ILP 2021 – W1S1
Getting started

Matthieu DE MARI – Singapore University of Technology and Design

A quick word about me

- Matthieu (**Matt**) DE MARI
- Lecturer at SUTD (Python, Deep Learning, AI, and more)
- Information Systems Technology and Design (ISTD) pillar/faculty
- PhD from CentraleSupelec (France)

- Email: matthieu_demari@sutd.edu.sg
- Office @ SUTD: 1.702.27

Outline (Week1, Session1 – W1S1)

- About this course: syllabus, objectives, Zoom, eDimension, practice, grading, etc.

- What is programming?
- Key concepts about programming and computer science.
- Programming languages.

- Installing and configuring Python, and extra packages.
- Our first programs!

Objectives of this Summer School

Objectives:

- Give the students an introduction to Computer Science,
- Programming,
- and Python.

Delivery:

- 3x 2h-lessons per week
- Lessons include a bit of theory (PPT slides) and practice activities (in Jupyter Notebooks)

Topics

- Week1 Session 1 (W1S1): Getting started, key concepts, configuring and installing Python
- W1S2: Variables, math operators, comments, printing and getting
- W1S3: None type, Boolean types and functions
- W2S1: More practice on functions
- W2S2: If, elif, else, while, break statements
- W2S3: More practice on if, elif, else, while
- W3S1: For loops, generators and recursion
- W3S2: The list type
- W3S3: Advanced concepts on for loops and list type

Topics

- W4S1: Debugging, errors, asserts and time
- W4S2: Numpy library (part 1) and imports
- W5S1: More on Numpy (part2), randomness and mini-project #1
- W5S2: Everything about strings
- W5S3: Dictionaries and object-oriented thinking
- W6S1: Object-oriented programming (part 1)
- W6S2: Object-oriented programming (part 2) and mini-project #2
- W6S3: Final exam? (to be confirmed)

Edimension

Teaching materials

- PPT/PDF contain the lecture materials (PPT preferred)
- Activities notebooks and their answers
- The teaching materials will be uploaded on eDimension and made available on the same day.
- https://edimension.sutd.edu.sg/

Homeworks, extras and exams

Practice?

- In-class activities: activities, done together during online lessons.
- Solutions are provided on other notebooks.

Need some extra practice?

- Homeworks: nope.
- Extra practice: basic exercises and notions, to practice the concepts seen in class a bit more.
- Extra challenges: advanced versions of the activities discussed in class.
- None of them are mandatory. Solutions are provided (except for challenges!)

Plot twist: GAMIFICATION

“Games are a good way of thinking about real problems. I use games in all my courses […] because things you've played with are things you remember.”

- Jarrett Walker, international consultant in public transit network design.
(He also has a fantastic blog about using planning games, like MiniMetro and SimCity to explain and understand notions of transportation network design)
http://humantransit.org/2014/12/learning-how-transit-works-from-mini-metro.html

Plot twist: GAMIFICATION

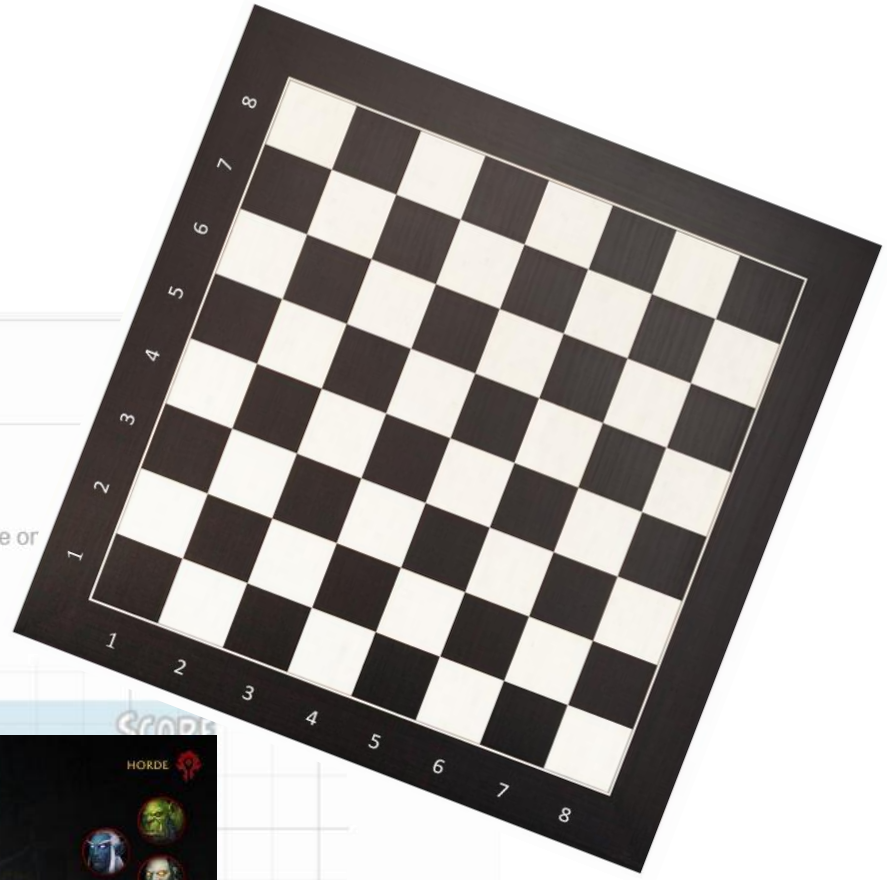
Activity 2 - Ballistics of an angry bird

Problem statement

In the angry bird game, the player has to launch birds at structures from a slingshot. The player gets to decide on an **initial angle theta (in degrees)** and **an initial speed for the bird alpha (in m/s)**.

After releasing, the angry bird goes flying into a parabolic curve, as shown in the figure below.

Plot twist: GAMIFICATION



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12

Exams

Final (100%) – On W6S3 (to be confirmed).

- Covers notions in W1-W6.
- Theory MCQ.
- Maybe, a few practice questions.

Survey

- During this class, I might often use online “surveys”.
- These help me check your understanding of this class and adjust accordingly… Please fill them!

- Speaking of... **Here is your first survey: what is “programming”?**

https://docs.google.com/forms/d/e/1FAIpQLSejSKnRZYR-2kN1MlcEV0_5KNh0pu6V6JOaQsqS9Vo5iHEF1A/viewform?usp=pp_url

Programming: definition

- **Definition (Programming):**
  Programming refers to the process of designing and building an executable computer program, to accomplish a specific computational task.

  It involves tasks such as
  - analysis,
  - designing **algorithms**,
  - and implementing said **algorithms** in a chosen programming language (a.k.a. **coding**).

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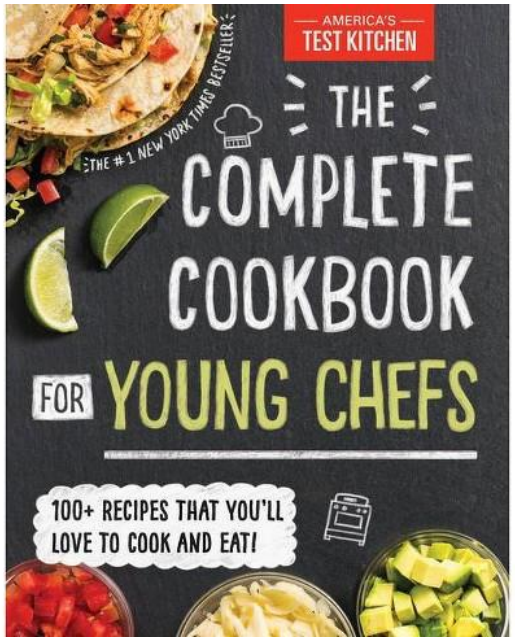
  - and implementing said **algorithms** in a chosen programming language (a.k.a. **coding**).

- **Layman definition (Programming):** **Programming** consists of defining a sequence of instructions that the computer must follow to accomplish a task.

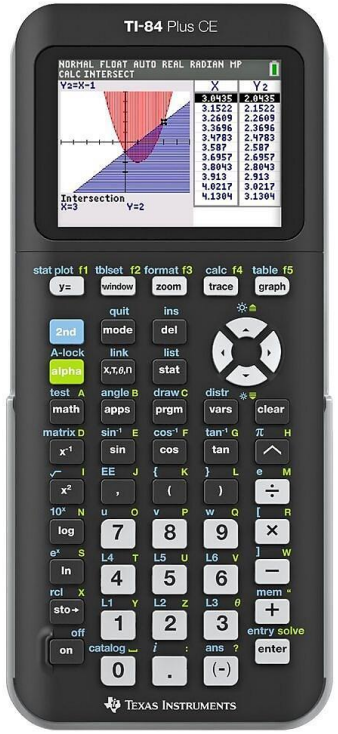
Programming: some analogies

- Think of it as a food **recipe** book! A recipe requires you to follow and execute a set of instructions to cook a recipe from scratch!



Programming: some analogies

- Or a **sequence of operations** you would normally do on a calculator to find a result.



- **Example problem:** compute the area of a circle with radius 10.
  - Type 10,
  - Type multiply key,
  - Type 10,
  - Press equal/enter key,
  - Type multiply key,
  - Type π,
  - Press equal key again,
  - You have reached your result.

Algorithm: definition

- **<u>Definition (Algorithm):</u>** An **algorithm** is a finite sequence of instructions, typically used to solve a class of problems or perform a computation task.

  When executed, on a provided set of **inputs**, it will proceed through a set of well-defined states and will eventually produce an output.

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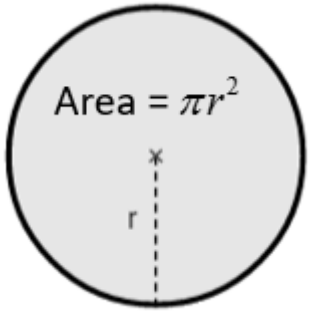
ALGORITHM

The life of a programmer



1. **Identify a problem.**
2. **Come up with a general algorithm to solve it.**
   - Step-by-step instructions.
   - Think of it as a ‘recipe’ or a ‘flowchart’.
3. **Represent this algorithm as a program, using a chosen programming language.**
4. **Execute the program on a computer!**

- Type 10,
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ALGORITHM

python™

Quick question

→ **Who is considered the inventor of computers and “programming”?**

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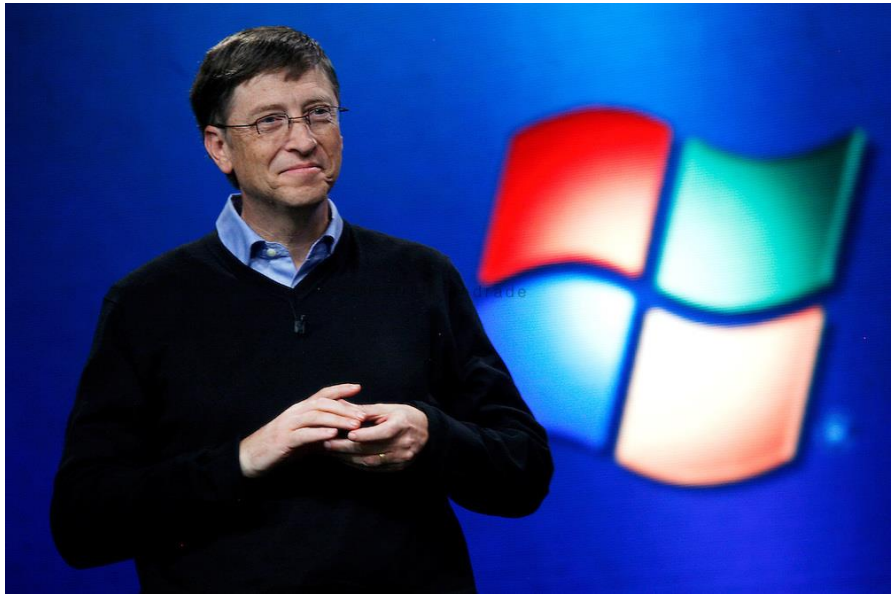
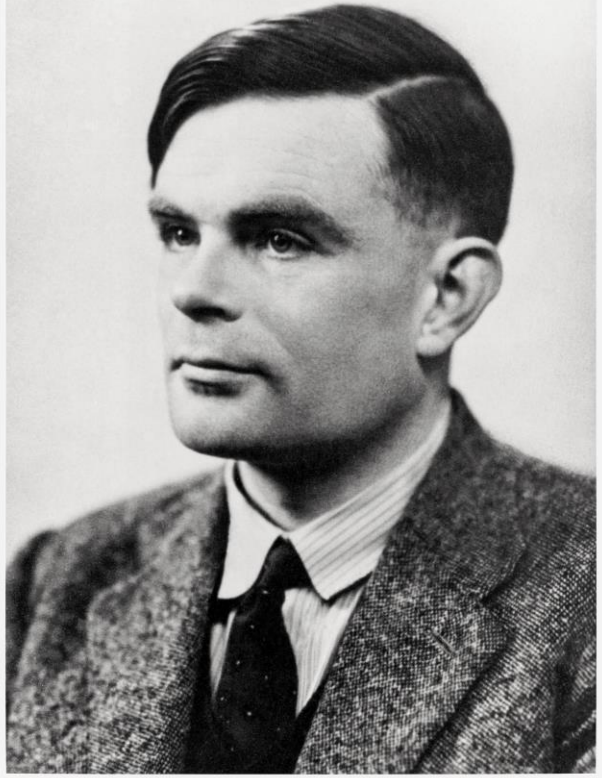
Hint: it is NOT one of the persons below.



The “father” of computer science

Alan Mathison Turing (1912–1954) was an English mathematician, computer scientist, logician, cryptanalyst, philosopher, and theoretical biologist.



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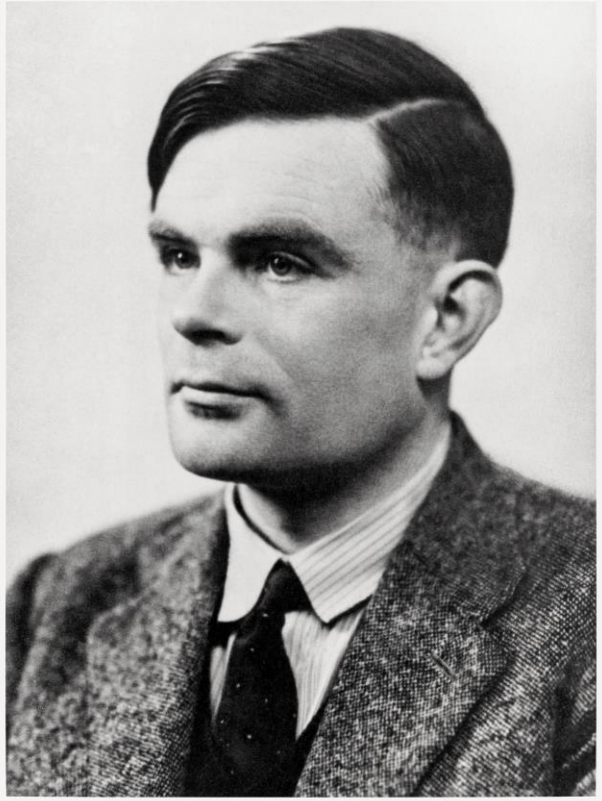
- Turing was highly influential in the development of theoretical computer science, formalized algorithmic concepts, and created the first Turing machine, which can be considered the first model of a general-purpose computer.



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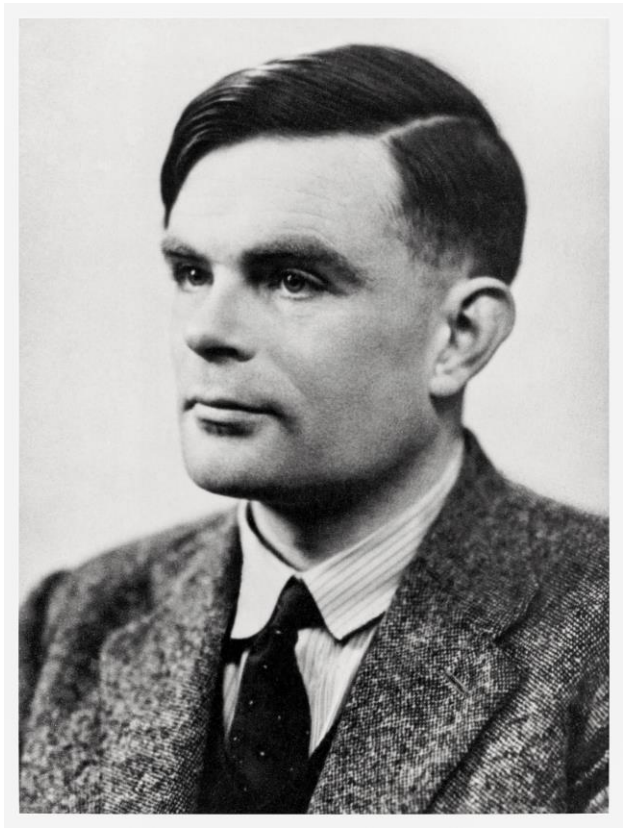
- During World War 2, he came up with an idea of a “computer-like” machine, to decode encrypted transmissions from the German army.
- Thanks to his decryption device, it has been estimated the war in Europe was shortened by more than two years and saved over 14 million lives.



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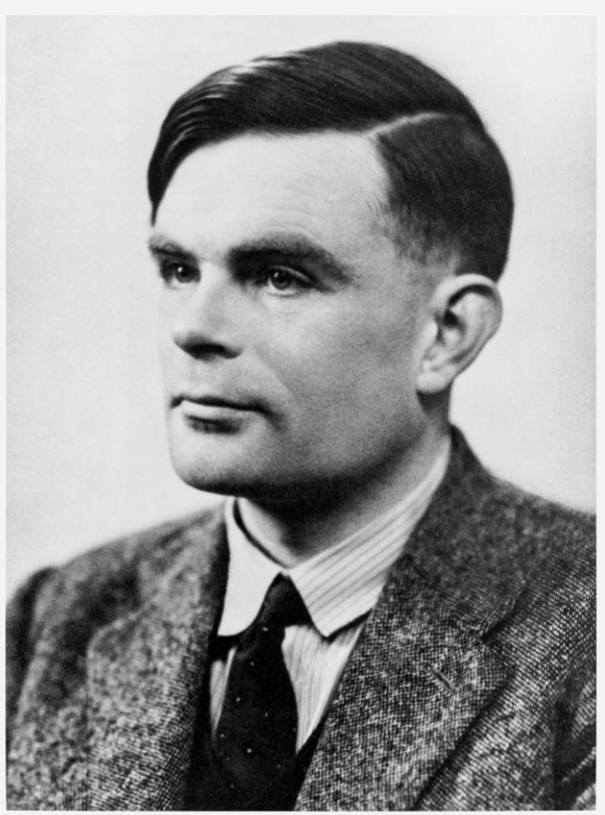
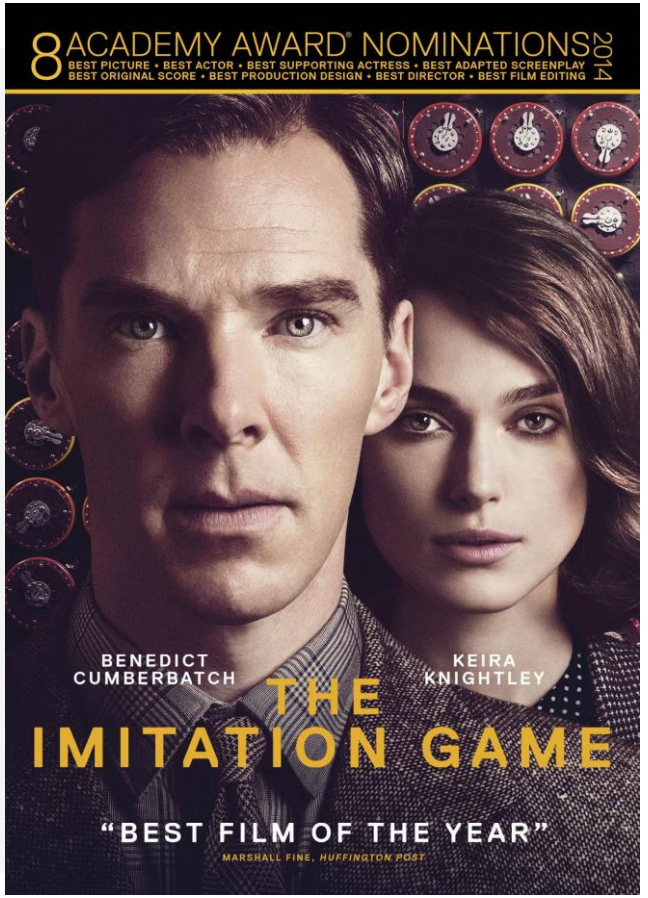
- Learn more about Alan Turing, by watching **The Imitation Game** movie.





About your computer

Your computer is good at doing two, and **only** two, things

1. **Perform computational tasks (calculations)**, as described by an algorithm provided by a human to the computer.
2. **Remember the results of these computational tasks**, by storing them in its internal memory (and eventually retrieving these results later on, by accessing its memory)

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And that is it.

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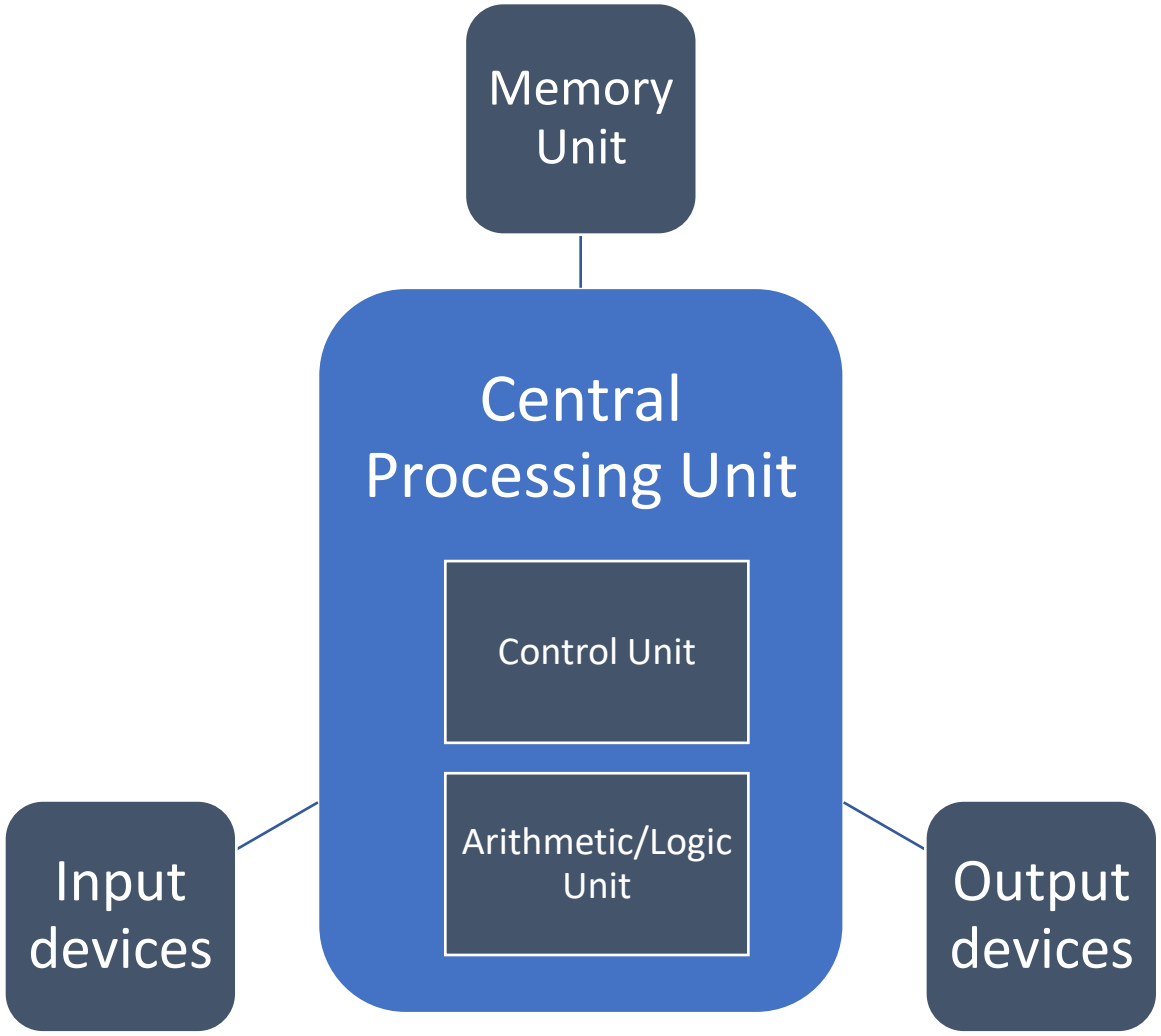
Because all operations performed by computers nowadays can be broken down to combinations of both aforementioned operations.

The Von Neumann architecture

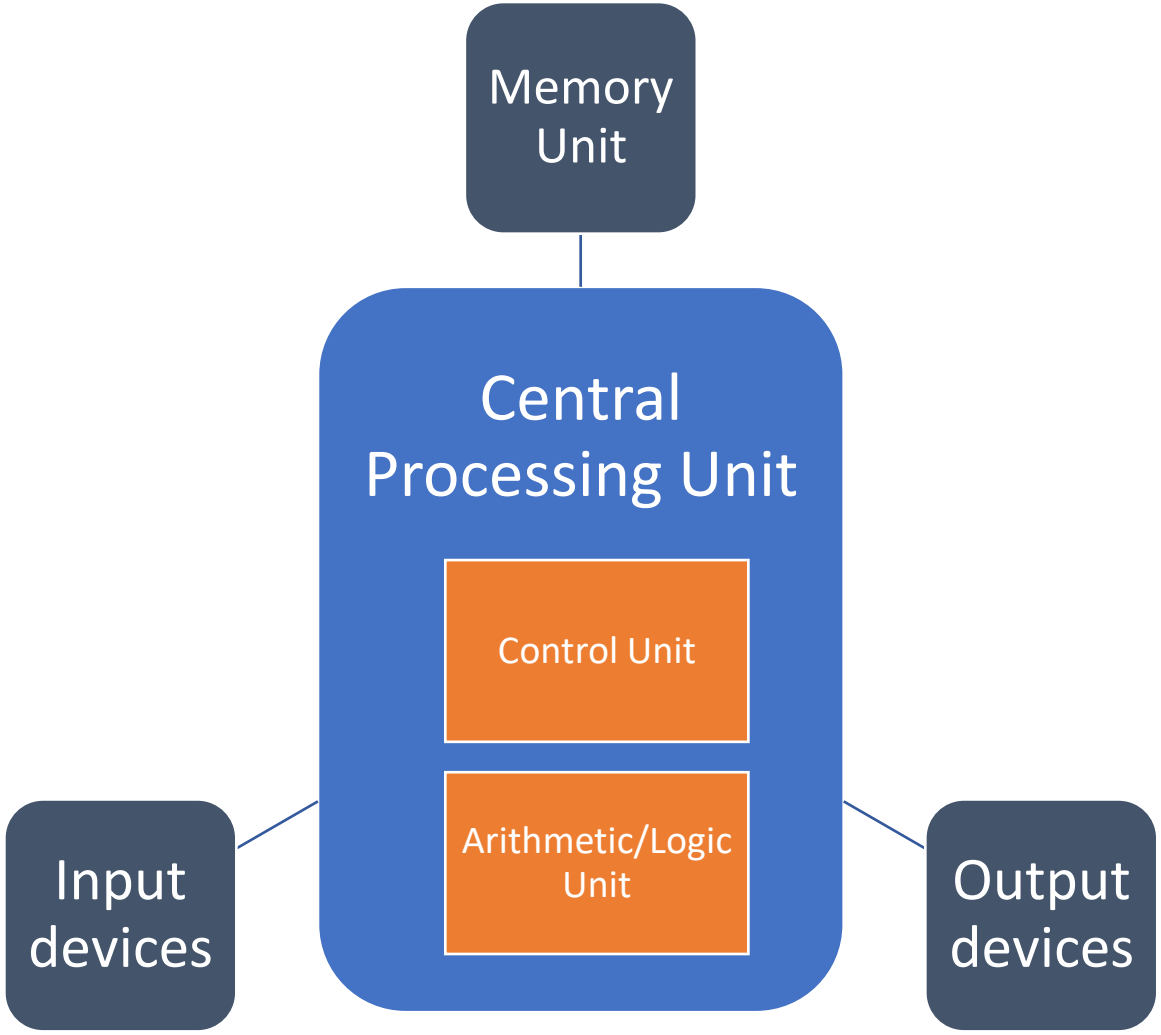
- **Definition (Von Neumann architecture):** The Von Neumann architecture describes one of the first architectures for a computer.



The Von Neumann architecture

It first consists of a **Central Processing Unit (CPU)**, which itself consists of…

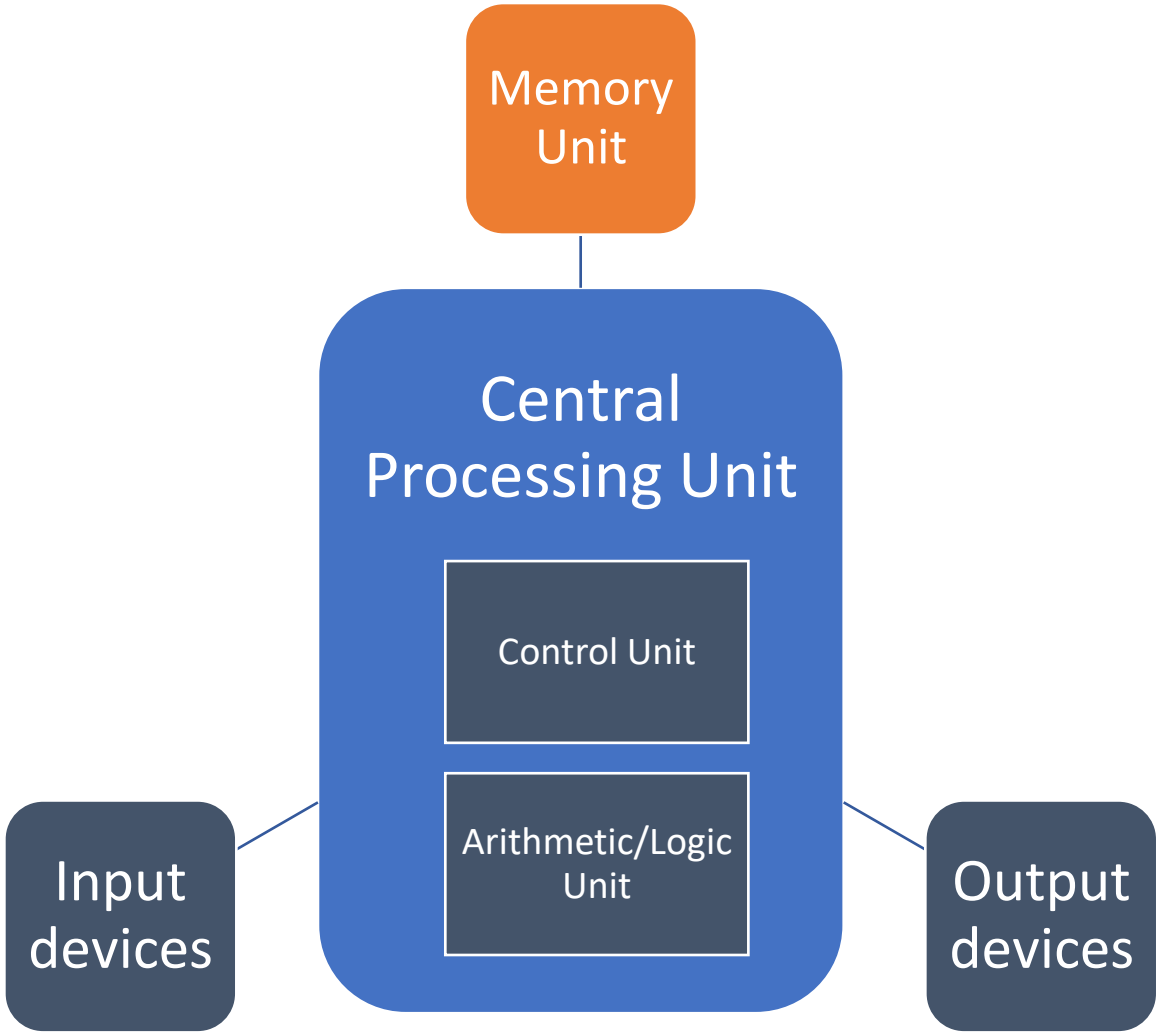
- An **Arithmetic/Logic Unit** (in charge of dealing with instructions, typically math operations, in binary 0/1),
- And **a Control Unit** (in charge of the hardware and communication between different hardware elements)



The Von Neumann architecture

It also contains…

- A **Memory Unit** (for storing and retrieving results from previous computational tasks, using binary formatting 0/1),



The Von Neumann architecture

It also contains…

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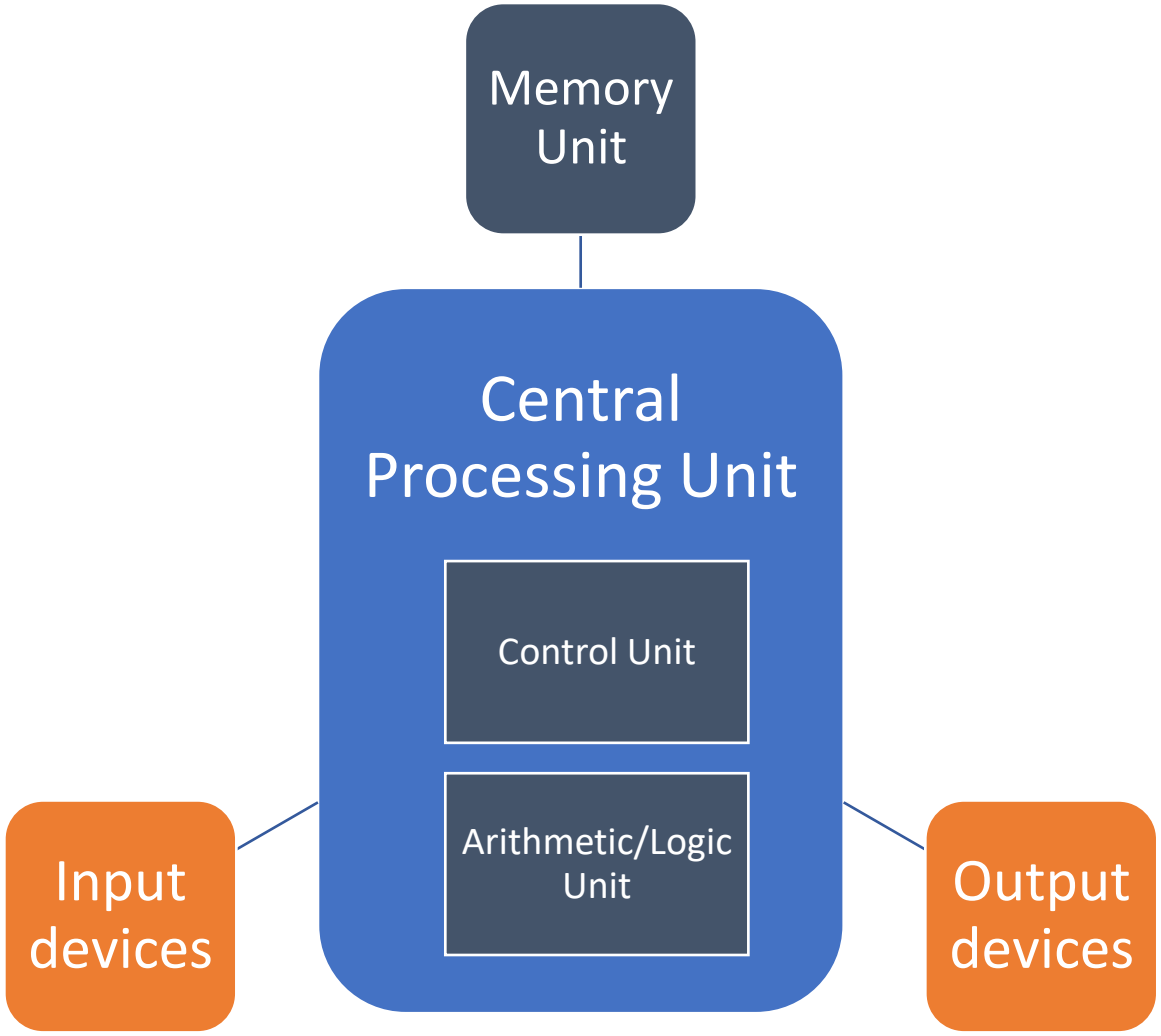
- **Inputs and Outputs Devices** (e.g. mouse, keyboard, screen, microphone, webcam, etc.).



The problem of dealing with binary and the need for programming languages

- **Observation:** in a computer, all operations (computational and memory tasks) and are performed in **binary**.

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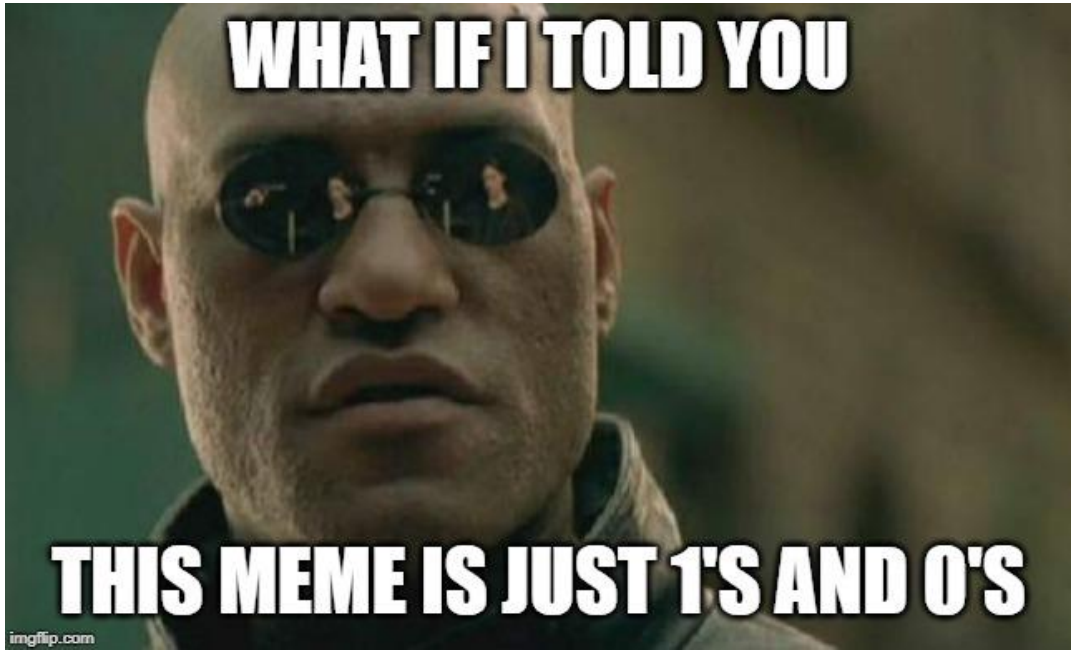
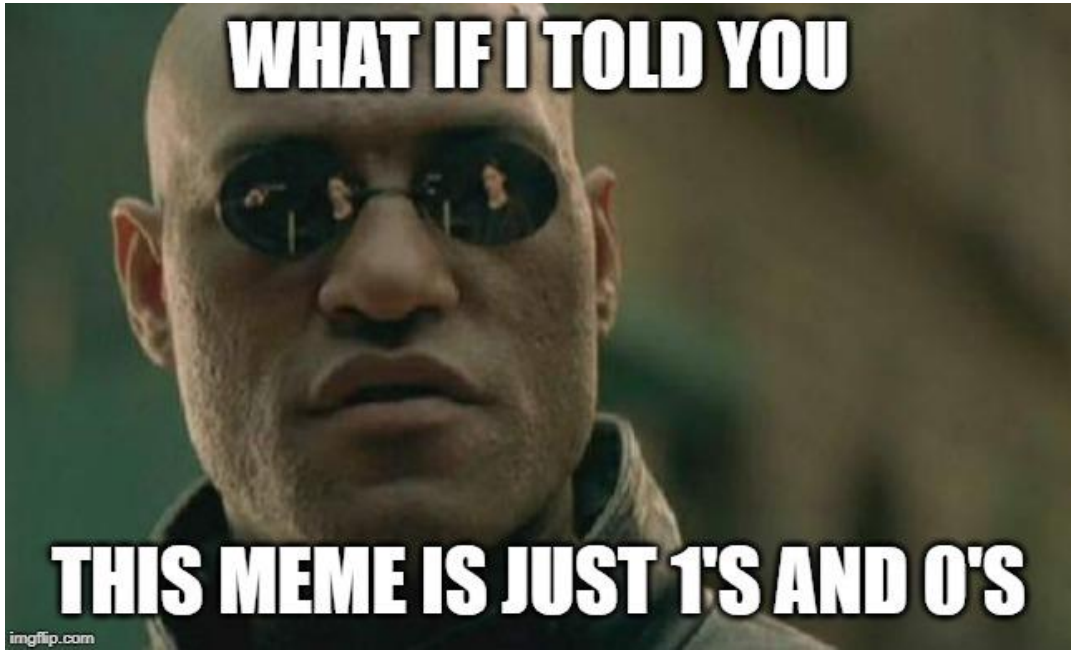


The problem of dealing with binary and the need for programming languages

- **Observation:** in a computer, all operations (computational and memory tasks) and are performed in **binary**.

- **Problem:** binary is heavy and difficult to read for humans.
- **Example:** “Matthieu”, in binary, is “01001101 01100001 01110100 01110100 01101000 01101001 01100101 01110101“.



The problem of dealing with binary and the need for programming languages

- **Observation:** in a computer, all operations (computational and memory tasks) and are performed in **binary**.

- **Solution:** find an intermediate language, readable by humans, to address the computer.
  - **High-level language:** closer to human language
  - **Low-level language:** closer to binary

Generations	Languages	Characteristics
First-generation languages (1954 – 1958)	FORTRAN I, ALGOL 58, Flowmatic, IPL V	Mainly used for mathematical calculations; consists only of global data and sub-programs.
Second-generation languages (1959 – 1961)	FORTRAN II, ALGOL 60, COBOL, Lisp	Use extended to business applications; artificial intelligence; subroutines, block structure, data types introduced.
Third-generation languages (1962 – 1970)	PL/1, ALGOL 68, Pascal, Simula	Use extended to wider applications; ideas of modules and data abstraction introduced.
The generation gap (1970 – 1980)	C, FORTRAN 77	Many languages invented with few surviving; small executables, thrust towards standardization.
Enhanced popularity of object-orientated languages (1980 – 1990)	Smalltalk 80, C++, Ada83, Eiffel	Languages derived from previous ones; the idea of a class as a basic unit of abstraction.
Emergence of frameworks (1990 – present)	Visual Basic, Java, Python, J2EE, .NET, Visual C++, Visual Basic .NET	Widespread use of integrated development environments (IDE); focus on Web-based systems.

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- **Observation:** in a computer, all operations (computational and memory tasks) and are performed in **binary**.

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  - **Low-level language:** close to binary (difficult to learn)

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Python: what is it?

About Python: Python is an interpreted, high-level, general-purpose programming language.

- Created by Guido van Rossum and first released in 1991.
- Currently on its **v3**, since **2008**.
- Python's design philosophy emphasizes code **readability**.
- Its language constructs aim to help programmers write clear, logical code for small and large-scale projects.

Why learn Python?

- **High-level language:** easy to write and read, and therefore well-suited for beginners.

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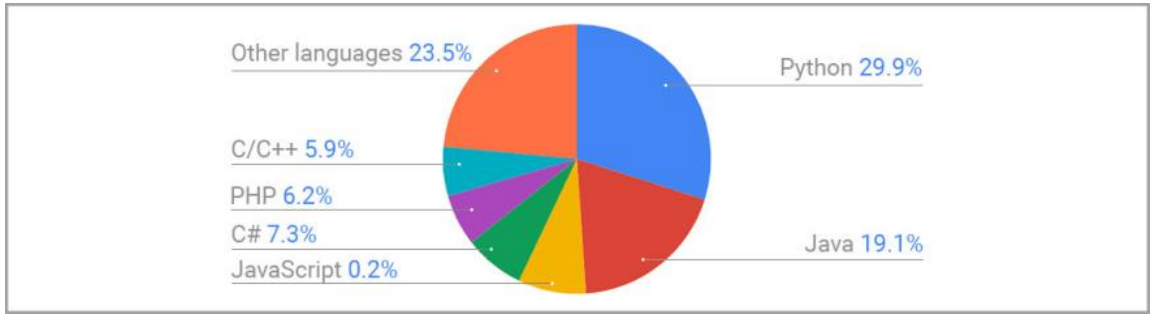
- **Dynamic typing:** in layman terms, Python is able to manage the data saved to memory, in an automated and efficient fashion, without human intervention.

- **Python is the #1 language for data science and AI at the moment:** several frameworks such as Tensorflow (Google AI), Pytorch (widely used in academic research on AI), etc.



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- **Also, high interoperability with other languages:** Jumping to or including another language (Java, C, SQL, etc.) is easy, once you know Python.

→ Overall, Python is a good **entry point** for beginners in both programming and computer science, and therefore the first language we teach in SUTD.

Installing Python

- In this class, we will use **Python 3.9(.6)** (latest stable version as on the 19th of July 2021).
- Download it here (for 32/64-bit Windows and Mac users, Linux users can get it via apt-get or SoftwareCenter)

https://www.python.org/downloads/

Installing Python

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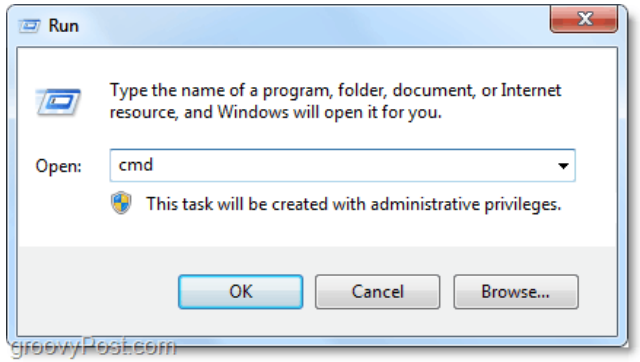
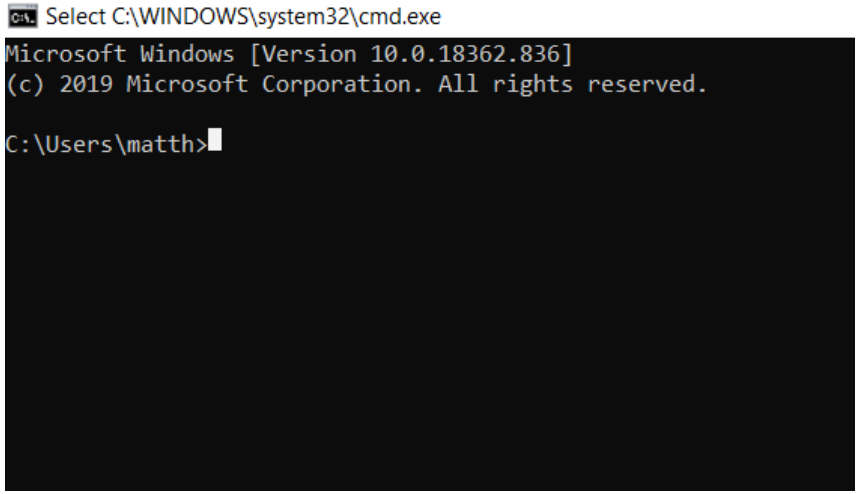
Opening a console (Windows)

- Check your installation has completed appropriately, by trying to open a **console**.



- **Windows:** the cool way.

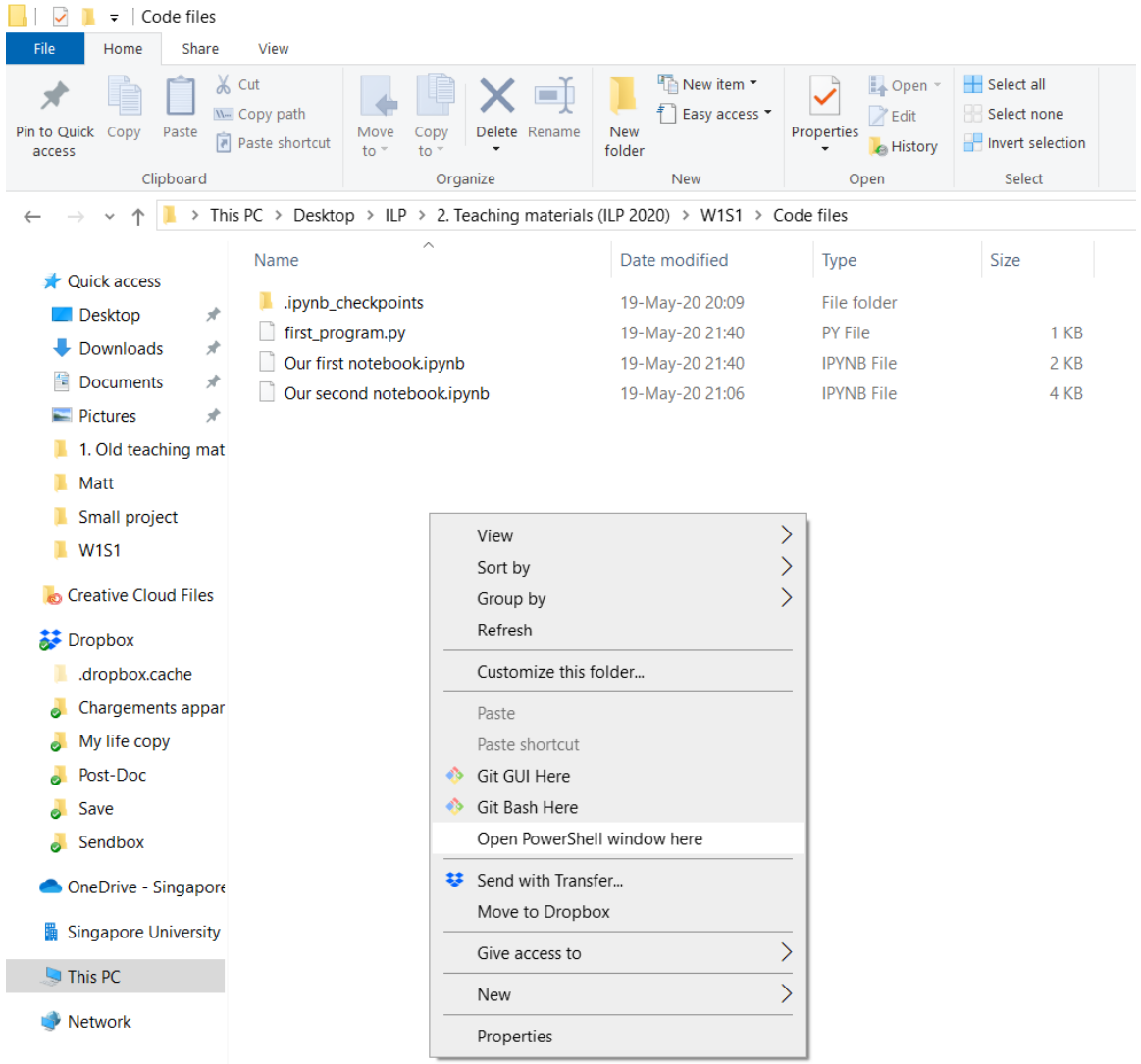
1. Press simultaneously **Windows key + R**,
2. then type **cmd**, and press **Enter.**



Opening a console (Windows – option 2)

- **Windows option 2:** faster and more convenient way, in my opinion

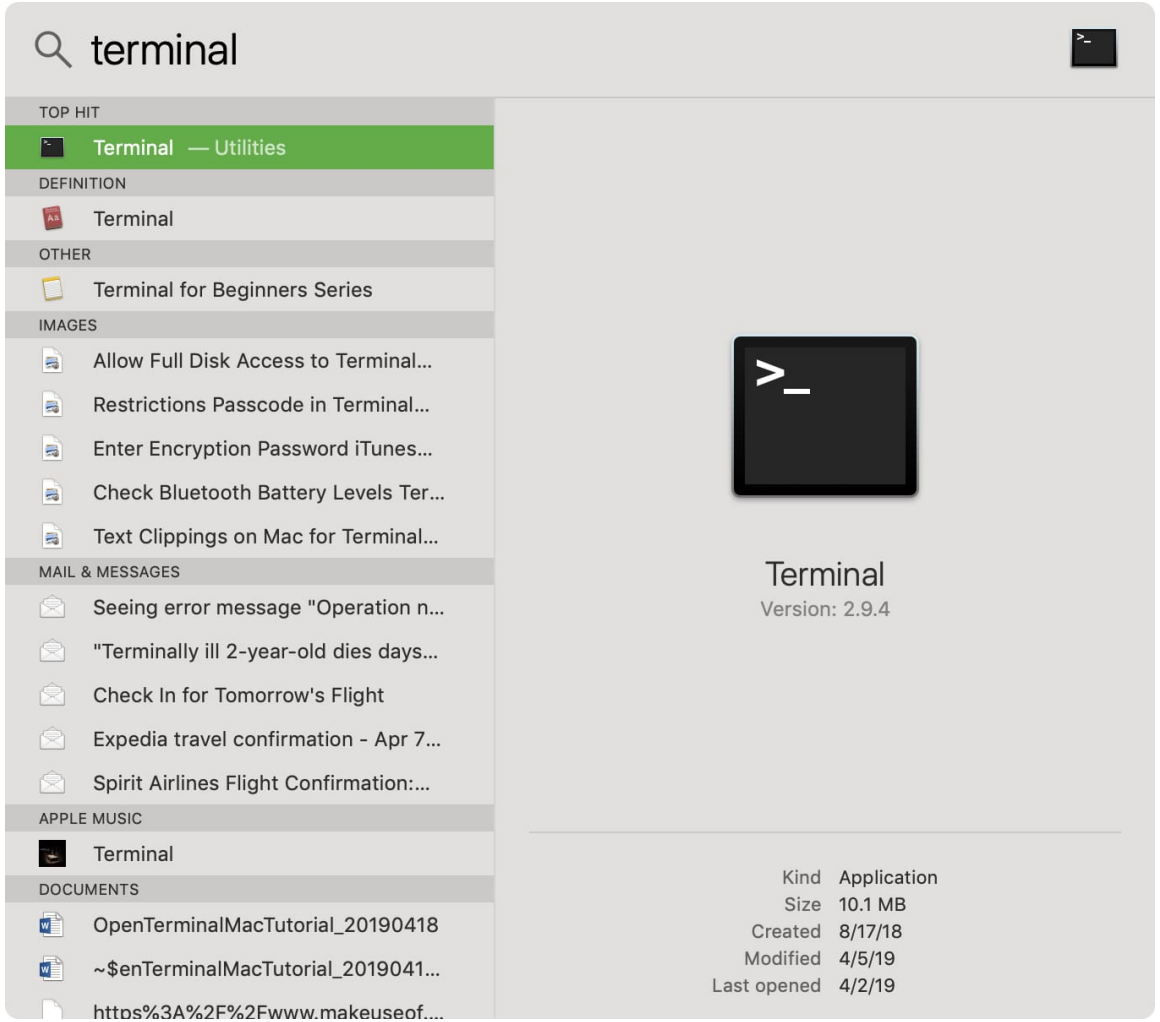
1. **Open an explorer** in the folder you attempt to work in.
2. **Hold shift** and **right-click** in an empty space of the explorer window.
3. **Choose "Open Powershell window here".**



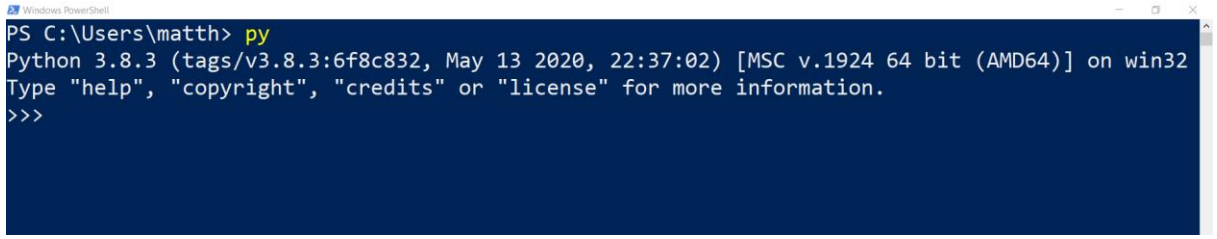
Opening a console (Mac OS)

- **Mac:** roughly the same procedure

1. Press simultaneously **Command key + Space**,
2. Then type **Terminal**,
3. It should appear as your top result, click it



Your first run of Python!



Start python by **typing one** of the following commands in the console and press **Enter!**

(Note: one of these should work, might vary depending on your machine!)

- **py (most frequent one, works in my case)**
- py3
- python
- python3

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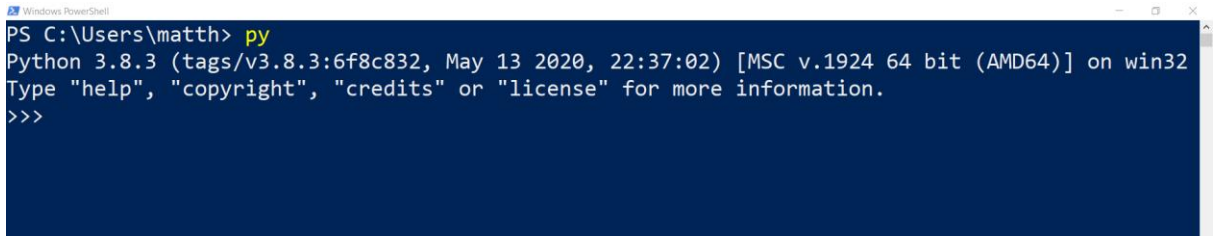
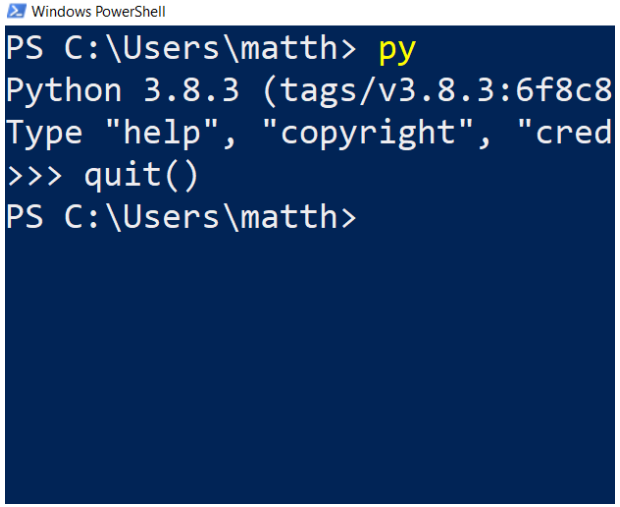
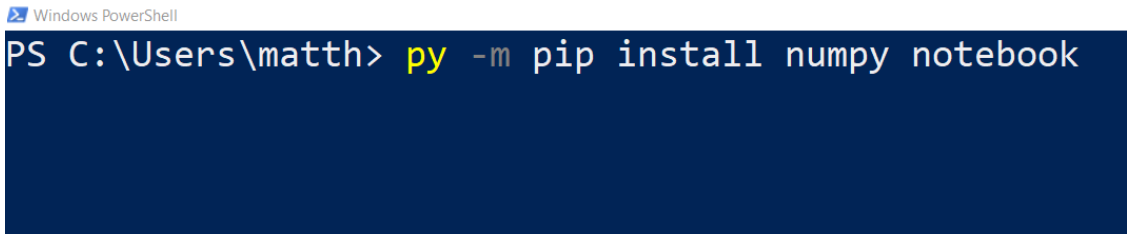


To exit Python, simply type quit() and press enter.



Installing & updating packages in Python

- Next, let us install **packages**. (**Packages** are extra functionalities for Python.)



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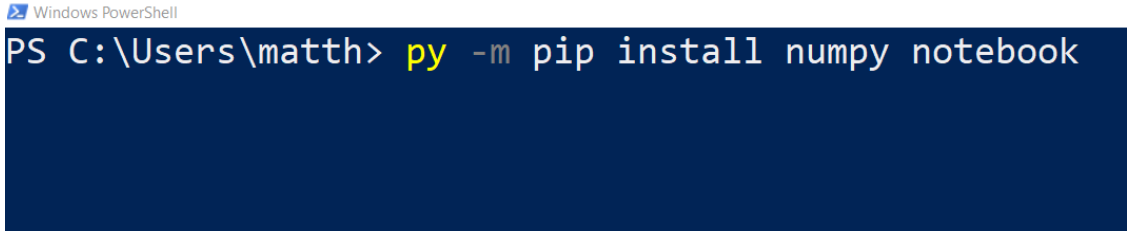

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Note: if you are using **py3, python or python3** instead of **py**, adjust accordingly!

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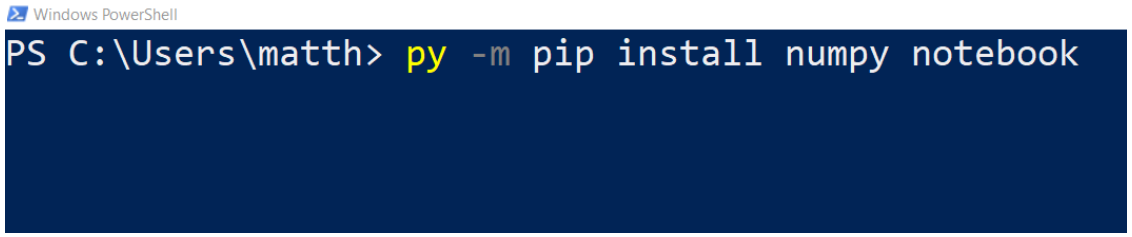
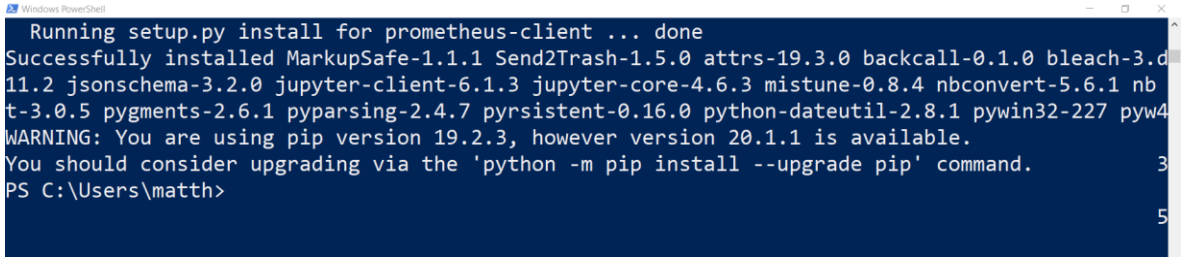


It shall run for a while, download and install a few things…
(numpy for advanced math computation and notebook, which we will use later on)



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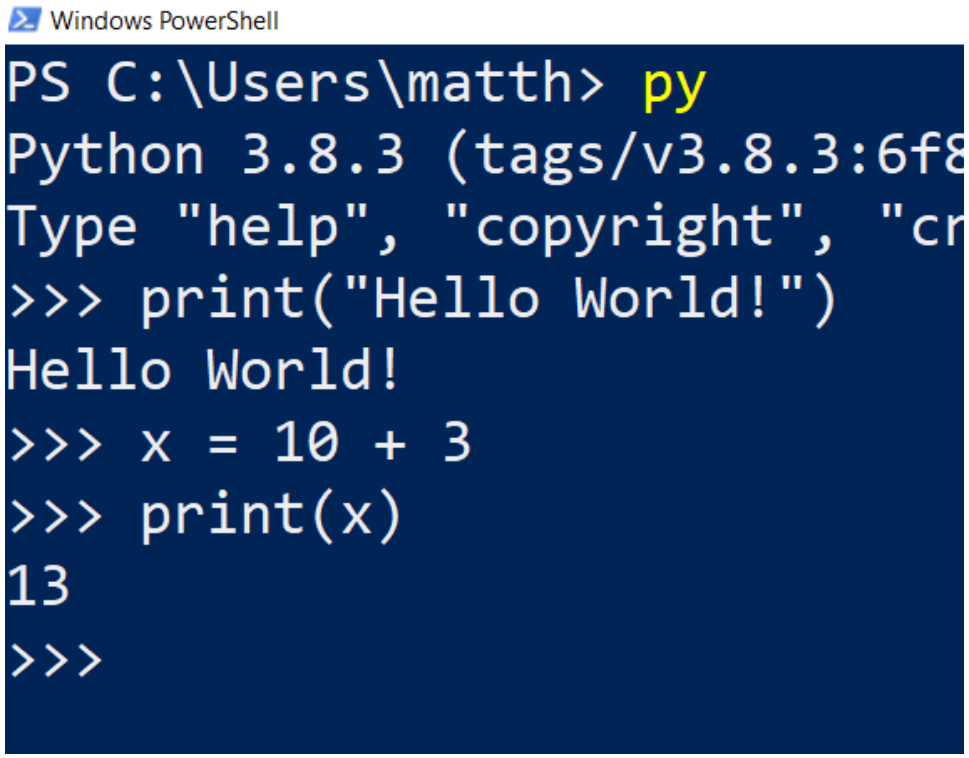

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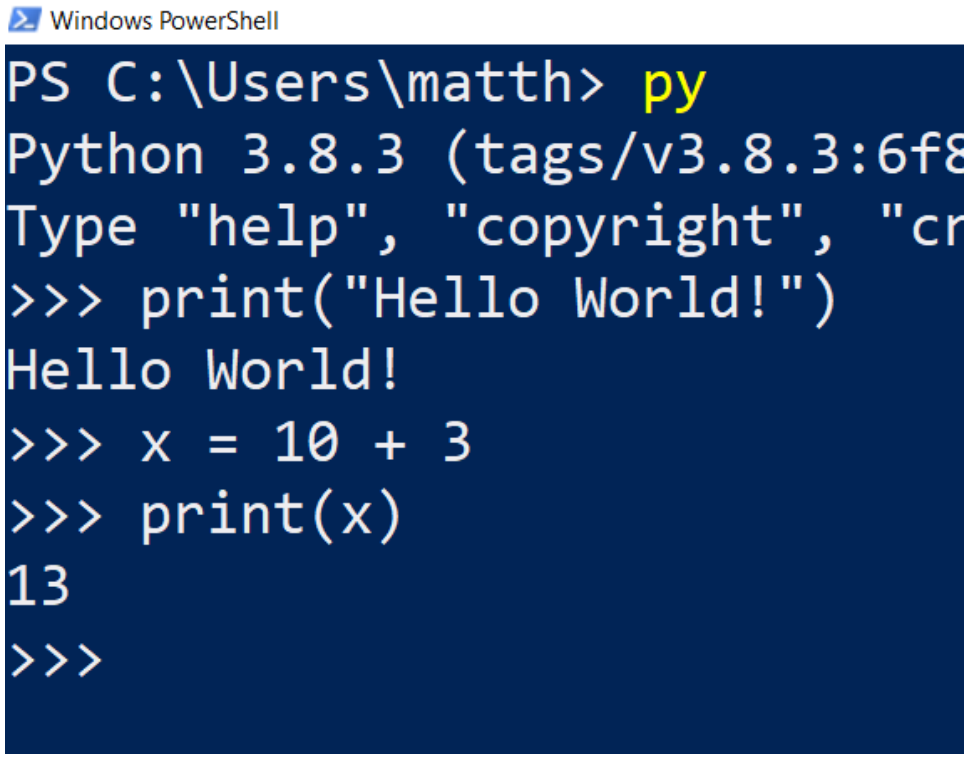
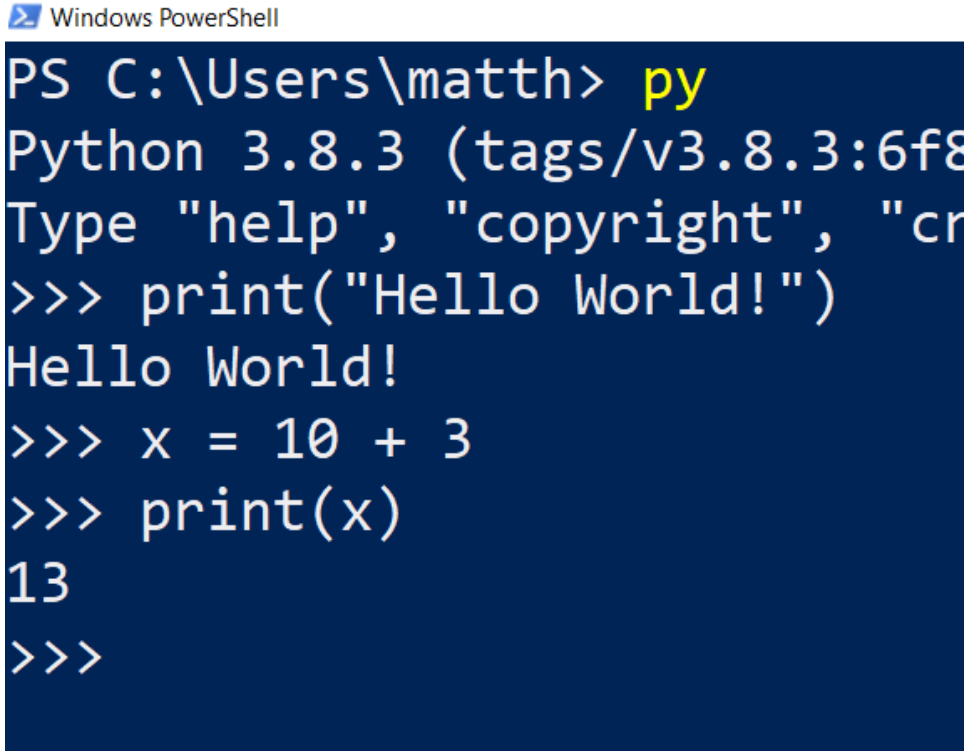


Our first program!

- Assigning something to memory is done with the = sign.
- **Note:** The = sign does not bear the same meaning as seen in mathematics.
- In computer science it means:
  - Assign what is on the right-hand side of the equal sign to memory.
  - The name of this element, called a **variable**, consists of the text on the left-hand side of the equal sign.



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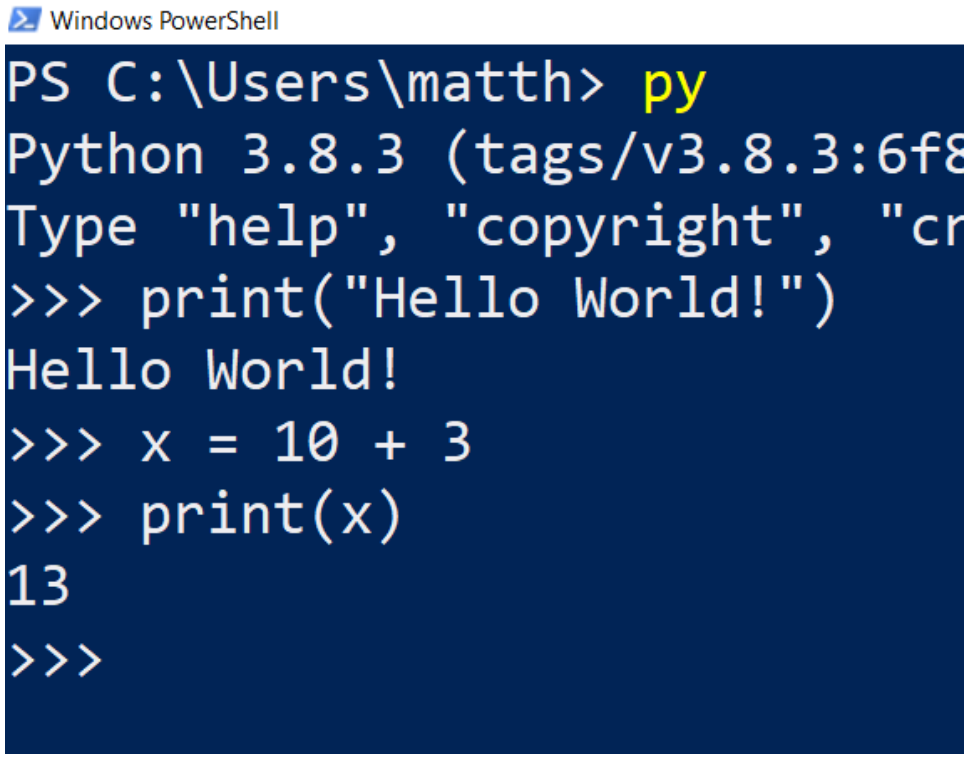

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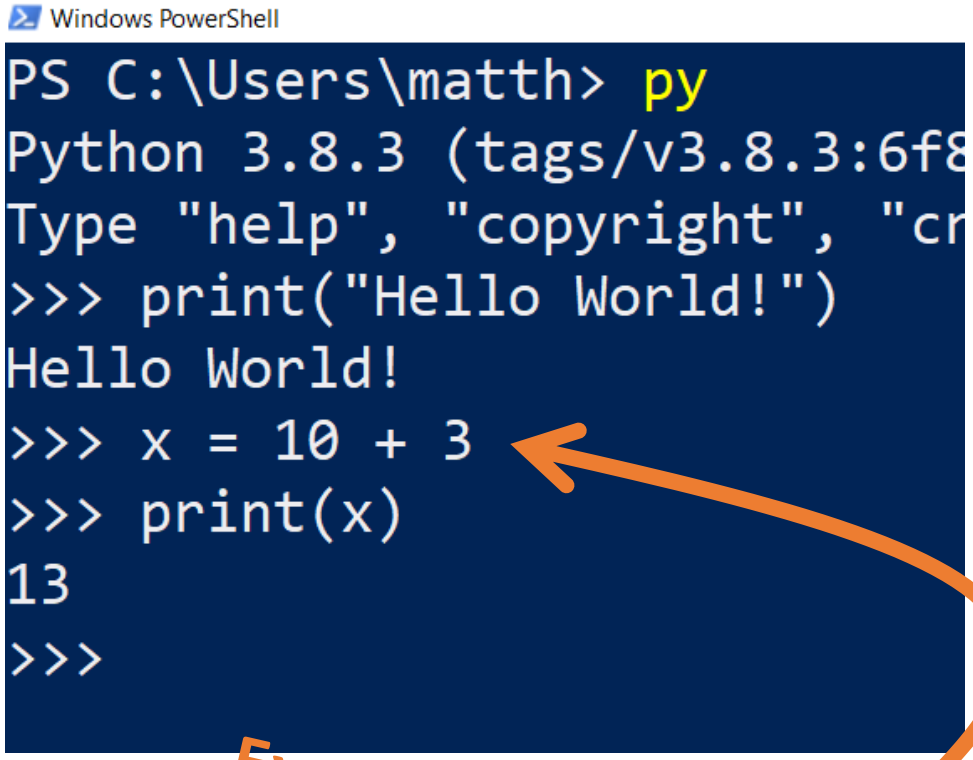

Executes in the background but shows nothing! Need to explicitly ask for a print().

Matt's Great advice #1

Matt's Great Advice #1: the print() function in Python.

The **print()** function is the most important Python function.

It is **only way** for you to check what is being computed and stored in memory at any given time.

Use it and abuse it, to check what your program is doing!

Executing a .py file in console mode

- You should have downloaded a few files along with the lecture notes on eDimension.
- More specifically, we will now use the **first_program.py** file.

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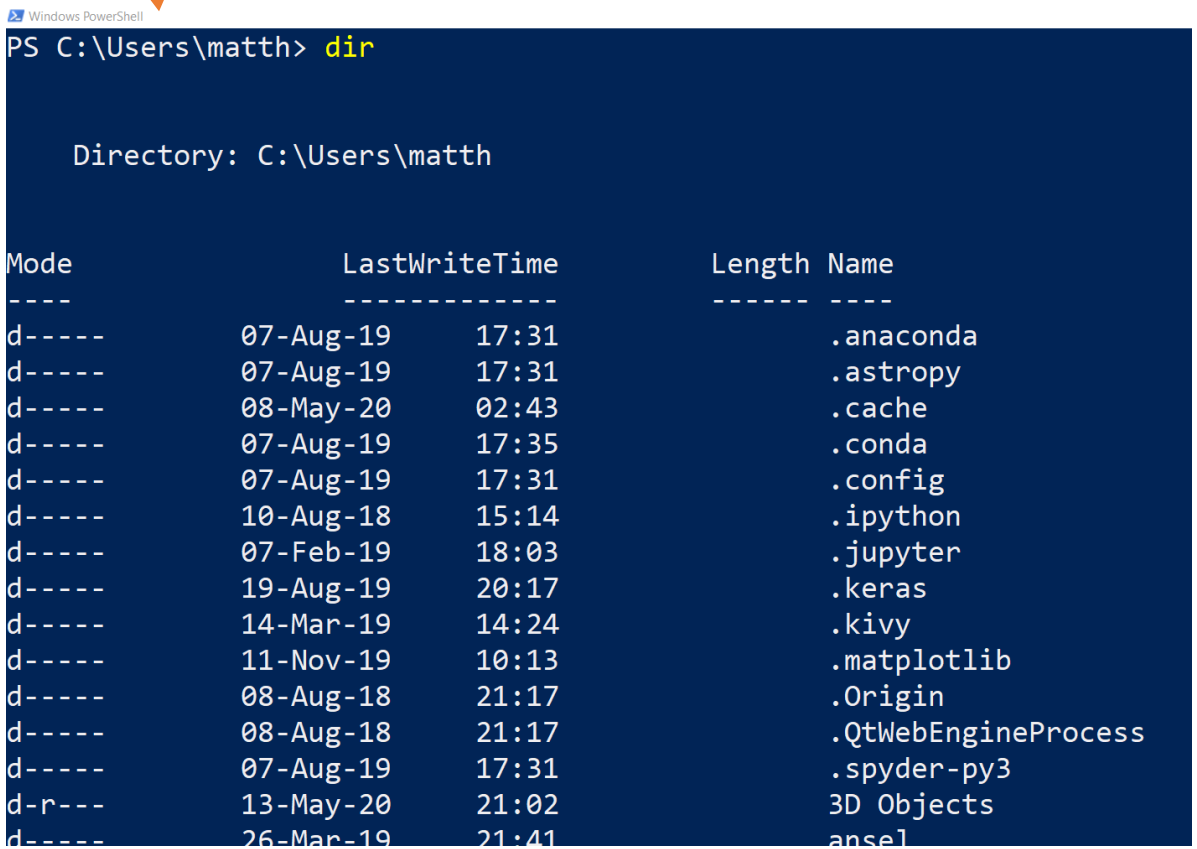
- You should have downloaded a few files along with the lecture notes on eDimension.
- More specifically, we will now use the **first_program.py** file.
- Identify where your **first_program.py** file is currently located, before moving to the next slide.

Executing a .py file in console mode

- **Command (dir/ls):** The **dir command** (or **ls command** in Mac OS/Linux) lists the folders and files in your current location.

Current location is C:\Users\matth\



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- **Command (dir/ls):** The **dir command** (or **ls command** in Mac OS/Linux) lists the folders and files in your current location.
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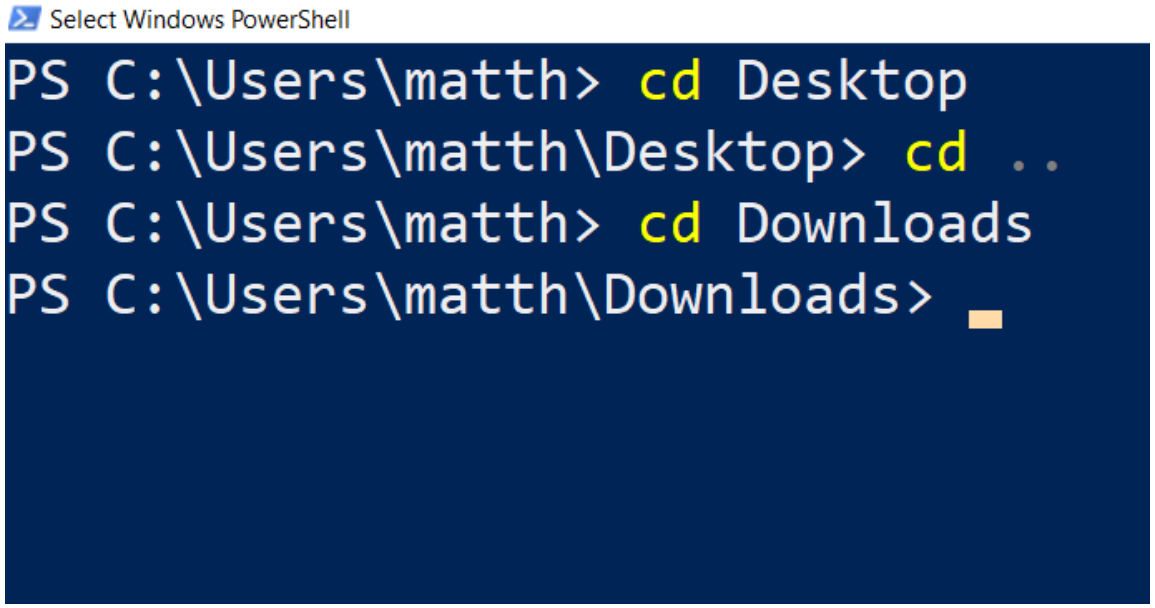
Observe how the current location is changing every time.



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- **Note:** the command "**cd ..**" moves you back one level.

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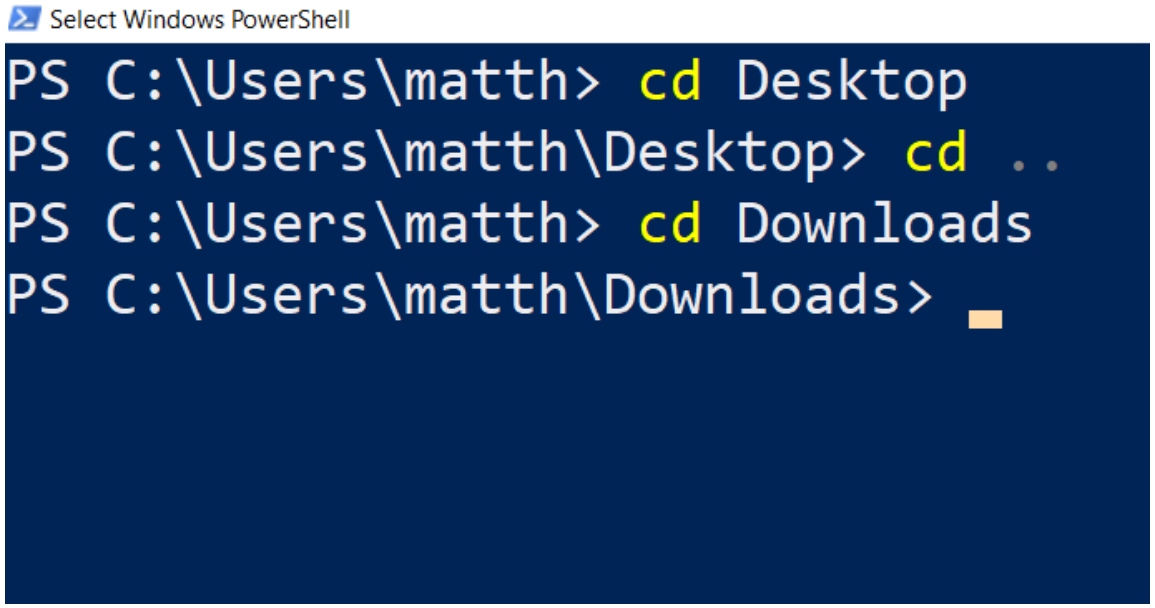
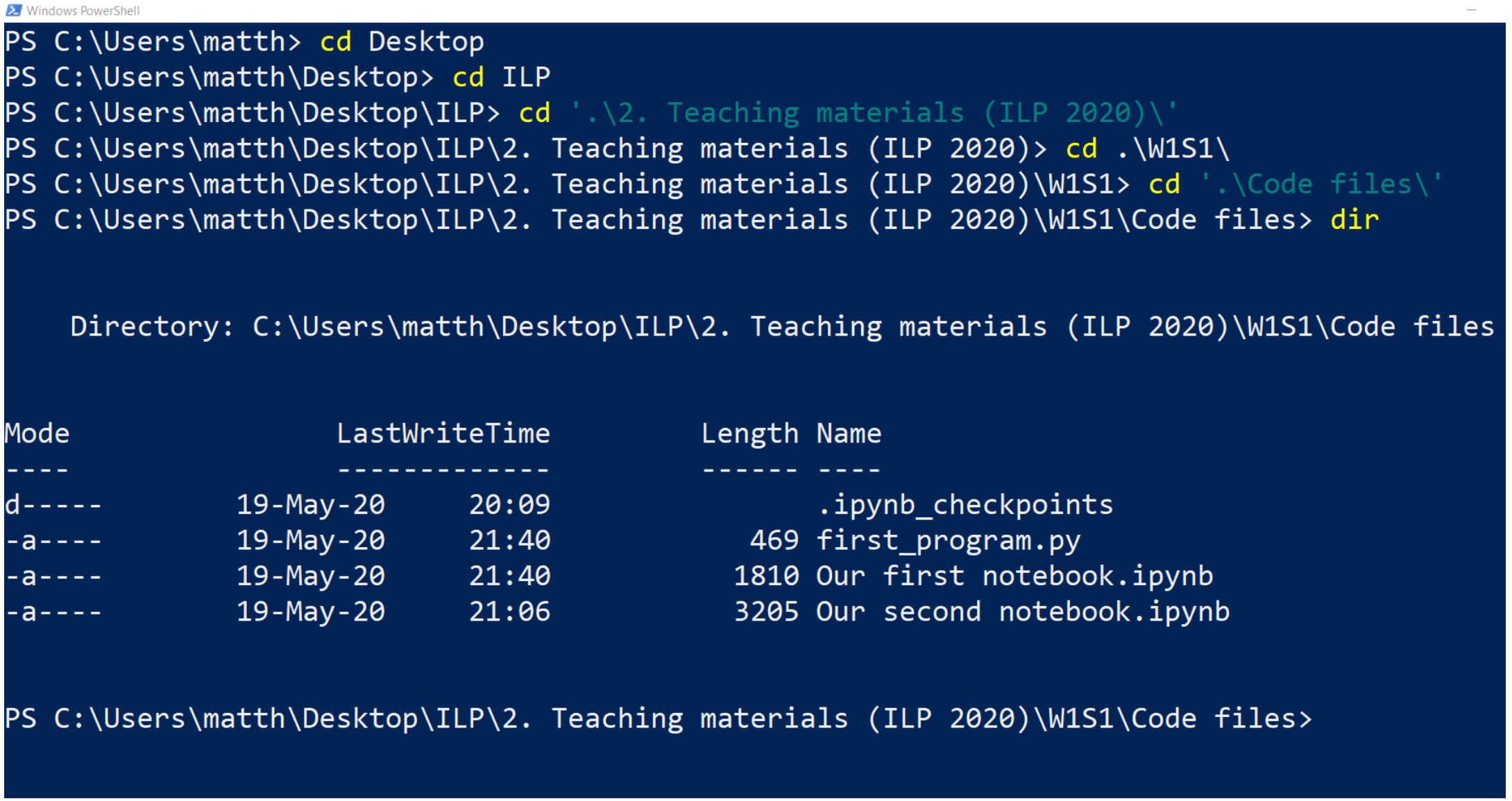
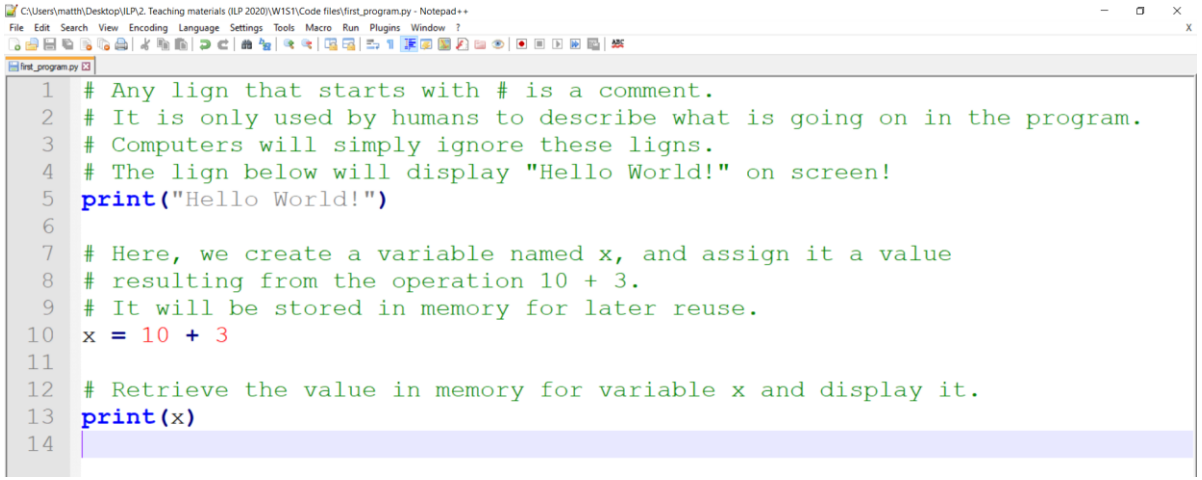




→ Now, use cd/dir/ls commands to move to the location of your **first_program.py** file !

Checking your .py file

- Open your **first_program.py** file with any text editor (specifically do it by right clicking and asking to open with a text editor).
- Recognize the code we used earlier.



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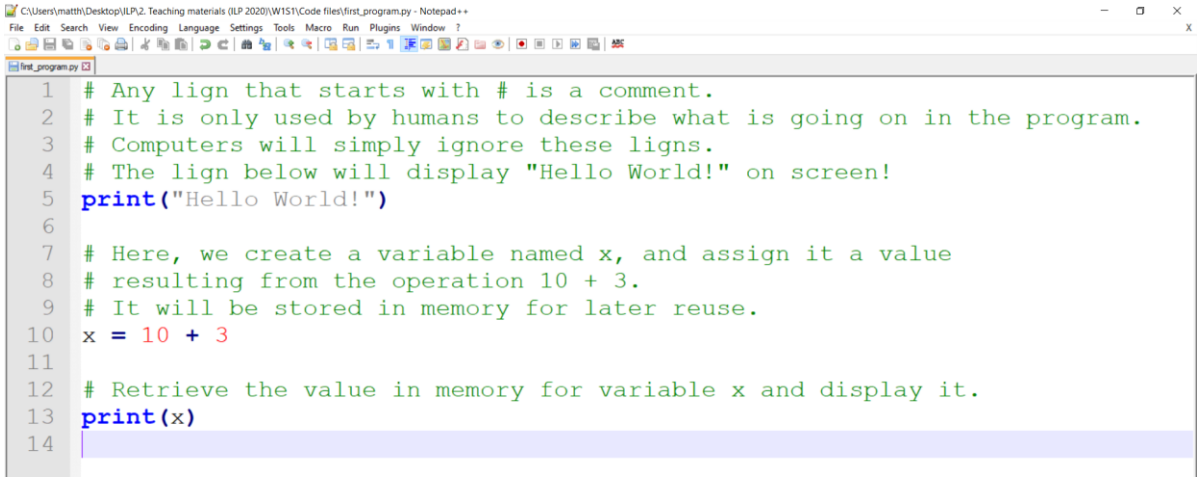
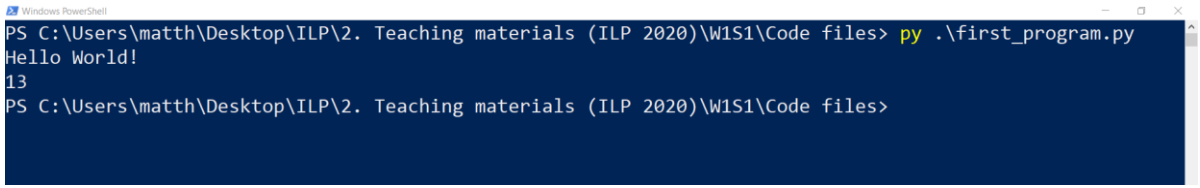
- Recognize the code we used earlier.
- Later on, you can run the code in the **first_program.py** file, all at once, by typing the following command in your console

py first_program.py





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- **Suggestion:** we should use an **Interactive Development Environment (IDE)**, which makes the coding easier for us.
- In this course, I suggest to use **Jupyter Notebook**, but you might look online for other IDEs if you want!

Running Python from an IDE, such as a Jupyter Notebook

- Return to your console, **outside** of the Python environment (use **quit()** if needed).

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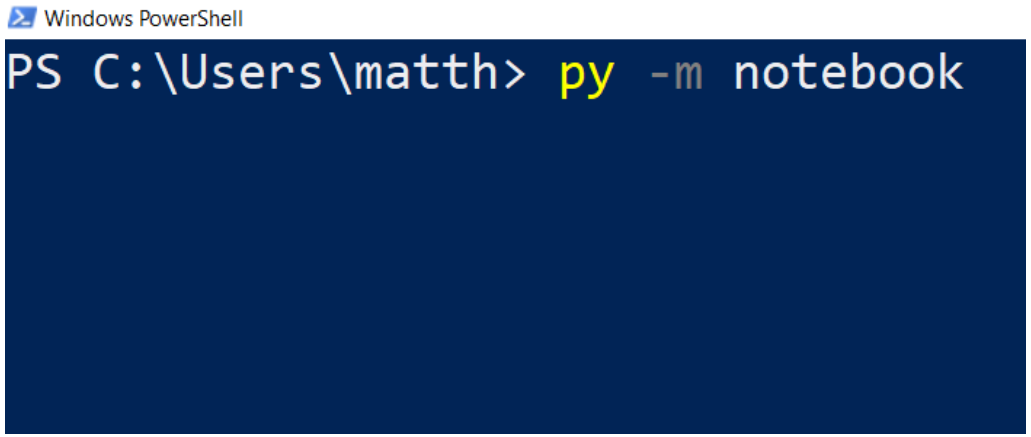

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- Return to your console, **outside** of the Python environment (use **quit()** if needed).
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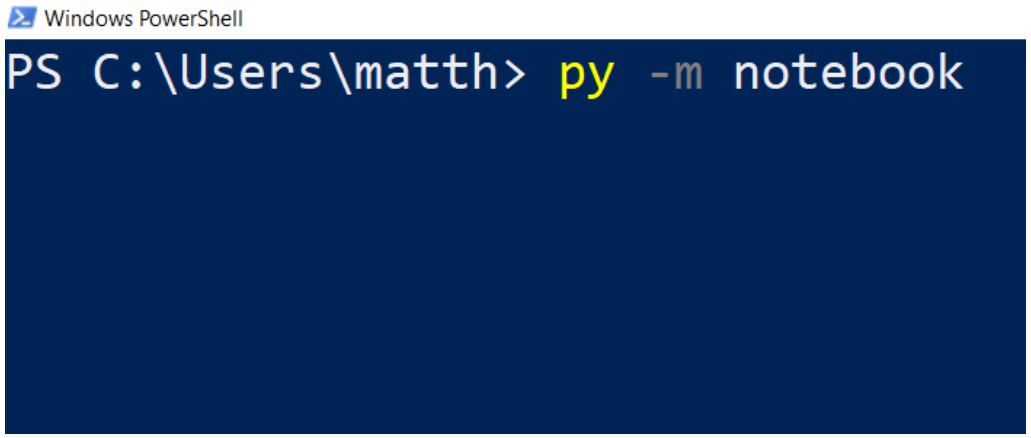
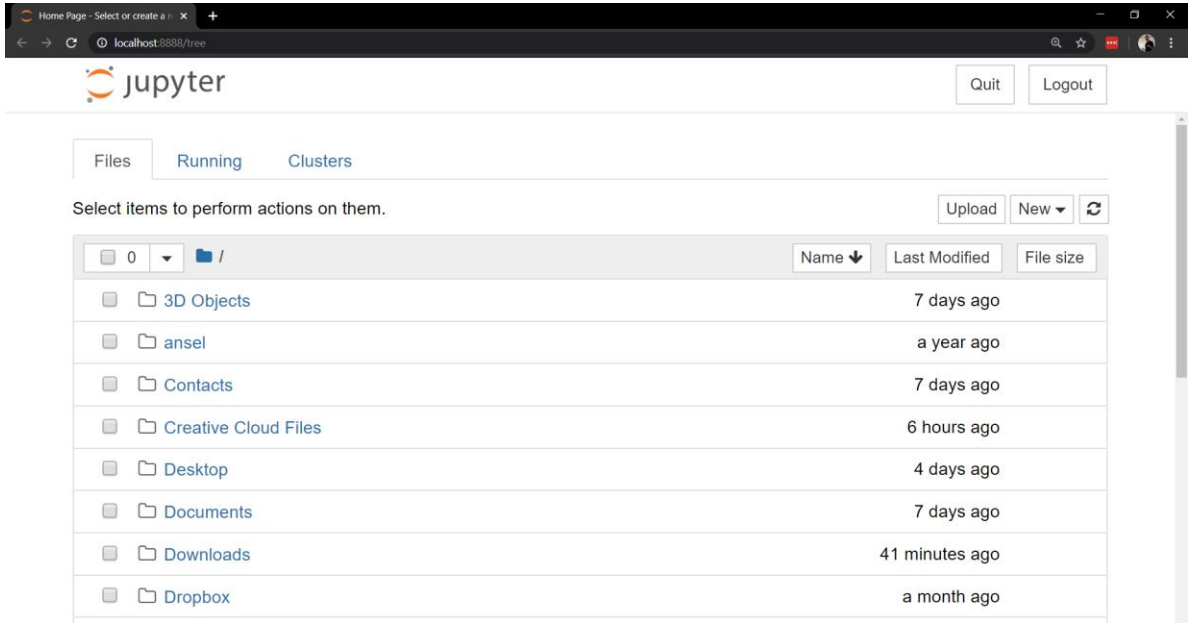
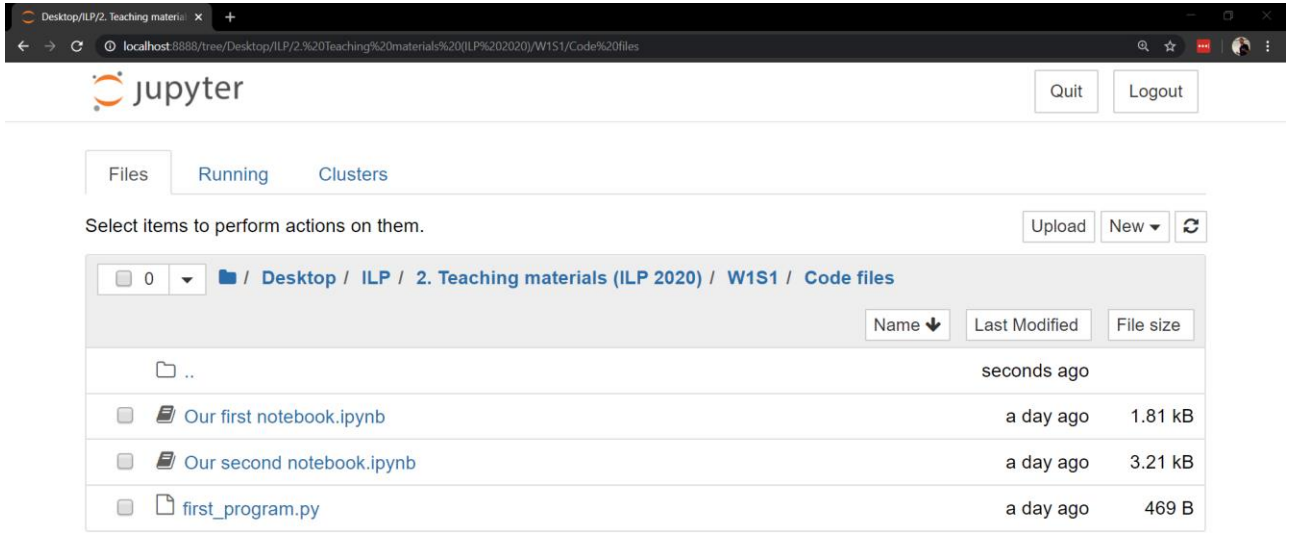
- **It should open a notebook window/tab in your web browser.**





Running Python from an IDE, such as a Jupyter Notebook

- Notebooks are a more convenient way to program on Python.
- They provide an explorer to navigate to a folder of your choice.
- Move to the folder where the code you downloaded is.



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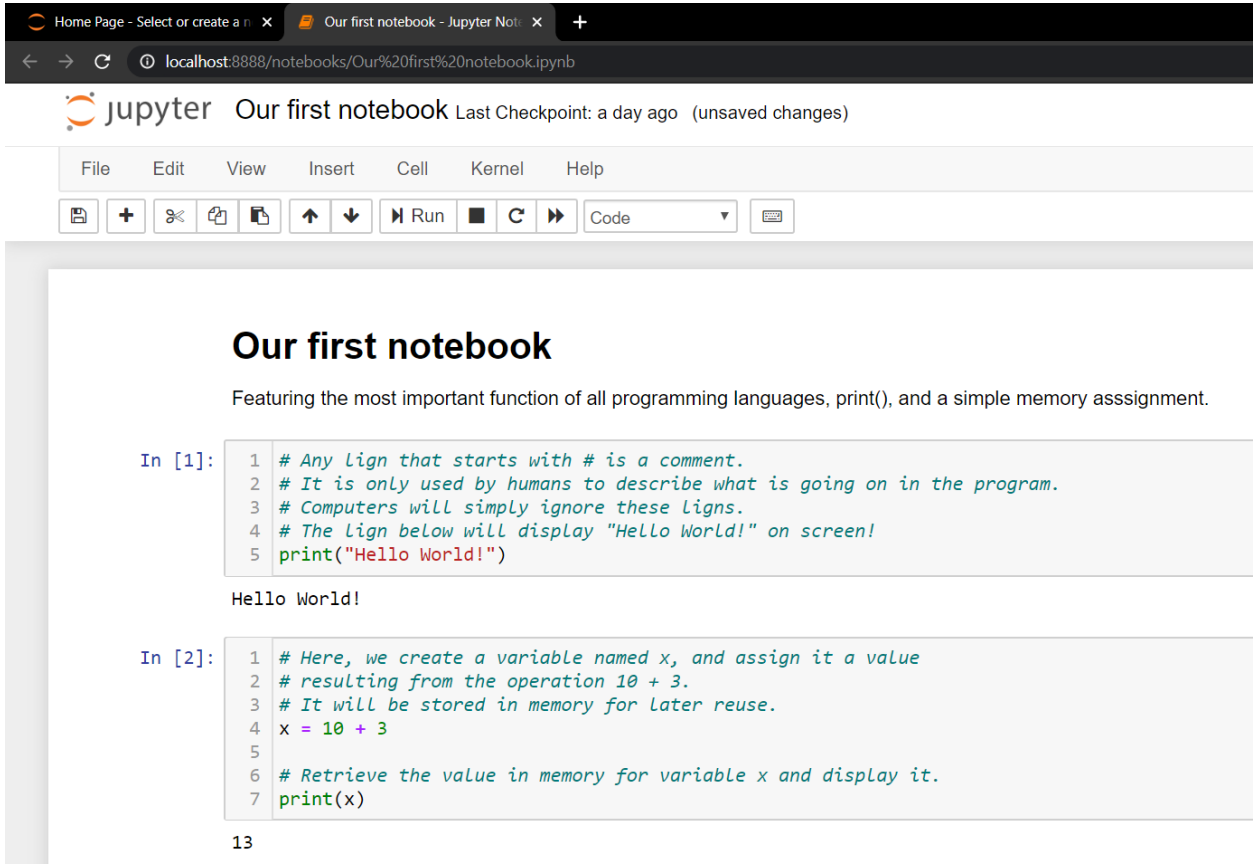

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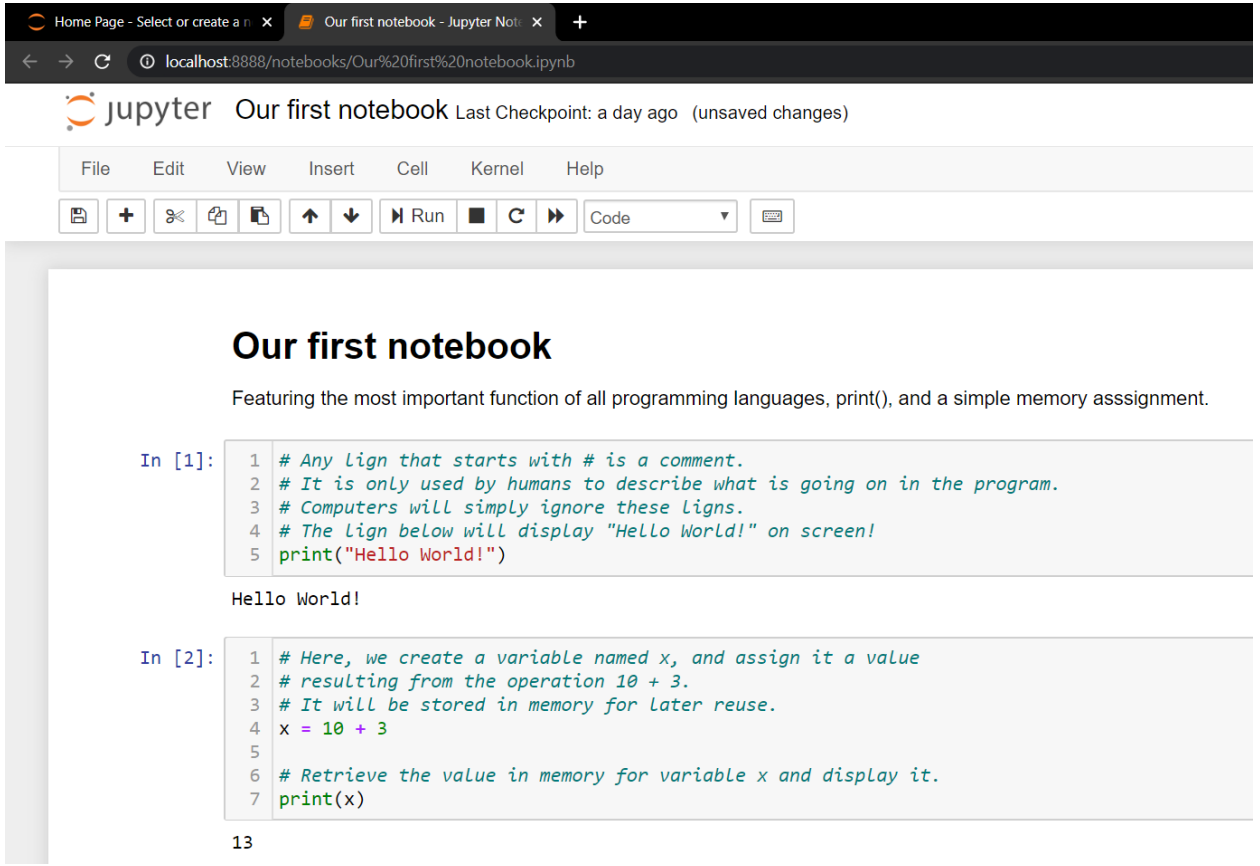
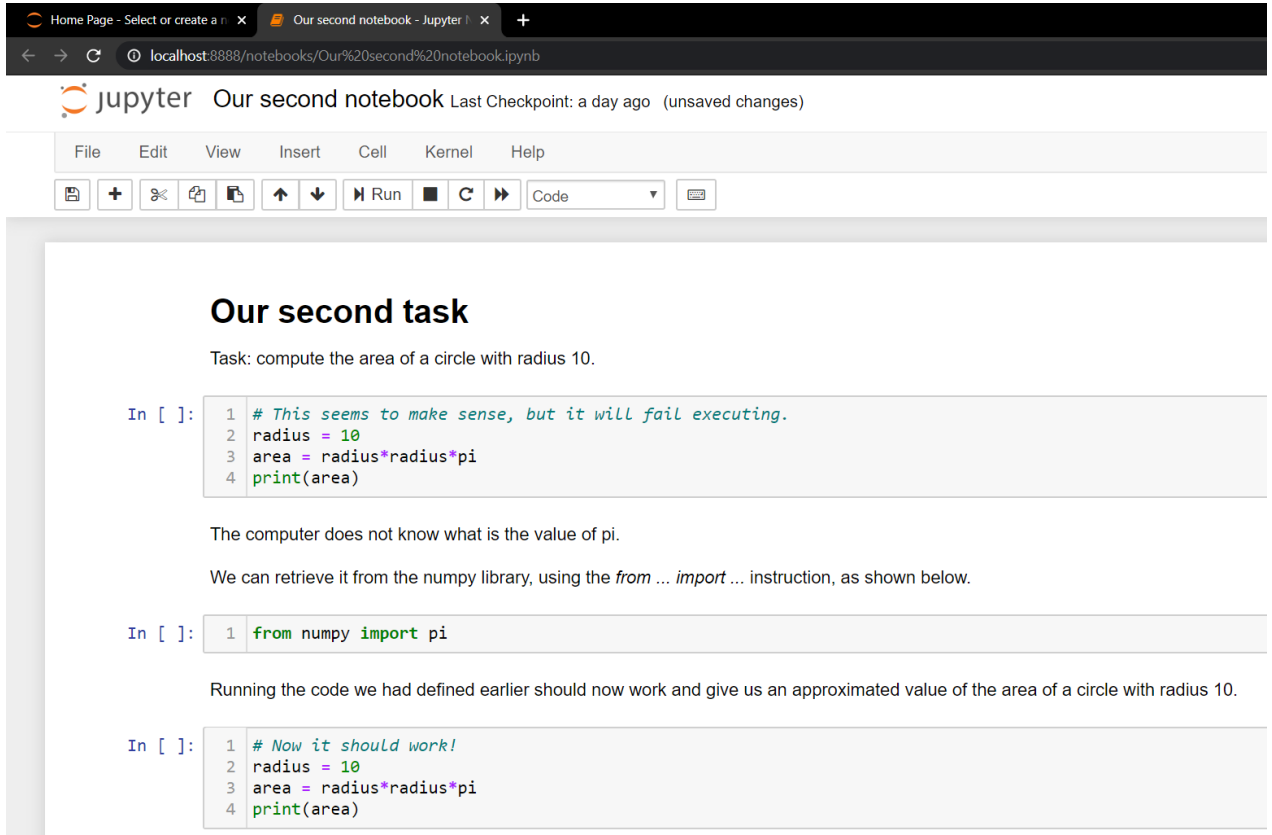
- Try executing a cell of code by selecting it and pressing **Shift+Enter**!
- A lot more convenient isn’t it?



Our second task

- Let us consider a **second task:** compute the area of a circle with radius 10.

- Open the second notebook.



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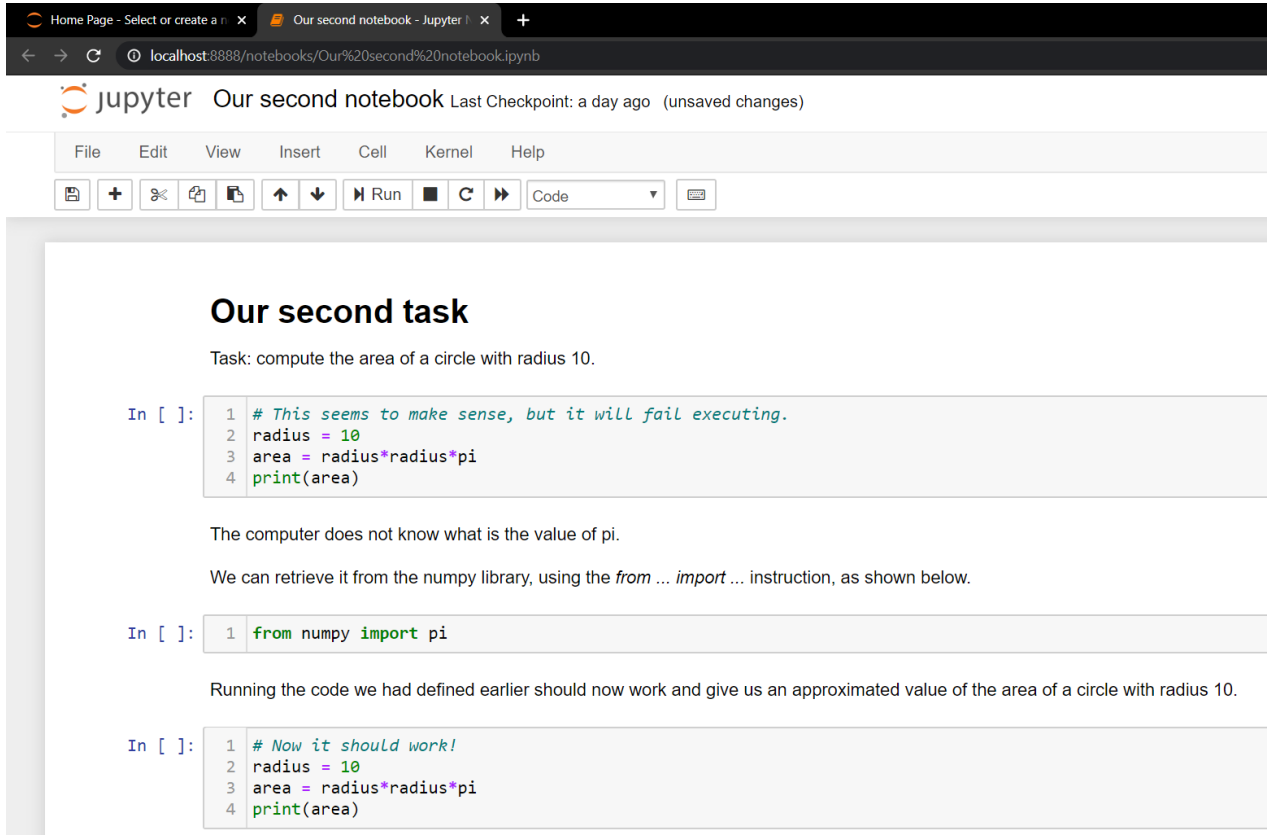
- **Note:** in computer science, the multiplication operation is denoted $*$, not $\times$.



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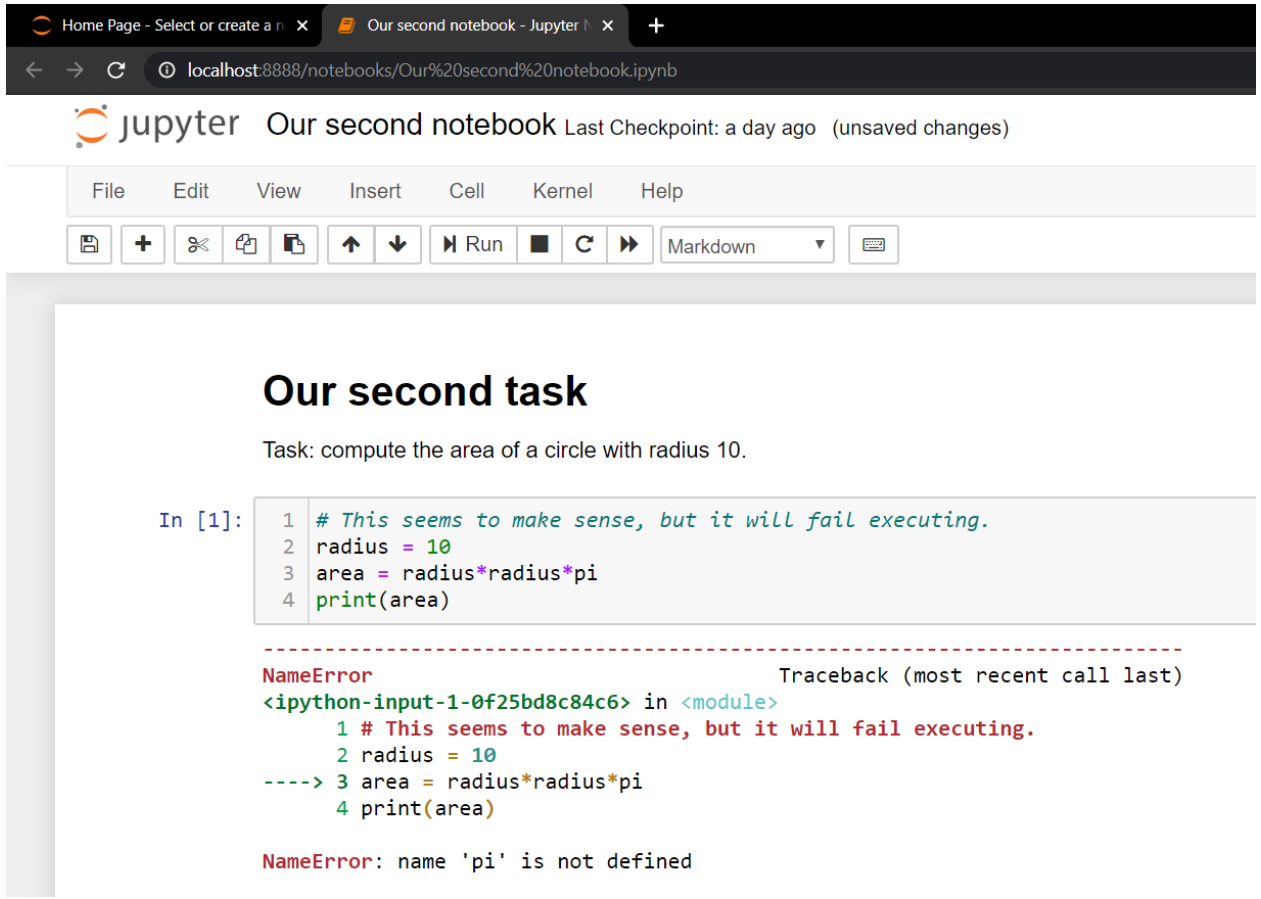
  → **We need the value of pi.**



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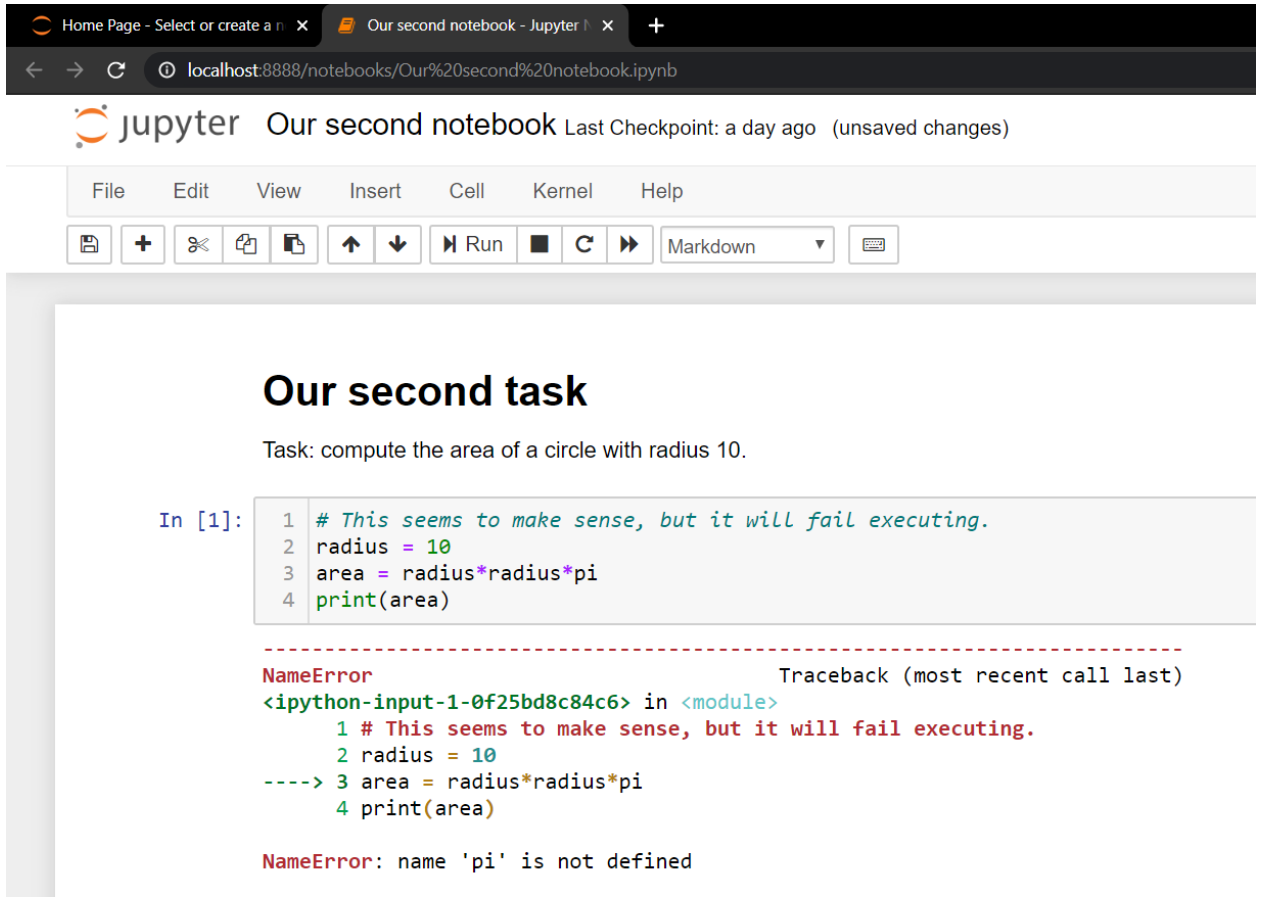
  → **We need the value of pi.**

- We could create a variable named pi and assign it the value 3.14, but it is better to retrieve it from a **package**.



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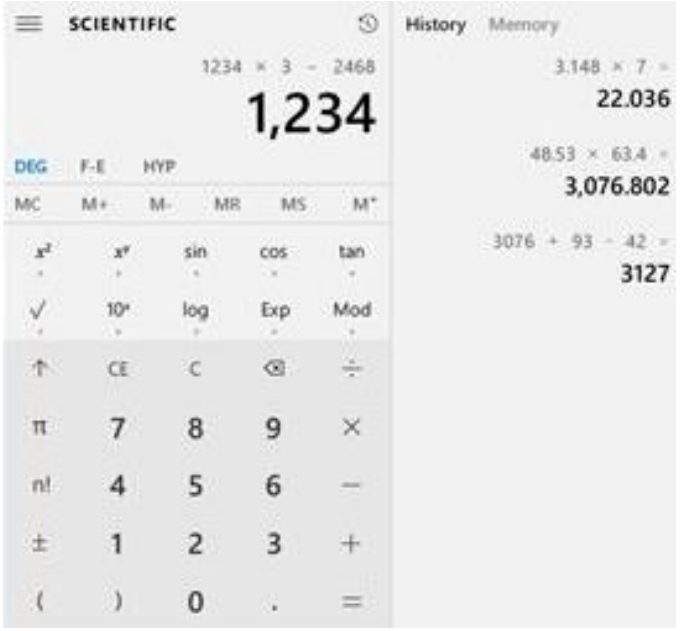

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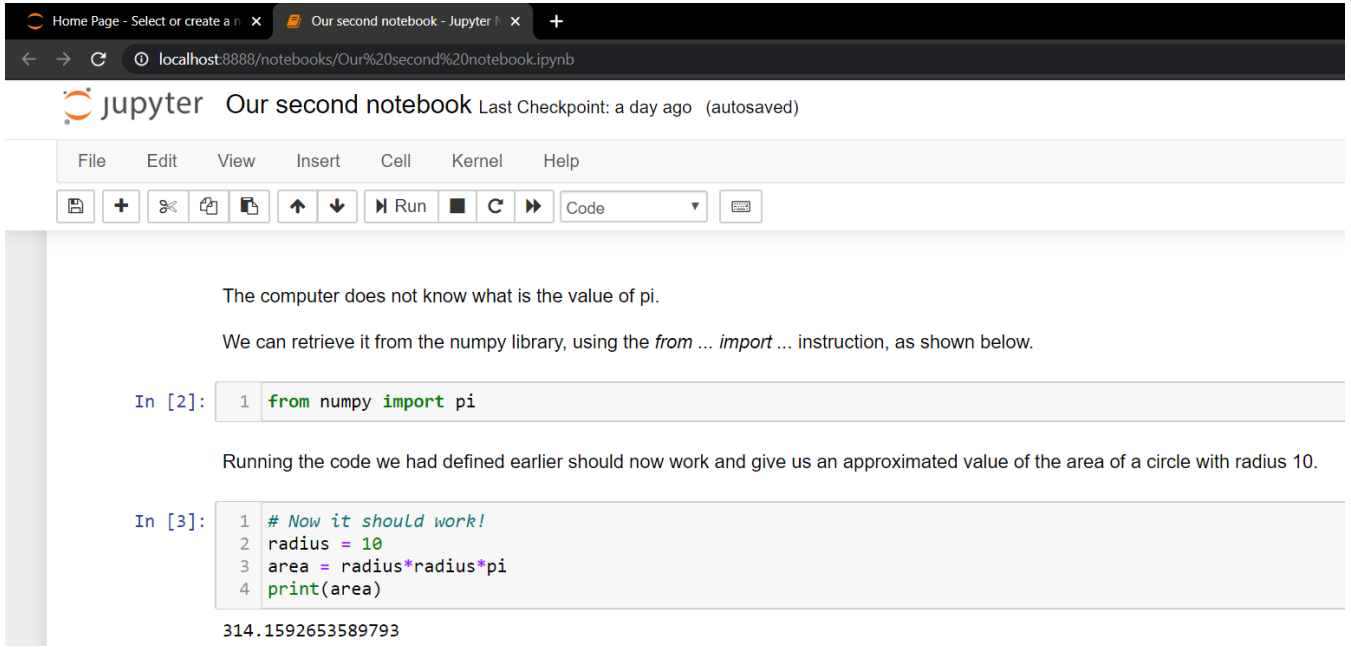

Congrats, you now have a Python-compatible machine, ready to run!

Feel free to play around a bit more if you want!

python™

Conclusion

What we have seen

- What is programming?
- Programming Languages and why we will use Python.
- Installing Python, extra packages and IDEs.
- Test run to confirm everything works.

→ If you were able to execute the two codes (in console and Jupyter Notebooks): you are officially done for today.

→ Let me know in Zoom chat if you have encountered technical issues and we will try to fix them together.