

Electronic Work Record – Laura Cairns

Project Notes – Term 1, Week 2

12/10/20

Plan for today:

1. DO RISK ASSESSMENT
2. GitHub tutorials
3. Read code example
4. Read Mika's updates

Risk assessment attempted, emailed to Mika for checking.

Github tutorials:

1. <https://guides.github.com/activities/hello-world/>
Activities to introduce basic concepts of repositories, branches, commits, pull requests and merging. How to do on site.
2. <https://guides.github.com/introduction/git-handbook/>
Explanation of Git, **Git commands**, example of command line editing
3. <https://guides.github.com/activities/forking/>
Forking
4. <https://guides.github.com/features/wikis/>
Using GitHub for project documentation

Questions to ask Mika: *(Emailed and response received)*

1. Risk assessment
2. Record of work
 - a. Using GitHub? Assume Wiki?
 - b. Have existing word doc and notebook of notes made so far, want to add to wiki, and make wiki main hub?

Made notes in notebook from Issue #1 – Where to Start?

13/10/2020

Commands to run code in Godzilla: (From Mika Email)

```
git clone https://github.com/r-preston/MPhysProject2021.git
cd MPhysProject2021
module use /warwick/epp/modules
module load linuxbrew
./scripts/example.py (what actually works here is: python example.py)
gs plot.pdf
```

Questions

- Gs command did not work (15/10/20: Due to x-forwarding, solved below using filezilla)
- Not sure of the formula (15/10/20: Solved)

14/10/2020

Risk Assessment Submitted Uploaded to Electronic Record

15/10/2020

Weekly Meeting

ALWAYS SET UP COMMAND WITH LINE IN TOP LEVEL READ ME:

```
module use /warwick/epp/modules
module load linuxbrew
```

Issue #2 – ROOT

ROOT is a CERN project. ROOT trees are the data format -> use to extract data and can create histograms

Rule of thumb, python 100x slower than C, but ROOT uses C so takes similar times in both.

Can type C code directly into the ROOT command.

```
root -l /storage/epp2/phshgg/DVTuples__v23/5TeV_2017_32_Down_EW.root
```

gDirectory->ls()	List files in directory
gDirectory->cd("directory")	Enter a directory
gDirectory->cd("../")	Enter top directory
DecayTree->GetEntries()	
DecayTree->Show()	Argument to choose specific branch entry
DecayTree->Draw("mum_PT")	Argument is name of branch
c.SaveAs("filename.filetype")	
.q	Exit root

1. root -l /storage/epp2/phshgg/DVTuples__v23/5TeV_2017_32_Down_EW.root
2. gDirectory->ls()

3. `dDirectory->cd("Z")`
4. `DecayTree->GetEntries()`
5. `DecayTree->Show()`
6. `DecayTree->Draw("mum_PT")`

IF x forwarding doesn't work in Draw command, ie doesn't open plot, there are alt commands, replacing draw command

1. `TCanvas c`
2. `DecayTree->Draw("mum_PT")`
3. `c.SaveAs("plot.pdf")`
4. Use filezilla to get plot

More General Notes about Issues #2 and #3

- Save plots as pdf for reports – high resolution
Saving as png is more convenient for GitHub and webbrowsers but this has a compromise in graphics
- Faster path:
`Root -l -b -q path`
-l no login, -b no x forwarding, -q quit root when script run
- Instructions to write a root macro on Issue #2:
Open chosen code editor (notepad), copy & paste code, save as .C, filezilla to Godzilla, run with command on issue, creates png.
- TBrowser reliant on x-forwarding, not essential if does not work -> Mika normally uses to demonstrate features of root. Opens a browser window to go through data branches. Mika claims it is not very useful.
- `cat filename` – shows contents of file
- `python filename` – runs python file
- Low energy data set is quite small. Different centre of mass energy therefore less events.
- Issue #3 uses python to access ROOT.
- -i option use python in command line interactively

Discussion of Collider maths

`mup_PT = entry.mup_PT` makes floating point variable from entry

In the lab frame a charged particle has 3 degrees of freedom, cartesian or cylindrical – pseudorapidity (Polar angle), azimuthal angle, transverse momentum.

Particles are relativistic therefore also need to know mass, have to work with 4 momentum, but assume are muons so have same mass, therefore has 3 degrees of freedom.

6 variables, (Eta, phi, pt for mu+ and mu-)

Translate to px, py, pz. Uses $M=0.105$ GeV for muon mass. Use to make 4 momentum of both muons.

See Issue#3

Mass as last element. "4vectors have a special way of squaring themselves". Uses 4 vector mathematics.

Command Line Prompts

<https://www.codecademy.com/learn/learn-the-command-line/modules/learn-the-command-line-navigation/cheatsheet>

Ctrl+z	Stops job (python process)
Ctrl+c	Cancels currently running program
Ctrl+d	Exits python fully, but cannot if there are stopped jobs
fg	Reloads stopped job
cat <i>filename</i>	Shows contents of file
python <i>filename</i>	Runs python code
python -i <i>filename</i>	Runs python code interactively
ls	Lists contents of current directory
cd <i>directory</i>	Enters directory
cd ..	Enters parent directory
module spider <i>Program</i>	Search tool for programs
Right click	Copy and Paste

SCRPT Video Rewatch – How to open Spyder

```
module spider Spyder
module spider spyder/4.0.1.Python.3.7.4
module load GCC/8.3.0 OpenMPI/3.1.4
module load spyder/4.0.1.Python.3.7.4
spyder3
```

Code Testing and Practice

- Successfully ran example.py
- Completed Issue #2 in meeting – Familiarisation with the ROOT TBrowser
- Completed Issue #4 in meeting – Writing a simple C ROOT macro
 - root_macro.C
 - "Instructions to write a root macro on Issue #2:
Open chosen code editor (notepad), copy & paste code, save as .C, filezilla to Godzilla, run with command on issue, creates png."
- Tested code from Issue #3 – Familiarisation with pythonic event loop in ROOT
 - Used interactive python to test ch.Show & ch.Scan, and made notes on their functions
 - Successfully looped over entries – branch contains 5840 entries.

CREATED PROJECT LOOK UP DOCUMENT, CONTAINING CODE TABLES, GLOSSARY, KEY POINTS AND IDEAS

Uploaded to Electronic Record

Where to Start? – Attempting to search for Z boson and find Invariant Mass of two muon system

Issues #1 and #3 on r-preston repository

Z/DecayTree

Looking at data “Z/DecayTree”

- This is a low energy run at \sqrt{s} 5 TeV
- Contains 5840 entries
- `/storage/epp2/phshgg/DVTuples__v23/5TeV_2017_32_Down_EW.root`
- `mup_` branches give positively charged muon, and `mum_` branches give negative muon
- PT = transverse momentum, units MeV (`mup_PT`, `mum_PT`)
- ETA = pseudorapidity (polar angle)
- PHI = azimuthal angle

To access this data, ROOT.TChain needs argument ‘Z/DecayTree’

Used `issue3_pythonic_event_loop.py` to find number of entries

Emacs -nw use `ctrl+x`, `ctrl+c` to exit terminal

Invariant Mass Calculation

Use $M = 0.105$ GeV for mass of muon.

Calculation in book (pg19 – 21)

http://edu.itp.phys.ethz.ch/hs10/ppp1/2010_11_02.pdf

Details of coordinate system, notes made in Notebook (pg20)

Managed to code calculation and calculated in ROOT using `TLorentzVector`, however, no plot.

`ZMassAttempt1510_CalculatesZMass_noplot.py`

16/10/2020

- Worked out ROOT code required to create histogram, using `hist.Fill(x)`
- Corrected output as had not square rooted invariant mass
- Produced histograms for both manual calculation code and using `TLorentzVector`
- Code attached to Electronic Record for both versions
 - `ZMassAttempt_Maths.py`
 - `ZMassAttempt_ROOT.py`
- Uploaded histograms in comment on Issue #3
- Made notes in Notebook r/work done and bin sizes

More comments from Mika with simplified method for `TLorentzVector`

Action:

- Re-attempt code using `TLorentzVector` to make more efficient
- Work out how to edit histogram layout – add axis labels, title etc.

Workbook Notes

PAGE	DATE	TOPIC
17	12/10/2020	GitHub Tutorials Issue #1 Where to Start?
18	17/10/2020	Meeting Notes
19 - 21		Invariant Mass Calculation

Attached Files (GitHub)

DATE	FILE
14/10/2020	Risk Assessment
15/10/2020	Project Look Up Document
	ZMassAttempt1510_CalculatesZMass_noplot.py
16/10/2020	ZMassAttempt_Maths.py
	ZMassAttempt_ROOT.py
	ZMassPlot_Maths.pdf
	ZMassPlots_ROOT.pdf

Link to Issues #1-4, example.py