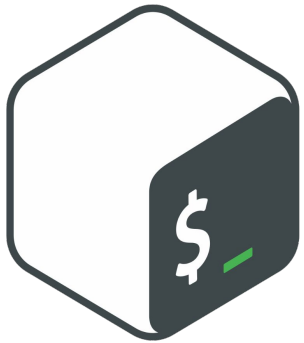


A Quick Intro to lxplus, bash & python

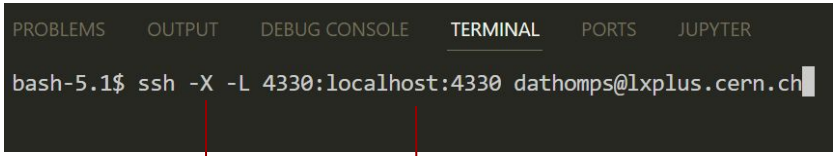
Starterkit 2022
28th November
Richard Williams & Dan Thompson

What is lxplus?

- lxplus is CERN's interactive linux service for all CERN users
- It consists of ~100 of virtual machines each with 30GB RAM & 8 cpus, equipped with fairshare systems to ensure everyone can stay online!
- By logging in to `USERNAME@lxplus.cern.ch` the system will connect you to the machine `lxplus7NNN` with the most resources available.
- **Let's log in!**

More Detailed Instructions in Pre-Workshop Checklist

Linux/MacOS -> Open a Terminal



X11-Forwarding (for viewing graphics)

Port Forwarding, choose **any number, remember it for later!**

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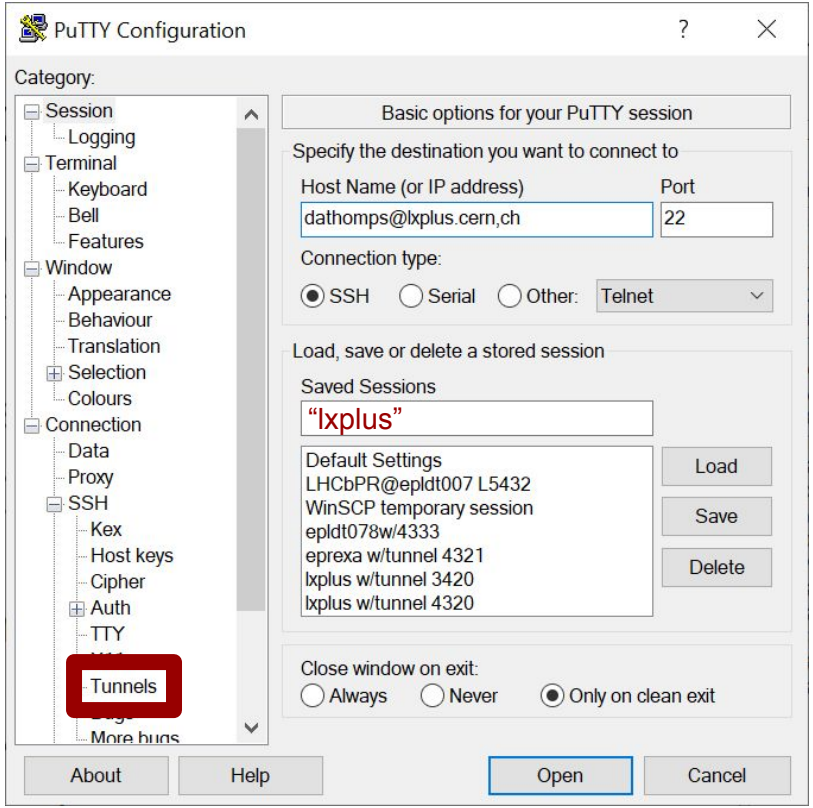
Windows (Putty)



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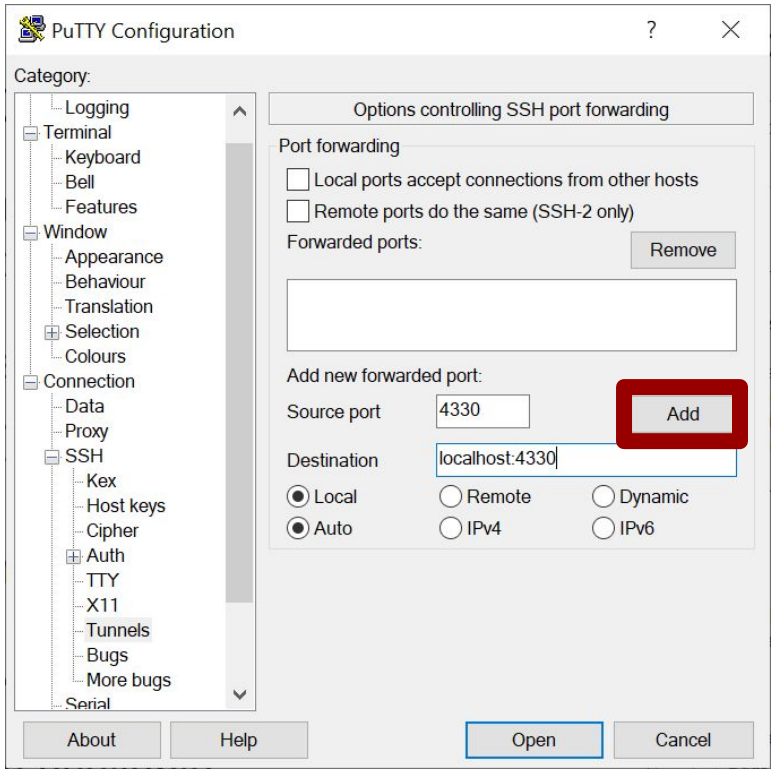

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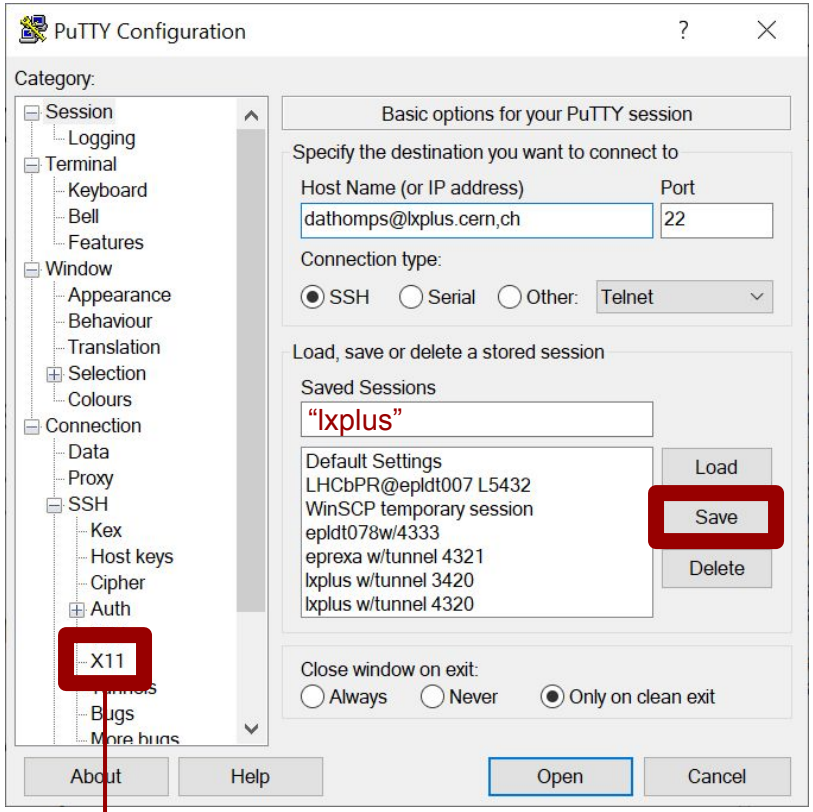


✓ Enable X11 Forwarding

More Detailed Instructions in Pre-Workshop Checklist

lxplus Tips and File Storage

- You can increase your `/afs/cern.ch/user/u/username/` disk space if you need to.
- In LHCb we also have access to an lxplus work directory: `/afs/cern.ch/work/u/username/` with more space available.

- CERN EOS: You have two long term storage areas, more info here
  - `/eos/user/u/username/` Your private EOS space (also visible on CERNBox)
  - `/eos/lhcb/user/u/username/` For storing tuples

https://resources.web.cern.ch/

⬇

List Services

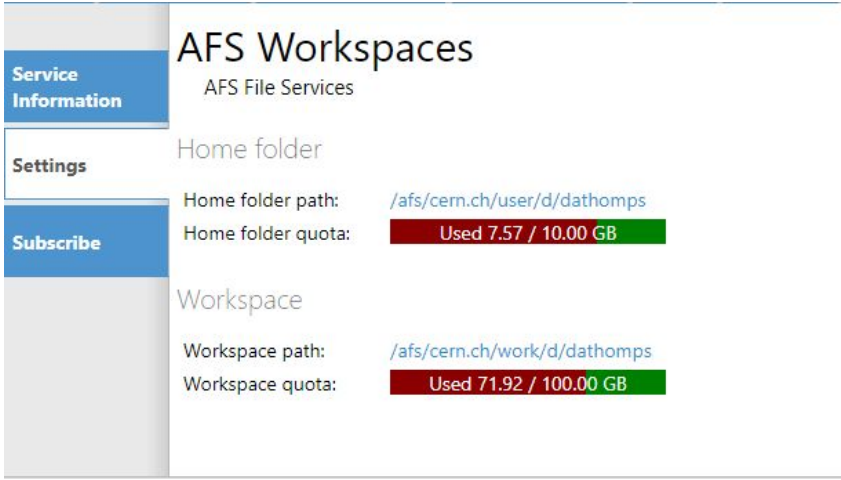
⬇

AFS Workspaces

⬇

Settings

⬇



Bash Introduction

- `pwd` : Shows the current working directory path
- `ls` : List files/directories
  - `ls -a` : For hidden locations
  - `ls -l` : For extra details
  - `ls path/to/dir` : to peek at a specific directory
  - Can combine arguments (`-alh` etc.)
- `cd dir` : Move about directories
  - `cd /..` To move up a directory
- `touch filename` : create a new file
- `mkdir dir` : Create directory
- `cp source destination` : copy
- `mv source destination` : move
- `rm file` : remove a file
  - `rm -d` for removing a directory
  - `rm -r` recursive, remove directory and its contents

```
[dathomps@lxplus738 Starterkit22]$ pwd
/afs/cern.ch/user/d/dathomps/Starterkit22
[dathomps@lxplus738 Starterkit22]$
[dathomps@lxplus738 Starterkit22]$ ls
testFile.txt  testLesso  testLesson  testScript.sh
[dathomps@lxplus738 Starterkit22]$ ls -alh
total 10K
drwxr-xr-x.  4 dathomps z5 2.0K Nov 20 23:04 .
drwxr-xr-x. 36 dathomps z5 4.0K Nov 20 23:02 ..
-rw-r--r--.  1 dathomps z5    0 Nov 20 23:04 testFile.txt
drwxr-xr-x.  2 dathomps z5 2.0K Nov 20 23:04 testLesso
drwxr-xr-x.  2 dathomps z5 2.0K Nov 20 23:04 testLesson
-rw-r--r--.  1 dathomps z5    0 Nov 20 23:04 testScript.sh
[dathomps@lxplus738 Starterkit22]$ cd testLesson
[dathomps@lxplus738 testLesson]$ pwd
/afs/cern.ch/user/d/dathomps/Starterkit22/testLesson
[dathomps@lxplus738 testLesson]$ cd ..
[dathomps@lxplus738 Starterkit22]$ pwd
/afs/cern.ch/user/d/dathomps/Starterkit22
[dathomps@lxplus738 Starterkit22]$
```

Bash Introduction

Use tab for autocomplete; Super useful!
Try double tapping tab?

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```
[dathomps@lxplus738 Starterkit22]$ touch testFile2.py
[dathomps@lxplus738 Starterkit22]$ ls -l
total 4
-rw-r--r--. 1 dathomps z5    0 Nov 20 23:19 testFile2.py
-rw-r--r--. 1 dathomps z5    0 Nov 20 23:04 testFile.txt
drwxr-xr-x. 2 dathomps z5 2048 Nov 20 23:04 testLesso
drwxr-xr-x. 2 dathomps z5 2048 Nov 20 23:04 testLesson
-rw-r--r--. 1 dathomps z5    0 Nov 20 23:04 testScript.sh
[dathomps@lxplus738 Starterkit22]$
[dathomps@lxplus738 Starterkit22]$
[dathomps@lxplus738 Starterkit22]$ mkdir testFiles
[dathomps@lxplus738 Starterkit22]$ ls -l
total 6
-rw-r--r--. 1 dathomps z5    0 Nov 20 23:19 testFile2.py
drwxr-xr-x. 2 dathomps z5 2048 Nov 20 23:19 testFiles
-rw-r--r--. 1 dathomps z5    0 Nov 20 23:04 testFile.txt
drwxr-xr-x. 2 dathomps z5 2048 Nov 20 23:04 testLesso
drwxr-xr-x. 2 dathomps z5 2048 Nov 20 23:04 testLesson
-rw-r--r--. 1 dathomps z5    0 Nov 20 23:04 testScript.sh
[dathomps@lxplus738 Starterkit22]$ cp testScript.sh testFiles/.
[dathomps@lxplus738 Starterkit22]$
[dathomps@lxplus738 Starterkit22]$ ls testFiles
testScript.sh
```

`.` Points to the “current” directory

Bash Introduction

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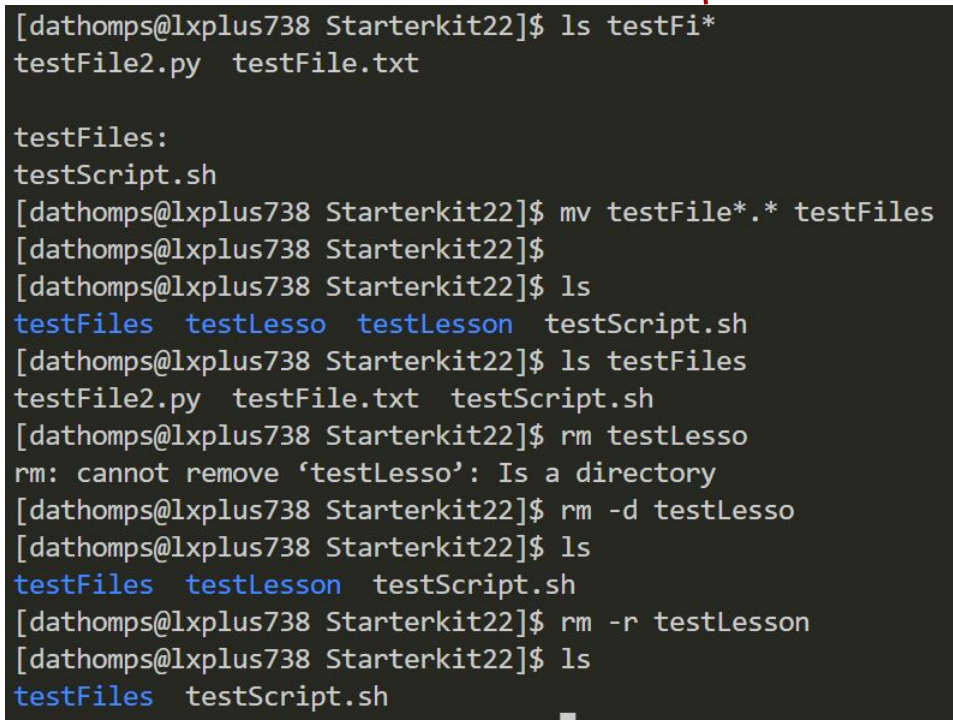
Wildcards * : the shell will fill these with any character(s)



Editing Files! A million ways available, choose your fave!

There are numerous ways to edit text files when connected via ssh, some lxplus options:

- Terminal Text Editors: `vim, nano` + more - Vim Guide, nano Guide
- X-Forwarding Text Editors: `emacs, gedit` - Allows editing in external window
- Local Text Editors: Mount your file system with `sshfs` or a remote scp file explorer (I use winscp)
- IDEs: Integrated Development Environments can combine your shell, file explorer and text editor into one program! Vscode

For now I will use `nano`:

`$nano testFile.txt` : Creates a new file, now we can create anything!

Exercise! Create and save a testFile.txt using one of the above methods. Use `$ cat testFile.txt` to quickly check the content!

Extra Info!

- A description of most commands can be accessed using `command --help`

- For further information on bash check the documentation: https://devdocs.io/bash/

- For a more extensive tutorial follow the HEP Software Foundation "Introducing the Shell"

```
[dathomps@lxplus738 Starterkit22]$ mv --help
Usage: mv [OPTION]... [-T] SOURCE DEST
  or:  mv [OPTION]... SOURCE... DIRECTORY
  or:  mv [OPTION]... -t DIRECTORY SOURCE...
Rename SOURCE to DEST, or move SOURCE(s) to DIRECTORY.

Mandatory arguments to long options are mandatory for short options too.
      --backup[=CONTROL]       make a backup of each existing destination file
  -b                           like --backup but does not accept an argument
  -f, --force                  do not prompt before overwriting
  -i, --interactive            prompt before overwrite
  -n, --no-clobber             do not overwrite an existing file
If you specify more than one of -i, -f, -n, only the final one takes effect.
      --strip-trailing-slashes  remove any trailing slashes from each SOURCE
                                 argument
  -S, --suffix=SUFFIX          override the usual backup suffix
  -t, --target-directory=DIRECTORY  move all SOURCE arguments into DIRECTORY
  -T, --no-target-directory    treat DEST as a normal file
  -u, --update                 move only when the SOURCE file is newer
                                 than the destination file or when the
                                 destination file is missing
  -v, --verbose                explain what is being done
  -Z, --context                set SELinux security context of destination
                                 file to default type
```

Bash Scripts

- Let's take a look at `lbConda_Starterkit_Create.sh`
- This is a shell script, allowing us to take the commands we use frequently and save them in a chain that we can run with a one line command!

```
$ nano lbConda_Starterkit_Create.sh
```

```
#!/bin/bash
source $HOME/.bashrc
shopt -s expand_aliases

(source /cvmfs/lhcb.cern.ch/lib/LbEnv
lb-conda-dev virtual-env default/2022-11-21 $1
$1/run pip install zfit==0.10.1
$1/run python -m ipykernel install --user --name=$1
) &> starterkitWrapperInstall.txt
```

Tells the terminal to run the script in the bash shell

Access our home environment + aliases

Access LHCb Commands

install a new python env

install zfit (for tomorrow!)

install a kernel

Write the output to a .txt file

Links for More Info!

- cvmfs
- LbEnv
- lb-conda
- pip
- ipykernel

Preparing for Today's Lesson!

If this doesn't work, try the "Copy From afs" slide in the backup

- Let's use these skills to prepare for today's Python lesson.
- First we need to download the repository
  - `$ mkdir Starterkit2022; cd Starterkit2022`
  - `$ git clone https://gitlab.cern.ch/rmwillia/starterkit-2022-python-and-bash-tutorial`
- Take a look around, there are a number of notebooks, root files and csv's!

- Now return to `/path/to/user/Starterkit2022/starterkit-2022-python-and-bash-tutorial/` And then…
  - **`$ bash lbConda_Starterkit_Create.sh starterkitEnv &`**

- What did this script do? Let's investigate!
- (Spoiler alert, it's installing a python environment ready for the week ahead!)

Bash Scripts

- Let's take a look at `lbConda_Starterkit_Create.sh`
- This is a shell script, allowing us to take the commands we use frequently and save them in a chain that we can run with a one line command!

```
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```

Links for More Info!

- cvmfs
- LbEnv
- lb-conda
- pip
- ipykernel

Let's create our own!

Creating our own!

`$nano testScript.sh`

```
#!/bin/bash

echo "hello world"

echo "We are storing ${1} in 'myVariable'"

export myVariable=$1

echo "myVariable is ${myVariable}"
```

⬅ Prints the statement to the terminal

$1 (or $2, 3, 4 etc…) refers to the 1st, 2nd, 3rd, 4th arguments of the script

↖ Creating a new environment variable

⬅ Now use it! $name tells bash to look for the variable “name”

What happens if you run: `$ bash testScript.sh`

How about: `$ bash testScript.sh something`

Try: `$ bash testScript.sh something else`

Maybe: `$ bash testScript.sh “something else”`

Exercise!

Have a go playing around with this script to get some practise!

Idea: What does $0 do?

Environment Variables & .bashrc

What did `export myVariable=$1` do? It made a new variable **within that script.**

Try `$ echo $myVariable` in your terminal…

We can use bash scripts to create variables within other environments:

- Instead use source: `$ source testScript.sh something`
- Now: `$ echo $myVariable` this variable is available in the terminal!

This can be very useful when you need to frequently access the same filepaths, commands or phrases -> write the variables to a bash script and `source`!

.bashrc: Located in your `$HOME/.bashrc` is a very convenient file for storing your favourite environment variables and commands.
Every time you login to lxplus `$ source .bashrc` runs automatically!
e.g I have `export WORK=/afs/cern.ch/work/d/dathomps/` in mine!

Links to Further Techniques and tools, Endless Possibilities!

- So much more to teach, so little time! More on HEP Software Foundation:
  - Introducing the Shell
  - More about the UNIX Shell
- Want to keep a session running? Tmux/Screen guide, tmux cheat sheet
- lxplus HTCondor, when your shell script needs more power!
- pypi the huge ecosystem of python modules
  - lb-conda wrappers, an easy way to install and use new packages… more about this now!

How to Run Python!

- Your python environment installation should have completed now.
- Now we can begin coding with python!
- In the directory `starterkit-2022-python-and-bash-tutorial` take a look at `PythonExample.py` and try running it with

```
$ starterkitEnv/run python PythonExample.py
```

This launches the environment we created and runs python!

Try editing, saving and re-running this python file

Alternatively we can launch a **new bash session** in the environment by

`$ starterkitEnv/run bash` and then simply `$ python PythonExample.py`

Jupyter - python in a Notebook!

- For this python session + zFit tomorrow we will need jupyter notebooks
- Jupyter provides a web based interactive python session which combines developing, documenting, and executing code into one package!

From your `starterkitEnv` bash session (`$ starterkitEnv/run bash`) run:

```
$ jupyter notebook --port=NNNN --no-browser
```

where NNNN is the port number you entered when logging in to lxplus!

Follow or copy the link that produced into your browser and an interactive web-based application should appear!

(Note: Jupyter will root itself to the directory you launched it from)

Summary

Thanks for listening to this *very* quick intro! Feel free to ask any questions throughout the week, no question is a bad question!

Links to more in-depth tutorials:

- HSF Shell/Bash Tutorial
- HSF Introduction To Python
- bash, python cheat-sheets

Remember, the internet is your friend, someone has always had the same issue/question!

A note for the future: Style and Documentation! style-guides exist to help you make software that is easy to understand for others and probably even you!

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