

Introduction to ROOT

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May 28, 2021

Outline

- Where to start for beginners
- What can you do with ROOT
- Where to Get Helps

Getting Started

- A few places to start
 - A ROOT Guide For Beginners: <https://root.cern/primer/>
 - Courses: https://root.cern/get_started/courses/
 - tutorial examples: <https://root.cern/tutorials/>
- Learn by using!

A list of things you can do with ROOT

- Read and Write Data from ROOT Tree
- Draw histograms in 2D and 3D
- Draw scatter plots in 2D and 3D
- Fitting with points in histograms and scatter plots
- Matrix Operations
- Pseudo-Random Number generator
- and more ...

User Interfaces: 1) C++ interpreter, 2) Graphical UI, 3) Macros and Programs

Tree

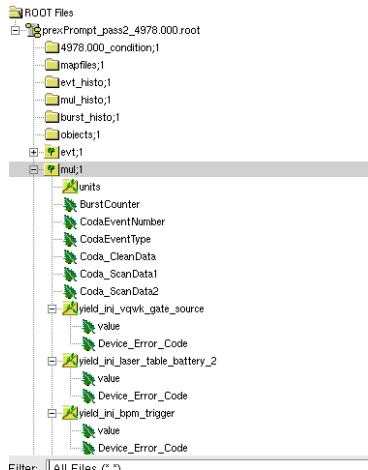
Usually, a Tree is a table of numbers.

- each row is an Entry
- each column is a Leaf of the Tree

```
root [6] T->Scan("hit.x:hit.y:hit.z:hit.vx.hit.vy:hit.vz")
*****
* Row * Instance * hit.x * hit.y * hit.z * hit.vx.hi * hit.vz *
*****
* 0 * 0 * * * * * * *
* 1 * 0 * -42.51334 * 20.678809 * -1375.5 * -1.963505 * -4259.650 *
* 1 * 1 * 15.363994 * -10.22891 * -1375.5 * -1.963505 * -4259.650 *
* 2 * 0 * -0.855654 * -12.82149 * -1375.5 * -1.300009 * -4787.608 *
* 3 * 0 * -615.8181 * 585.49843 * 19279.5 * 0.8823284 * -4252.180 *
* 3 * 1 * -615.8382 * 585.51683 * 19279.975 * 0.8823284 * -4252.180 *
* 3 * 2 * -615.8403 * 585.51877 * 19280.025 * 0.8823284 * -4252.180 *
* 3 * 3 * -637.1780 * 604.90543 * 19779.5 * 0.8823284 * -4252.180 *
* 3 * 4 * -637.1984 * 604.92385 * 19779.975 * 0.8823284 * -4252.180 *
* 3 * 5 * -637.2005 * 604.92579 * 19780.025 * 0.8823284 * -4252.180 *
* 3 * 6 * -654.9442 * 621.02443 * 20193.5 * 0.8823284 * -4252.180 *
* 3 * 7 * -654.9646 * 621.04292 * 20193.975 * 0.8823284 * -4252.180 *
* 3 * 8 * -654.9667 * 621.04487 * 20194.025 * 0.8823284 * -4252.180 *
* 3 * 9 * -676.4421 * 640.56982 * 20693.5 * 0.8823284 * -4252.180 *
* 3 * 10 * -676.4625 * 640.58852 * 20693.975 * 0.8823284 * -4252.180 *
* 3 * 11 * -676.4647 * 640.59049 * 20694.025 * 0.8823284 * -4252.180 *
* 3 * 12 * 1364.8968 * -238.2662 * 20694.5 * 175.66160 * 27011.407 *
* 3 * 13 * -1051.266 * 760.17443 * 20694.5 * -824.1616 * 24138.592 *
* 3 * 14 * -1164.734 * 775.15133 * 20194.5 * -824.1616 * 24138.592 *
* 3 * 15 * -616.0267 * 585.20070 * 19279.5 * -591.0865 * 18695.464 *
* 3 * 16 * -637.3782 * 604.29887 * 19779.5 * -591.0865 * 18695.464 *
* 3 * 17 * -655.0574 * 620.11215 * 20193.5 * -591.0865 * 18695.464 *
* 3 * 18 * -676.4089 * 639.21032 * 20693.5 * -591.0865 * 18695.464 *
* 3 * 19 * -732.4521 * 692.20519 * 21999.5 * 0.8823284 * -4252.180 *
```

Tree

- a .root file can have multiple Trees.
- a Tree can have multiple Branches.
- a Branch can have multiple Leaves.
- a Branch can have only one Leaf.



Read Data From Tree

- to know about the Tree structure
root [] T->Print()

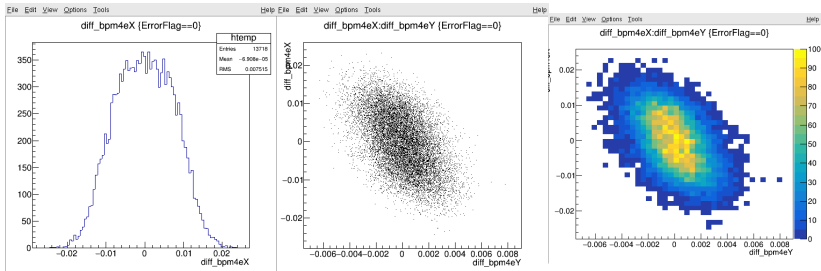
```
root [7] T->Print()
*****
*Tree   :T           : Geant4 Moller Simulation
*Entries : 100000    : Total = 2261472058 bytes File Size = 1222581184 *
*       :           : Tree compression factor = 1.85
*****
*Branch :units
*Entries : 100000    : BranchElement (see below)
*****
*Br     0 :ppm       : Double_t
*Entries : 100000    : Total Size= 810480 bytes File Size = 17862 *
*Baskets : 117       : Basket Size= 8192 bytes Compression= 45.23 *
*****
*Br     1 :ppb       : Double_t
*Entries : 100000    : Total Size= 810480 bytes File Size = 17863 *
*Baskets : 117       : Basket Size= 8192 bytes Compression= 45.22 *
*****
```

- to Print out the Tree contents with numbers
root [] T->Scan(...)
- Write your own Macro and load values in Branch/Leaf by pointers
T->SetBranchAddress(...)
T->GetBranch("..")->GetLeaf("..")->SetAddress(...)
- Draw a Histogram from Tree
root [] T->Draw(...)

Histogram

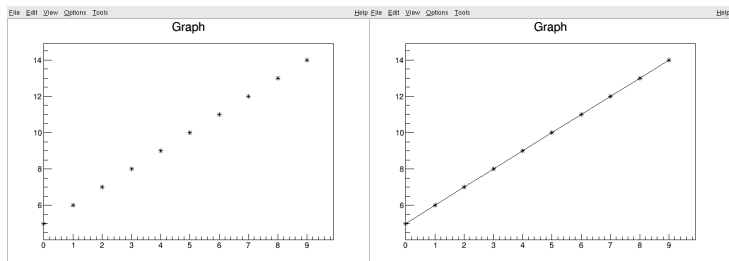
Draw a histogram from Branches of a Tree

- T->Draw("x");
- T->Draw("x", "x>0 && y<0");
- T->Draw("y:x", "x>0 && y<0");
- T->Draw("y:x", "x>0 && y<0", "COLZ");
- T->Draw("z:y:x", "x>0 && y<0", ...);



TGraph in 3-steps

- 1 Fill data in arrays for X and Y
`Double_t x[10] = { }; Double_t y[10] = { };`
- 2 Create a TGraph pointer (or object)
`TGraph *gr1 = new TGraph(10,x,y);`
- 3 Choose a good style :
`gr1->Draw("AP"); gr1->Draw("ALP");`

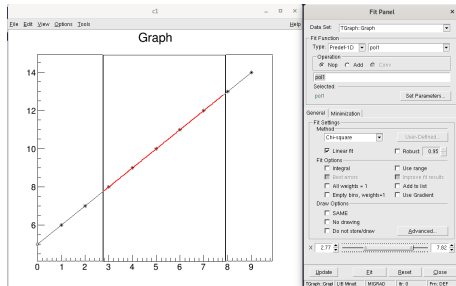


Markers, Lines ..

<https://root.cern.ch/doc/master/classTGraphPainter.html>

Fitting

Right click shows a menu then left click “FitPanel”, ,



Or use command lines
root [] gr1->Fit("pol1");
root [] h1d->Fit("gaus");

then push “Fit” button The Same way for a histogram

Where to Get Helps

- ROOT forum: <https://root-forum.cern.ch/>
- Reference Documentation: <https://root.cern/doc/master/>