

OL Astroparticle Meeting
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2nd Feb 2024



CERN News



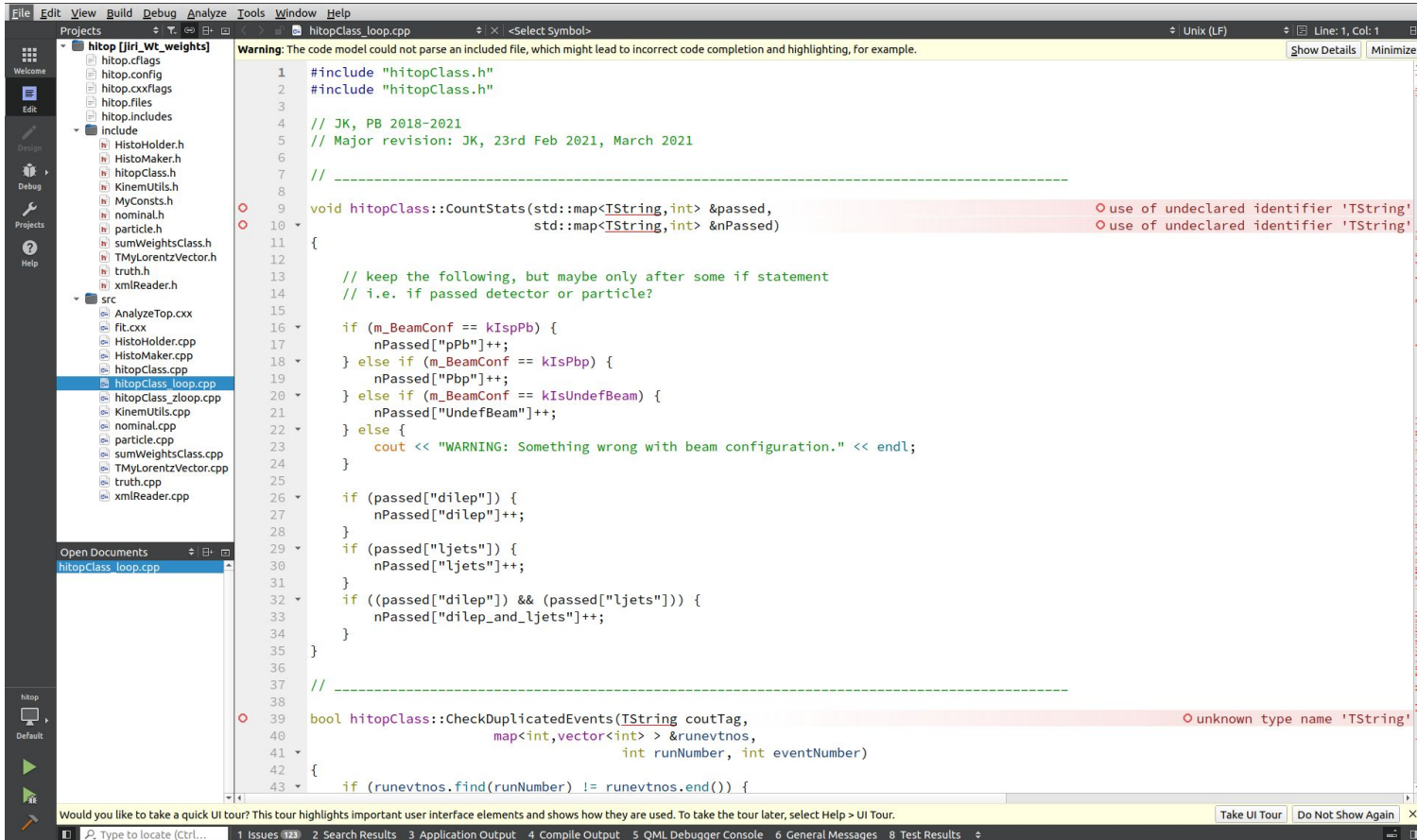
IDE

- Integration Development Environment
 - pico, emacs, vim, gvim...
 - sublime, geany, kate, qtcreator, eclipse...
 - visual studio code!
- spyder, jupyter notebook

emacs

```
File Edit Options Buffers Tools C++ Help
Save Undo
#include "KinemUtils.h"
//
//
//
double DeltaPhi(double phi1, double phi2)
{
    double dphi = fabs(phi1-phi2);
    if (dphi > TMath::Pi())
        dphi = 2.*TMath::Pi() - dphi;
    return dphi;
}
//
double computeneutrinozp(const TMyLorentzVector lepton, double metx, double mety, bool invertSolutions, double etabias) {
    //computing z component of neutrino momentum given lepton and met
    double pzneutrino;
    double met = sqrt ( sqr(metx) + sqr(mety) );
    double m_W = 80.399; // in GeV, given in the paper
    double k = (( sqr( m_W ) - sqr( lepton.M() ) ) / 2 ) + (lepton.Px() * metx + lepton.Py() * mety);
    double a = sqr ( lepton.E() ) - sqr ( lepton.Pz() );
    double b = -2*k*lepton.Pz();
    double c = sqr( lepton.E() ) * sqr( met ) - sqr( k );
    double discriminant = sqr(b) - 4 * a * c;
    double quad[2] = { (- b - sqrt(discriminant)) / (2 * a), (- b + sqrt(discriminant)) / (2 * a) }; //two possible quadratic solns
    if (discriminant < 0) pzneutrino = - b / (2 * a); //if the discriminant is negative
    else { //if the discriminant is greater than or equal to zero, take the soln with smallest absolute value
        double absquad[2];
        for (int n=0; n<2; ++n)
            absquad[n] = fabs(quad[n]);
        if (fabs(etabias < kEpsilon)) {
            if (absquad[0] < absquad[1]) {
                if (!invertSolutions)
                    pzneutrino = quad[0];
                else
                    pzneutrino = quad[1];
            } else {
                if (!invertSolutions)
                    pzneutrino = quad[1];
                else
                    pzneutrino = quad[0];
            }
        }
    }
}
KinemUtils.cpp Top (17,0) Git-Jiri_MT_weights (C++//1 +2 Abbrev)
```

QtCreator



File Edit Search View Document Project Build Tools Help

Symbols Documents ExRootTreeReader.cpp HistoHolder.cpp **HistoMaker.cpp** HistoTools.cpp KinemUtils.cpp TestGenCorrCode.cxx TMyLorentzVector.cpp

```

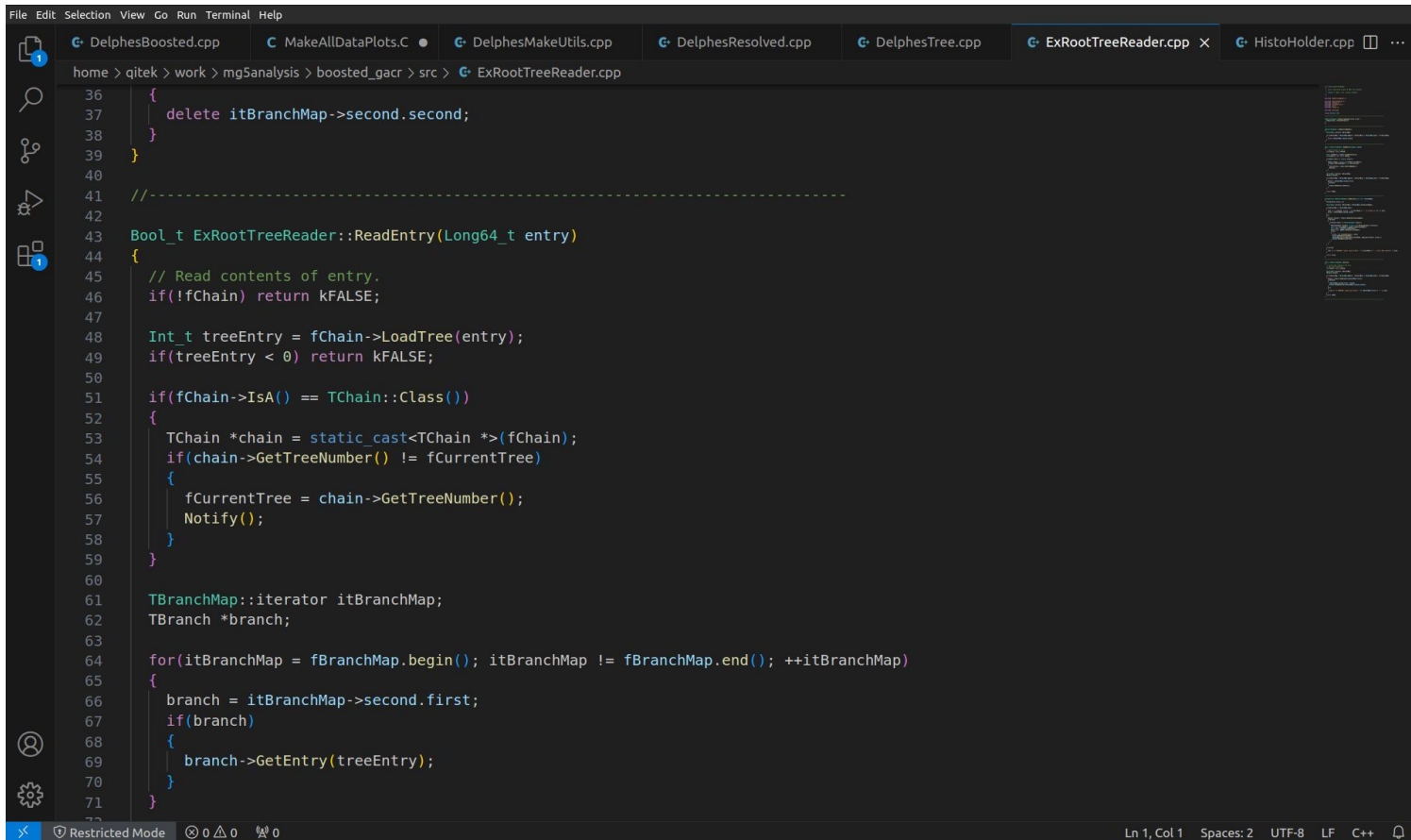
411 if (jettype == kWTagJets && ! jet->Wtag() )
412     return false;
413     return true;
414 }
415 }
416 //
417 //
418
419 void HistoMaker::MakeSpecialHistos(HistoHolder *hold, TString jname, TString jtag, bool makeReplicas)
420 {
421
422     TString GeV = " [GeV]";
423
424     // cout << "In MakeSpecialHistos, jname=" << jname.Data() << " jtag=" << jtag.Data() << endl;
425
426     // double p0max = 1000;
427     // hold -> AddTH1D(jname + "Pout", jname + "Pout;" + jtag + " |p_{out}|" + GeV, m_nPhysObjBins["DiTopPout"], m_PhysObjBins["DiTopPout"]);
428     hold -> AddTH1D(jname + "Pout", jname + "Pout;" + jtag + " |p_{out}|" + GeV, m_nPhysObjBins["DiTopPout"], m_PhysObjBins["DiTopPout"]);
429     hold -> AddTH1D(jname + "DeltaPhi", jname + "DeltaPhi;" + jtag + " #delta#phi^{t#bar{t}}", m_nPhysObjBins["DiTopDeltaPhi"], m_PhysObjBins["DiTopDeltaPhi"]);
430     hold -> AddTH1D(jname + "CosThetaStar", jname + "CosThetaStar;" + jtag + " |cos#theta*|" , m_nPhysObjBins["CosThetaStar"], m_PhysObjBins["CosThetaStar"]);
431     hold -> AddTH1D(jname + "Delta", jname + "Delta;" + jtag + " #delta^{t#bar{t}}", m_nPhysObjBins["Delta"], m_PhysObjBins["Delta"]);
432     hold -> AddTH1D(jname + "Chittbar", jname + "Chittbar;" + jtag + " #chi^{t#bar{t}}", m_nPhysObjBins["Chittbar"], m_PhysObjBins["Chittbar"]);
433     hold -> AddTH1D(jname + "Yboost", jname + "Yboost;" + jtag + " y_{boost}^{t#bar{t}}", m_nPhysObjBins["Yboost"], m_PhysObjBins["Yboost"]);
434     hold -> AddTH1D(jname + "Rttbar", jname + "Rttbar;" + jtag + " R^{t,t,1}", m_nPhysObjBins["Rttbar"], m_PhysObjBins["Rttbar"]);
435
436
437     if (makeReplicas) {
438         TString repdir = "replicas";
439         if (!gDirectory->GetDirectory(repdir)) {
440             gDirectory->mkdir(repdir);
441         }
442         gDirectory->cd(repdir);
443         for (unsigned int irep = 0; irep < m_nReplicas; ++irep) {
444             TString rehtag = Form(" rep%i",irep);
445             // hold -> AddTH1D(jname + "Pout", jname + "Pout;" + jtag + " |p_{out}|" + GeV, nPtBins, 0, p0max);
446             hold -> AddTH1D(jname + "Pout" + rehtag, jname + "Pout;" + jtag + " |p_{out}|" + GeV, m_nPhysObjBins["DiTopPout"], m_PhysObjBins["DiTopPout"]);
447             hold -> AddTH1D(jname + "DeltaPhi" + rehtag, jname + "DeltaPhi;" + jtag + " #Delta#phi^{t#bar{t}}", m_nPhysObjBins["DiTopDeltaPhi"], m_PhysObjBins["DiTopDeltaPhi"]);
448             hold -> AddTH1D(jname + "CosThetaStar" + rehtag, jname + "CosThetaStar;" + jtag + " |cos#theta*|" , m_nPhysObjBins["CosThetaStar"], m_PhysObjBins["CosThetaStar"]);
449             hold -> AddTH1D(jname + "Delta" + rehtag, jname + "Delta;" + jtag + " #delta^{t#bar{t}}", m_nPhysObjBins["Delta"], m_PhysObjBins["Delta"]);

```

19:10:50: This is Geany 1.32.
19:10:50: File /home/qitek/work/riwet/bootstrap/Rivet-3.0.2/riwet_analysis/src/PseudoTopStudy.cc opened(1).
19:10:51: File /home/qitek/work/riwet/bootstrap/Rivet-3.0.2/analyses/pluginATLAS/ATLAS_2015_I1404878.cc opened(2).
19:10:51: File /home/qitek/work/riwet/bootstrap/Rivet-3.0.2/src/Core/Analysis.cc opened(3).
19:10:51: File /home/qitek/work/riwet/bootstrap/Rivet-3.0.2/include/Rivet/AnalysisHandler.hh opened(4).
19:10:51: File /home/qitek/work/mg5analysis/boosted_gacr/src/AnalyzeBoosted.cxx opened(5).

line: 1/2649 col: 0 sel: 0 INS TAB mode: LF encoding: UTF-8 filetype: C++ scope: unknown

Visual Studio Code



```
File Edit Selection View Go Run Terminal Help
DelphesBoosted.cpp MakeAllDataPlots.C DelphesMakeUtils.cpp DelphesResolved.cpp DelphesTree.cpp ExRootTreeReader.cpp HistoHolder.cpp ...
home > qitek > work > mg5analysis > boosted_gacr > src > ExRootTreeReader.cpp
36 {
37     delete itBranchMap->second.second;
38 }
39 }
40
41 //-----
42
43 Bool_t ExRootTreeReader::ReadEntry(Long64_t entry)
44 {
45     // Read contents of entry.
46     if(!fChain) return kFALSE;
47
48     Int_t treeEntry = fChain->LoadTree(entry);
49     if(treeEntry < 0) return kFALSE;
50
51     if(fChain->IsA() == TChain::Class())
52     {
53         TChain *chain = static_cast<TChain *>(fChain);
54         if(chain->GetTreeNumber() != fCurrentTree)
55         {
56             fCurrentTree = chain->GetTreeNumber();
57             Notify();
58         }
59     }
60
61     TBranchMap::iterator itBranchMap;
62     TBranch *branch;
63
64     for(itBranchMap = fBranchMap.begin(); itBranchMap != fBranchMap.end(); ++itBranchMap)
65     {
66         branch = itBranchMap->second.first;
67         if(branch)
68         {
69             branch->GetEntry(treeEntry);
70         }
71     }
72 }
```

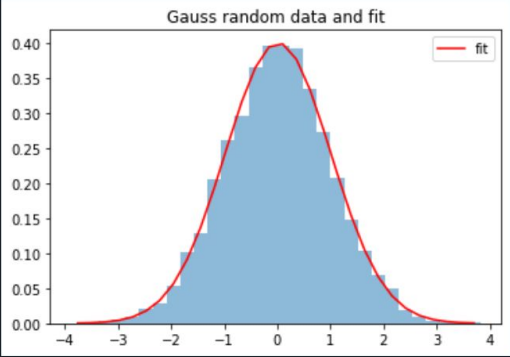
Ln 1, Col 1 Spaces: 2 UTF-8 LF C++

Spyder

/home/qitek/work/github/PyPlay/pyplot/hausFitChi2.py

```
1 #!/usr/bin/python
2
3 # thanks! how do I obtain the chisquare and number of degrees of freedom of the above fit?
4
5 # In this updated code, we calculate the residuals as the difference between the normalized histogram data and the fitted Gaussian fi
6
7
8 #Thanks, but unfortunately For the printd chisq I get 'inf', so something is wrong, could you please correct your code?
9
10 #I apologize for the error in my previous response. The issue is that the calculation of the chi-square value is incorrect, and it's
11 #To fix this issue, we need to use the squared residuals instead of the normalized histogram data in the chi-square calculation. Her
12
13 import numpy as np
14 import matplotlib.pyplot as plt
15 from scipy.optimize import curve_fit
16
17 #####
18
19 # Define the Gaussian function to fit the histogram
20 def gauss(x, a, mu, sigma):
21     return a * np.exp(-(x - mu)**2 / (2 * sigma**2))
22
23 #####
24
25 # Generate some random data from a Gaussian distribution
26 data = np.random.normal(0, 1, 10000)
27
28 # Create the histogram
29 n, bins, patches = plt.hist(data, bins=30, density=True, alpha=0.5)
30
31 # Get the bin centers and normalize the histogram
32 bin_centers = (bins[1:] + bins[:-1]) / 2
33 #bin_widths = (bins[1:] - bins[:-1])
34 #n = n / np.sum(n * bin_widths)
35
36 print(n)
37
38 # Fit the histogram with the Gaussian function
39 popt, pcov = curve_fit(gauss, bin_centers, n, p0=[1, 0, 1])
40
41 # Calculate the chi-square and degrees of freedom
42 residuals = n - gauss(bin_centers, *popt)
43 print(residuals)
44
45 # JK: correction was needed: keep only nonzero values!
46 safe_residuals = []
47 safe_n = []
48 for res, binc in zip(residuals, n):
49     if binc > 0:
50         safe_n.append(binc)
51         safe_residuals.append(res)
52
53 # convert to np arrays:
54 np_safe_residuals = np.array(safe_residuals)
55 np_safe_n = np.array(safe_n)
56
57 # sum of [(n - fit)^2 / (sqrt(n))^2
58 chisq = np.sum(np_safe_residuals**2 / (np_safe_n ** 2))
59 dof = len(np_safe_n) - len(popt)
60
61 print(f"Chi-square value: {chisq:.3f}")
62 print(f"Degrees of freedom: {dof}")
```

Gauss random data and fit



Help Variable Explorer Plots Files

```
IPdb [1]: runfile('/home/qitek/work/github/PyPlay/pyplot/hausFitChi2.py', wdir='/home/qitek/work/github/PyPlay/pyplot')
[ 8.8337629e-04 1.55335851e-03 2.71836339e-03 6.21340204e-03
 9.70844070e-03 2.05818943e-02 2.83486468e-02 5.43672679e-02
 1.00967783e-01 1.28539755e-01 2.05430605e-01 2.61739561e-01
 2.95136597e-01 3.64649033e-01 3.96104380e-01 3.95327705e-01
 3.9260932e-01 3.33592022e-01 2.7308132e-01 2.00140969e-01
 1.47568299e-01 1.04462822e-01 6.51240977e-02 4.89305411e-02
 1.82518685e-02 8.54342781e-03 3.49503865e-03 2.33002577e-03
 7.76675256e-04 7.76675256e-04]
[ 8.63955019e-05 7.74819128e-04 8.40845538e-04 1.97845909e-03
 7.74016040e-04 2.95234727e-03 -4.18788456e-03 -1.79658437e-03
 1.02905916e-02 -8.38903520e-03 1.20348147e-02 6.26080112e-03
 -2.05223614e-02 -1.35970873e-04 1.81836921e-03 -3.27597043e-03
 1.57087964e-02 2.57113261e-04 -2.71613338e-03 -5.16357122e-03
 -6.78787360e-03 -6.10913004e-06 2.99298384e-03 9.77618719e-03
 -3.43065485e-03 -2.68069040e-03 -1.9454252e-03 -1.35061655e-04
 -2.68087037e-04 3.62588178e-04]
Chi-square value: 0.012
Degrees of freedom: 27
```

Warning

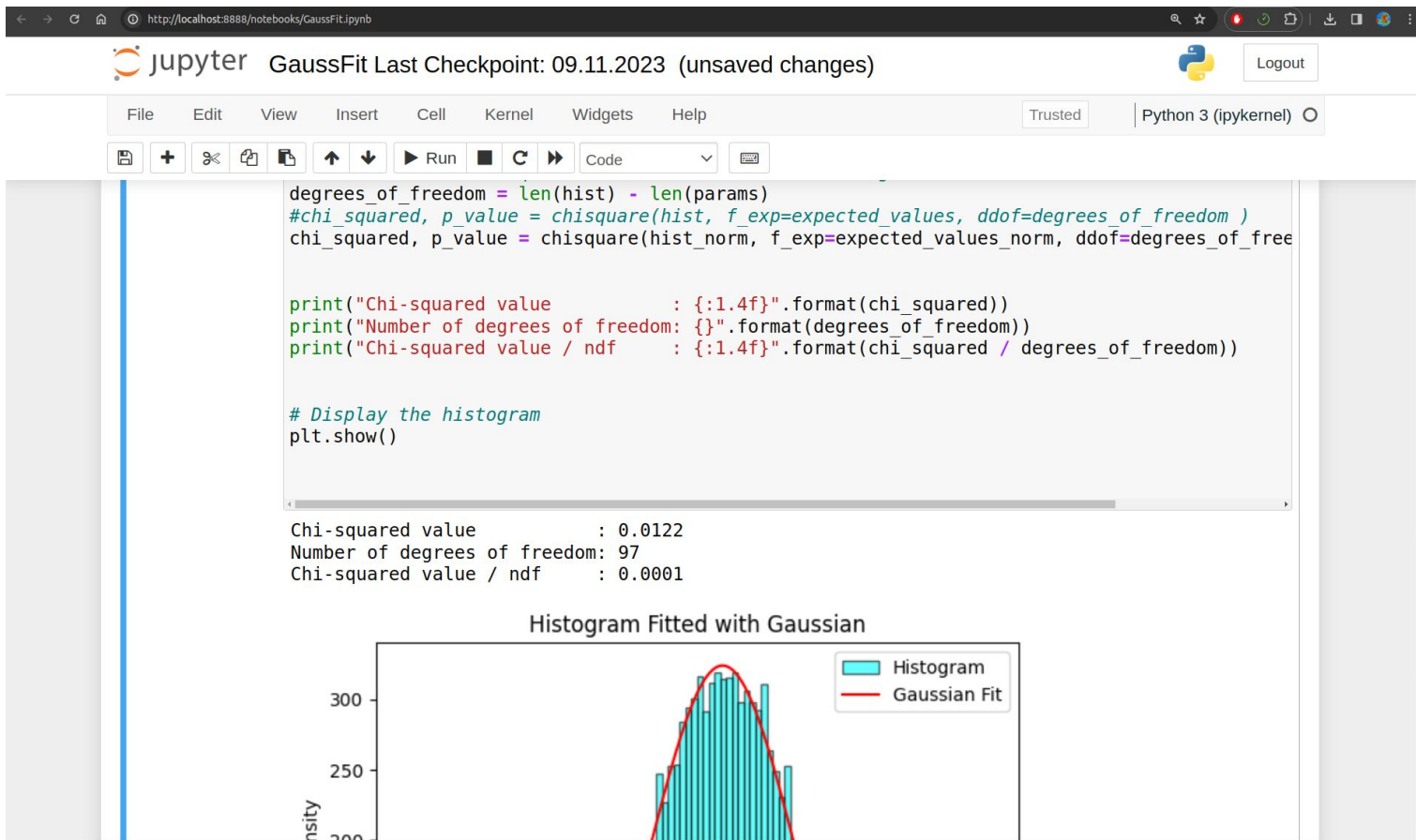
Figures now render in the Plots pane by default. To make them also appear inline in the console, uncheck "Mute Inline Plotting" under the Plots pane options menu.

```
IPdb [2]:
```

Python Console History

custom (Python 3.10.12) Completions: custom LSP: Python master [280] Line 13, Col 1 ASCII LF RW Mem 72%

Jupyter notebook



C++

- `[](){}();`
-

Lambda funkce

- anonymní funkce, která je např. hned volána a není potřeba ji tak pojmenovávat:)
- C++
 - <https://en.cppreference.com/w/cpp/language/lambda>
 - <https://stackoverflow.com/questions/34778041/what-does-mean-in-c>
- Python
 - https://www.w3schools.com/python/python_lambda.asp

Lambda

- `[](){}();`
 - `[capture](params){code;}`(instantly call with params);

Lambda

- `[](int n){cout << n << endl;}(5);`
 - 5
-

Lambda

- `[](int n){for (unsigned int i = 0; i < n; ++i) {cout << i*i << endl;}}(5);`
 - 0
 - 1
 - 4
 - 9
 - 16
-

Lambda

- `[](int n, int power){for (unsigned int i = 0; i < n; ++i) {cout << pow(i, power) << endl;}}(5,3);`
 - 0
 - 1
 - 8
 - 27
 - 64
-

Lambda

- `auto fn = [](int power, int n = 10){for (unsigned int i = 0; i < n; ++i) {cout << pow(i, power) << endl;}};`
- `fn(4,5)`
 - 0
 - 1
 - 16
 - 81
 - 256
-

Lambda

- BTW c.f. Python list comprehension:
- `[i*i for i in range(0,5)]`
 - `[0, 1, 4, 9, 16]`
- Jako lambda funkce v Pythonu
- `sq = lambda n: [i*i for i in range(0,n)]`
- `sq(5)`
 - `[0, 1, 4, 9, 16]`

Lambda



You

example of python lambda function which can serve as a generator of a doubler or a tripler of an argument



ChatGPT

Certainly! You can create a lambda function that serves as a generator for a doubler or a tripler. Here's an example:

python Copy code

```
doubler = lambda x: x * 2
trippler = lambda x: x * 3

# Example usage
value = 5

doubled_value = doubler(value)
trippled_value = tripler(value)

print(f"Original value: {value}")
print(f"Doubled value: {doubled_value}")
print(f"Tripled value: {trippled_value}")
```

In this example, the `doubler` lambda function takes an argument `x` and returns its double, while the `trippler` lambda function returns the triple of the argument. You can replace the `value` variable with any number to see the doubled and tripled values.



Message ChatGPT...



Lambda



You

can this be done using a single lamda function and generating a double, tripler or any other power on demand?



ChatGPT

Yes, you can create a single lambda function that generates a doubler, tripler, or any other power on demand using a higher-order function. Here's an example:

python

Copy code

```
power_generator = lambda n: (lambda x: x ** n)

# Example usage
doubler = power_generator(2)
tripler = power_generator(3)
quadrupler = power_generator(4)

# Use the generated functions
value = 5

doubled_value = doubler(value)
tripled_value = tripler(value)
quadrupled_value = quadrupler(value)

print(f"Original value: {value}")
print(f"Doubled value: {doubled_value}")
print(f"Tripled value: {tripled_value}")
print(f"Quadrupled value: {quadrupled_value}")
```

In this example, `power_generator` is a lambda function that takes an exponent `n` and returns another lambda function that raises its argument to the power of `n`. You can then create specific generators like `doubler`, `tripler`, or `quadrupler` by passing the

Lambda

Funkce, která vrací lambda funkci:)



You

how the above can be written in c++?



ChatGPT

In C++, you can achieve a similar functionality using lambda expressions and function objects. Here's an example:

cpp

Copy code

```
#include <iostream>
#include <functional>

int main() {
    // Define a lambda function that generates a power function
    auto power_generator = [](int n) {
        return [n](int x) { return x * n; };
    };

    // Example usage
    auto doubler = power_generator(2);
    auto tripler = power_generator(3);
    auto quadrupler = power_generator(4);

    // Use the generated functions
    int value = 5;

    int doubled_value = doubler(value);
    int tripled_value = tripler(value);
    int quadrupled_value = quadrupler(value);

    std::cout << "Original value: " << value << std::endl;
    std::cout << "Doubled value: " << doubled_value << std::endl;
```

Lambda

You
how can I pass another argument, say how many numbers to be printed out to the desired power?

ChatGPT
To pass another argument specifying how many numbers to be printed out to the desired power, you can modify the lambda functions accordingly. Here's an example in C++:

**** doubler ****

2 to the power of 2 is: 4

4 to the power of 2 is: 8

8 to the power of 2 is: 16

16 to the power of 2 is: 32

32 to the power of 2 is: 64

**** tripler ****

2 to the power of 3 is: 6

6 to the power of 3 is: 18

18 to the power of 3 is: 54

54 to the power of 3 is: 162

162 to the power of 3 is: 486

**** quadrupler ****

2 to the power of 4 is: 8

8 to the power of 4 is: 32

32 to the power of 4 is: 128

128 to the power of 4 is: 512

512 to the power of 4 is: 2048

:-)

```
#include <iostream>
#include <functional>

int main() {
    // Define a lambda function that generates a power function
    auto power_generator = [](int n) {
        return [n](int x, int count) {
            for (int i = 0; i < count; ++i) {
                std::cout << x << " to the power of " << n << " is: " << x
                    << "\n";
                x *= n; // Update x for the next iteration
            }
        };
    };

    // Example usage
    auto doubler = power_generator(2);
    auto tripler = power_generator(3);
    auto quadrupler = power_generator(4);

    // Use the generated functions
    int value = 2; // Starting value
    int count = 5; // Number of values to print

    doubler(value, count);
    tripler(value, count);
    quadrupler(value, count);

    return 0;
}
```

Lambda



You

great, thank you a lot. just beware, in your last C++ code your program was not doing power but multiplication;)



ChatGPT

You're absolutely right, and I appreciate your keen observation. My apologies for the oversight. Here's the corrected C++ code, ensuring it correctly calculates the power:

cpp

Copy code

```
#include <iostream>
#include <functional>

int main() {
    // Define a lambda function that generates a power function
    auto power_generator = [](int n) {
        return [n](int x, int count) {
            for (int i = 0; i < count; ++i) {
                std::cout << x << " to the power of " << i + 1 << " is: "
            }
        };
    };

    // Example usage
    auto doubler = power_generator(2);
```

Lambda



You

but you're still not updating the number to be made to the desired power...



ChatGPT

You're right, and I appreciate your patience. I misunderstood your initial request. Here's the corrected C++ code where the base value is updated for each iteration:



You

still, this code provides the correct powers, but of numbers which are not consecutive by 1...



ChatGPT

You're right, and I appreciate your patience. I misunderstood the requirement again. Here's the corrected C++ code to generate consecutive powers of the base value:

..and so on, chat
gpt4 never
managed to
fixed the code...

Lambda

TTree Analysis frameworks

- Manual branches read
- MakeClass()
- Compiled using MakeClass
- Python
 - pyroot
 - uproot
- ROOT Data Frame

ROOT Data Frame

- https://root.cern/doc/master/classROOT_1_1RDataFrame.html#crash-course
- <https://cms-opendata-workshop.github.io/workshop-lesson-root/05-rdataframe/index.html>
- https://root.cern/doc/v622/classROOT_1_1RDataFrame.html
- <https://indico.fnal.gov/event/23628/contributions/241029/attachments/154864/201541/RDF%20%40%20ROOT%20workshop%202022.pdf>

[OBJ]

