basics of Lua can get you some extra tickets into the professional gaming industry.

I will go into the deep of how Lua works later in this book, but the famous "Hello World" program is only one line: "print('Hello World!')".

Lua has also been designed to not bother about platform specific issues. So basically a Lua script should work in Windows, MacOS and Linux and basically any platform you can think of.

1.2 What do you need to install for this course.

When it comes to Game programming one of the most complete Lua engines to make anything is LÖVE (http://love2d.org) but I advise you not to start with LÖVE right away. Before we get onto a complete engine like that it's essential that you first understand how Lua itself works. For that you need a Lua program you can run from the CLI. This program can only perform the core features, but it's good enough for testing what you've learned. If CLI tools are too difficult for you to understand, you can also use the Lua playground (https://www.lua.org/cgi-bin/demo). You can just enter the Lua code and the result will appear as soon as you click "run". For training this will do.

To Test the playground just type "print('Hello World!')" in the textarea and then click "Run", and "Hello World!" should appear below. When you use the cli tool type "cat > hello.lua" in the terminal when you use Linux, Mac or BSD and "copy con hello.lua" on Windows and type

"print('Hello World!')" and press enter and press ctrl-D in Linux/Mac/BSD and ctrl-z on Windows then type "lua hello.lua" and if you see "Hello World!", you can see you installed the CLI tool correctly.

When you really get serious into Lua scripting you will need an editor that can handle Lua Scripting. I use the Lua Devolopment Tools for Eclipse, but that can be a rather complex to understand. Atom, Geany, SublimeText, NotePad++ should all be able to allow you to work with Lua scripts.

1.3 How to use this book

I will try to take you step by step into the secrets of Lua. I will show you many scripts. It could be wise to copy these and try what they do.

Code will look like this:

```lua
-- Test
a="Hello World"
print(a)
```

The colors you see is called "Syntax Highlight". This will help you a lot keep some overview over your code.

When you see this icon and the text beside it with a blue background, it means that I got something very important to tell. Like all programming languages Lua can be full of trapdoors you can easily fall through, and you should therefore be aware of those. I make these warnings for a reason.

When you see this icon on an amber background, it means that I am about to tell you some typical nerdy stuff, that is just nice to know, but most of all aimed to people who can look beyond the regular stuff. If you have no understanding of what I tell here, then don't you worry one bit, as it's not really important to move on. Perhaps if you got more understanding of Lua and you want to read this over, hey, why not ;)
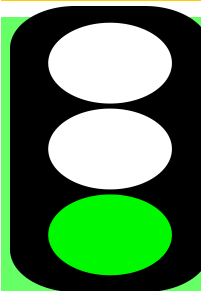
And lastly when you see this icon on a green background, I'll be giving you some exercise. The best way to learn to code, no matter if you do that in Lua, Pascal, BASIC or even in C is by doing it. And thus a few assignments never hurt.

These assignments may sometimes have some code snippets, but mostly you are on your own, but you area allowed to look things up in the previous chapter or paragraphs or sections to see the solution. Sometimes I may even give you some pointers of the expected output, so you can check a few things for yourself.

And with this all discussed, I wish you good luck with this book.

2. Hello World! Your first real program.

Most traditionally the first program you'll be writing in whatever language you're gonna learn is Hello World! It's been said that the first time Hello World was written was to demonstrate a prototype of the C programming language.

In C Hello World looks like this:

```c
#include <stdio.h>
int main(void){
    printf("Hello World\n");
}
```

Not really much to it, even in C, although in C you need 4 lines and in Lua, just one.

```lua
print("Hello World")
```

Now "print" is a function. I'll go into the deep about what functions are later in this book, but for now it's important to know that a function can be used to make Lua do something. In the case of "print" that is to put something on the screen. "Hello World" is was we call a string. A string is a series of characters, usually used to form text. So in English we said to Lua *put the text "Hello World" on the screen.*

Let's test this out. Copy that line into a program or onto the playground and run it and see what happens. It should show "Hello World".

When it comes to strings in nearly any language you will need quotes. In the example I used double quotes. Lua will also understand single quotes. It doesn't really matter if you use single or double quotes, as long as you are consequent in using the same quotes to end the quotes as you started them. I however advice double quotes. If you will ever consider moving on to C, Go, C# and some other languages in this family single quotes have a different meaning, and thus you can confuse yourself when you use single quotes (big exception is Pascal that requires single quotes).

Now I'm gonna take you into something important. Especially when you coded in BASIC or Pascal before you can really suffer here. Lua is case sensitive.

```lua
PRINT("Hello World")
```

This code will therefore not work. Try it and you will see Lua complain about a trying to call a "nil value" or something like that. I shall go into the deep about what a "nil value" is later, but for now let's suffice to say that a nil value means that you are trying to do something with something that does not exist, and therefore Lua can't handle that. Lua does make a difference between upper and lower case letters. So "print" and "PRINT" are therefore not the same. Especially when you move on to more complex Lua scripting you should be very strict on yourself on how you use upper and lower case or your scripts can become a big mess.

Now with this knowledge you can take this a little bit further. "print" will not only show text on screen. It will also move to the next line. And thus we can also do this:

So without trying this out in the playground or a cli tool, you must be able to tell what this program does:

```
print("USA stands for United States of America")
print("Its first president was George Washington")
print("It borders to Canada and Mexico")
```
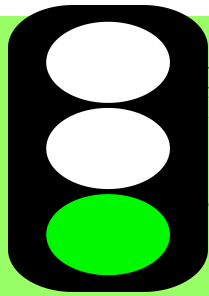
Now write a program that shows your name and your age, your date of birth and your city of birth onto the screen. All data fields I asked for should have their own line in the output.

If you can do this, you have understood the basic of the Hello World sequence and then we can get on the move for the next chapter.

3. Variables

Like any programming language Lua handles data most of all through variables.

Unlike compiler based languages such as C, Go and Pascal, Lua does not require any variable declarations. A variable is technically created on the moment it's first asked for.

Variables can be defined, and read out. Read data can be put on the screen, or be used for creating new data, or be checked.

In this particular chapter I'll limit stuff to definitions of variables, reading and some nice manipulations.

Strictly speaking Lua only has 5 data types for variables: nil, boolean, string, number, table and function. I will not discuss function in this chapter. I will get to that once we'll really go into the deep of functions, and for tables same story.

Variables can also be global and local. I will get to the difference between the local and global in a later section. For now we'll only use globals. Global variables are available in your entire script, and that is all you need to know for now.

Definining variables is as easy as this:

```lua
a = 1 -- number
b = true -- boolean
c = "Hello World" -- string
d = { 3, 4, 5, 10 } -- table
e = function() print("Yo!") end -- function
n = nil -- nil
```

Now "--" in Lua means a comment. Lua will ignore everything that comes after that.

3.1 The nil type

Nil is a word that you'll soon hate when you get into Lua coding. It will haunt you wherever you go. Any variable you did not yet define will automatically be of the nil type, and the nil type only has one "value". Nil.

Nil just means your variable contains no data at all. In most cases nil cannot be used and thus an error will pop up if you try.

Nil can also be enforced like you can see in the code in the intro section of this chapter by simply saying "myvar = nil". Especially when working with tables this can get you far as this may cause Lua to automatically clean up all the memory taken by the table. More about that when I actually come to tables.

3.2 The number type

The number type is like the name suggests for storing numbers. These can be integers as well as floats. Now number variables are pretty important as they allow you to perform mathematical calculations, and even the simplest of programs (well except maybe Hello World) will often require you to do some calculations. Scoring points, deducting hitpoints, but also determining coordinates of the player or the enemies. The number type makes it all possible.

3.2.1 Definition and showing numbers

```lua
a = 1
print(a)
```

Yeah, well it's really that simple. This program will define 1 into variable a. And print will then show the content of a.

Note that now that we are using a variable and not a string we do not quote it. Due to that Lua understands this is a variable and will thus just show the value of variable a

```lua
a = 1
b = 5
print(b)
print(a)
```

Now 1 will be put in a and 5 will be put in b. Note that I first asked to show variable b and then variable a. This will cause Lua to first output 5 and then 1. It is very important that you put the commands in the correct order to prevent bugs. In this case it didn't matter in which order I defined the variables, but the order of the print instructions do.

3.2.2 Mathematics with variables

Now we get into actual programming.

For this I'll need to discuss operators. For mathematic formulas Lua has 6 operators at your disposal.

Addition	+
Subtraction	-
Multiplication	*
Division	/
Modulo	%
Empower	^

Lua does take in calculations the official order into account when multiple operators are used, so first empowering, then multiplication and division and lastly additions and subtractions, but just like in normal mathematics you can alter this order with parents ( ).

Now I'm sure this all sounds a bit like abracedabra. So let's explain by means of some examples.

When doing math in Lua you can use both numbers and variables in your formulas and you can use them in both your definitions as in function arguments, so you can do this:

```lua
print( 2 + 5 )
```

And you can also do this:

```
a = 2
print(a + 5)
```

Both examples will put 7 on the screen.

But this works too:

```
a = 2 + 5
print(a)
```

And yeah, you can also go this way:

```
a = 2
b = 5
c = a+b
print(c)
```

Anything is possible.

Now that's interesting, but can you also make a variable increment itself? Sure!

```
a = 1
a = a + 1
print(a) -- outputs 1
a = a + a
print(a) -- outputs 4
```

And basically you can go all the way with this with the other operators.

The "%" operator or "modulo" (in some programming languages this is the "mod" keyword) is an operator that can confuse some people. It contains the remainder value of a division.

8 % 4 = 0

9 % 4 = 1 (8:4=2 and 1 remains).

If you have been using C/C++/Go/C# before you will not like to hear this, but Lua has no shortcut incrementors or manipulation support. So a++ or a-- do not exist in Lua and there is also no variant for a+=4 or anything like that. I'm afraid this is something you'll have to deal with.

I've not been informed by any plans of support for this in the future. I wouldn't be surprised if it will be implemented, but for the good of this book, I'll do without them. :(

Now like I said before, Lua can handle more complex formulas by working with parents, in which like in real-life mathematics the stuff between parents takes priority

```
a = 4
b = 6
c = 2
d = (a+b)/c
print(d) -- outputs 5
```

Since a is 4 and b is 6 and c is 2 the formula send to d is basically *(4+6)/2*, so first calculate what is between the parents, well 4+6=10, so that makes 10:2 which is 5 and thus the output.

3.2.3 Assignment
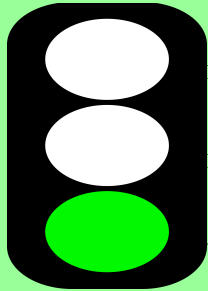
Write a program in which you have variable a and b are defined with random numbers of your choice, as long as it's anything higher than zero.

Then let it output the result of adding the two variables, then subtract then multiplied by each other and then divided.

Then make the same program make the two variables double themselves and do the same sequence of mathematic results again.

Please make sure you read the assignment well and that you've understood it well, as this may be one of the more complex ones to understand at once.

3.3 The string type

3.3.1 An introduction to strings

Strings are in Lua pretty easy to use. Like I said strings are a chain of characters, usually used for text. Technically strings can have any length and you can do various things with them.

Defining a string variable is as simple as this:

```
mystring = "Hello World"
```

It's that easy. Now you can just use functions like print to put the content onto the screen.

```
mystring = "Hello World"
print(mystring)
```

Copying a string to another variable does not require special functions (like strcpy in C), but can just be done as easily as this:

```
mystring = "Hello World"
mystring2 = mystring
print(mystring2)
```

3.3.2 Concatenation

Now in Lua you cannot do any mathematic things on strings (seems logical, but there are some languages (like JavaScript) that can under certain circumstances, so that's why I explicitly note it), but there are ways to do some manipulations on strings.

One of the most common actions you can do with strings is concatenation, which is, simply appending a string to a string. Maybe that didn't make much sense, so let's demonstrate.

```
h = "Hello"
w = "World"
hw = h..w
print(hw)
```

So we placed "Hello" in h and "World" in w. In the third line we concatenate these strings and the result is stored in hw.

Now when you copied this program to the playground or a cli tool you will see something went "wrong". The output is "HelloWorld" and not "Hello World". This is not Lua's fault, but mine. I didn't put a space in the original variables. Spaces are just characters just like letters, so if you want them you must put them in, and if you don't want them, leave them out. Unwanted spaces or spaces not appearing when they should can easily happen in careless handing of strings, and sometimes the results are pretty downhearting and heart to find when debugging.

Now the funny part to concatenation is that Lua even allows numbers to be concatenated into strings.

```
s = "I am "..40.." years old"
print(s)

s = "I was born in "
y = 1975
s2 = s..y
print(s2)
```

Both examples work just fine.
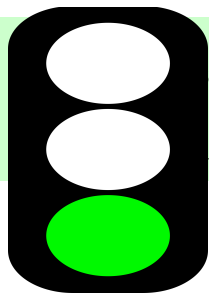
Create a program in which one variable contains your name as a string and another variable that contains your age (in years) as a number.

Create a third variable that concatenates the variables in a string where the out put will be "My name is <name> and I am <age> years old."

3.3.3 C formatted strings in Lua

 Now the C junkies reading this will very likely prefer C-formatting for concatenation, and therefore it's good to know that Lua has full support for this. There are basically 2 ways to do this, and it just comes down to what you think is best.

There is no variant to printf, but rather to sprintf and the result is just returned as a string. Two examples to do this:

```lua
name = "Jeroen"
year = 1975
mystring = string.format("My name is %s and I was born in %d",name,year)
print(mystring)
```

This is the simple way to do this. Of course to a real C programmer it goes without saying that you can use functions as parameters, so you can also do print(string.format(blah blah)).

There is also a kind of OOP way to do this and that'll look like this:

```lua
name = "Jeroen"
year = 1975
mystring = ("My name is %s and I was born in %d"):format(name,year)
print(mystring)
```

Now this way to go is also completely valid. Please note the (and the) in which the format string is set *is* required, or Lua will throw an error.

3.3.4 String Slicing

String slicing has always been an important thing you can do with strings. And that's why Lua too has support for this. Lua uses the string.sub() function for this.

The basic syntax for string.sub is as follows:

$$string.sub(string, startsubstring, endsubstring)$$

Now this is pretty vague, I know.

When you are new to programming let me first tell you what string slicing is. It's nothing more or less than cutting or copying a part out of a string and make a new string out of that.

I guess that made even less sense, so let's demonstrate with some examples:

```lua
s = "I am Jeroen"
print(string.sub(s,6)) -- outputs "Jeroen".
print(string.sub(s,1,4)) -- outputs "I am".
print(string.sub(s,6,8)) -- outputs "Jer".
print(string.sub(s,6,6)) -- outputs "J".
```

Of course, the question is if you have understood what this all does.

Let's ignore the first print line for now, I'll get back to that later. The second line I did request the

characters on spots 1 till 4. Well:

1. Spot #1 contains "I"
2. Spot #2 contains a space
3. Spot #3 contains "a"
4. Spot #4 contains "m"

And the combined result is returned and thus the string "I am" was formed this way. Now all the two lines below that line basically perform the same trick.

In the first print line you may have seen that I did not give a number for the ending spot. And yet the line outputs "Jeroen". When no ending spot is given Lua will assume that the last spot of the string will be the ending spot, and since the first letter of "Jeroen" was on spot #6, it therefore puts in all letters coming next.

Now there's another trick... Negative numbers in string.sub()

```
s = "I am Jeroen"
print(string.sub(s,-6)) -- Outputs "Jeroen"
print(string.sub(s,-6,-2)) -- Outputs "Jeroe"
print(string.sub(s,-6,8)) -- Outputs "Jer"
```

Well do you have any idea what just happened here?

Indeed when negative numbers are used, it will count from the right in stead of the left. So -6 means 6th spot from the right. Since the last word "Jeroen" contains 6 letters, you can easily guess why my name was outputted. And I did not give an ending number so Lua did just assume I wanted to go to the end of the string.

Well the -6 -2 combination is now easy to guess. From the 6th spot from the right (J) to the 2nd spot from the right (e) and thus "Jeroe" was outputted. Easy, huh?

The last one is put in to show you that negative numbers and positive numbers can just be combined. From the 6th spot from the right (J) to the 8th spot from the left (r) and thus "Jer" was outputted.

> Now Lua will not moan or whine or anything when you come up with an impossible combination like from 6 to 5 (from the left). Whenever you come up with impossible combinations, string.sub will just return an empty string. As a programmer you are fully responsible for giving correct digits to string.sub for proper output!
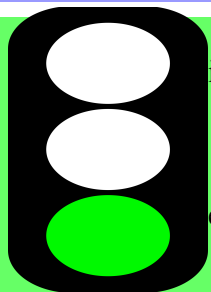
> Now create a program with a string variable containing the string "Donald Trump is the 45th president of the United States".
>
> Then make it output "Donald" by slicing out that name.
>
> Then make it output "States" simply by slicing out from the right without an ending point.
>
> Then make it output "Trump" by slicing out that name from the left.

And lastly (and that may be a tricky one) make it output "United" simply by slicing from the right only.

3.4 Boolean type

Now the last type I will cover in this chapter (as I will go into the deep of tables and functions types later) is the boolean type. Now "boolean" is not really coming from an existing word like the names of the other types. It was named after the English mathematician and philosopher George Boole, who lived from 1815 until 1864.

Boolean types can be pretty abstract when you are new to programming, but they might well be one of the most important types in the history of programming.

A boolean type can only have two values. "true" and "false".

Now at first sight, this may seem pretty pointless, however boolean values are often generated through expressions. When I'm gonna explain about the 'if' and the 'while' commands you will find out how important boolean expressions can be, and then it's good to know that you can store the output in a variable.

Now this is getting quite abstract, so let's throw in an example:

```
s1 = "Donald Trump"
s2 = "Donald Trump"
s3 = "Barack Obama"


b1 = s1 == s2
b2 = s1 == s3


print(b1) -- Outputs "true"
print(b2) -- Outputs "false"
```

Now the first three lines don't need any explanation, I think.

Now in Lua "==" means that Lua needs to check if the value in both variables are the same. If so the outcome is "true" if not the outcome is false. Now this makes it very easy to see why b1 contains "true" since both s1 and s2 contained "Donald Trump". As s3 contains "Barack Obama" which is of course not "Donald Trump" b2 became false.

```
s1 = "Donald Trump"
s2 = "Donald Trump"
s3 = "Barack Obama"


b1 = s1 ~= s2
b2 = s1 ~= s3


print(b1) -- Outputs "false"
print(b2) -- Outputs "true"
```

Now I've altered the code a bit. You can see I replaced both "==" operators with "~=". In Lua "~=" means "is not". And hence now b1 became false as I made it check if "Donald Trump" is not "Donald Trump", but as that is both the same string "is not" is therefore not the case (you follow as double negative is always hard to understand), and thus the outcome "false". And I wanted "Donald Trump" not to be "Barack Obama" in b2, well since that is not the case, the outcome is "true".

Now boolean expressions too are in for combinations.

```lua
s1 = "Donald Trump"
s2 = "Donald Trump"
s3 = "Barack Obama"


b1 = s1 == s2 and s1 == s3
b2 = s1 == s2 or  s1 == s3


print(b1) -- Outputs "false"
print(b2) -- Outputs "true"
```

"and" and "or" are keywords reserved for usage in boolean checks. Now can you see why the output is the way it is?

Basically the code explains itself.

For b1 in wanted "Donald Trump" to be "Donald Trump" AND "Donald Trump" to be "Barack Obama". Due to the "and" keyword both statements must be true, but as the latter is false the entire expression is false.

For b2 either one of the two statements or both had to be true, well since the first statement is true so the entire statement is true and that the latter is not, is no longer relevant.

Then there is one final keyword to keep in mind and that is "not" and it does exactly what the name implies.

```lua
s1 = "Donald Trump"
s2 = "Donald Trump"
s3 = "Barack Obama"


b1 = not ( s1 == s2 )
b2 = not ( s1 == s3 )


print(b1) -- Outputs "false"
print(b2) -- Outputs "true"
```

Since I put in "not" this time, it basically may not be "true". Since s1 *has* the same value as s2 that is true, but as it may not be true, "false" is the result, and since s1 did not have the same value we did see what we want and get "true".

Lua can be a very strange beast in parse checkings, and if you are using an IDE that supports parse checking then "b1 = not s1==s2" will be taken as a valid instruction, but the outcome may surprise you as what Lua will do is "b1 = (not s1)==s2". I therefore advice to never use 'not' without parents, but to always include them like shown above.

Now it is also cool to note, and that is where boolean expressions can be powerful is that they can also be used on mathematic operations and concatenations, and all this in real time. Let's write a

small program to demonstrate this:

```
b1 = 5+7 == 12
b2 = 5+8 == 15
d1 = "Donald"
d2 = "Trump"
d3 = "DonaldTrump"
b3 = d3 == d1..d2
print(b1)
print(b2)
print(b3)
```

Well since 5+7 is indeed 12, b1 will be true. Since 5+8 is 13 and not 15, b2 will be "false", and the concatenation of "Donald" and "Trump" is indeed "DonaldTrump", so that outcome also fits and thus "true".

Lastly there are a few more operators for you to keep in mind:
- Greater than   >
- Lower than   <
- Greater than or equal >=
- Lower than or equal   <=

They can be used in stead of == or ~= but only when you are using number values.

```
b1 = 5+7 == 12
b2 = 5+8 <= 15
d1 = "Donald"
d2 = "Trump"
d3 = "DonaldTrump"
b3 = d3 == d1..d2
print(b1)
print(b2)
print(b3)
```

When I change the code to this, you will see 3x "true" as output, and that fits since 5+8 is 13 which happens to be lower than 15.

4. The "if" keyword

4.1 if … then … end

Now the "if" keyword is important to understand. This is one of the commands in which you'll be able to make your program actually respond to what the user is doing.

Basically you say "*if* something is the case *then* perform all instructions until the *end*".

The basic syntax is like this:

```
if <boolean-expression> then
<all instructions to perform when the boolean expression happens
to be true>
end
```

Now the "end" keyword pops up for the first time in this book, and it's the most used keyword in Lua. "if" creates what we call a scoop. A scoop is just a collection of commands. Every scoop ends with the "end" keyword (few exceptions, but we'll get to that later). For C users, it's basically what you use accolades for in C, but in Lua "if" and other commands like that will always open a scoop.

Now let's demonstrate this:

```
name = "Neil Armstrong"
print(name)
if name=="Neil Armstrong" then
    print("Yup, that's the name of the first man on the moon.")
end
```

Let's break this down a bit. The first two lines should be known by now. With "if" we start the "if"-statement and as you can see the name is checked in the same way as we create a boolean variable. The "then" keywords lets Lua know the end of the expression is reached and starts the scoop with all the commands that should be executed then, which is now only one, but there is no limit how far you can go with then and lastly the "end" commands closes the "if" scoop.

If you run this program you can see that the program confirms that Neil Armstrong is the first man on the moon. If you put anything else in the "name" variable nothing will happen aside from showing the name, after all that confirmation command should only be executed if the expression is true.

NOTE: You can see that I put in some leading spaces for all commands within the "if" scoop. We call this "indenting". It is good practice to follow my example on this, as this keeps your code more readable. It's then easier to see what belongs to what scoop. If you want to plan to learn Python in the future all scoops end when you stop indenting in Python. Although Lua doesn't care about this, you can spare yourself some misery when you also learn Python, and also for good overview it's better.

4.2 if...then...else... end

```
name = "Neil Armstrong"
print(name)
if name=="Neil Armstrong" then
    print("Yup, that's the name of the first man on the moon.")
else
    print("No, the name is not the name of the first man on the moon.")
end
```

Perhaps you can see a little where I'm going here. If the variable name contains "Neil Armstrong" then the first scoop is performed. Else will end the first scoop and open a new one and there all the commands are shown performed when the expression was false.
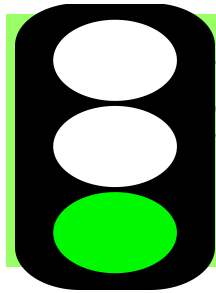
Now you should be able to make a program that checks if a variable called "name" (string) actually contains your name, and if a variable called "age"(number) contains your correct age and make the computer say "Correct" if it's correct and "Incorrect" when it's incorrect.

All the information you need to do so is in the last two subsections.

4.3 if … then … elseif … then … else … end

```
name = "Neil Armstrong"
print(name)
if name=="Neil Armstrong" then
    print("That's the name of the first man on the moon.")
elseif name=="George Washington" then
    print("That's the first president of the United States")
elseif name=="Margaret Thatcher" then
    print("That's the first female prime minister of the United Kingdom")
else
    print("I don't know who that is.")
end
```

Now this looks a bit more complicated, but it's not as hard as it looks.

"elseif" simply means "if any of the previous statements was wrong check this one and execute if true". You can throw in as many elseif statements as you want, and the last else is also optional. Now you can get a real show on the road, eh?

This note only matters when you have experience with C, Go, C#, Pascal or any other programming language.

Lua has no case-support, meaning that if you ever need casing you are basically condemned to use if-elseif-else structures like above. It's a very serious downside about Lua, and I do not know if future versions will ever support it. Sorry about that!
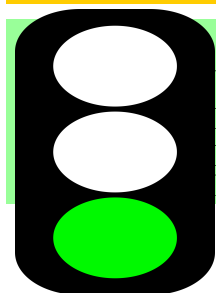
Now make a program in which you put in the name of a person you know in a variable called "name" and use ifs and elseifs to check the name and state that person's profession and in the end an else statement stating that you don't know that persons profession. Now change the name variable with several tests to see what happens.

5. Loops

Loops allow your program to do things over and over, again and again.

Now basically there are three ways in which Lua can loop. "For", "While" and "Repeat/Until".

5.1 For

For can be used in multiple ways, but for now, we will only use it for countdowns and countups. Let's demonstrate the for routine, eh?

```lua
for i=1,10 do
    print(i)
    if i%2==0 then
        print("Even")
    else
        print("Odd")
    end
end
```

The "for" command creates a variable just for itself and that is in this case "i". This variable will only exist within the "for"-scoop, not outside of it. It will be defined as 1 and then all commands in the for-scoop will be executed and after that "i" will be increased with 1 and then the scoop will go on again. Once "i" has reached 10 at the end of the for-scoop, the loop will end and the first command after the "end" will then execute.

Now it's nice to note that if has its own scoops. Lua will know which end belong to which scoop, as basically end closes all scoops in reverse order as they are created, so the parser (the program inside Lua that checks and interprets your code) will not get confused.

Now basically any value can do, as long as you first put in the start value and the end value at the end. The instruction as shown above however, can only count up, but like I hinted, counting down is possible if you enter a third number, which we call the "step value"

```lua
for i=10,1,-1 do
    print(i)
    if i%2==0 then
        print("Even")
    else
        print("Odd")
    end
end
```

Due to the step value being negative Lua knows it should now count backwards.

Now this is fun, but we can basically go into any direction here with any kind of values

```
for i=0,50,5 do
    print(i)
    if i%2==0 then
        print("Even")
    else
        print("Odd")
    end
end
```

This example works the same as the programs before, however now "i" will be incremented with 5 every cycle.
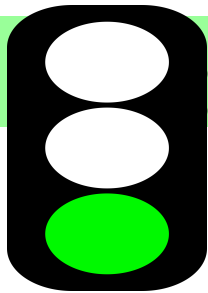
Now make a program and use the for-command in order count from 1 till five and combine it with the if-elseif commands to make it print the number in word in stead of digits.

5.2 While

Now proper understanding of the "while" command is very important. The working of the "while" command is similar to "if" command however while keeps repeating the scoop until the boolean expression it comes with returns false.

Now while should be handled with care and perhaps this examples show you why:

```
name = "Jeroen"
while name=="Jeroen" do
    print("Looping")
end
```

Yup, the loop goes on forever, as the expression will always be true.

But we can do something else here:

```
a = 0
b = 1
while b<10 do
    a = a + 1
    if a>b then
        a = 1
        b = b + 1
    end
    print(a..","..b)
end
```

Well as the variable being checked by while now we don't have an infinite loop. The variable b can be changed in every cycle, but that doesn't necessarily happen (as would be the case in a for-

loop). This is one of the most common loops in most of your programming work. Since we've not yet gone into the deep of functions yet, I cannot demonstrate much more, but this does show the basic idea of what to expect on while loops.

5.3 Repeat Until

Repeat until work pretty similar to while, although it is different on a small yet essential point. Where while checks as soon as the loop starts, repeat until checks when the loop ends. Due to this it is possible with while the loop gets skip altogether, as there could be a boolean expression that is false from the start. Since Repeat Until checks at the end the loop will always be executed at least once.

```
a = 0
b = 1
repeat
    a = a + 1
    if a>b then
        a = 1
        b = b + 1
    end
    print(a..",".b)
until b>=10
```

This program is a bit of the repeat/until variant of the program I wrote earlier with while. Now if you'd make b to value 10 in the while-version of this program, you'd see nothing happens, if you do that here, you'll see the loop is performed once. In this original setup you should see any difference. Whether you should go for while or repeat/until is always a matter of judging the situation you're in as a programmer.

Please note that repeat until does not require an "end" to end the scoop the loop is in. Since until always comes at the end of the scoop, it's simply not needed.

Now here's a trapdoor, and especially when you are used to coding in C (or any of its variants) and therefore used to the do{}while() loops you can easily fall for this.

Where while keeps looping as long as the boolean expression is true, the repeat/until loops will loop like the word "until" implies, loop until the expression is true. In other words the expression must be false in order to keep looping. (It may seem a bit strange for a language developed in C to take over the standard of Pascal for this).

5.4 Break

This is a command I do not want to put too much attention on, as you can better avoid it, but when you need it, it's there. The break command will immediately terminate a loop and continue the program with the next command after it.

```lua
while true do -- start infinite loop
   a = math.random(1,10) -- generate random number from 1 till 10
    print(a)
    if a == 5 then break end
end
print("I have now left the loop")
```

Normally I'd use repeat until for this, but this terrible code demonstrates how break works.

The math.random() function just generates (pseudo-)random numbers and as soon as number 5 was generated the break command is executed causing the loop to end and go to the "print" command after the "end" (or until in case of a repeat/until loop).

Please note that break only works inside a loop. It has no effect on other kinds of scoops and without a loop it may even throw an error.

6. Tables

Tables is where working with Lua becomes fun. Tables are a very powerful instrument. There is a lot a programming language should support which Lua does not, however tanks to the table system you can cheat on that. Even OOP (object oriented programming) becomes possible, although Lua officially doesn't support that.

6.1 Using tables as arrays

Arrays in programming languages are variables containing a series of values. In Lua you can use tables to make this happen. Best is maybe to show this in example code.

```lua
a = {} -- create table
a[1] = "One"
a[2] = "Two"
a[3] = "Three"
a[4] = "Four"
a[5] = "Five"
for i=1,5 do
    print(a[i])
end
```

When you ever programmed in another language you'll be used to 0 being starting index of an array. Lua however uses 1 as starting index on an array. Never forget this or you can mess up dearly!

Although 0 can be used as an index, in array usage it will be ignored.

Well the variable "a" is thus the table and the numbers between the brackets [and] are called the indexes. Now now you can see maybe why understanding arrays is so important and how much power they can give. The for-loop at the end of the code above shows that you can use a variable to determine the index number.

The fun doesn't end there. The example above can be done with less code. Like this:

```lua
a = {"One","Two","Three","Four","Five","Six","Seven","Eight","Nine","Ten"}
for i=1,#a do
    print(a[i])
end
```

You can, as you can see, easily define the entire array in one line. The first entry will be index #1, the 2nd will be index #2 and so on. And #a means "length" of "a". This sign can be used for strings and array-based tables to get the length. If it's a string #a will contain the number of characters, and in a table the number of indexes.

Now in Lua any undefined variable will be considered "nil". Table elements are no different from this point. So a[12] will be nil, as I didn't define that index. #a will basically count from index 1 until the first 'nil'. Since a[11] is the first nil in the example above #a will therefore be 10. When you put in the line a[6]=nil, then #a will be 5 and despite 7, 8, 9 and 10 having values. They will be ignored. I'll get later on how you can properly remove values from an array.

The for loop I used in the example above is considered dirty in Lua. Many programming languages contain a workabout that we often call "foreach". Now "foreach" is not a keyword in Lua, but the name is based on the fact that much programming languages either have "foreach" or "for" and an expression with "each" in it. Forget about that for now, let's do this the Lua way.

```lua
a = {"One","Two","Three","Four","Five","Six","Seven","Eight","Nine","Ten"}
for i,n in ipairs(a) do
    print(n)
end
```

The keyword "ipairs" is one you'll find a lot in Lua scripts. The "for" command will loop as always, but a bit differently than in the examples we had up until now. It will now take all indexes in order and loop the scoop tied to this until the first "nil" arrives. In the example above "i" will contain the index number during each loop cycle and "n" the value stored in that specific element.

Is the fun over of using arrays in Lua. No! Lua can do something more. Tables can be altered after their definitions. In the first example you saw you can do that one by one so adding "a[11]='Eleven'" is just a simple way to go, but in an OOP set up game, you can go even further than this, as then you can just add objects as they go. Imagine a space shooter in which enemies just fly in at random, becoming more and more? Arrays can do this.

```lua
a = {}
-- method #1 for addition
table.insert(a,"One")
table.insert(a,"Two")
table.insert(a,"Three")

-- method #2 for addition
a[#a+1]="Four"
a[#a+1]="Five"
a[#a+1]="Six"

for i,n in ipairs(a) do
    print(n)
end
```

In the example above I've shown you two methods to add elements to an array. There is some debate among Lua programmers which method is best and even the creators of Lua are not too sure, but I personally prefer method #2.

Anyway, you can go as far as you want to go with this. There is no official limit (although there are limitations to your RAM, but don't worry about that when you are only an amateur. In my Sixty-Three Fires of Lung game, I've used with array with over thousands if not ten-thousands if elements).
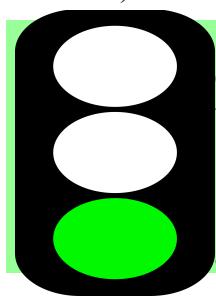
Make a program and create a table and add three animal names in it in the creation instruction. Then add a random number of other animals with either table.insert() or the a[#a+1] method I showed above.

Now make a for-loop that shows all these animals.

Lastly use a print instruction that shows how many animals there are in your array.

Lastly I will explain table.remove(). That can be used to remove one element from your array and all the other elements will be adapted to the new situation.

Try adding the line "table.remove(a,3)" in your program (assuming your table variable is "a") just before the for-loop and run the program again and see what happens. ;)

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