Advanced Research Computing

@arc_du

July 7, 2020

Learn how to programme (in Python)

2020-07-

Learn how to programme (in Python)

Marion Weinzierl

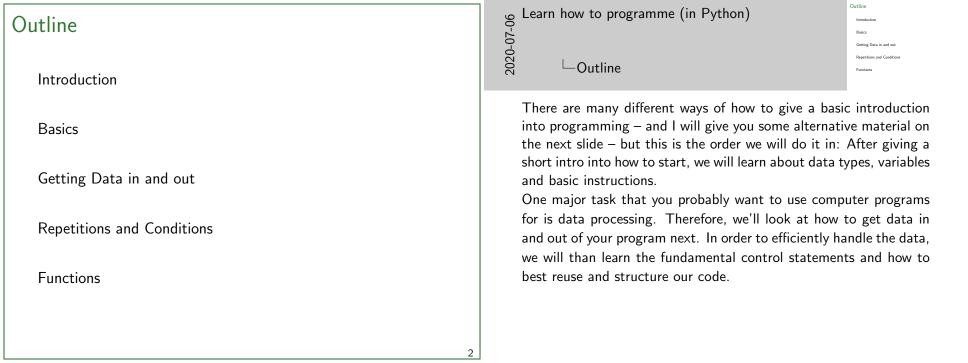
Advanced Brownic Computing

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July 7, 2020

Welcome to our programming course. This course will teach you the basics of computer programming. We use Python as programming language in this course, but we hope that you will be able to transfer your knowledge to other languages easily, once you got the hang of "thinking like a programmer". The basic principles are similar in most popular programming languages.

Before we start, just some words about how this course will be organised. [mute microphones, switch on cameras, ask questions in chat or unmute yourselves, colleagues here to help, break at around 11am, presentation – live coding (type along) – practise etc.]



2020-07

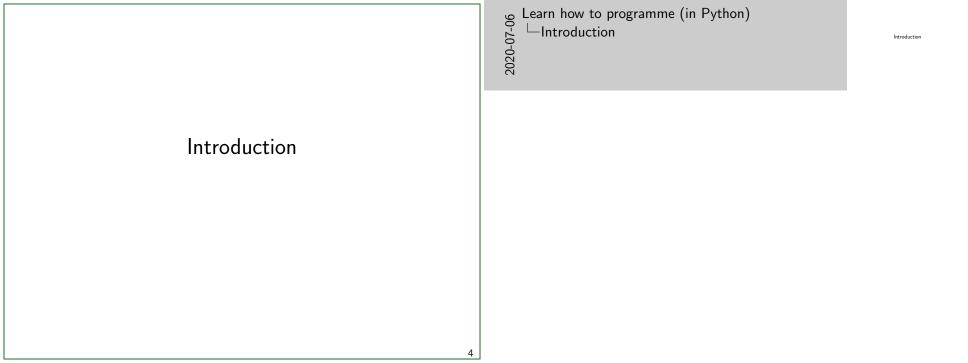
- ► Python Wiki Python for Non-Programmers
- ► How to think like a Computer Scientist
- ► A Whirlwind Tour of Python
- ► Software Carpentry Programming with Python

Materials used and recommended

and seems to be targeted at a more technically-minded audience. Finally, you might or might not have heard of the Software Carpentry. This is an organisation aimed at providing basic software training for everyone. They have a "train the trainers" approach, which means that they provide material and training courses for software carpentry trainers. Thankfully, you are also allowed to access and use their material for free. This training course here gives a Python

introduction at hands of a practical data processing task.

In contrast to that, "A Whirlwind Tour of Python" has a faster pace,



Course Objectives

► how to structure your code using functions

what can lead to your program not working, and what t where to find further resources to practice your Python

By the end of this course you should know

Course Objectives

Let's talk about our course objectives now. My main objective is to enable you to start programming with this course. Of course I

cannot teach you all there is to learn about programming. But I hope to give you a starting point. We will talk about how to get a simple computer program running, the basics in terms of data types. variables, if-statements and loops, getting data in and out of your program, functions and variable scope, and a bit about comments and error types and error handling. By the end of the course I hope you will be able to continue from there. Programming is a lot about learning by doing. There are tons of online (and offline) resources, and also forums (online and offline) where you can ask for help.

By the end of this course you should know

▶ how a basic computer program is written and executed,

▶ what basic data types and control statements are,

▶ how to get and process user input and data, ▶ how to structure your code using functions,

what can lead to your program not working, and what to do about it.

▶ where to find further resources to practice your Python programming.

☐ Introduction ☐ Programming and Programming Languages

Learn how to programme (in Python)

do the work for us.

Why do we want to program? Well, first of all: Why do YOU want to program? I would be interested to hear what your reason for attending this course is, and what you hope do with your programming skills. Please, just unmute yourselves, or put your reasons in the chat and I will read them out.

[Collect reasons why participants want to learn programming]

Maybe we can summarize this as follows: We want the computer to

Programming and Programming Languages

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8 Learn how to programme (in Python)

—Introduction

With a computer program we tell the computer to do some of the work we cannot or do not want to do by hand.

Programming and Programming Languages

Programming and Programming Languages

Programming means: make the computer do the work for you!

- ▶ Do the maths
- ► Boring repetitions
- ► Too complicated/extensive tasks
- ► Big data sets

2020-07-(-Programming and Programming Languages

Learn how to programme (in Python)

-Introduction

These can be small things, like looping over repetitive tasks, or com-

puting some mathematical expression. Or we might want to process data sets of some sort, do some kind of agent-based or numerical simulations, make different software components work together,... Being able to program opens up a whole lot of possibilities!

Programming and Programming Languages

Programming and Programming Languages

Steps:

- ► Write your code in high-level programming language.
- ► Translate into low-level (machine/assembly) language.
- ► Execute program.

□ Introduction
□ Programming and Programming Languages

Learn how to programme (in Python)

Now, how do we get the computer to do these things for us? This is what we ar doing: We write the program in a language that we as human beings (with some training) can understand. As the computer won't be able to understand the code that way, we then compile it, which means that we translate it into computer language. Then we execute the program and, given we have made no mistake, the computer will get working for us.

Programming and Programming Languages

Programming and Programming Scripting Languages

Steps:

Write your code in high-level programming language.

- vviite your code in nigh-level programming language.
- ► Interpret code and execute directly

☐ Introduction
☐ Introduction
☐ Programming and Programming Scripting
☐ Programming and Programming Scripting

Programming and Programming Scripting

Languages

Things can be made a little bit easier by using an interpreted script-

Learn how to programme (in Python)

ing language instead of a compiled programming language.

- ► Write your code in high-level programming language.
- ► Interpret code and execute directly

Beware: Oversimplification!

Learn how to programme (in Python)

Introduction

Programming and Programming Scripting
Languages

Please note that I am oversimplifying here a bit with regards to the terminology. The point I want to make is that there are languages, such as Python, which we will be using in this course, that translate and execute the code directly, without us having to do a separate compilation step.

Programming and Programming Scripting

➤ Write your code in high-level programming language

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How do you start?	Learn how to programme (in Python)		
 We go the easy way (so you can build it up from there): ► Choose Python. ► Skip the installation bit: Jupyter Notebooks. ► HOWEVER: You have to type yourselves! Don't copy-paste (yet)!¹ 	 [show how to login to Jupyter server, open new Jupyter Notebook, open new Terminal and start Pyter 		
► Have a play. If you try to copy-paste from these slides, you will sometimes get a syntax error because of the characters used in the PDF.	 shut down running processes menu items in Jupyter Notebook 		

-Introduction Choose Python. ► HOWEVER: You have to type yourselves! Don't ► Have a play. ⊢How do you start? ³If you try to copy-paste from these slides, you will sometimes get a syntax error because of the characters used in the PDF show how to • login to Jupyter server,

How do you start?

We go the easy way (so you can build it up from there):

- - open new Jupyter Notebook,
 - open new Terminal and start Python interpreter,
 - shut down running processes
 - menu items in Jupyter Notebook tab.

Hello World!

Learn how to programme (in Python)

Untroduction

Hello World!

It is a tradition in the programming world that you start learning a new programming language by writing a program that prints out the words "Hello World!" to your standard output (for example, the terminal).

Hello World! (in C++)	
helloworld.cpp:	
#include <iostream></iostream>	
using namespace std;	
<pre>int main() { cout << "Hello World!\n"; return 0; }</pre>	
compile:	
g++ -o helloworld helloworld.cpp	
execute:	
./helloworld	
11	

```
-Introduction
                                                         cout << "Hello World!\n"
        -Hello World! (in C++)
                                                        helloworld
Let's first have a look at how this would look like in C++, a compiled
language.
This is the program: You include the necessary tools for inputs and
outputs, and define a namespace, which means, a scope for your
variable names. Don't worry about all these details now, if you go
back to this slide at the end of the course, you will hopefully under-
stand (most of) what's going on. You define your main function,
```

Learn how to programme (in Python)

Hello World! (in C++)

print the words to your standard output, and return zero, which means, all worked well. The next step, as you will remember, is compiling the program, which is what we are doing in the next box.

And finally, we execute the program, and it will print "Hello World!". Don't be scared now, we will now do the equivalent in Python.

Learn how to programme (in Python) Introduction
└─Hello World! (in Python)
That's it. A bit easier. Let's do it all together now.

[Run Hello World, explain how to actually execute the program] To make it a bit more interesting, let's play around with it together. Don't worry if you don't understand why these commands look like

of what is written down.

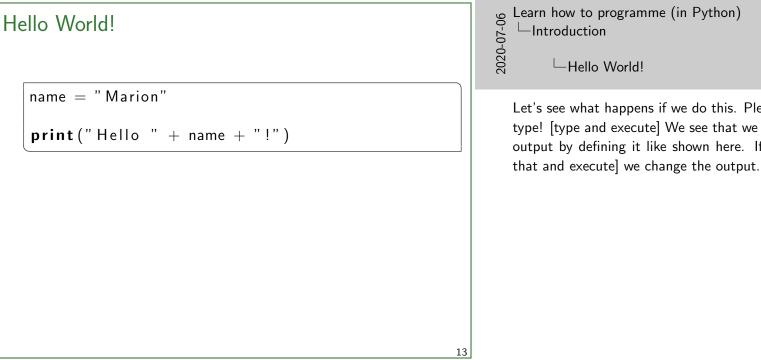
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they do, and what the syntax exactly means. We will go through this in a moment. Just a short note on terminology, to make sure we are on the same page: "syntax" is the form of a computer program, i.e., how things

are written down. On the other hand, "semantics" is the meaning

Hello World! (in Python)

print ("Hello World!"



Let's see what happens if we do this. Please, again, type along as I type! [type and execute] We see that we can put the name into the

output by defining it like shown here. If we change the name [do

print("Hello " + name + "!")

Hello World!

```
☐ Introduction
☐ Hello World!
☐ Hello World!
☐ Hello World!
☐ Itype and exe-
```

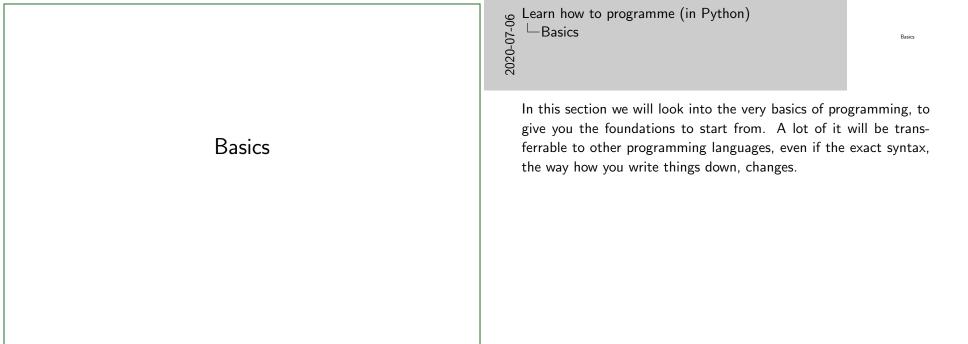
Hello World!

However, if you look closely at the syntax and compare with what we have done before, it has changed. What happens if we add the quotation marks around "mySum"? [demonstrate]

cute] As you can see, it has actually added the numbers together.

You can see, there is a lot going in these few lines. Let's stop for a moment and look into the details.

Learn how to programme (in Python)



Learn how to programme (in Python) **Basics** -Basic Data Types When you are programming, you have to be clear about what type

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each "item" you are handling has. Each data type has different rules. In the most basic version, Python has the following data types:

Basic Data Types

► Booleans: True, False

- Strings, which are bits of text, noted by single or double quotation marks, which can be nested.
- Integers, which are whole numbers, positive or negative.
- Floats, or floating points numbers, which allow for a fractional part.
- Booleans, or bools, which are truth values, and can be either true or false.

2020-07-06 -Basics: Variables

Basics

Learn how to programme (in Python)

The next essential concept you need to know for programming in

Basics: Variables

► Suntay: name - value

Python are variables. By writing "name = value", you are basically saying "I reserve a space in memory for my data bit, which is value, and I call it name".

Then you can use the name to further process your data bit, as we have seen in the example with the print statement.

Learn how to programme (in Python)

Basics

Examples

In this example we see the print statement again. It will usually

expect a string, or something that can be converted to a string. Here we are saying that the variable "myString" should have the string value 'He said "Hello", and then put the print statement separately. The "type" command is able to tell us, what type the variable "myString" has. [demonstrate]

As a side note, many programming languages, in particular compiled programming languages, require you to explicitly state the data type

of your variable when you create it. We do not need to do that here.

Examples

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```
Examples
  print(2+5)
  print("2+5 = " + 2 + 5)
  print("2+5 = " + str(2 + 5))
  print ("2+5 = ", 2 + 5)
```

Basics -Examples The third example shows you how to explicitly cast a number to

Learn how to programme (in Python)

concatenate it to the other string".

a string. We tell it "add 2 and 5 together, make it a string, and

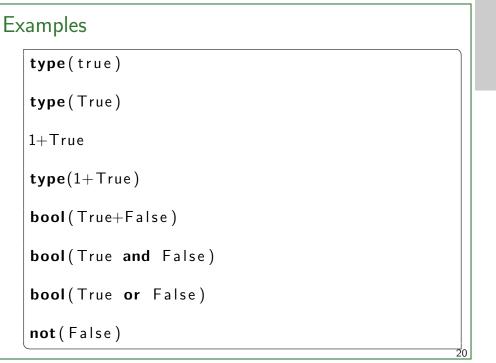
Examples

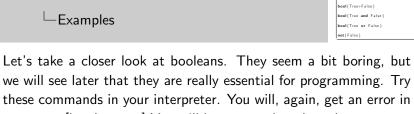
print (2+5)

print("2+5 - " + 2 + 5) print("2+5 = " + str(2 + 5)) print("2+5 - ", 2 + 5)

To make things a bit more complicated (or easier, depending on your point of view), you can do the same things by simply putting a comma instead of the plus in the print statement. Ask me about the meaning behind that at the end of the course, when we have talked about functions!

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Learn how to programme (in Python)

Basics

Examples

type(1+True)

these commands in your interpreter. You will, again, get an error in one case. [let them try] You will have seen that the values are case sensitive, so you have to make sure to write "True" and "False" with capital letters. You will also have noticed that "True" has the numerical value one, and "False" is zero. You can invert the value with "not", and combine two values logically with "and" and "or".

Basic Operations

It is very important to be aware how these operations are executed in long arithmetic expressions. Generally, if you have something like a plus b plus c, it happens from left to right: First a plus b, and then plus c. However, if you have exponents, like a to the power of b to the power of c, the right-most operations happens first: b to the power of c, and then a to the power of the result. Exponents bind stronger than times and division, i.e. exponents are computed first, and times and division is stronger than plus and minus. If in doubt, just use parenthesis.

You will have the chance to play around with this in a moment, and find out for yourselves how it works.

- ► String: concatenation with + ► Bool: and, or, not
- ► Numerical data: +, -, *, /, %, **, abs, ...
- ► Order of execution:
 - 1. ()
 - 2 **
 - 3. *,/
 - 4. +, -
 - 5. Left-to-right (except exponentiation!)
- ⇒ Use parenthesis to make sure!

Basics: Comments (and Documentation)

This is my programme to demonstrate how to # do simple calculations in Python.

myNumber = 2

print (myNumber)







myOtherNumber = myNumber+5

myNumber = myOtherNumber/2 # I have to divide

by 2 here, as the # results are

otherwise rubbish

-Basics: Comments (and Documentation)

& Learn how to programme (in Python)

beginning or in the middle of a line.

-Basics

vOtherNumber - mvNumber+5 # results are print (myNumber)

Basics: Comments (and Documentation)

But first, I want to show you two more things.

One is comments. When you are writing your code, your intentions and your thinking might seem obvious, and you just want to get it running. However, believe me: If someone else is looking at your code at some point, and this someone else might be you in two

weeks time, things are very probably not that obvious anymore. I

found myself puzzling over my own code and why on earth I have

done things like that quite often. In order to put a comment in your code you have to tell the interpreter that this bit is just for the humans reading the code, not

interesting for the computer. In Python this is done by putting a hash symbol in front of the comment. This can be either at the

Firers in computer programs are called "bugs" for histori-For complex projects, you will usually spend more time testing and debugging than writing code

-Debugging and Types of Errors

Basics

► Errors in computer programs are called "bugs" for historic reasons.

For complex projects, you will usually spend more time testing and debugging than writing code.

► Three types of errors:

Syntax errors - written the code wrongly

Semantic errors - written the wrong code

- Runtime errors - something's wrong with the code (during execution)

• The third type is runtime errors. These will just appear during execution, for example because your code cannot cope with a certain type of input. An example would be a code that divides a number by another number given by user input, which errors if the user input is zero or a string.

- what happens if you add a float and an integer,
- ▶ what happens if you mix numbers and bools in arithmetic expressions.
- ▶ how setting parenthesis changes the result of a large arithmetic expression.
- ▶ to print statements that include variables of different data types,
- try to reproduce each of the error types,

Learn how to programme (in Python) Basics

do, but you can do something different.

Have a play

how setting parenthesis changes the result of a large

yourselves. I want you to think about data types, variables, the different operations, comments and errors, and find out more about how they work by experimenting. Write little bits of code and see what works, what doesn't, and how the output changes. I wrote down some examples here, in case you are unsure what to

Now it's time for you to try the things that we have learned about

Again, if you have any question or need help, we are here to help. I'll give you about 10 minutes, then I'll go with you over possible solutions for my examples above.

-Getting Data in and out

Getting Data in and out

in one way or the other. Most times, we do not want to explicitely write our data into our code, which is also called "hardcoding", and has a bad reputation. Instead, we want to be able to provide data during runtime, and have a general program that is able to process the data.

How then do we get the data in and out of our program?

level. I expect that most of you are interested in processing data

Learn how to programme (in Python) Getting Data in and out User Input User Input As an equivalent to the print statement, there is the input statement. It just takes the input from the command line or terminal, and you can do with it whatever you like. For example, here I am putting it

message to the user to tell them what kind of input you expect. Note that, just as print outputs a string, any user input will be interpreted as of type string, regardless of whether it is made out of letters, numbers, or symbols. So you might need to convert it to whatever data type you need it to be.

into a variable x, and then output it. You can also add a prompting

This kind of user input is, of course, not suited for inputting large data sets. It is rather for getting in, for example, parameters, the path to the data set, or other settings or instructions to the program.

- Reading and writing files
 - # Create a file object
 - myFile = **open**("testfile.txt", "w")

 - Two things to note here:
 - ► My object "myFile" is different from my file "testfile"!
 - ► There are different modes:
 - read: r

 - (over-)write: w
 - append: a
 - read+write: w+ or r+

mode.

ω Learn how to programme (in Python) Getting Data in and out -Reading and writing files

Create a file object myFile = open("testfile.txt", "w") Two things to note here: ► My object "myFile" is different from my file "testfile" ► There are different modes: The actual data input will usually happen over a file. Follow me

Reading and writing files

in creating a new file. [demonstrate] As you will see, there is now a new file called "tesfile.txt" in your working directory. [show] But that is not the only thing that happened. At the same time, a file object called "myFile" was created in your program. These are two different things. For example, if I rename or delete the file object,

my file in the file system won't change. This might sound trivial,

but I thought I mention it, as it could lead to confusion. The w here stands for "write". If there is already a file with this name, we will now overwrite its contents. If we instead open the file

with "a" for "append", we start writing after the existing content. We can also open the file in read-only mode, or in read-and-write

```
And some more.")

myFile.write("\n\nl can also add numbers \
like this: %d %d \n" %(22, 333))

myFile.write(str(222))

# Don't forget to close the file
myFile.close();
```

see also f-strings

Learn how to programme (in Python)

Getting Data in and out

Reading and writing files

Reading and writing files

Reading some text and numbers into our file. Note that,

Reading and writing files

again, everything needs to be a string. We can put in numbers either by converting them directly to a string, or by putting in a place holder, like this "percent d", for numerial or decimal values, and then putting in the number after the string. The "backslash n"

The single backslash is a line continuation character and tells the interpreter that we are not done yet with that command, but that it continues in the next line.

At the end, we close our file, and then can no longer write to it

symbol stands for a line break.

[give them some minutes to do that]

unless we open it again.

Try for yourself to write something into the file you just created, and then check the content of your file!

Create a file object (this time for reading) myFile = open("testfile.txt", "r")

Read it and print it to screen print(myFile.read())

Try this:

print(myFile.read(7)) print(myFile.readline()) print(myFile.readlines())

Don't forget to close the file myFile.close();

Learn how to programme (in Python) -Getting Data in and out Reading and writing files

print(myFile.read()) print (myFile.read (7)) print (myFile.read line ()) print(myFile.readlines()) # Don't forget to close the file In the next step, we will read out data from the file that we have

Reading and writing files

just created. There are different ways of doing this. In this example, I combine the reading directly with a print statement, so that I see the result. Usually you would probably put the output of the reading

Have a go with these four different version of file reading. [give them some minutes You have seen that you can read the whole file in one go, read single characters from the file, or a whole line. If you apply the "readline" command repeatedly, it will go on to the next line of your file.

Interesting is the output of the "readlines" command. It gives you

a structure that has all the lines of the file in it, as separate strings, divided by commas.

operation into a variable, and continue to process it.

```
Learn how to programme (in Python)
Getting Data in and out
                                                                print(myList[3]) # Note: [] not ()
            What do we have here?
                                                                print(myList[:2]) # More slicing
     This kind of structure is called a list, and it is an essential data
     structure in Python programming.
     We can access the entries using square brackets. The first entry
     in the list is entry number zero, because we are programmers now,
     and programmers and computer scientists like to start counting from
     zero. We can even go backwards, in a periodic sense, and land at
     the last entry of the list at -1, the second-last at -2, and so on. We
     can take a slice of the list, for example the entries one to three -
     note that, in this notation, the first entry given is included and the
     last excluded. If we just put a colon, we mean that we go all the
```

What do we have here?

mean the whole list.

Have a Play!

https://www.w3schools.com/python/python_lists.asp

Learn how to programme (in Python)
Guide Getting Data in and out

Have a Play!
//www.w3schools.com/python/python_lists.asp

This is something that is worth getting your head around. Please go to the website given here, read through it and try their examples. At the end, you will find a list of methods on lists, with links to further information. Even though the website uses all toy examples, these are really useful tools in data processing. Try to think how you would use these methods on your actual research data. I'll give you 10 minutes, then we'll continue.

```
For Arithmetic Operations Better: Arrays
  import array as arr
  myList = [1, 2, 3, 4, 5]
  myArray = arr.array('i', myList)
  Alternative import:
  from array import *
  myList = [1, 2, 3, 4, 5]
  myArray = array('i', myList)
```

see also numpy arrays, (here a tutorial)

Getting Data in and out

For Arithmetic Operations Better: Arrays

Just as a side note, if you are working with numerical data, you might prefer to use arrays. Arrays can perform arithmetic operations

Learn how to programme (in Python)

might prefer to use arrays. Arrays can perform arithmetic operations directly on a slice, or the whole array. Here are two examples of how to convert lists of integers into integer

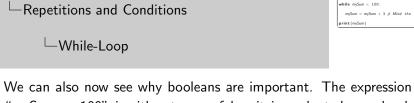
For Arithmetic Operations Better: Arrays

arrays. I won't go into more details about that here.

Repetitions and Conditions

Repetitions and Conditions

Now we know how to do simple computations in Python. But imagine a situation where you have read in all 1000 lines of your data file in a neat list, and now have to perform the same computation with all of them. Or you have 1000 files that you need to process all in the same way. Or you want to do repeatedly apply an operation to your data until it fulfils a certain condition. You definitely do not want to do this by hand, now that you know how to program!



Learn how to programme (in Python)

While-Loop

"mySum < 100" is either true or false, it is evaluated as a bool. If I would write "while true" my loop would just continue to run indefinitely. I can then tell it explicitely to stop, for example if a certain conditions applies, using the key word "break". If I write "while false", the interpreter will simply skip over the loop and not execute its body (which is how we call the inner part of a loop).

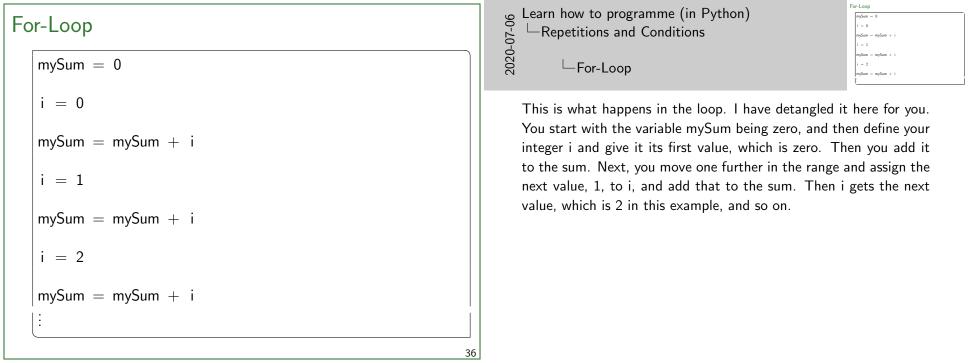
```
For-Loop
  mvSum = 0
   for i in range (5): # i goes from 0 to 4
      mySum += i \# mySum = mySum + i
   print ( mySum )
```

```
Learn how to programme (in Python)
   Repetitions and Conditions
      For-Loop
But I am showing you here a common way of creating a sequence
of integers that run from zero up to a certain value, the "range"
```

For-Loop

command. "range(5)" will give you a list with the numbers 0, 1, 2, 3, 4. You see, the list has 5 entries, and we start counting, again, from zero. [demonstrate what "range(5)" does, using "print(*range(5))"

to unpack the range sequence You can also start from a different number than zero, and go in different steps than steps of one. The syntax is "range(start, stop, step)". [demonstrate this – remember commas, not colons!]



```
For-Loop – Real-Life Examples
  for i in range(1, 100):
     filename = "myfile"+str(i)+".dat"
    #Do stuff with that file
  for i in range (100):
     currentFile = myFileList[i]
    #Do stuff with that file
  for myFile in myFileList:
    #Do stuff with that file
```

```
& Learn how to programme (in Python)
       Repetitions and Conditions
                                                                            filename - "myfile"+str(i)+".dat
                                                                           #Do stuff with that file
                                                                           for i in range(100):
                                                                           currentFile - myFileList[i]
            For-Loop – Real-Life Examples
                                                                           #Do stuff with that file
                                                                           for myFile in myFileList:
                                                                           #Do stuff with that file
   Given the previous example you might wonder what this kind of loop
    is useful for, but as soon as you start programming you will find that
    you use it a lot. Practical examples would be looping over all the
```

For-Loop - Real-Life Examples for i in range(1, 100)

files in a directory, or all the files in a file list, as shown here. As I had mentioned before, you can directly loop over all elements in a list, so the second and third example are actually equivalent.

(There will be some annoying whitespace if you type it like that, just remove the linebreaks and the whitespace in the messages in your code.)

than your second number.")

Learn how to programme (in Python) Repetitions and Conditions -If-Statement

print("Your first number is bigger than rour second number.")

You will get to play with these things in a moment.

Back from real-world examples to toy examples. This example code takes two user inputs, converts the string that the input function sees to a floating point number, compares the numbers and gives an output depending on which one is bigger. Again, mind the indentation and the colon! The "else" part is optional, if we only want to make an output in one case, we just omit it.

As the footnote here says, the whitespace in the second line of each print statement is just for readability on this slide.

However, there is one big issue with this code.

```
Learn how to programme (in Python)
  Repetitions and Conditions
      □Do we trust the user...?
You should, however, be aware that "try-except" is not always great
```

num2 - float(input("Another number!") print("Your first number is bigger tha

print("This wasn't a valid input

Do we trust the user 7

if you are developing or debugging a code, as the interpreter will no longer tell you which line in the "try" bit has actually errored. It is, however, useful for user-facing code.

Have a play!

You could try

- writing numeric data into a file using a loop, and reading them into a list.
- ▶ defining a 2d list using a 'lists in a list' notation [[...],[...]] and try accessing its elements.
- doing nested loops,
- ▶ thinking about what type of errors *try-except* is able to catch (see slide 22),

Learn how to programme (in Python) Repetitions and Conditions

Have a play!

writing numeric data into a file using a loop, and reading

► defining a 2d list using a 'lists in a list' notation [[...],[...]

thinking about what type of errors try-except is able to

We have learned quite a lot of new concepts, and I would like you to have a play with all of this now. Again, here are some examples what you could do, but feel free to come up with your own examples, and don't hesitate to ask for help.

We will continue with the last part of this training in 20 minutes.

-Functions

Functions

have written a particularly useful bit of code, for example a code that finds all the occurences of a word in a text and counts them, or replaces them by something else. Or a code that does a very specific computation with your data. And now you want to do the same in a different context, with different words or data. What do you do? Do you copy-and-paste the code and replace the words or numbers that will change in the new situation? What if you then realise you have to change a critical part of this program, will you remember to do that in all the copies of your code?

Let's move on to our last topic for today: functions. Imagine you

⇒ Somewhere someone must have written some code for that...

Can we do that as well?

Learn how to programme (in Python) -Functions -Functions

the keyboard in a certain order.

This is where functions come into play. In fact, we have already used functions today. We have used "print", "read", "input" and "open", given them parameters, and just accepted that this would perform more or less complex tasks. But of course, this is not some kind of computer magic, but somebody has written the code for what would happen if someone types the command "print" and gives it a string. We are just at the far end of a line of computer programmers that tell the computer what to do if somebody hacks on these keys on

Can we do that as well?

Functions ► Function Definition Arguments ► Function call

- ► Return statement
- Scope of variables

Learn how to programme (in Python) Functions -Functions What do we need to write our own functions? We need to know

how we define our function, and which arguments, or parameters, it accepts. We need to define whether the function is only supposed to do something, like the print statement take its arguments and prints it on the screen, or the write function writes text into a file. Or whether we want it to return a value that, for example, can be asigned to a variable, like the input function. It will also become

important that we are aware of how we should name our functions and variables, and from where in our program we can access them.

Functions

► Return statemen ➤ Function call ► Scope of variable

2020-07-

Learn how to programme (in Python)

Functions

Functions

Functions

Functions

Functions

Functions

Functions

Functions

in Python and is called, very sensibly, "sum".) We define it using the keyword "def", and again we use colons and indentation to show what belongs into the body of the function. In order to get our result out of the function we use the "return" keyword. We also define another function that does not have a return value, but just prints something. [type function definitions, show that nothing happens on execution] In order to actually execute the functions we have to call them. So, we assign the output of the first function

to the variable "myVar", and then use the second function to print the result. [demonstrate] We could have skipped the bit with the variable and used the call of the first function as parameter of the

second [demonstrate]

function.

Variables defined inside a function are only available in that

anotherFunction (myVar)

print("Here you go: ", parameter)

def anotherFunction(parameter):

-Functions

mySum - parameter1 + parameter2 def anotherFunction(parameter) Variables defined inside a function are only available in that

As you can see here, we assign the result of the function call to a new variable with a different name, "myVar". We could have chosen the same name, mySum, but what I want to make clear here is that variables have a certain scope, and are only known within this scope. If I try to access "mySum" from outside the function, without defining it here, the interpreter won't know it. [demonstrate] I could have two variables with the same name in here, one in the function. one outside, and one could be an integer and the other a string.

They wouldn't know of each other.

names!

understandable.

print("Here you go: ", parameter)

myVar = myFunction(22, 55)

anotherFunction (myVar)

Variables defined inside a function are only available in that function. We should really give the functions and variables better

-Functions Also, this code gives you a counterexample of good naming practice.

Learn how to programme (in Python)

If I look at the function calls I cannot guess at all what the functions will do, or what the variable will contain. It is good practice that your function and variable names make it very clear what they are. Do not use cryptic abbreviations or names like "a, b c", or "x1, x2, x3". I have seen this very often, and the same applies as I have already said about comments: If somebody else looks at your code, or if you look at your code at a later point, things might not

make sense anymore at all. In fact, if your variable and function names are meaningful you will need much less comments to make it

mySum - parameter1 + parameter2

Variables defined inside a function are only available in tha

lef anotherFunction(parameter)

Don't worry, we will not talk about recursion today, I just thought

I will put this link here in case any of you wants to have a look on advanced usage of functions later at home.

Advanced: Recursion

https://realpython.com/python-thinking-recursively

You could try

- ▶ thinking about how to best name the variables and functions in the examples above, and why meaningful names are crucial.
- writing your own functions, and let one be called from within the other.
- writing a code that uses all that you have learned today,
- ▶ use the Python debugger to step through your code,

Learn how to programme (in Python) -Functions

Have a play!

writing your own functions, and let one be called from

I'll give you another 20 minutes to put these things into practise, and then we'll have a short wrap-up before we are finished!

How to continue from here?

Before you leave this session, it would be great if you could leave feedback on this course in the form that I have linked here.

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Thank you very much! I hope you found this course useful.