ROOT

Pocket reference for 1st year course - BSc Physics, Unibo

2023

Contents

A general note: strings between `<` ... `>` are meant to be replaced by suitable ones (without the two kets)

1 General structure

ROOT contains **interpreter** : *Just-In-Time* compilation → prompt : special commands (not standard C++ syntax) with `.`.

Base class `TObject` → `TNamed` → `TH1` (histograms) → `TH1F, TH1D, THIC, TH1S` according to **type representing entries** (not the type of data!!)

2 Basic shell & prompt commands

! Possible to use $\boxed{Tab}$

- `root` launch ROOT
- `.q` quit
- `.L <file.C>` load file (symbols defined in a macro)
- `.help` `.?` full help list
- `.! <cmd>` call any shell command ¡cmd¿ without leaving ROOT
- `.files` shows loaded libraries / sources
- `.x <macro>` loads & runs a macro
- `.U <file.C>` unload
- `.! wslview <image-file>` (for WSL users) open image with default photo viewer from inside ROOT

Run a macro:

```
$ [0] .L <name>.C
$ [1] <name>()
```

Possible to type C++ commands directly in shell: **';' are unnecessary, object type can be omitted in declarations, possible to access members with obj name instead than pointer**:

```
$ [...] TH1F *histo=new TH1F(\histname"," Titolo", 100, 0, 10)
$ histname->Draw() // identical to histo->Draw()
```

Note: `#include <iostream>` and `namespace std;` are implicit!

Use prompt as calculator Ordinary operations + embedded library `TMath`:
`TMath::Abs(...), TMath::Exp(...), TMath::Gaus(...), TMath::Pi(), ...`

2.1 Recover session history

Saved in `$/home/.root_hist`

2.2 LaTeX

Can be used for labels etc. Same syntax as normal LaTeX

- `x_{1}` = x_1
- `x^{1}` = x^1

but commands are called with '`#`' instead of '`\`'

3 Macros

Two types of script

Unnamed script all code between {} + no declaration of classes, functions + no parameters (ok loops)

Named script like any C++ function + possible to define other functions, classes, use parameters
The executed function has the same name of the file (see Basics)

4 GUI

`TBrowser b` opens root files browser.
Double click on an object (e.g. histo) → opens new **TCanvas** and draws it

Handling TCanvas

if some of the followings not visible, click **View** and check out

Editor single left click on an object in graph → edit display parameters (color etc.)

Toolbar tools to insert text, symbols, etc.

Status bar shows object pointed by mouse & mouse position

Right click on object → contextual menu

Contextual menu

Rebin redefine binning

Fit (of FitPanel) fit a function on data (gaussian, exponential, polynomial etc.) → button `Set Parameters` for chosen distribution

To visualize fit on graph: right click on graph → open `TPaveStats::stats` → `SetOptFit` → se to `111`
`SetOptStat` allows do define other options

Canvas options Right click on canvas → `SetLogx`, `SetLogy` for logarithmic scale; `SetGridx`, `SetGridy` for grid

Saving file `File` ▶ `Save` (`Save As`)
Saving as `.C` file (containing the graph as C++ commands) enables to reproduce graph executing macro
Saving as `.root` file → saves canvas and all objects, double click on canvas inside .root (opened through TBrowser) to open and manipulate graph

5 Global variables

List of useful global pointers.

`gROOT` global info on current session: access to **every object created during session**

`gFile` current root file

`gStyle` access functionalities to manage graphic style

`gRandom` access random number generator (see PRNG)

`gPad` current pad (see Canvas)

Suggestion at the beginning of a macro, to eliminate copy created by multiple executions of code in a session:

```
delete gROOT->FindObject("<name>");
```

`gROOT->FindObject("<name>")` used to retrieve every object from gROOT

General styling

`gROOT->SetStyle("<style>")` set window style. Can be custom one or chosen between default ones: `Classic, Plain, Modern, Bold, Video, Pub`

6 Managing .root files

`TFile *file = new TFile("<name>.root", "RECREATE");` open file. `RECREATE` creates new file if name not found, otherwise overwrites existing one. Alternative option: `"NEW"` (error if already existing!)

`h->Write();` write object (pointed by `h`) on file

`file->Close();` close

7 Histograms

1D

```
TH1F* <pt-name> = new TH1F( "<name>", "<title>", <NxBins>, <xmin>, <xmax>);
// declare new histogram
// range [xmin, xmax] is equally subdivided in N bins

<pt-name>->Fill(<x>);
// fill histo with variable <x> (e.g. from MC generation or read file, data)

<pt-name>->Fill(<x>, <n>);
// fill histo with n identical occurrences of x

<pt-name>->Draw(); // draw histo
```

2D

```
TH2F* <pt-name> = new TH2F( "<name>","<title>",<NxB>,<xmin>,<xmax>,<NyB>,<ymin>,<ymax>);

<pt-name>->Fill(x,y);
<pt-name>->Draw();

<pt-name>->ProjectionX(); // returns TH1F of projection w.r.t. x
<pt-name>->ProjectionY();
<pt-name>->GetNbinsX();
<pt-name>->GetNbinsY();
```

3D

```
TH3F* <pt-name> = new TH2F( "<name>","<title>",<Nx>,<xmn>,<xmx>,<Ny>,<ymn>,<ymx>,<Nz>,<zmn>,<zmx>);
```

N-D

```
THnSparse* pt = new THSparse( "<name>", "<title>", <Ndims>, <xmin>, <xmax>, <chuncksize>);
// min and max same for all dimensions
```

7.1 Overlap histos

```
// declare and initialize two histos, with pointers h1, h2
h1->Draw();
h2->Draw("same"); // or h2->Draw("SameHist");
```

7.2 Histo Draw options

`"E"` show error bars

`"hist"` show only histogram

`"lego"` lego plot

`"cont"` contour lines (linee di livello)

`"Surf"` surface

`"P"` draw marker (except empty bins)

`"AXIS"` draw only axis

`"AXIG"` draw only grid (if requested)

`"FUNC"` When histo has fitted function, draw the fit result only.

`"TEXT"` Draw bin contents as text (format set via `gStyle->SetPaintTextFormat`).

`"X+"` The X-axis is drawn on the top side of the plot.

`"Y+"` The Y-axis is drawn on the right side of the plot.

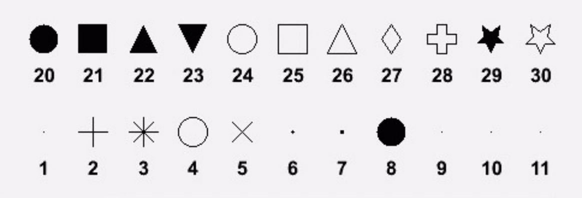
`"MIN0"` Set minimum value for the Y axis to 0, equivalent to `gStyle->SetHistMinimumZero()` .

OPTIONS ARE NOT CASE SENSITIVE

They can also be concatenated without spaces & commas: `"opt1 opt2"`

7.3 Cosmetics for histos

`h1->SetMarkerStyle(<code>);` set style, see ↑ for codes:



`h1->GetXaxis()->SetTitle("<title>")` change axis title, same for y with `GetYaxis()`

`SetFillColor(<color>)` see after for codes

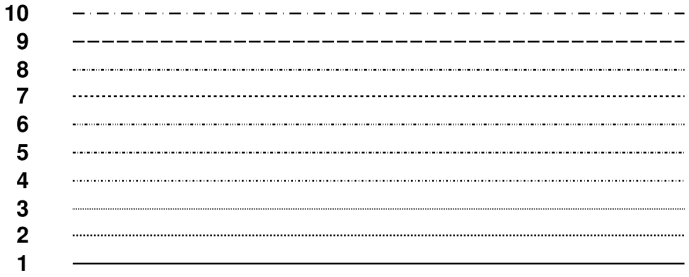
`SetFillColorAlpha(<color>, <transparency ratio>)` allows to manipulate opacity, e.g. `(kBlue, 0.35)`

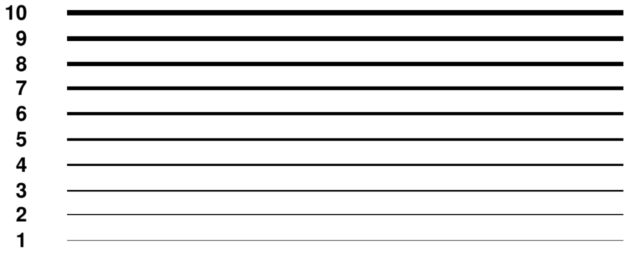
`SetLineColor(<color>)` **or** `SetLineColorAlpha(<color>, <transp>)`

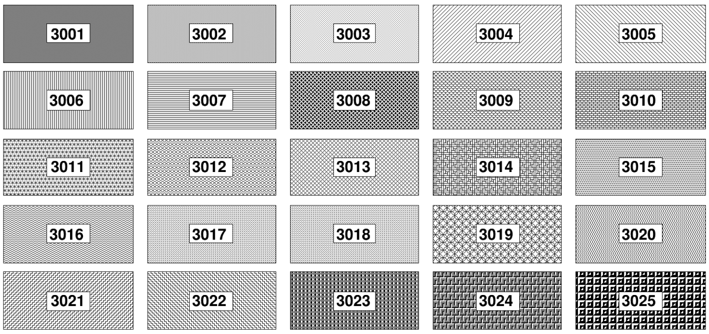
`SetLineStyle(<code>)` see below

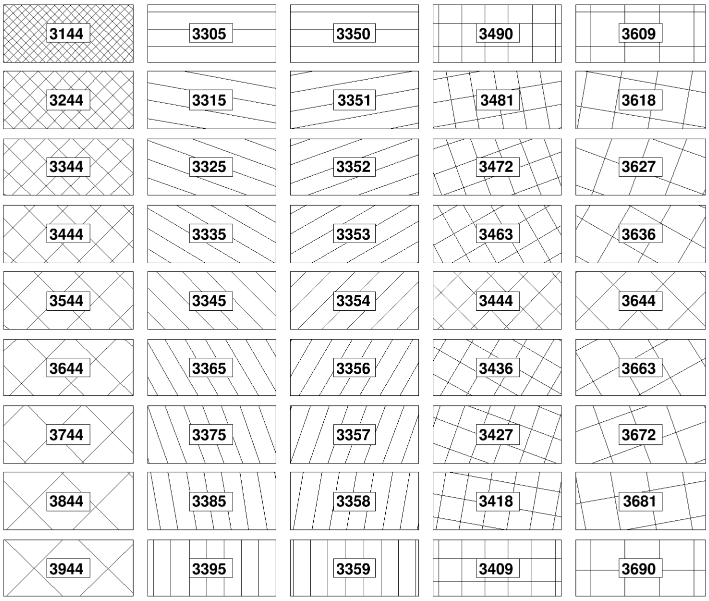
`SetLineWidth(<width>)` see below

`SetFillStyle(<code>)` **0** for hollow, **1001** for solid, **3000 + pattern number** see below









7.4 Other member functions for histos

`GetMean()` mean

`GerRMS()` `GetStdDev()` root of variance / SD

`GetMaximum()` maximum bin content

`GetMaximumBin()` location of maximum (≠ former)

`GetBinCenter( <bin_number> )` center of bin

`GetBinContent( <bin_number> )` content of bin

`GetBinError( <bin_number> )`

`SetBinContent( <bin_number>, <value> )`

`SetBinError( <bin_number>, <value> )`

`GetNbinsX()` number of bins

Note: for out-of-range entries:
`h->GetBinContent(0)` returns number of **underflow**
`h->GetBinContent(h->GetNbinsX()+ 1)` return number of **overflow**

`GetEntries()` total entries (includes under/overflows)

`Integral( <bin_index1>, <bin_index2> )` integral on specified range

`Integral()` total integral

`GetIntegral()` array of cumulative entries

`GetMeanError()` error on mean estimate

`GetRMSError()` `GetStdDevError()` error on RMS estimate

7.5 Operations on histos

Form homologue histograms (**same range and number of bins**): overloads for **istances**, **NOT POINTERS**:

```
TH1F h1;
TH1F h2 = 3*h1;
TH1F h3 = h1+h2;
```

Otherwise through methods:

```
h->Add(<pt1>, <pt2>, <n1>, <n2>); // sum stored in *h, *h = n1*h1+n2*h2
h->Multiply(3);
h->Divide(<pt1>, <pt2>, <n1>, <n2>); // analogous to sum
```

7.6 Filling a histo from ascii file

```
TH1F *h1 = new TH1F("h1","Tempi di Caduta",8,-0.5,15.5);

ifstream in;
in.open("maxwell.dat");
Float_t x,y;
while (1) { // always true condition: iterates until break called
   in >> x >> y;
   if(!in.good()) break;
   h1->Fill(y);
}
in.close();
```

8 Graphs

Two classes: `TGraph` (series of N X-Y couples), `TGraphErrors` (derived from former, includes also errors on both X and Y)

TGraph Constructors Derived class!

`TGraph (Int_t n, const Double_t *x, const Double_t *y)` n couples, `x` and `y` are **arrays**!

`TGraph (const char *filename, const char *format="%lg %lg", Option_t *option="")` input file **must contain 2 separate columns of values** (divided by blank delimiter)
Default format: `"%lg %lg"` (2 double)
To skip columns: `%lg %*lg %lg"`
Additional options to interpret different delimiters: can be explicitly specified in option argument (`option = "<symbol>"`)

TGraphErrors Constructors

`TGraphErrors (Int_t n, const Double_t *x, const Double_t *y, const Double_t*ex=0, const Double_t *ey=0)`
analogous to TGraph, `ex` , `ey` = arrays of errors (for negligible/null uncertainty: substitute with `0`)

`TGraphErrors (const char *filename, const char *format="%lg %lg %lg %lg", Option_t *option="")`
input file **must contain at least 3 columns**. If there are 4 (or more, only first 4 read): X, Y, EX, EY. If only 3: X,Y,EY.

COMMA FOR DECIMALS MUST BE REPLACED WITH DOT

8.1 Graph member functions

(`graph` here is the pointer) — inherited by `TGraphErrors` !
Cosmetics:

`graph->SetTitle("<title>")`

`graph->SetMarkerStyle(kOpenCircle)` (here `kOpenCircle` is default code)

`graph->SetMarkerColor(kBlue)` (`kBlue` also default)

`graph->SetLineColor(kBlue)` ...

Statistical properties:

`graph->GetCorrelationFactor()`

`graph->GetCovariance()`

`graph->GetPoint(<i>,<x>,<y>)` returns `i` -th point

`graph->GetX() / graph->GetY()` returns pointer to array of x / y values

`graph->GetN()`

`graph->Integral()`

Other:

`graph->AddPoint(<x>,<y>)`

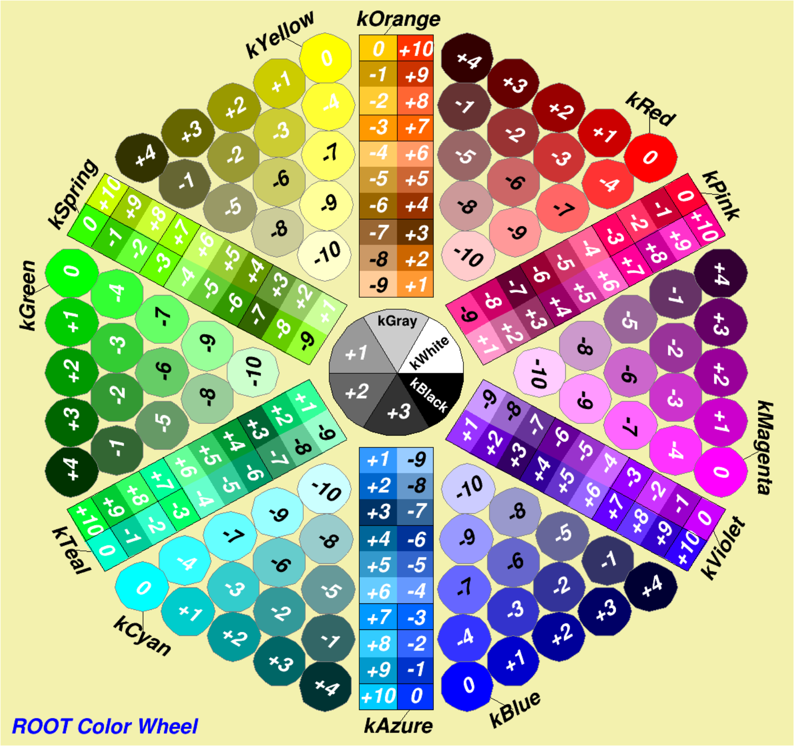
`graph->SetPoint(<i>, <x>, <y>)`

`graph->GetXaxis()` pointer to X axis ▶ `graph->GetXaxis()->SetTitle("title")`

`graph->GetYaxis()` pointer to Y axis ▶ `graph->GetYaxis()->SetTitle("title")`

`graph->SetMinimum(<double>)` set minimum on Y

`graph->SetMaximum(<double>)` set maximum on Y



8.2 Color reference

8.3 Drawing TGraph

`graph->Draw(<options>)`

`"A"` draws axis

`"P"` draws points markers (the current one set)

`"E"` draws error bars

`"AI"` draws invisible axis (no labels)

`*` draws star at each point (alternative to P)

`C` draws a smooth curve connecting points

`X+` X axis drawn on the top side

`Y+` Y axis drawn on the right side

`RX` reverse the X axis

`RY` reverse the Y axis

8.4 Drawing TGraphErrors

Along with previous options, some specific ones:

`Z` do **not** draw horizontal and vertical lines at the end of error bars

`>` draw arrow at the end

`|>` filled arrow

`X` do **not** draw error bars

`||` draw only lines at the end of bars, **not** bars themselves

`0` force error bars drawing also for points outside visible range along Y (by default they're not drawn)

`2` draw error rectangles

`3` filled area through the end points

`4` smoothed filled area

`5` like `2`, but countour lines are drawn.

8.5 Additional styling

`gStyle->SetErrorX(<dx>)` if set to 0 removes error along x

`gStyle->SetEndErrorSize(<n_px>)` size of line at the end of error bars. Default $= 1$.

8.6 Fit

The following syntax is valid both for histos and graphs.

`Fit( "<name>", <option>, <graphic_opt>, <xmin>, <xmax>)` where `name` is one of the defaults: `gaus, gausn` (normalized), `landau, landaun, expo, pol1, pol2, ..., pol9` (polynomial of degree n), `chebyshev1, chebyshe`
To print list of avaiable functions:

```
TF1::InitStandardFunctions(); // not needed if ‘gROOT->GetFunction‘ is called before
gROOT->GetListOfFunctions()->ls()
```

`name` can also be a formula accepted by the linear fitter with the operator `++`
(e.g. `x++sin(x)`, for fitting `[0]*x+[1]*sin(x)`)

`Fit( TF1* f1, <option>, <graphi_opt> , <xmin>, <xmax> )` with previously defined function (see after)

`graphic_opt` is analogous to the one for `Draw`, whereas `option` can contain one (or more) of the following:

FOR HISTOS ONLY

`L` use logarithmic likehood method (instead of default Chi square)

`WIDTH` scales histogram bin content by bin width (useful for variable bins)

`MULTITHREAD` forces employment of multithreading whenever possible

FOR GRAPHS ONLY

`W` ignore point errors when fitting TGraphErrors

FOR BOTH HISTOS AND GRAPHS

`R` use fitting range specified in the function range (default is histo’s)

`C` in case of linear fit, disables calculation of Chi square (saves CPU time)

`Q` quiet mode: print minimum data

`V` verbose mode: print everything

`S` stores full fit result and returns a `TFitResultPtr` for access

`TF1* fitFunc = <pt>->GetFunction("f1")` recover fit function from histo (analogous for graph)

`fitFunc->GetChisquare()`

`fitFunc->GetParameter(<i>)` `i`-th parameter value

`fitFunc->GetParError(<i>)` error on `i`-th parameter

8.6.1 Statistics & fit parameters

`gStyle->SetOptStat(<ksiourmen>)` choose statistics parameters to be displayed (each mode with a value - default **0** if omitted):

- `k` **1** = print kurtosis, **2** = print kurtosis + k. error
- `s` **1** = print skewness, **2** = print skewness + s. error
- `i` **1** =print integral of bins, **2** = print integral of bins with option
- `o` **1** = print number of overflows
- `u` **1** = print number of underflows
- `r` **1** = print SD **2** = print SD + SD error [1]
- `m` **1** = print mean **2** = print mean + mean error
- `e` **1** = print number of entries
- `n` **1** = print histogram name

STARTS FROM THE END:

```
gStyle->SetOptStat(11); // only name + entries
gStyle->SetOptStat(1101); // name, mean, RMS
```

`gStyle->SetOptFit(<pcev>)` analogous for fit parameters:

- `p` **1** = print Probability
- `c` **1** = print Chisquare / Number of d.o.f.
- `e` **1** = print errors
- `v` **1** = print name/values of parameters (only non-fixed) **2** = print name/value of *all* parameters

`gStyle->SetOptFit(1)` is **equivalent** to `gStyle->SetOptFit(111)` (!)

9 Functions

In 1 variable (x): class **TF1**. User-defined function (and function objects, lambda) or built-in function objects → **TFormula**
For more dimensions (variables) **TF2, TF3**.

`TF1 *f1 = new TF1("f1", "sin(x)/x",<xmin>,<xmax>)`

`TF1 *f2 = new TF1("f2", "f1 * 2",0,10)` previously defined functions can be used in definition of new ones

`TF1 *f3 = new TF1("f3","[0]*x*sin([1]*x)",-3,3)` possible to use parameters

`f3->SetParameter(<index>, <value>)` to **initialize** one of them

`f3->SetParameters(<value1>, <value2>, ..., <valuek>)` following order!

See TFormula for more info

```
Double_t MyFunction(Double_t *x, Double_t *par){
    Float_t xx = x[0];
    Double_t val = TMath::Abs(par[0]*sin(par[1]*xx)/xx);
    return val;
}
```

[1] Actually `r` stands for Root Mean Square, defined according to

$$x_{RMS} = \sqrt{\frac{1}{n}\sum x_i^2}$$

Note: important to follow this signature!

`TF1 *f4 = new TF1("f4",MyFunction,0,10,2);`
last constructor parameter is **number of parameters in MyFunction**

`TF1 *f5 = new TF1("f5", [](double *x, double *p) <function body> , <xmin>, <xmax>, <npar>)`
use of lambdas is also possible

`TF1 *f6 = new TF1("f6", "[](double *x, double *p) <function body> ", <xmin>, <xmax>, <npar>)`
also as string expression (JIT will do the rest)

Cosmetics

`f1->SetLineColor(kRed)`

`f1->SetLineStyle(2)` 2 = dashed, 3 = dotted, 4 = dasheddotted

Member functions:

`f1->Eval(<x_value>)` evaluate on a point

`f1->Integral(<a>, <b>)` compute $\int_a^b f1$

`f1->SetMaximum(<value>)` set maximum for Y axis

`f1->SetMinimum(<value>)` minimum for Y axis

`f1->SetRange( <x_min> , <x_max> )` set interval for indipendent variable to `[x_min,x_max]`

10 TMath and TFormula

TMath

`TMath::Abs(<x>)`

`TMath::AreEqualAbs(<x>,<y>,<eps>)` returns true if `TMath::Abs(x-y) < eps`

`TMath::ASin(<x>)` ; `TMath::ASinH(<x>); TMath::ATan(<x>); TMath::ACos(<x>); TMath::ACosH(<x>)`

`TMath::Cos(<x>)` ; `TMath::CosH(<x>)`

`TMath::Sin(<x>)` ; `TMath::SinH(<x>)`

`TMath::Tan(<x>)` ; `TMath::TanH(<x>)`

`TMath::Ln10()` returns $\ln 10$

`TMath::LogE()` returns $\log_{10} e$

`TMath::Ldexp(<x>, <exp>)` where `exp` is integer. Returns $x \cdot 2^{exp}$

`TMath::Log(<x>)` natural logarithm

`TMath::Log10(<x>)` returns $\log_{10} x$

`TMath::Log2(<x>)` returns $\log_2 x$

`TMath::Max(<x>,<y>)` returns maximum value between `x` and `y` (for integers, doubles... everything)

`TMath::Min(<x>,<y>)` same but for minimum

`TMath::Nint(<x>)` rounds `x` to mearest integer

`TMath::Power(<x>,<y>)` returns x^y

`TMath::Prob(<chi2>,<ndof>)` returns probability for $\chi^2 =$ `chi2` with `ndof` degrees of freedom

`TMath::Sq(<x>)` returns x^2

`TMath::Sqrt(<x>)` returns $\sqrt{x}$

CONSTANTS

`TMath::E()` returns e

`TMath::G()` returns G

`TMath::Gn()` returns g

`TMath::H()` returns h `TMath::Hbar()` returns $\hbar$

`TMath::K()` returns k_B

`TMath::Na()` returns N_A

`TMath::Pi()` returns π

`TMath::R()` returns R

`TMath::Sigma()` returns σ (Stefan-Boltzmann)

`TMath::Sqrt2()` returns$\sqrt{2}$

TFormula

`gaus(<const>,<mean>,<sigma>` not normalized

`landau(<mpv>,<sigma>)`

`expo(<const>,<slope>)` e^{A+Bx}

`pol<N>(<p1>, ...   ,<pN>)` polynomial $\sum_{i=1}^{N} pi \cdot x^i$

`sqrt(<x>)`

`sq(<x>)` x^2

`pow(<x>,<y>)` x^y

`<x>*<y>`

`<x>^<n>` or `<x>**<n>`

`<x>/<y>`

`sin(<x>)` `cos(<x>)` `tan(<x>)`

`asin(<x>)` `acos(<x>)` `atan(<x>)`

`sinh(<x>)` `cosh(<x>)` `tanh(<x>)`

`asinh(<x>)` `acosh(<x>)` `atanh(<x>)`

`exp(<x>)`

`log(<x>)`

`log10(<x>)`

`e` | `pi`

`ln10` | `sqrt2`

In function initialization, values can be replaced either with the variable `x` or parameters `[i]`.
Some special ones, where `n` **is the starting index for numbering.**

`gaus(<n>)` not default normalized gaussian with three parameters

`gausn(<n>)` normalized gaussian with three parameters

`expo(<n>)` exponential with three parameters

`pol<N>(<n>)` polynomial with `N` parameters

11 Legend

```
TLegend *leg = new TLegend(<x1>,<y1>,<x2>,<y2>,\ <title> ");
```

$(x1, y2)$ = bottom left corner, $(x2, y2)$ = upper right corner **in normalized coordinates**, so 1 = **pad** height / width

$$x = \frac{absolute\ \ horizontal\ \ position}{screen\ \ width} \qquad y = \frac{absolute\ \ vertical\ \ position}{screen\ \ height}$$

x goes from left to right, y from bottom to top
Careful when using more pads (see **Canvas syntax**)

```
leg->AddEntry(graph,"Punti sperimentali");
leg->AddEntry(f,"Fit Lineare");
leg->AddEntry(<object>,"<description>");
leg->AddEntry(<object>,"<description>", "<option>"); // alternative syntax
```

Possible options:

```
leg->Draw("Same");
leg->SetTextAlign(31); // right
```

Cosmetics (`gStyle` member functions)

```
gStyle->SetLegendBorderSize(<n>);
gStyle->SetLegendFillColor(<color>);
gStyle->SetLegendFont(<n>); // see below
gStyle->SetLegendTextSize(<size>); // see below
```

font code (`<n>`) = 10 × font number + precision

Example of fonts with precision $= 2$:

12 Canvas syntax

`TCanvas* myCanvas = new TCanvas()`

`TCanvas* myCanvas = new TCanvas()`

`myCanvas->Print("<file-name>.<extension>", "<option>")` prints canvas to file. Possible formats: `.ps` (Postscript, default one) with options `Portrait` or `Landscape`, `.eps` (encapsulate Postscript), `.pdf` with option `Title: <title>`, `.svg, .tex, .gif, .gif+<N>` (animated gif, where `N` is the delay in units of 10ms), `.xpm, .png, .jpg, .tiff, .cxx, .xml, .json, .root`.

12 : *ABCDEFGH abcdefgh 0123456789 @#$*

22 : **ABCDEFGH abcdefgh 0123456789 @#$**

32 : ***ABCDEFGH abcdefgh 0123456789 @#$***

42 : ABCDEFGH abcdefgh 0123456789 @#$

52 : *ABCDEFGH abcdefgh 0123456789 @#$*

62 : **ABCDEFGH abcdefgh 0123456789 @#$**

72 : ***ABCDEFGH abcdefgh 0123456789 @#$***

82 : `ABCDEFGH abcdefgh 0123456789 @#$`

92 : *`ABCDEFGH abcdefgh 0123456789 @#$`*

102 : **`ABCDEFGH abcdefgh 0123456789 @#$`**

112 : ***`ABCDEFGH abcdefgh 0123456789 @#$`***

122 : ΑΒΧΔΕΦΓΗ αβχδεφγη 0123456789 ≅#∃

132 : ABCDEFGH abcdefgh 0123456789 @#$

142 : ✌👌👍👎 ♏♐♑♒ 🗀🗁🗎🗏🗐 ✍✂✍

152 : *ΑΒΧΔΕΦΓΗ αβχδεφγη 0123456789 ≅#∃*

`myCanvas->SetCanvasSize(<x_px>,<y_px>)`

`myCanvas->SetWindowSize(<x_px>,<y_px>`
If canvas size exceeds window size, scrollbars are displayed

`myCanvas->GetWh` get value of window height

`myCanvas->GetWw` get value of window width

`myCanvas->ToggleToolBar()` hides if shown or vice versa

Pads

`myCanvas->Divide(<nx>, <ny>)` divides equally into nx×ny pads

`myCanvas->Divide(<nx>, <ny>, <x_margin>, <y_margin>, <color>)` Same; margins are given as **percent of canvas**. `color` is the color of new pads;

Pads can be divided in sub-pads.

`myCanvas->cd(<pad_num>)` sets current pad. Starts from `1`, `0` is parent pad (frame). Current pad can be retrieved through `gPad`. It goes by rows, so the numbering looks like:

$$\begin{bmatrix} 1 & \rightarrow & n \\ n+1 & \rightarrow & 2n \\ \vdots & \vdots & \vdots \\ (m-1)n+1 & \rightarrow & mn \end{bmatrix}$$

13 Pseudo-Random number generation: TRandom

Classes with algorithms employed:

- `TRandom` .... Linear Congruential Generator

↖ *It's a* **very bad** *generator, not to be used!*

- `TRandom1` .... RANLUX
- `TRandom2` .... Tausworthe
- `TRandom3` .... Mersenne Twister

13.1 Methods for generic distributions

Called on global pointer `gRandom` or on `TRandom*` pointer after declaration

`Uniform(<double_1>, <double_2>)` uniform distribution on]`double_1, double_2`[based on `Rndm()`

`Rndm()` uniform in

`Uniform(<double>)` uniform distribution on]`0, double`[

`Integer(<int_max>)` uniform **integer** distribution on [`0, int_max - 1`]

`Gaus(<mean>, <sigma>)` (careful, just one ' `s` ')

`Poisson(<mean>)` **integer** poissonian distribution

`PoissonD(<mean>)` **double** poissonian distribution

`Binomial(<n_tot>, <prob_of_succ>)`

`Exp(<tau>)`

`Landau(<mpv>, <sigma>)` Landau distribution: `mpv` is the *most probable value* (moda) and sigma is *not* the SD (which is undefined)

13.2 Random generation from a generic function

```
TF1 *f1 = new TF1("f1", "<expression>", <xmin>, <xmax>);
double rd = f1->GetRandom();
```

`r` is now a random variable distributed according to the PDF defined by `f1`. It is not necessary to manually ensure that `f1` is normalized: **normalization is carried out automatically**, the only requirement on the function is **continuity**.

`histo->FillRandom("<function>", <n>)` fills the histogram with `n` extractions from a random variable distributed according to `f1` (name). Same considerations as before apply.

13.3 Filling an histo with randomly generated values

```
for(Int_t j=0;j<ngen;j++){ // generation loop
   Double_t x = gRandom->Uniform(xmin,xmax); // extraction
   h->Fill(x); // filling
}
```