

# ROOT-CERN

Muhammad Farooq  
email: 2714befarooq@gmail.com  
muhammad.farooq@cern.ch

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## Introduction

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Root[1][2] is scientific toolkit used for data analysis , statistical analysis,multivariate analysis (TMVA)[3], visualization and storage. It's C++ programming based, but also integrated to other languages like Python(PYRoot)[4], and R(ROOTR)[5].

## 1 Build Prerequisites

Before, going to install Root first, we have to install pre-requisites for Root-Build Prerequisites [6]. I'm Ubuntu user. So, I have installed root on ubuntu. Just write packages Figure 1 on ubuntu terminal and press Enter Figure 2.

## 2 Downloading

After, install packages for Build-Prerequisites, now we have to download the root packages[7] in source.tar file[8].

## 3 Installation

After, download .tar file you can shift this file in your desired working area. Like I copy this .tar file in Home Directory Figure 3. Now, extract this **root\_v6.20.04.source.tar.gz** like Figure 4.

Now, go into **root-6.20.04** directory Figure 5, then **./configure - -all** Figure 5. Now go back from this directory Figure 5 by typing **cd ...** Make a directory **mkdir root** Figure 5, go into root directory **cd root** Figure 5. At the last, type **cmake ../root-6.20.04/** and Press Enter Figure 5.

After cmake, now we have to make all files like **make -j4** Figure 6. After make files, now type **make install** Figure 7. Now root install in your working **Home** directory. Now, we have to set path for Root. For this purpose open a new terminal and type **nano .bashrc** and Press Enter Figure 8. When you Enter this will open a new terminal like Figure 9 and Scroll down and type **source /home/muhammad/root/bin/thisroot.sh** here before **root/bin/thisroot.sh** write your home address, then press **Ctrl+S** and then **Ctrl+X** to Exit.

Open a new terminal and Write **source .bashrc** like Figure 10 and press Enter and then Type **root** like Figure 10 and Press Enter. To Exit from root terminal press **.q**.

## 4 Setting the Environment Variables

For setting the Environment variables [12] open a new terminal and write the following command on terminal like Figure 11.

## 5 PyRoot

Here, I will discuss how to install Pyroot[13] binding in Root. For this purpose, first we have to install pre-requisite for this. First, open a new terminal and write **sudo apt install python-pip** like Figure 12 and Press Enter. Now, write **pip install jupyter metakernel** like Figure 13 and Press Enter. After this installation, write on terminal **root --notebook** and Press Enter. This will open a Jupyter notebook like Figure 14.

## 6 Root-Tutorials

For root-tutorials you can visit my Github repository [9] and other tutorials [10], [11].

## References

- [1] Root, [\*https://root.cern.ch/\*](https://root.cern.ch/)
- [2] Root, [\*https://arxiv.org/pdf/1508.07749.pdf\*](https://arxiv.org/pdf/1508.07749.pdf)
- [3] TMVA, [\*https://arxiv.org/abs/physics/0703039\*](https://arxiv.org/abs/physics/0703039)
- [4] PyRoot, [\*https://root.cern.ch/pyroot\*](https://root.cern.ch/pyroot)
- [5] ROOTR, [\*https://root.cern.ch/doc/master/md\\_bindings\\_r\\_doc\\_users-guide\\_ROOTR\\_Users\\_Guide.html\*](https://root.cern.ch/doc/master/md_bindings_r_doc_users-guide_ROOTR_Users_Guide.html)
- [6] Build-Prerequisites [\*https://root.cern.ch/build-prerequisites\*](https://root.cern.ch/build-prerequisites)
- [7] Release 6.20/04 - 2020-04-01 [\*https://root.cern.ch/content/release-62004\*](https://root.cern.ch/content/release-62004)
- [8] Root Source distribution [\*https://root.cern/download/root\\_v6.20.04.source.tar.gz\*](https://root.cern/download/root_v6.20.04.source.tar.gz)
- [9] Root-codes, [\*https://github.com/MFarooq786/root-codes\*](https://github.com/MFarooq786/root-codes)
- [10] Root-Project official, [\*https://github.com/root-project/root/tree/master/tutorials\*](https://github.com/root-project/root/tree/master/tutorials)
- [11] Root-Summer-Course, [\*https://github.com/root-project/training\*](https://github.com/root-project/training)
- [12] Setting the Environment Variables, [\*https://root.cern.ch/root/html/doc/guides/users-guide/GettingStarted.html\*](https://root.cern.ch/root/html/doc/guides/users-guide/GettingStarted.html)
- [13] PyRoot-Binding, [\*https://root.cern.ch/how/how-use-pyroot-root-python-bindings\*](https://root.cern.ch/how/how-use-pyroot-root-python-bindings)

```
sudo apt-get install git dpkg-dev cmake g++ gcc binutils libx11-dev libxpm-dev
sudo apt-get install gfortran libssl-dev libpcre3-dev libxft-dev libxext-dev
sudo apt-get install xlibmesa-glu-dev libglew1.5-dev libftgl-dev libmysqlclient-dev
sudo apt-get install libfftw3-dev libcfitsio-dev graphviz-dev libavahi-compat-libdnssd-dev
sudo apt-get install libldap2-dev python-dev libxml2-dev libkrb5-dev libgsl0-dev libqt4-dev

sudo apt-get install libssl-dev libpcre3-dev xlibmesa-glu-dev libglew1.5-dev libftgl-dev
sudo apt-get install libmysqlclient-dev libfftw3-dev libcfitsio-dev graphviz-dev
sudo apt-get install libavahi-compat-libdnssd-dev libldap2-dev python-dev python-numpy-dev
sudo apt-get install libxml2-dev libkrb5-dev libgsl0-dev libqt4-dev r-base
```

Figure 1: Root-Build-Prerequisites

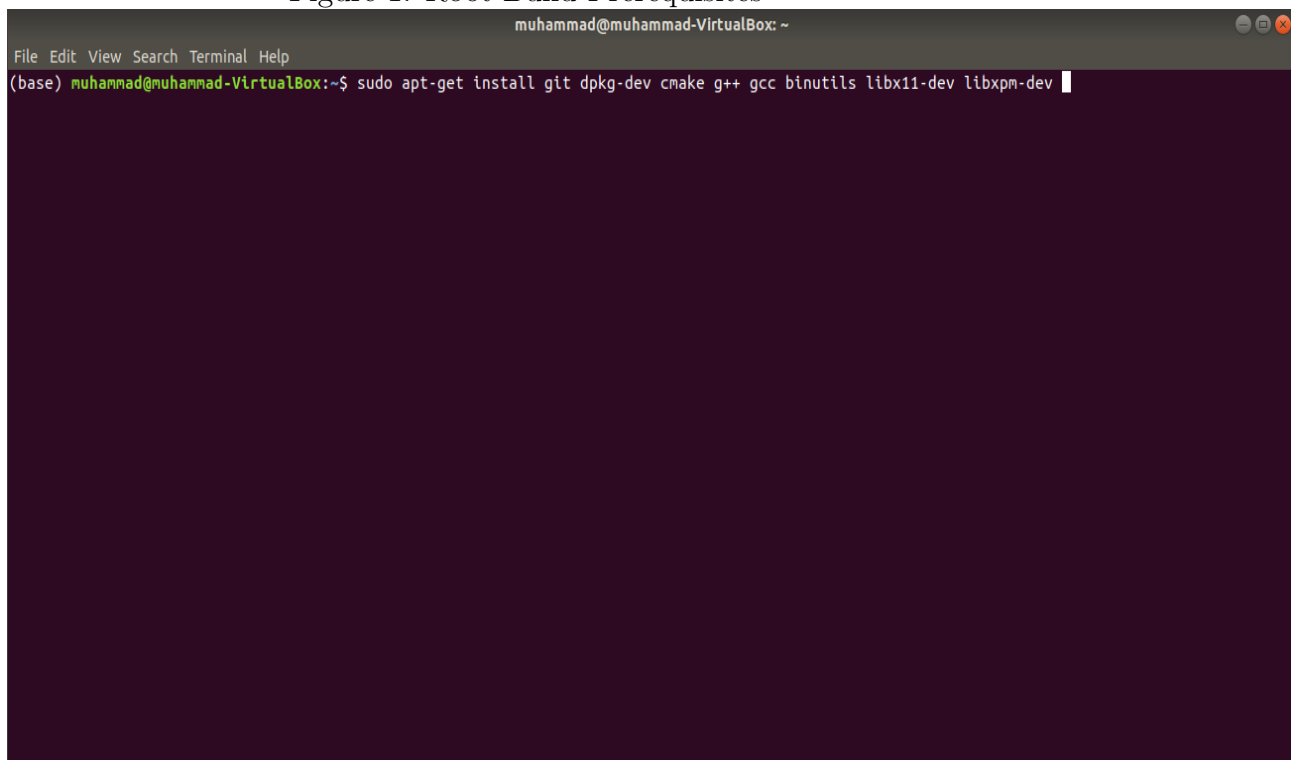


Figure 2: packages installation

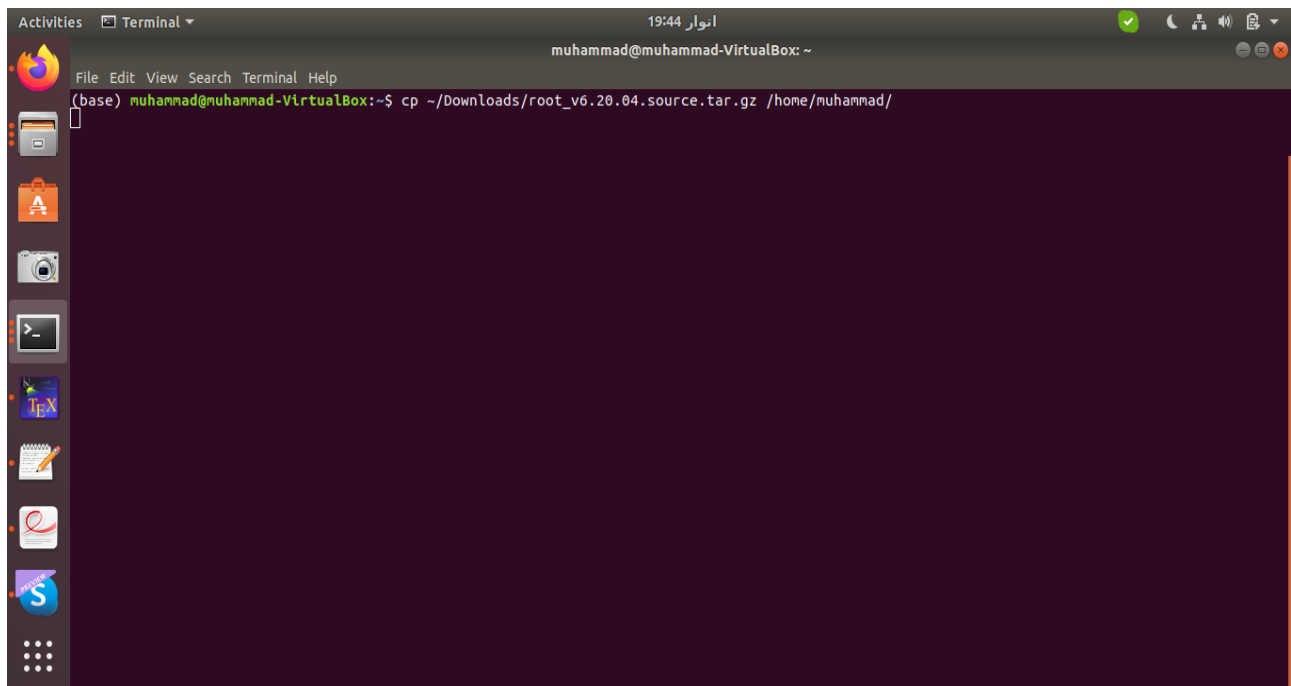


Figure 3: Home-Working Directory

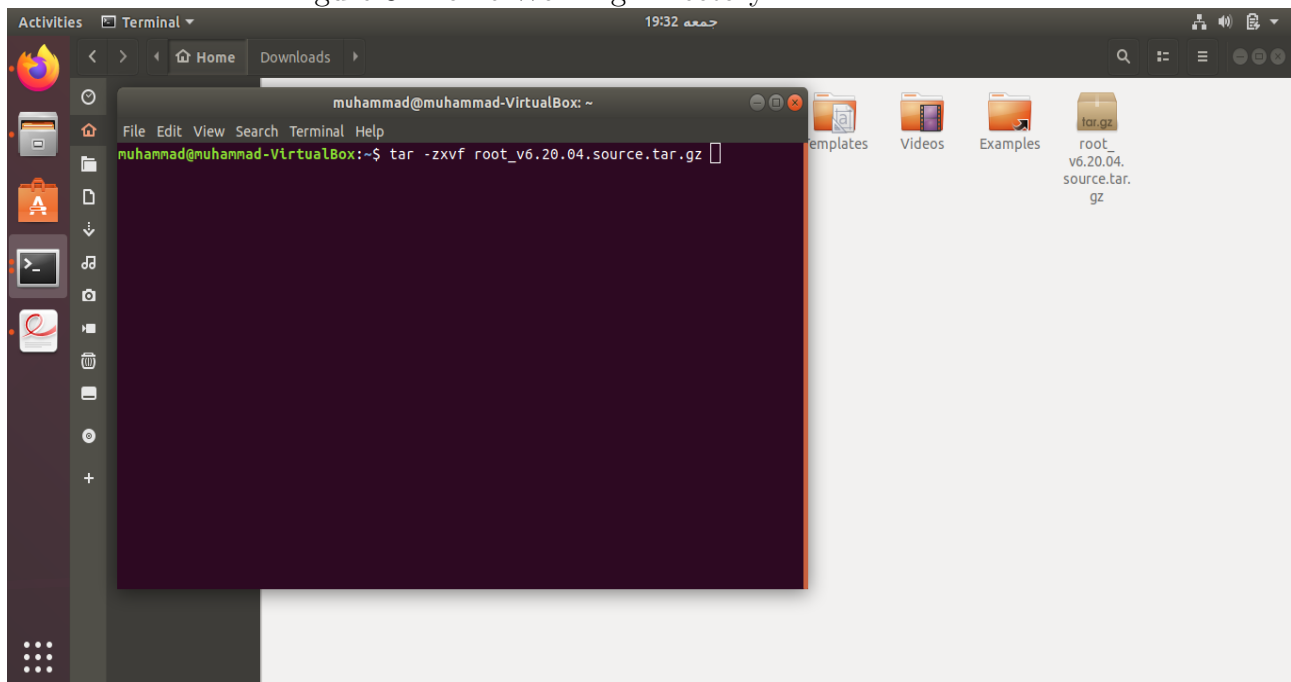


Figure 4: extract .tar file

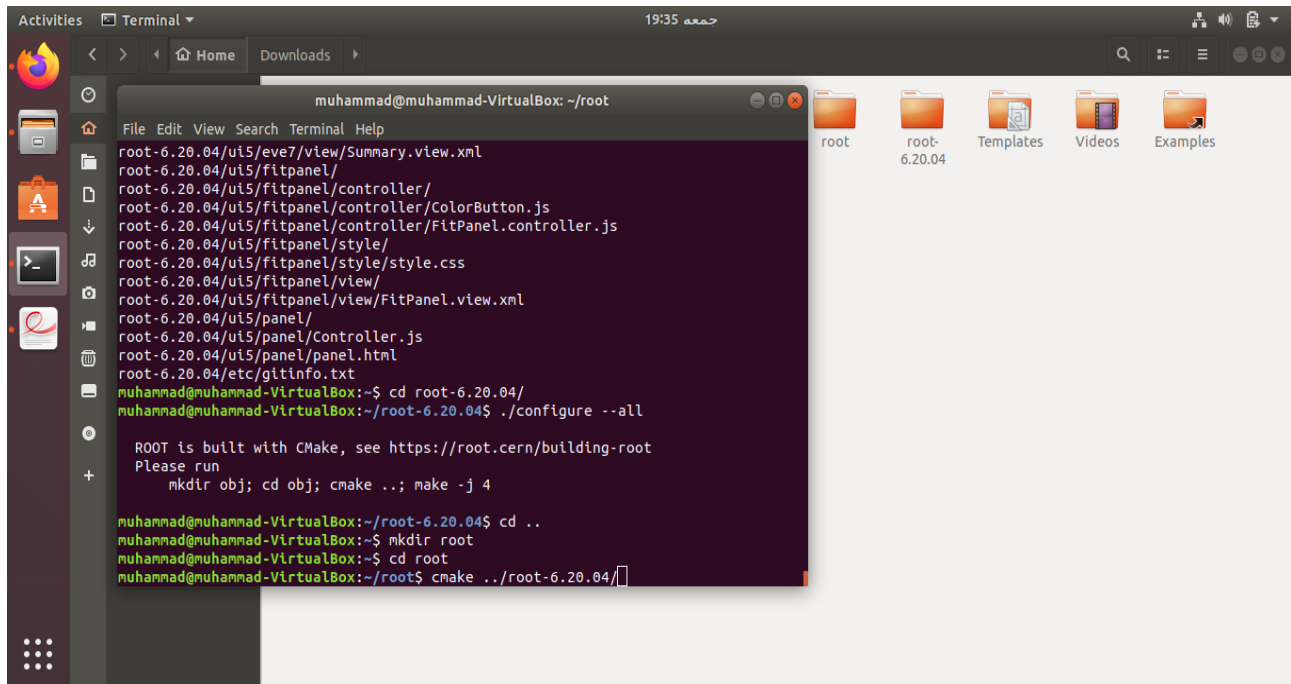


Figure 5: cmake

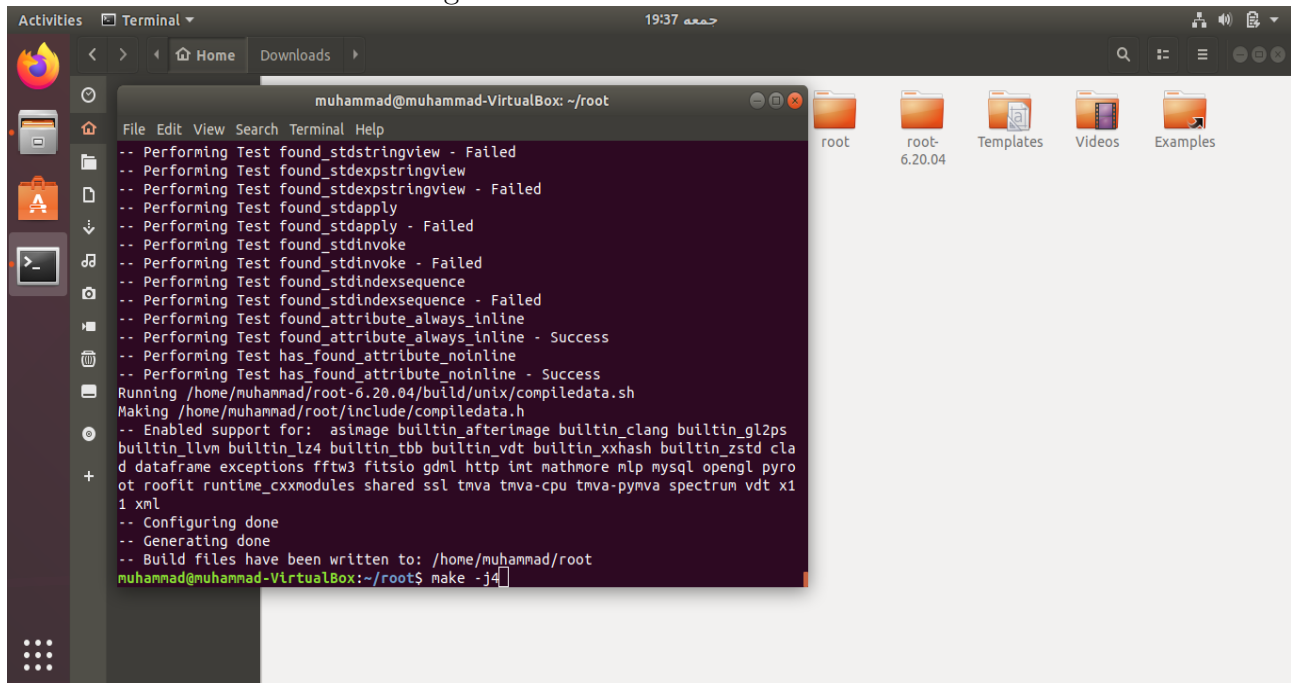
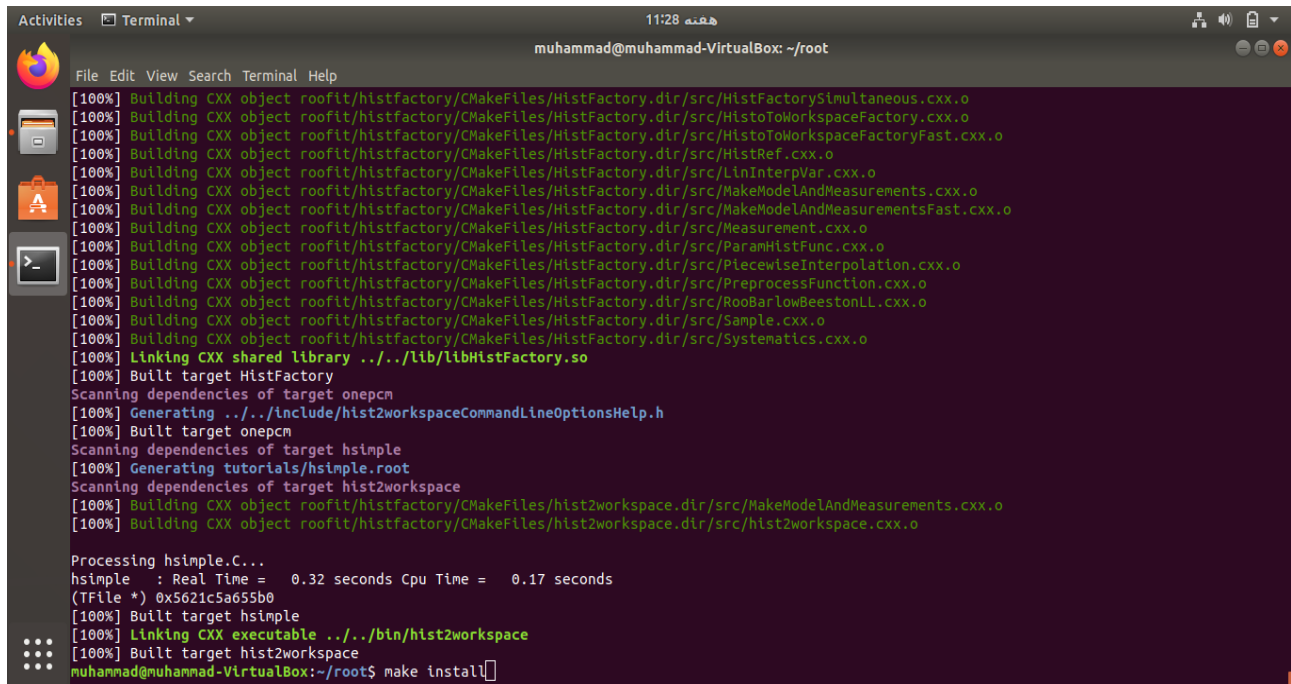


Figure 6: make files

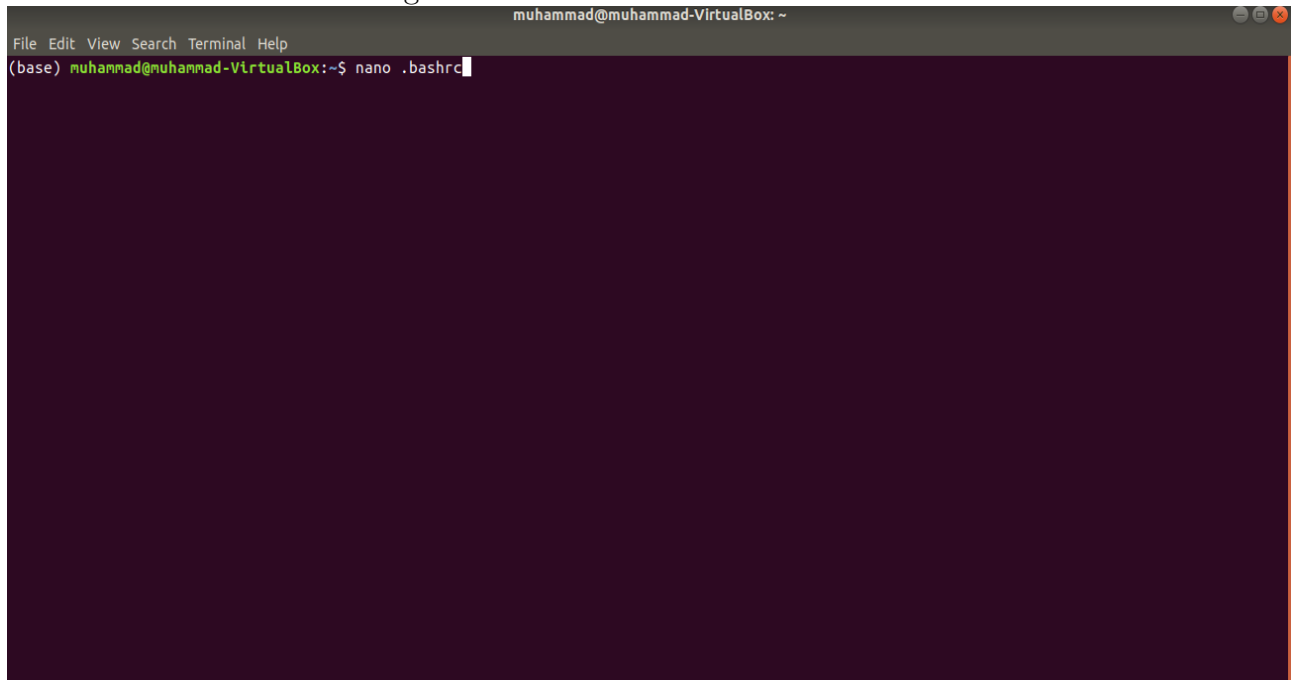


```
Activities Terminal 11:28 هفته
muhammad@muhammad-VirtualBox: ~/root

[100%] Building CXX object roofit/histfactory/CMakeFiles/HistFactory.dir/src/HistFactorySimultaneous.cxx.o
[100%] Building CXX object roofit/histfactory/CMakeFiles/HistFactory.dir/src/HistoToWorkspaceFactory.cxx.o
[100%] Building CXX object roofit/histfactory/CMakeFiles/HistFactory.dir/src/HistoToWorkspaceFactoryFast.cxx.o
[100%] Building CXX object roofit/histfactory/CMakeFiles/HistFactory.dir/src/HistRef.cxx.o
[100%] Building CXX object roofit/histfactory/CMakeFiles/HistFactory.dir/src/LinInterpVar.cxx.o
[100%] Building CXX object roofit/histfactory/CMakeFiles/HistFactory.dir/src/MakeModelAndMeasurements.cxx.o
[100%] Building CXX object roofit/histfactory/CMakeFiles/HistFactory.dir/src/MakeModelAndMeasurementsFast.cxx.o
[100%] Building CXX object roofit/histfactory/CMakeFiles/HistFactory.dir/src/Measurement.cxx.o
[100%] Building CXX object roofit/histfactory/CMakeFiles/HistFactory.dir/src/ParamHistFunc.cxx.o
[100%] Building CXX object roofit/histfactory/CMakeFiles/HistFactory.dir/src/PiecewiseInterpolation.cxx.o
[100%] Building CXX object roofit/histfactory/CMakeFiles/HistFactory.dir/src/PreprocessFunction.cxx.o
[100%] Building CXX object roofit/histfactory/CMakeFiles/HistFactory.dir/src/RooBarlowBeestonLL.cxx.o
[100%] Building CXX object roofit/histfactory/CMakeFiles/HistFactory.dir/src/Sample.cxx.o
[100%] Building CXX object roofit/histfactory/CMakeFiles/HistFactory.dir/src/Systematics.cxx.o
[100%] Linking CXX shared library ../../lib/libHistFactory.so
[100%] Built target HistFactory
Scanning dependencies of target onepcm
[100%] Generating ../../include/hist2workspaceCommandLineOptionsHelp.h
[100%] Built target onepcm
Scanning dependencies of target hsimple
[100%] Generating tutorials/hsimple.root
Scanning dependencies of target hist2workspace
[100%] Building CXX object roofit/histfactory/CMakeFiles/hist2workspace.dir/src/MakeModelAndMeasurements.cxx.o
[100%] Building CXX object roofit/histfactory/CMakeFiles/hist2workspace.dir/src/hist2workspace.cxx.o

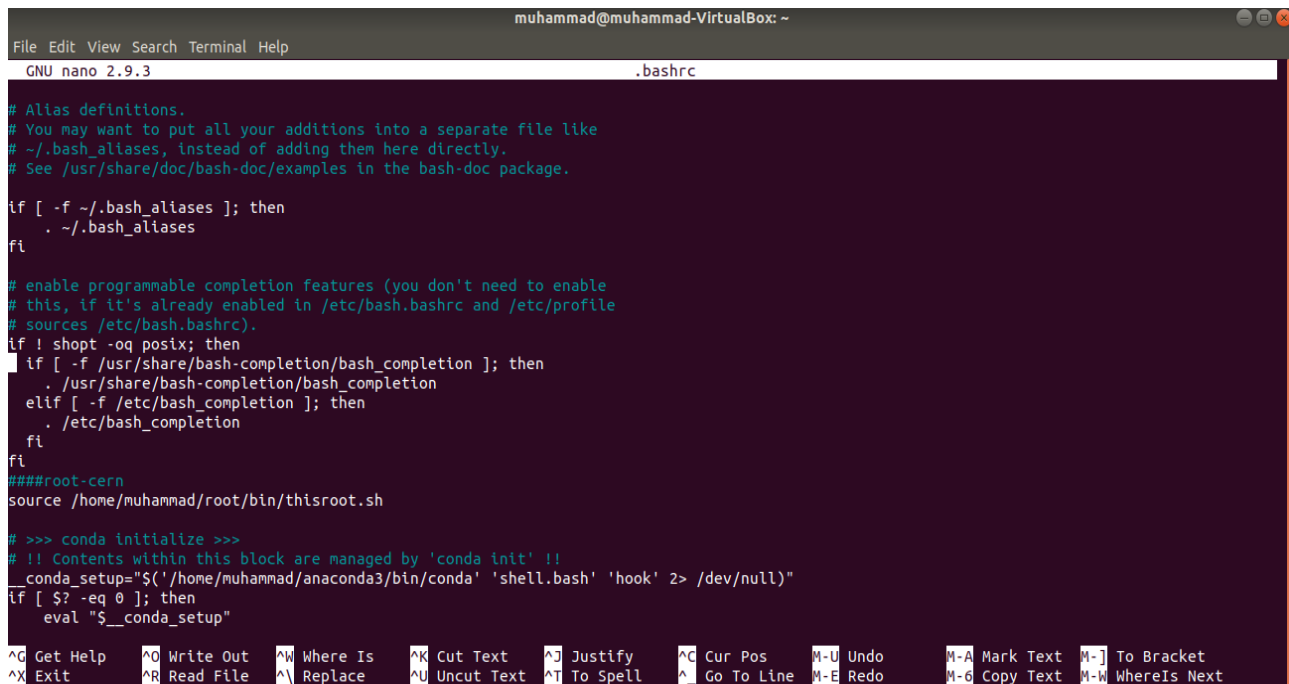
Processing hsimple.C...
hsimple : Real Time = 0.32 seconds Cpu Time = 0.17 seconds
(TFile *) 0x5621c5a655b0
[100%] Built target hsimple
[100%] Linking CXX executable ../../bin/hist2workspace
[100%] Built target hist2workspace
muhammad@muhammad-VirtualBox:~/root$ make install
```

Figure 7: make install



```
muhammad@muhammad-VirtualBox: ~
File Edit View Search Terminal Help
(base) muhammad@muhammad-VirtualBox:~$ nano .bashrc
```

Figure 8: nano .bashrc



The screenshot shows a terminal window titled 'muhammad@muhammad-VirtualBox: ~' with a menu bar (File, Edit, View, Search, Terminal, Help). The GNU nano 2.9.3 editor is open, editing the .bashrc file. The file content includes alias definitions, sourcing of .bash\_aliases, enabling of bash completion, and conda initialization. The conda initialization block sets up the conda environment and adds the conda bin directory to the PATH. The bottom of the screen shows a status bar with various keyboard shortcuts.

```
File Edit View Search Terminal Help
GNU nano 2.9.3 .bashrc

# Alias definitions.
# You may want to put all your additions into a separate file like
# ~/.bash_aliases, instead of adding them here directly.
# See /usr/share/doc/bash-doc/examples in the bash-doc package.

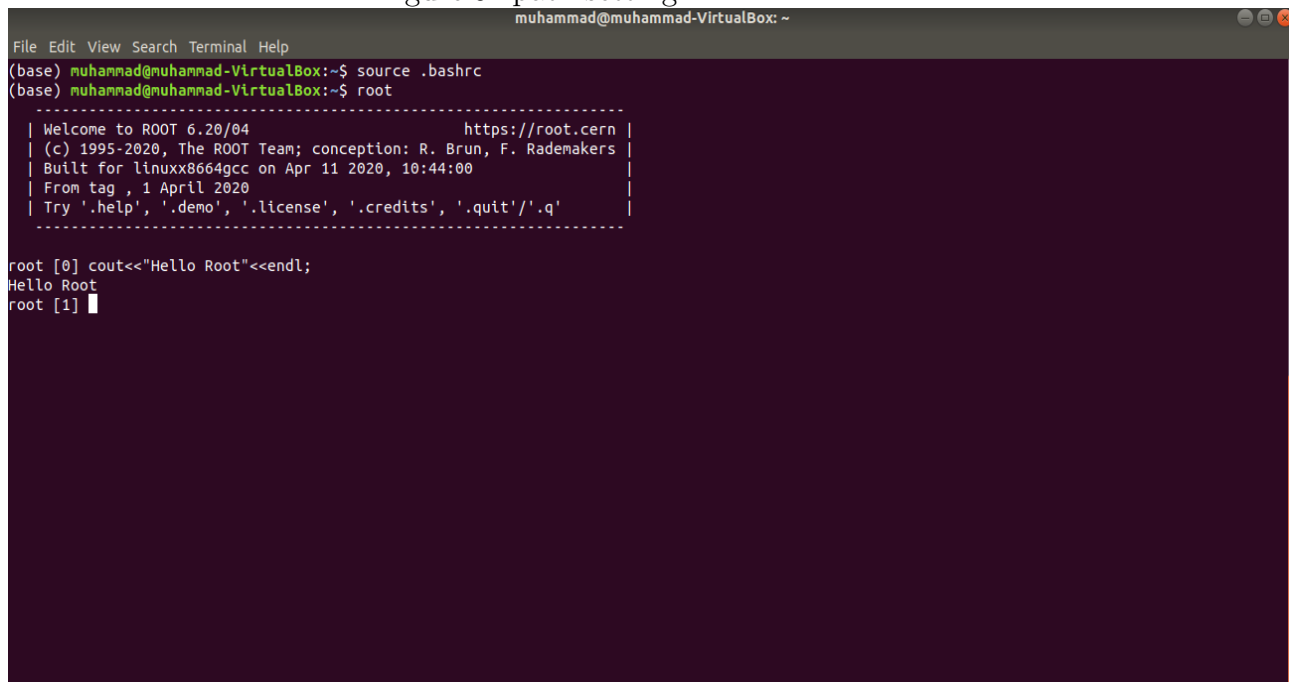
if [ -f ~/.bash_aliases ]; then
    . ~/.bash_aliases
fi

# enable programmable completion features (you don't need to enable
# this, if it's already enabled in /etc/bash.bashrc and /etc/profile
# sources /etc/bash.bashrc).
if ! shopt -oq posix; then
    if [ -f /usr/share/bash-completion/bash_completion ]; then
        . /usr/share/bash-completion/bash_completion
    elif [ -f /etc/bash_completion ]; then
        . /etc/bash_completion
    fi
fi

####root-cern
source /home/muhammad/root/bin/thisroot.sh

# >>> conda initialize >>>
# !! Contents within this block are managed by 'conda init' !!
__conda_setup="$('/home/muhammad/anaconda3/bin/conda' 'shell.bash' 'hook' 2> /dev/null)"
if [ $? -eq 0 ]; then
    eval "$__conda_setup"
fi
```

Figure 9: path setting



The screenshot shows a terminal window titled 'muhammad@muhammad-VirtualBox: ~' with a menu bar (File, Edit, View, Search, Terminal, Help). The user has executed the command 'source .bashrc' and 'root'. The ROOT 6.20/04 welcome message is displayed, including copyright information and a list of commands. The user then enters the command 'cout<<"Hello Root"<<endl;' and the output 'Hello Root' is shown.

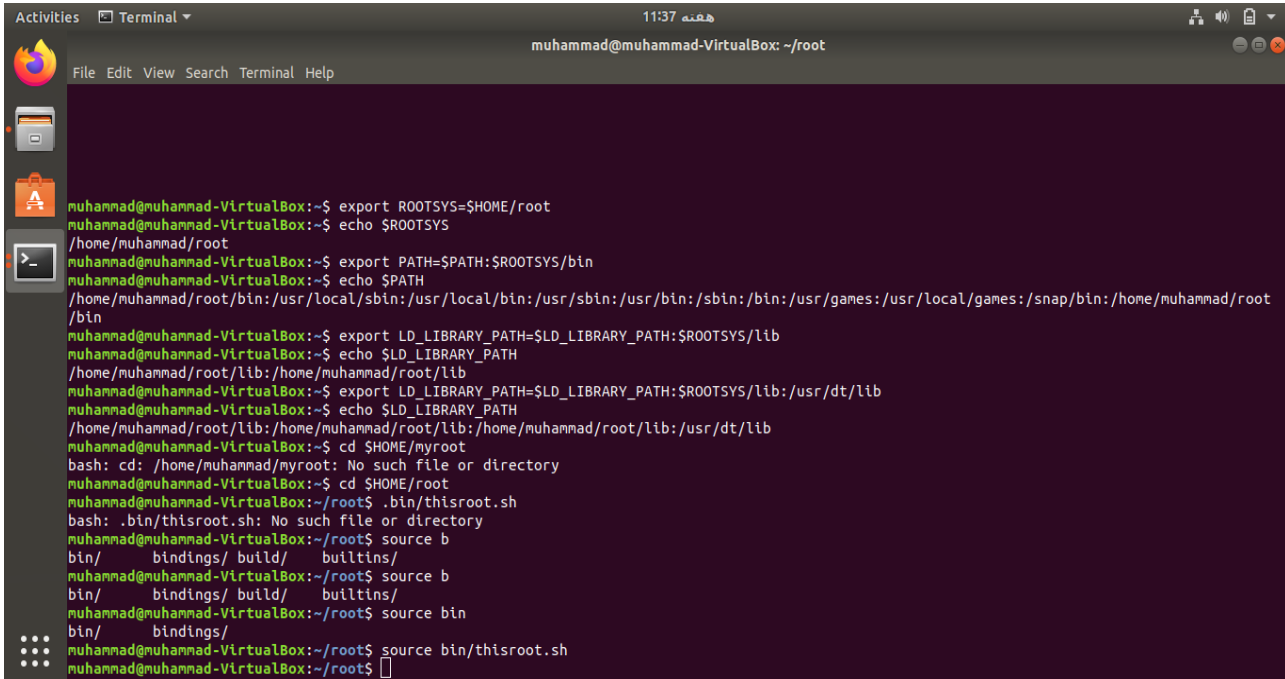
```
File Edit View Search Terminal Help
(muhammad@muhammad-VirtualBox:~$ source .bashrc
(muhammad@muhammad-VirtualBox:~$ root

-----
| Welcome to ROOT 6.20/04                               https://root.cern |
| (c) 1995-2020, The ROOT Team; conception: R. Brun, F. Rademakers |
| Built for linuxx86_64gcc on Apr 11 2020, 10:44:00 |
| From tag , 1 April 2020 |
| Try '.help', '.demo', '.license', '.credits', '.quit'/'.q' |
-----

root [0] cout<<"Hello Root"<<endl;
Hello Root
root [1] 
```

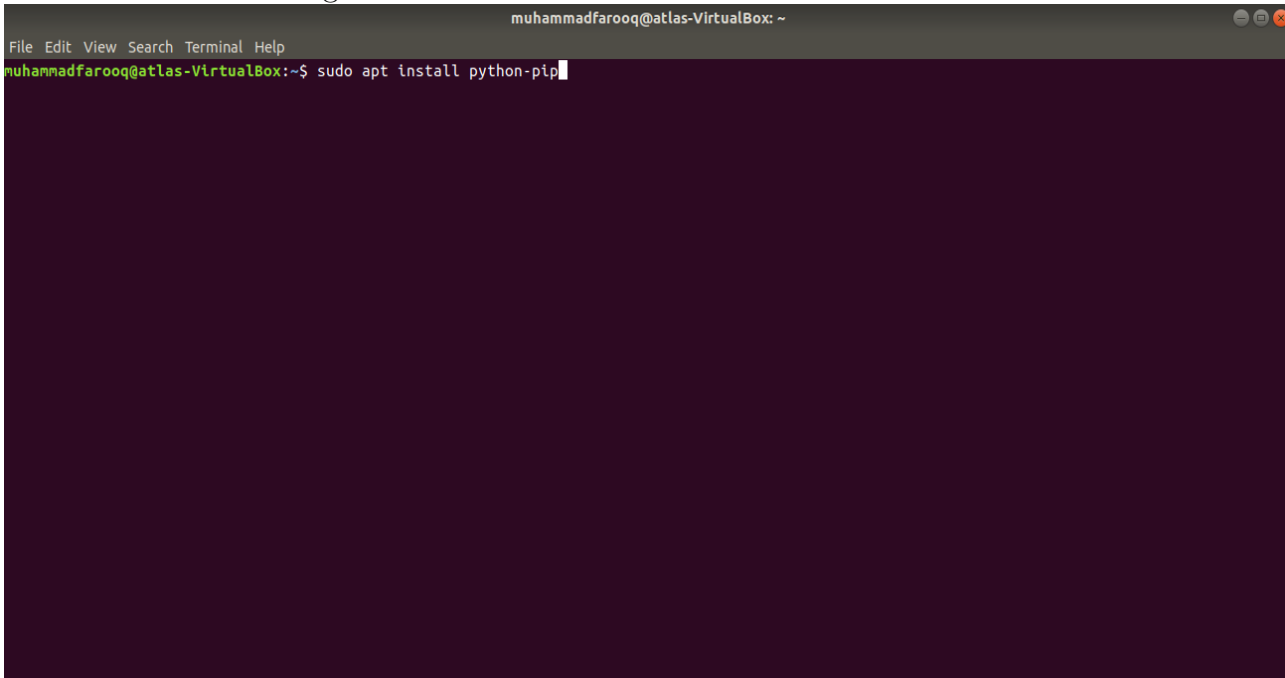
Figure 10: Welcome Root



A terminal window titled "Terminal" with a menu bar (File, Edit, View, Search, Terminal, Help) and a status bar (11:37, 11:37 هـ, muhammad@muhammad-VirtualBox: ~/root). The terminal shows a series of commands to set environment variables. The user sets ROOTSYS to \$HOME/root and echoes it. Then they set PATH to include \$ROOTSYS/bin and echo it. Next, they set LD\_LIBRARY\_PATH to include \$LD\_LIBRARY\_PATH:\$ROOTSYS/lib and echo it. They then set LD\_LIBRARY\_PATH to include \$LD\_LIBRARY\_PATH:\$ROOTSYS/lib:/usr/dt/lib and echo it. Finally, they attempt to cd to \$HOME/myroot (which fails with "No such file or directory"), cd to \$HOME/root, and source a script .bin/thisroot.sh (which also fails with "No such file or directory"). They then source a file b, then bin, and finally source bin/thisroot.sh.

```
muhammad@muhammad-VirtualBox:~$ export ROOTSYS=$HOME/root
muhammad@muhammad-VirtualBox:~$ echo $ROOTSYS
/home/muhammad/root
muhammad@muhammad-VirtualBox:~$ export PATH=$PATH:$ROOTSYS/bin
muhammad@muhammad-VirtualBox:~$ echo $PATH
/home/muhammad/root/bin:/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games:/usr/local/games:/snap/bin:/home/muhammad/root/bin
muhammad@muhammad-VirtualBox:~$ export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:$ROOTSYS/lib
muhammad@muhammad-VirtualBox:~$ echo $LD_LIBRARY_PATH
/home/muhammad/root/lib:/home/muhammad/root/lib
muhammad@muhammad-VirtualBox:~$ export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:$ROOTSYS/lib:/usr/dt/lib
muhammad@muhammad-VirtualBox:~$ echo $LD_LIBRARY_PATH
/home/muhammad/root/lib:/home/muhammad/root/lib:/home/muhammad/root/lib:/usr/dt/lib
muhammad@muhammad-VirtualBox:~$ cd $HOME/myroot
bash: cd: /home/muhammad/myroot: No such file or directory
muhammad@muhammad-VirtualBox:~$ cd $HOME/root
muhammad@muhammad-VirtualBox:~/root$ .bin/thisroot.sh
bash: .bin/thisroot.sh: No such file or directory
muhammad@muhammad-VirtualBox:~/root$ source b
bin/  bindings/ build/  builtins/
muhammad@muhammad-VirtualBox:~/root$ source b
bin/  bindings/ build/  builtins/
muhammad@muhammad-VirtualBox:~/root$ source bin
bin/  bindings/
muhammad@muhammad-VirtualBox:~/root$ source bin/thisroot.sh
muhammad@muhammad-VirtualBox:~/root$
```

Figure 11: Environment variables

A terminal window titled "muhammadfarooq@atlas-VirtualBox: ~" with a menu bar (File, Edit, View, Search, Terminal, Help). The terminal shows a single command: "sudo apt install python-pip".

```
muhammadfarooq@atlas-VirtualBox:~$ sudo apt install python-pip
```

Figure 12: python-pip

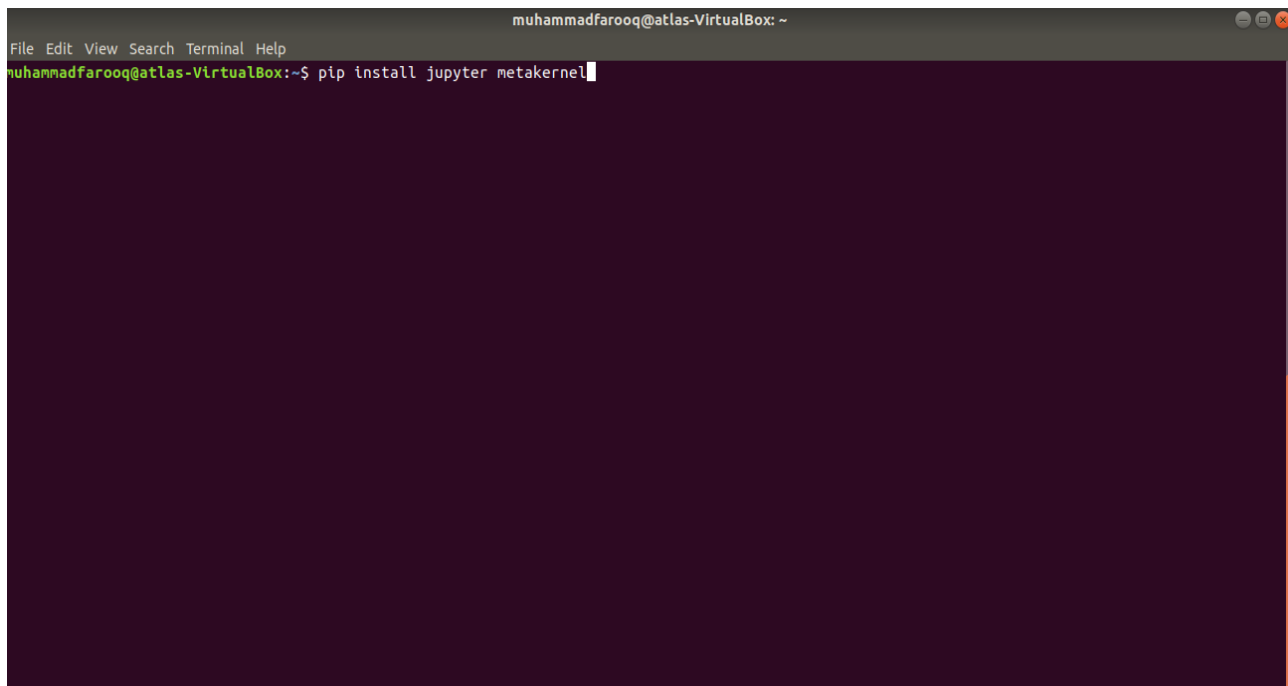


Figure 13: jupyter kernel

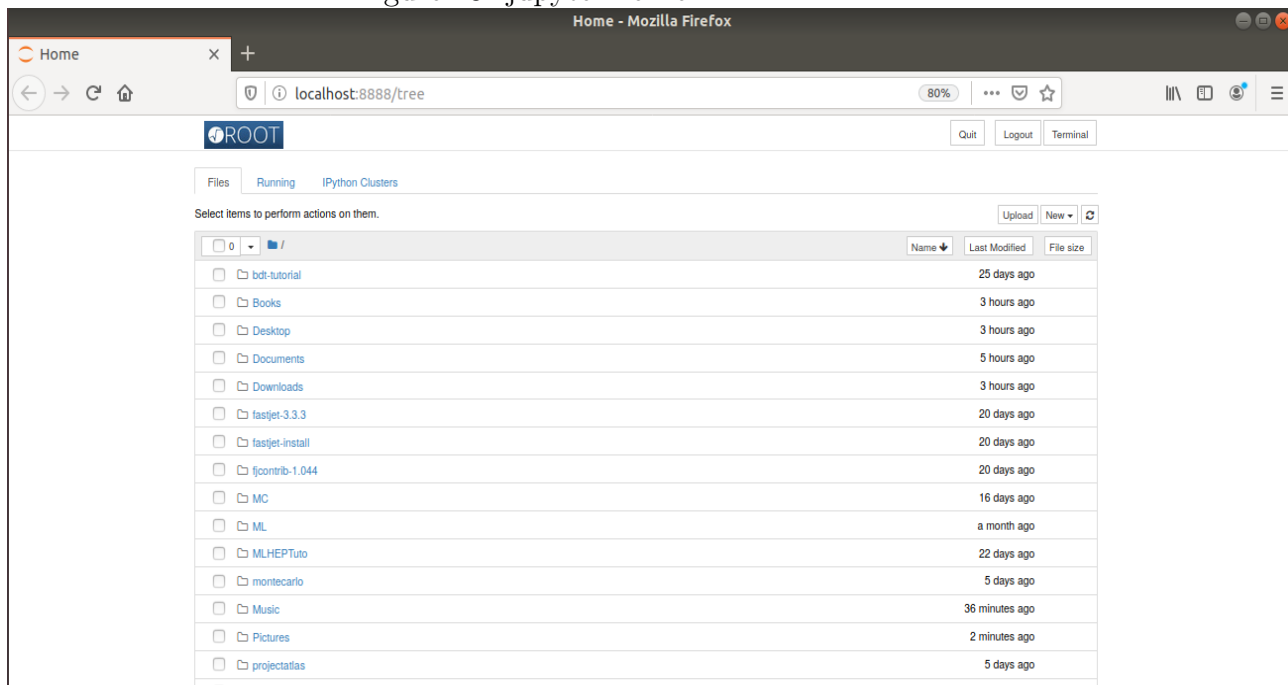


Figure 14: Root-Notebook