PROGRAMMING IN PYTHON I

Installation, Operating System, Terminal

Andreas Schörgenhumer
Institute for Machine Learning

JOHANNES KEPLER
UNIVERSITY LINZ

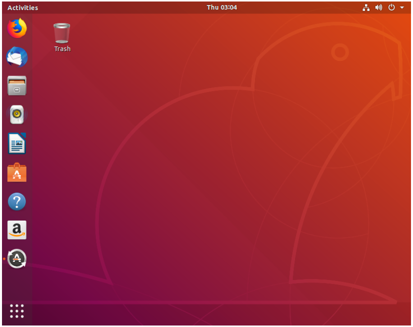
Institute for
Machine Learning

Copyright Statement

EXCURSION:
OPERATING SYSTEM (OS)

The Operating System

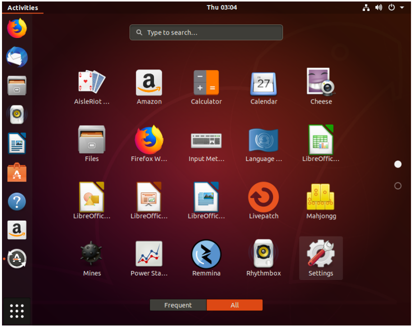
- Your **Operating System (OS)** is a program running on your machine
  - □ Linux (e.g., Ubuntu), MacOS, Windows, . . .
  - □ The following examples will be for `Ubuntu 18.04`



Ubuntu desktop in one of the (many) Ubuntu flavors

Programs and Processes (1)

- You can view (most of) the programs you install as plug-ins for your OS



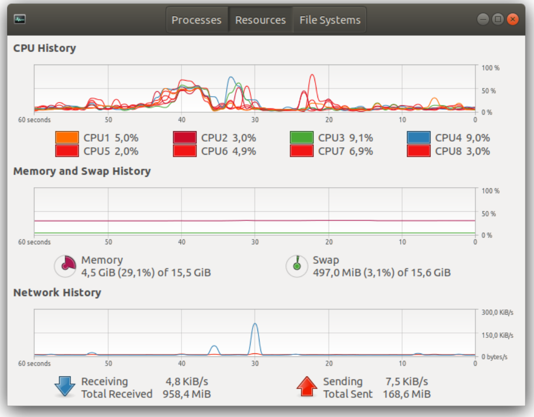
Part of programs installed on standard Ubuntu 18.04

Programs and Processes (2)

- Your OS manages (most of) the other programs that you install
  - □ It **schedules** when/how long a program and its processes can use the CPU
  - □ It **abstracts** from your specific hardware using **drivers** (drivers are programs that provide a standard interface to hardware components)
- Paths to installed programs are stored in **environment variables**
  - □ The environment variable *PYTHONPATH* is usually used for setting paths to Python packages. If you run into package-errors, check this variable.

Programs and Processes (3)

- The **System Monitor** or **Task Manager** is one of the tools to view some of the OS management



🟧 CPU1 5,0% 🟥 CPU2 3,0% 🟩 CPU3 9,1% 🟦 CPU4 9,0%
🟥 CPU5 2,0% 🟥 CPU6 4,9% 🟥 CPU7 6,9% 🟥 CPU8 3,0%

Memory
4,5 GiB (29,1%) of 15,5 GiB

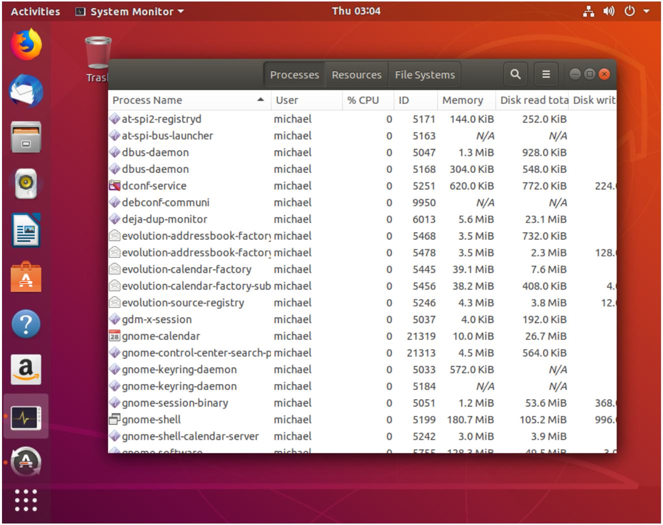
Swap
497,0 MiB (3,1%) of 15,6 GiB

Receiving 4,8 KiB/s
Total Received 958,4 MiB

Sending 7,5 KiB/s
Total Sent 168,6 MiB

System Monitor shows the current hardware utilization

Programs and Processes (4)



Process Name	User	% CPU	ID	Memory	Disk read tota	Disk writ
at-spi2-registryd	michael	0	5171	144.0 KiB	252.0 KiB	
at-spi-bus-launcher	michael	0	5163	*N/A*	*N/A*	
dbus-daemon	michael	0	5047	1.3 MiB	928.0 KiB	
dbus-daemon	michael	0	5168	304.0 KiB	548.0 KiB	
dconf-service	michael	0	5251	620.0 KiB	772.0 KiB	224.
debconf-communi	michael	0	9950	*N/A*	*N/A*	
deja-dup-monitor	michael	0	6013	5.6 MiB	23.1 MiB	
evolution-addressbook-factory	michael	0	5468	3.5 MiB	732.0 KiB	
evolution-addressbook-factory	michael	0	5478	3.5 MiB	2.3 MiB	128.
evolution-calendar-factory	michael	0	5445	39.1 MiB	7.6 MiB	
evolution-calendar-factory-sub	michael	0	5456	38.2 MiB	408.0 KiB	4.
evolution-source-registry	michael	0	5246	4.3 MiB	3.8 MiB	12.
gdm-x-session	michael	0	5037	4.0 KiB	192.0 KiB	
gnome-calendar	michael	0	21319	10.0 MiB	26.7 MiB	
gnome-control-center-search-p	michael	0	21313	4.5 MiB	564.0 KiB	
gnome-keyring-daemon	michael	0	5033	572.0 KiB	*N/A*	
gnome-keyring-daemon	michael	0	5184	*N/A*	*N/A*	
gnome-session-binary	michael	0	5051	1.2 MiB	53.6 MiB	368.
gnome-shell	michael	0	5199	180.7 MiB	105.2 MiB	996.
gnome-shell-calendar-server	michael	0	5242	3.0 MiB	3.9 MiB	
gnome-software	michael	0	5755	128.3 MiB	49.5 MiB	3.

System Monitor shows the currently managed processes

The System Terminal (1)

- Some OS and programs provide an abstract Graphical User Interface (GUI) with cursor, desktop, etc.
  - □ Sometimes comfortable, simpler, visually nicer
  - □ Additional work (needs to be implemented), not always handy, needs resources for rendering
  - □ **Remote servers and scientific ML programs usually do not provide GUIs**

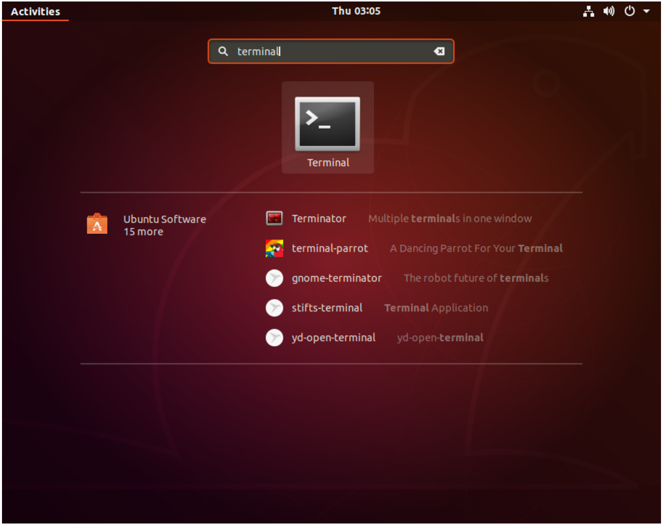
The System Terminal (1)

- Some OS and programs provide an abstract Graphical User Interface (GUI) with cursor, desktop, etc.
  - Sometimes comfortable, simpler, visually nicer
  - Additional work (needs to be implemented), not always handy, needs resources for rendering
  - **Remote servers and scientific ML programs usually do not provide GUIs**
- You can also use your OS directly via the **terminal** (also **console** or **command-line**)
  - Less additional work for the developer
  - Easier to interface with other programs

The System Terminal (1)

- Some OS and programs provide an abstract Graphical User Interface (GUI) with cursor, desktop, etc.
  - □ Sometimes comfortable, simpler, visually nicer
  - □ Additional work (needs to be implemented), not always handy, needs resources for rendering
  - □ **Remote servers and scientific ML programs usually do not provide GUIs**
- You can also use your OS directly via the **terminal** (also **console** or **command-line**)
  - □ Less additional work for the developer
  - □ Easier to interface with other programs
  - → **You'll need the terminal but you'll be fine, don't worry :)**

The System Terminal (2)



Activities

Thu 03:05

terminal

Terminal

Ubuntu Software
15 more

Terminator Multiple terminals in one window

terminal-parrot A Dancing Parrot For Your Terminal

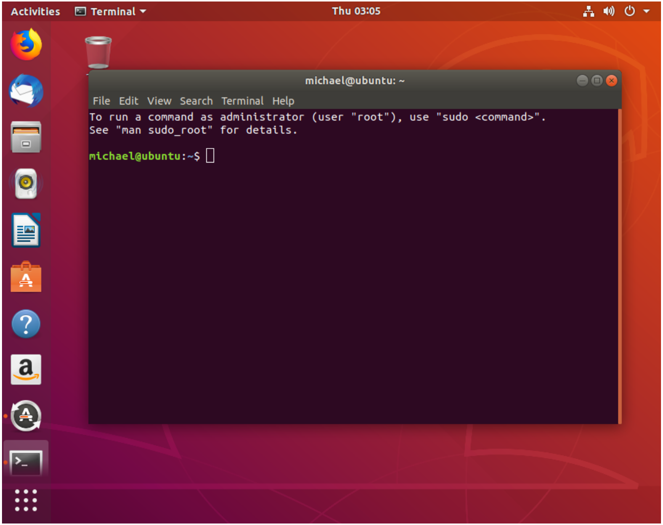
gnome-terminator The robot future of terminals

stifts-terminal Terminal Application

yd-open-terminal yd-open-terminal

Starting a terminal in Ubuntu

The System Terminal (2)



```
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

michael@ubuntu:~$ 
```

A terminal in Ubuntu

The System Terminal (3)

- The terminal should be in your list of programs (Windows: `cmd.exe`, Linux: `terminal`)
- Commands are written as text into the terminal and executed by pressing *Enter*
- The *Up* and *Down* keys let you view previously executed commands
- The *Tab* key will auto-complete your command/filepath (press twice to get a list of suggestions)

Many programs are only available via terminal!

INSTALLING PYTHON

Task: Download and Install Python

- **Python 64bit, version $\geq$ 3.9** (it might already be installed on some OS)
- Python official website: `http://www.python.org`
  - □ Simply download the latest version
  - □ Windows: Make sure to select that you want to add the Python path to the PATH environment variable! (however, you can always do it afterwards as well)

Python Packages (1)

- You can add new functions to your Python installation by installing additional **Python packages**
- Packages can be installed via **pip** (package installer for Python)
  - □ Pip guide: `https://docs.python.org/3/installing/index.html`
  - □ In the terminal you can install a package with the command

    ```
    pip3 install packagename
    ```

    or, depending on your installation,

    ```
    pip install packagename
    ```

Python Packages (2)

- pip for specific Python versions: You can use this line to install packages for, e.g., version 3.7:

```
python3.7 -m pip install packagename
```

- Under Ubuntu, you might have to run the following for other versions

```
sudo apt install -y python3-pip
python3.7 -m pip install pip
```

- Some packages require certain operating systems, software or drivers
- Python is mostly out-of-the-box platform independent – some packages are not!

Alternative: Anaconda/Miniconda

- Alternatively, you may use **Anaconda/Miniconda**:
  - □ Manages your Python installations
  - □ Allows for different Python versions and setups on one machine
  - □ If you know what you are doing, you may use Anaconda/Miniconda, otherwise stick with the standard Python installation
  - □ Instructions: `https://conda.io/projects/conda/en/latest/user-guide/install/index.html`

Python Documentation

- Official documentation:

  `http://www.python.org/doc/`

  `https://docs.python.org/3/`

- Official tutorial:

  `https://docs.python.org/3/tutorial/index.html`

- Many different online tutorial available

OPERATING SYSTEMS IN MACHINE LEARNING

Operating Systems in Machine Learning (1)

- Any OS will do, as long as you can get it to run
- Getting Python and PyCharm (integrated development environment (IDE) that supports you in programming) to run on different OS is straight-forward

Operating Systems in Machine Learning (1)

- Any OS will do, as long as you can get it to run
- Getting Python and PyCharm (integrated development environment (IDE) that supports you in programming) to run on different OS is straight-forward

  → **if it weren't for some important details...**

Operating Systems in Machine Learning (2)

- GPU and other hardware optimization
  - GPU drivers (NVIDIA CUDA + CUDNN) and their interface with packages like PyTorch and Tensorflow is crucial

  → **Setup of these drivers can be tricky for some OS and virtual machines**

  - Differences in multitasking between Windows and Linux

  → **Python does a good job in abstraction but interface of such functions might differ**

Operating Systems in Machine Learning (2)

- GPU and other hardware optimization
  - □ GPU drivers (NVIDIA CUDA + CUDNN) and their interface with packages like PyTorch and Tensorflow is crucial
  - → **Setup of these drivers can be tricky for some OS and virtual machines**
  - □ Differences in multitasking between Windows and Linux
  - → **Python does a good job in abstraction but interface of such functions might differ**
- Usage of (GPU) servers
  - □ Large-scale Machine Learning is done on dedicated severs, which typically run Linux
  - → **You need to know how to use a Linux terminal if you want to use such servers**

Operating Systems in Machine Learning (3)

- Portability issues (relevant for assignments!)
  - □ Python code is as portable as you design it to be
  - □ Assignment solutions will be graded on a Linux system
  - → **Paths, filenames, etc. are an easy source of portability issues!**

TASKS AND FIRST STEPS

Task 0: Using the System Terminal (1)

1. Open a system terminal (Windows: `cmd.exe`)

   Now you can type commands for your OS. Your current location is your home directory.

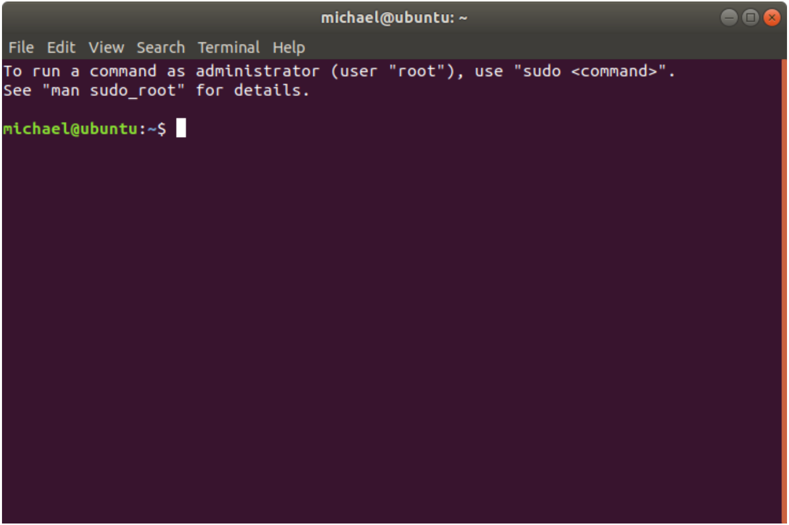
2. Type `ls` and press *Enter*

   You should see a list of files in the current directory

3. Type `cd mypathname` and press *Enter* to change the current directory

   Your current directory should have changed to `mypathname`, if that directory exists

Task 0: Using the System Terminal (2)

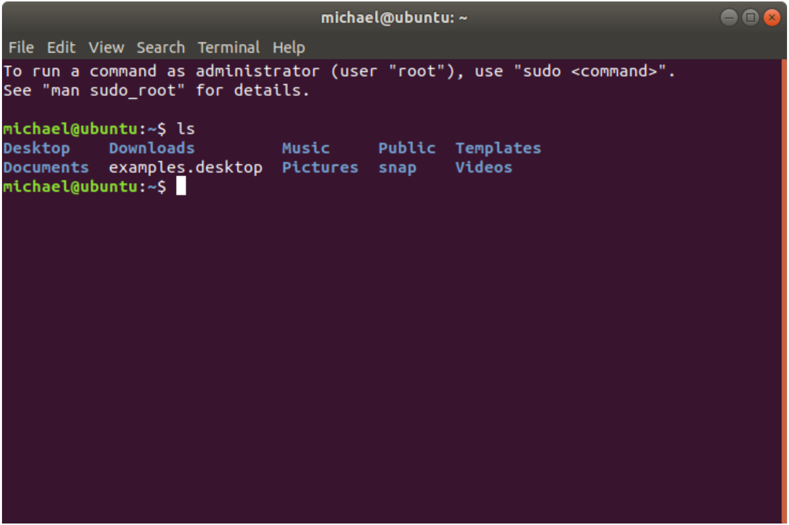


```
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

michael@ubuntu:~$ 
```

Starting a terminal in Ubuntu

Task 0: Using the System Terminal (3)

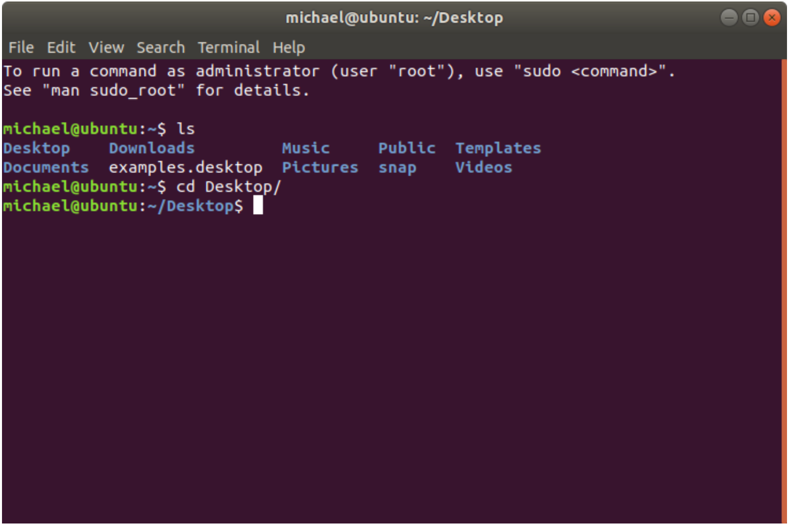


```
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

michael@ubuntu:~$ ls
Desktop    Downloads         Music     Public  Templates
Documents  examples.desktop  Pictures  snap    Videos
michael@ubuntu:~$ 
```

Executing ls in a terminal in Ubuntu

Task 0: Using the System Terminal (4)


michael@ubuntu: ~/Desktop
File Edit View Search Terminal Help

```
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

michael@ubuntu:~$ ls
Desktop    Downloads         Music     Public   Templates
Documents  examples.desktop  Pictures  snap     Videos
michael@ubuntu:~$ cd Desktop/
michael@ubuntu:~/Desktop$ 
```

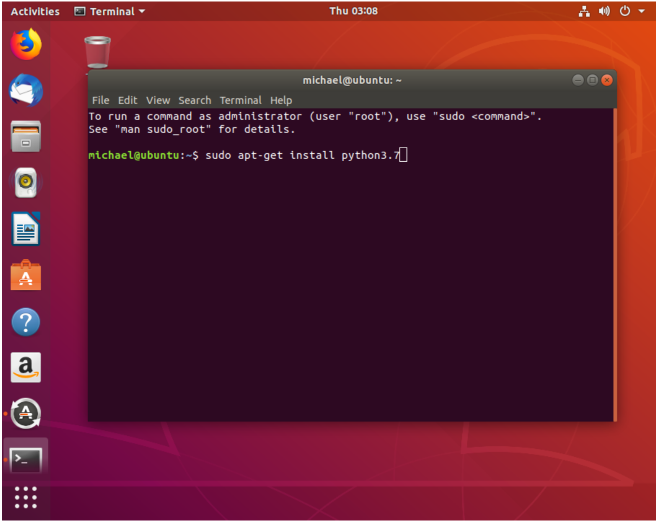
Executing cd in a terminal in Ubuntu

Task 1: Installing Python (1)

- Install Python 64bit, version 3.9 or higher, on your machine

Note: The following tutorial is based on version 3.7 (simply adapt this accordingly to the correct version)

Task 1: Installing Python (2)



```
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

michael@ubuntu:~$ sudo apt-get install python3.7
```

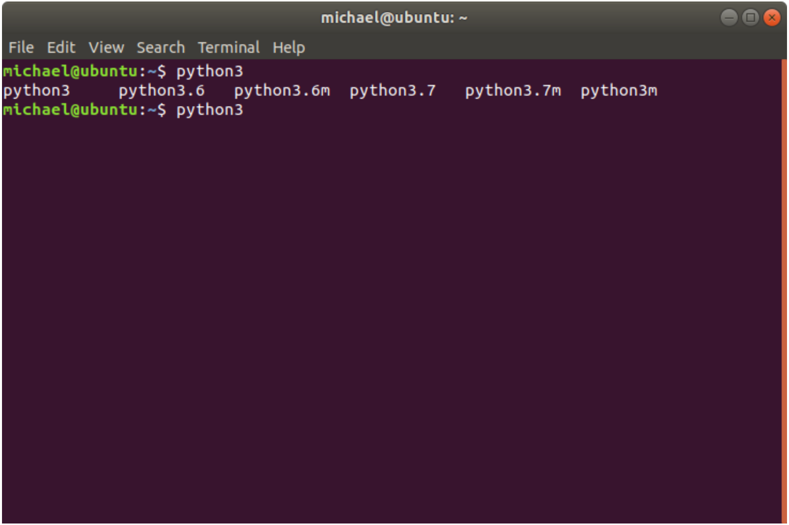
Installing Python under Ubuntu

Task 2: Using the Python Interpreter (1)

1. Open a system terminal
2. Type `python3` or `python` on Windows (or `python3.7` for specific version `3.7`)

   Or type `pyth` and press *Tab* for auto-complete (*Tab* twice for suggestions)
3. Press *Enter*
4. Now the terminal should have opened a Python interpreter, here you can use Python code
5. Verify that you have the correct Python version
6. Type `4+5` and press *Enter*
7. You should see the text `9` in your Python interpreter
8. Close the window or type `exit()` to exit the interpreter

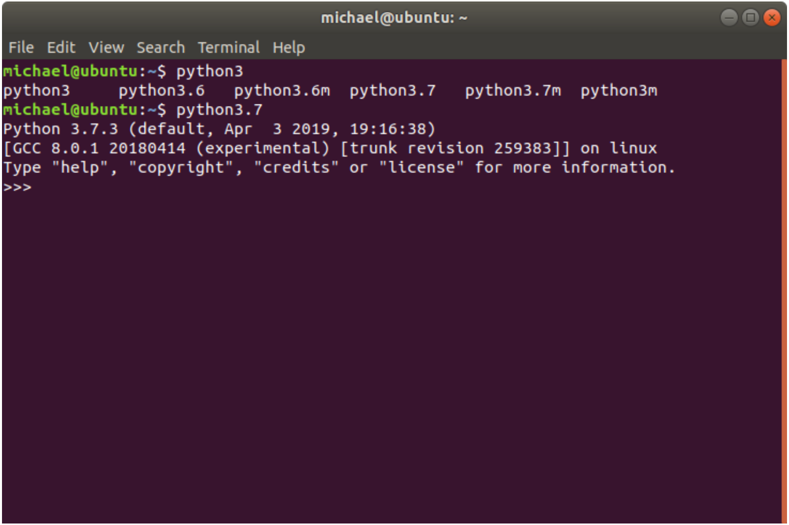
Task 2: Using the Python Interpreter (2)



```
michael@ubuntu:~$ python3
python3      python3.6   python3.6m  python3.7   python3.7m  python3m
michael@ubuntu:~$ python3
```

Tab twice for possibilities after typing *python3*

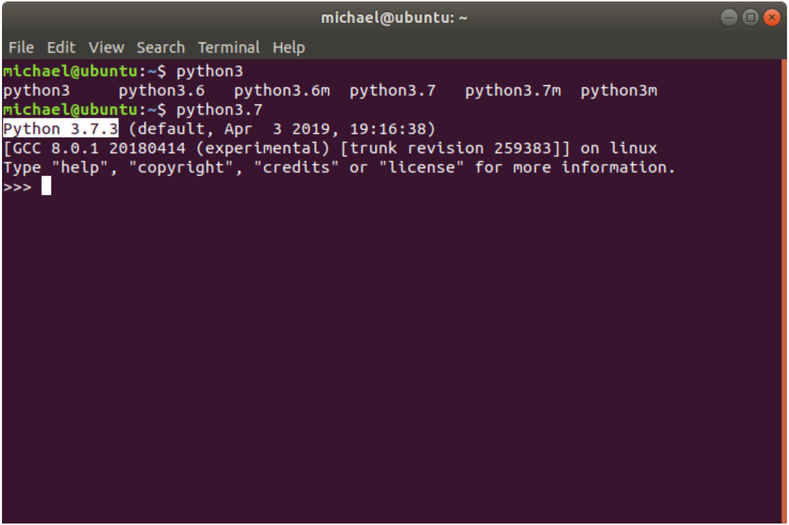
Task 2: Using the Python Interpreter (3)



```
michael@ubuntu:~$ python3
python3     python3.6   python3.6m  python3.7   python3.7m  python3m
michael@ubuntu:~$ python3.7
Python 3.7.3 (default, Apr  3 2019, 19:16:38)
[GCC 8.0.1 20180414 (experimental) [trunk revision 259383]] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>>
```

Starting Python interpreter with version 3.7

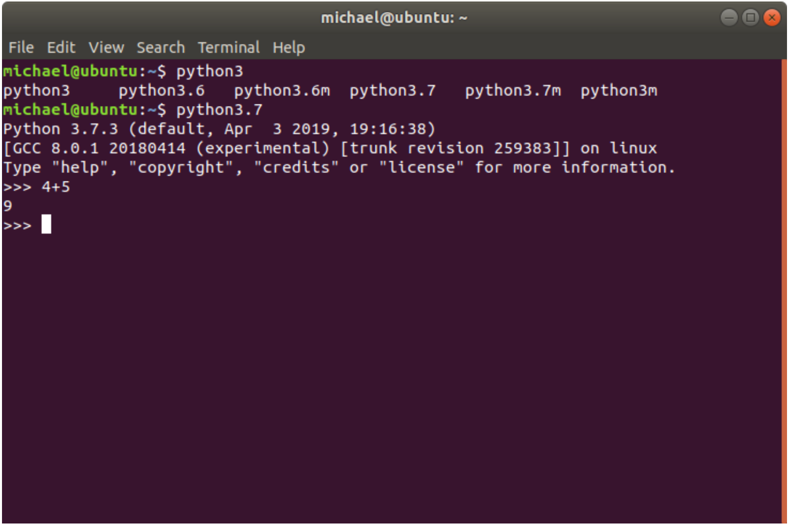
Task 2: Using the Python Interpreter (4)



```
michael@ubuntu:~$ python3
python3      python3.6   python3.6m  python3.7   python3.7m  python3m
michael@ubuntu:~$ python3.7
Python 3.7.3 (default, Apr  3 2019, 19:16:38)
[GCC 8.0.1 20180414 (experimental) [trunk revision 259383]] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> 
```

Verifying Python version visually

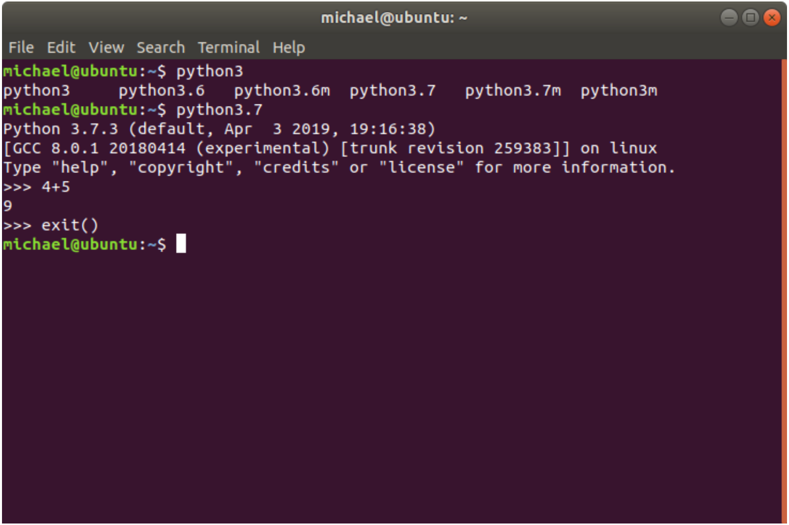
Task 2: Using the Python Interpreter (5)



```
michael@ubuntu:~$ python3
python3      python3.6   python3.6m  python3.7   python3.7m  python3m
michael@ubuntu:~$ python3.7
Python 3.7.3 (default, Apr  3 2019, 19:16:38)
[GCC 8.0.1 20180414 (experimental) [trunk revision 259383]] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> 4+5
9
>>> 
```

Calculating $4 + 5$

Task 2: Using the Python Interpreter (6)



```
michael@ubuntu:~$ python3
python3      python3.6   python3.6m  python3.7   python3.7m  python3m
michael@ubuntu:~$ python3.7
Python 3.7.3 (default, Apr  3 2019, 19:16:38)
[GCC 8.0.1 20180414 (experimental) [trunk revision 259383]] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> 4+5
9
>>> exit()
michael@ubuntu:~$ 
```

Exiting Python interpreter

Taks 3: Running a Python Script (1)

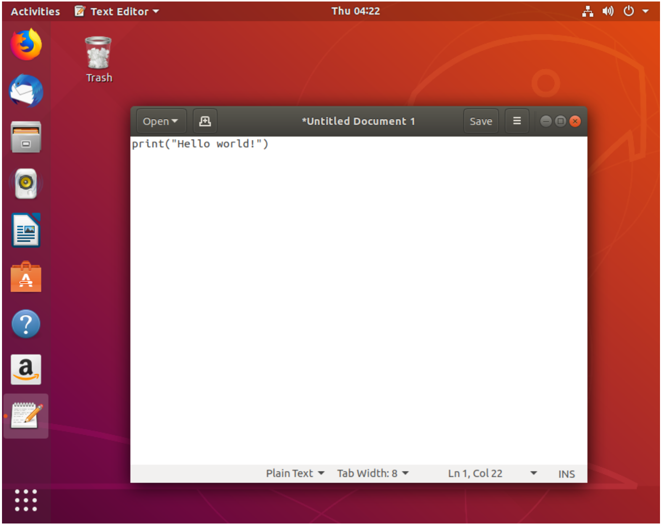
- Create an empty file named *test.py* with the contents

```
print("Hello world!")
```

  - Use `notepad`, `texteditor`, `gedit`, . . . to create it
  - Don't use `MSWord`, `Libreoffice`, . . . (will store format information in the file!)

- Run the file with Python
  1. Open a system terminal
  2. Change to the directory your file is located in:
     `cd path_to_directory`
  3. Run the file by typing `python3 test.py` and pressing *Enter*
  4. You should see the text *Hello world!* in your system terminal
  5. Ask for help if you ran into troubles

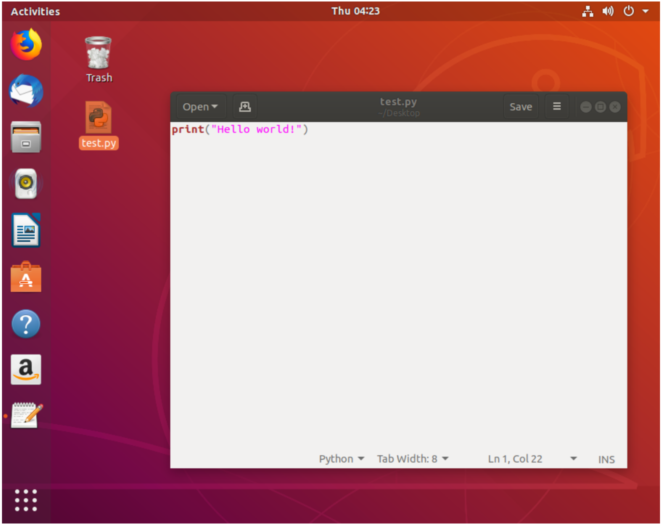
Taks 3: Running a Python Script (2)



```
print("Hello world!")
```

Opening a text editor and entering text print("Hello world!")

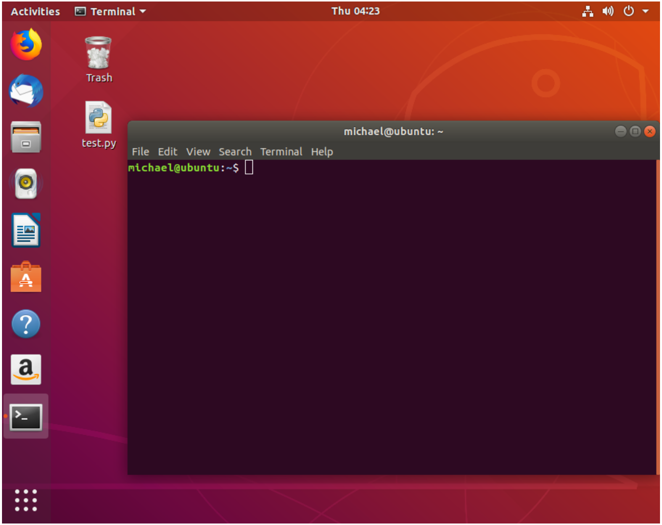
Taks 3: Running a Python Script (3)



```
print("Hello world!")
```

Saving file with name test.py to desktop

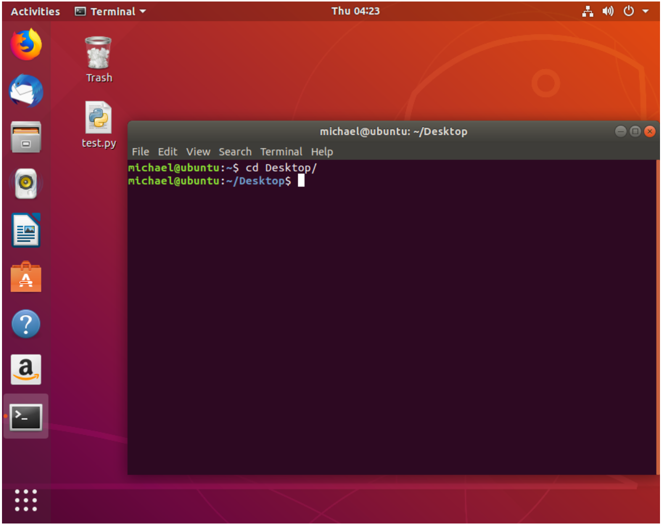
Taks 3: Running a Python Script (4)



```
michael@ubuntu:~$ 
```

Opening terminal

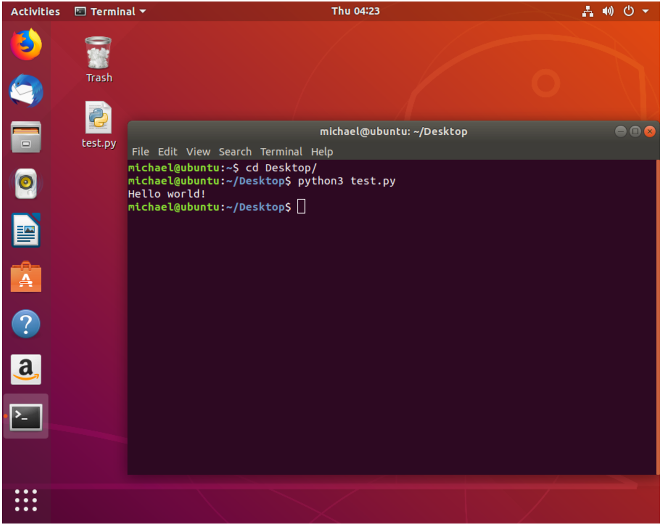
Taks 3: Running a Python Script (5)


Activities
Terminal
Thu 04:23
Trash
test.py
michael@ubuntu: ~/Desktop
File Edit View Search Terminal Help

```
michael@ubuntu:~$ cd Desktop/
michael@ubuntu:~/Desktop$ 
```

cd to directory where file is located at (in this case to desktop)

Taks 3: Running a Python Script (6)


Activities
Terminal
Thu 04:23
Trash
test.py
michael@ubuntu: ~/Desktop
File Edit View Search Terminal Help

```
michael@ubuntu:~$ cd Desktop/
michael@ubuntu:~/Desktop$ python3 test.py
Hello world!
michael@ubuntu:~/Desktop$ 
```

Running file test.py

You just ran a Python script! :)