

ROOT – Introduction

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IFJ PAN PPSS 2019

Basics of statistical analysis

ROOT

Interactive work

Scripts/programs

Documentation

Why statistical analysis in particle physics?

Makroscopic world (classical)

- Deterministic
- Known initial conditions (positions and momenta) → known future

Why statistical analysis in particle physics?

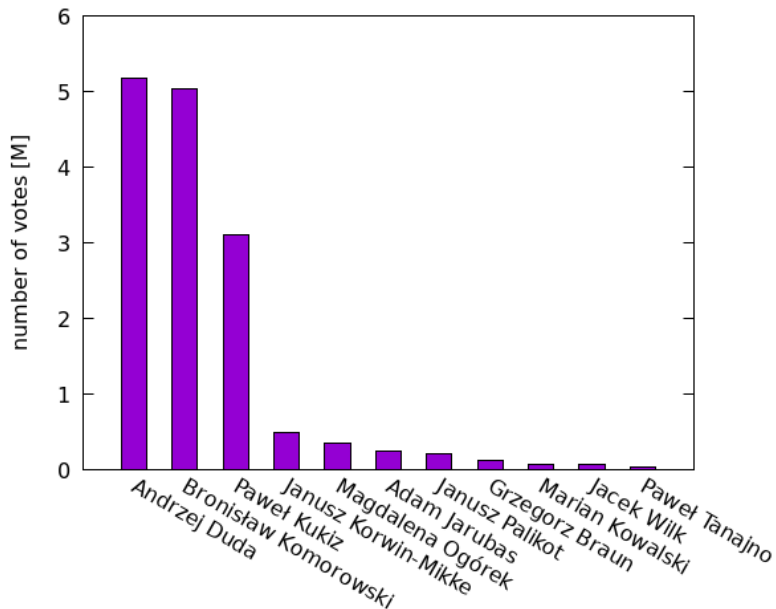
Makroscopic world (classical)

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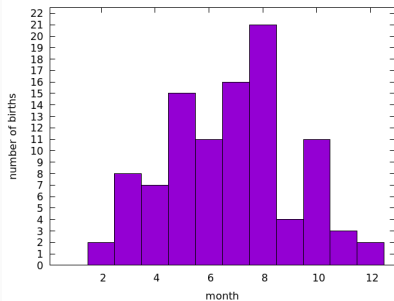
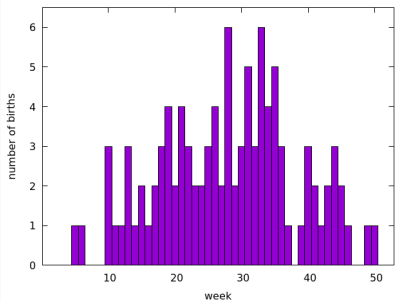
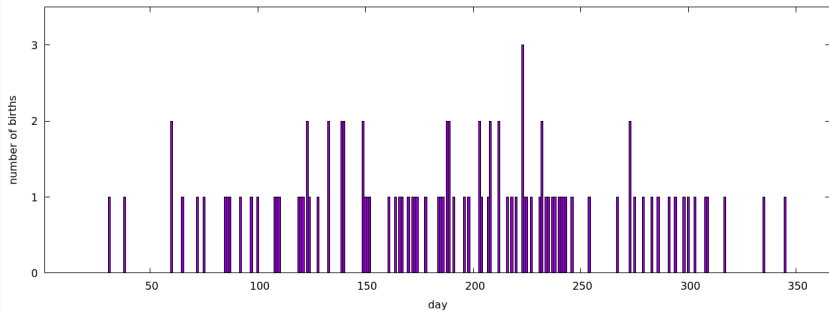
Mikroscopic world (quantum)

- Research tool – interactions (collisions) of particles
- Proton size: $1 \text{ fm} = 10^{-15} \text{ m} = 10^{-12} \text{ mm}$
- Electron size: smaller than 1/1000 protonu (only limit!)
- Initial conditions not fully under control
- Quantum randomness
- Results of a single interaction not reproducible
- **We measure probabilities of different events**

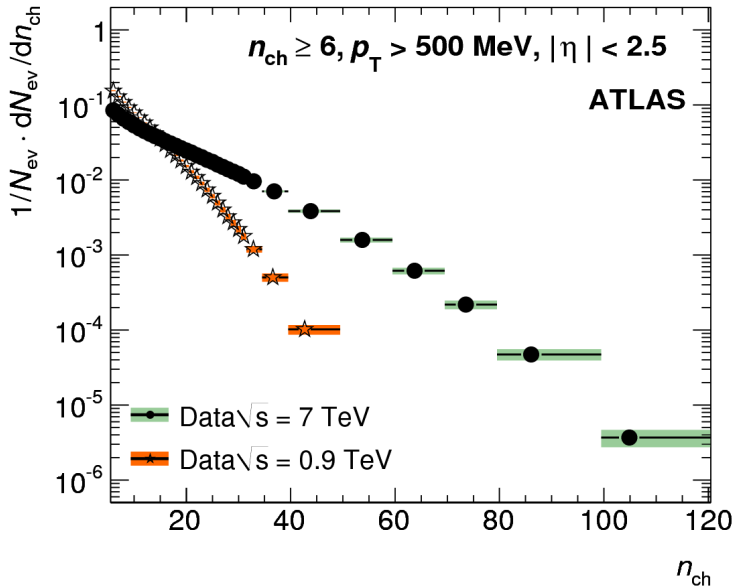
Statistical distribution



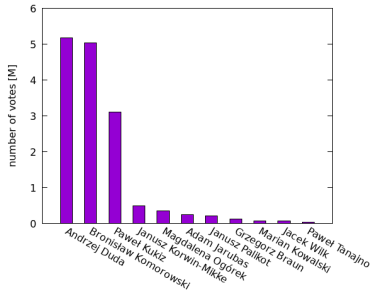
Histogram binning



Example from particle physics



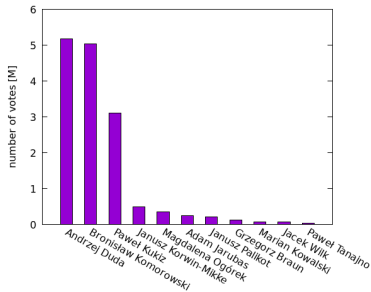
Logarithmic scale



Problem:

- Linear scale appropriate for relatively flat distributions
- "Tails" not well visible

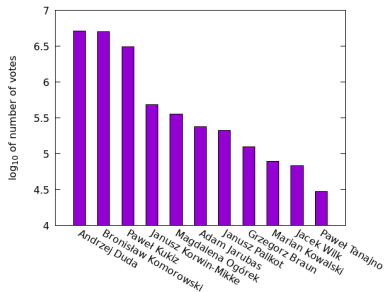
Logarithmic scale



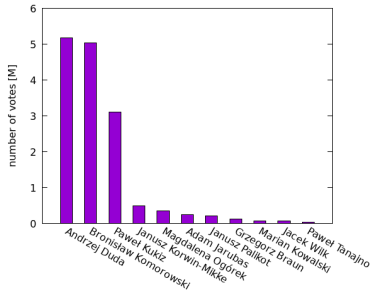
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Solution:



Logarithmic scale

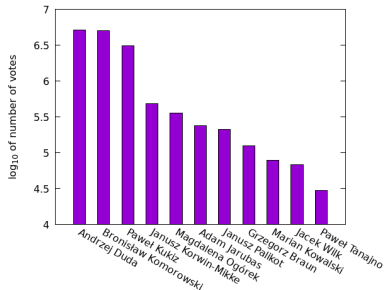


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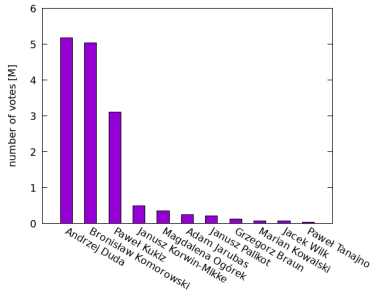
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Solution:

- Logarithm of number of votes



Logarithmic scale

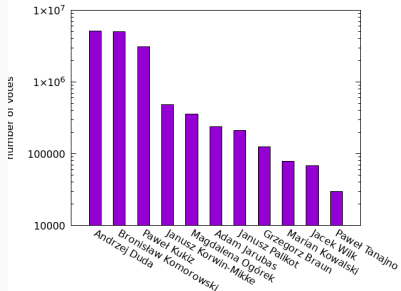
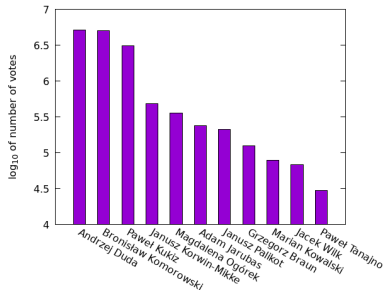


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Solution:

- Logarithm of number of votes
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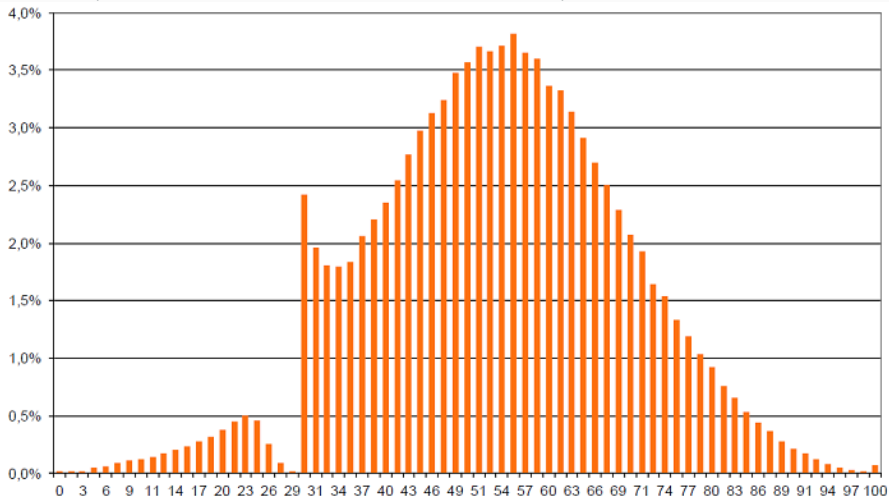


What can one learn from a statistical distribution?

Examination after high school in Poland. Marks: 0 – 100 points.
How do you think the distribution of results may look like?

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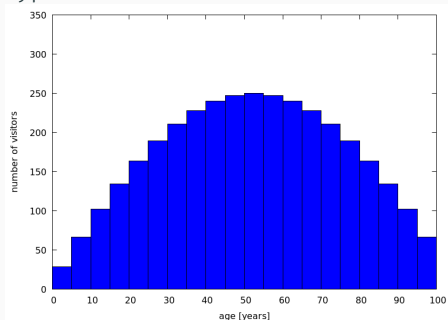
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Age of visitors in museum of particle physics

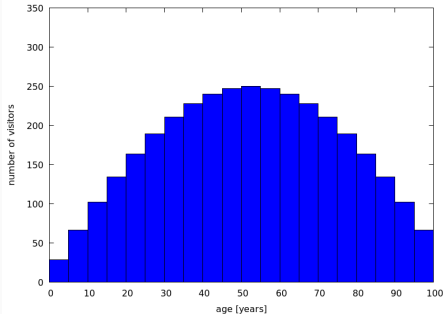
Typical distribution:



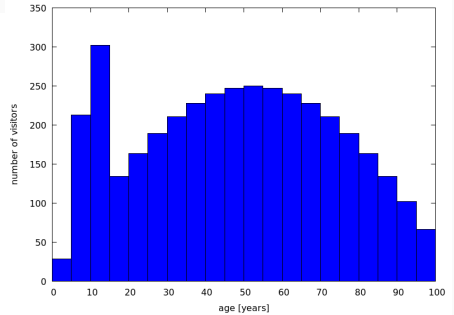
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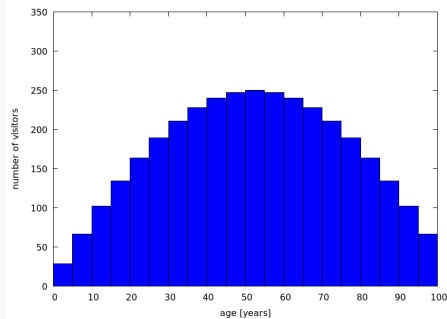
One day:



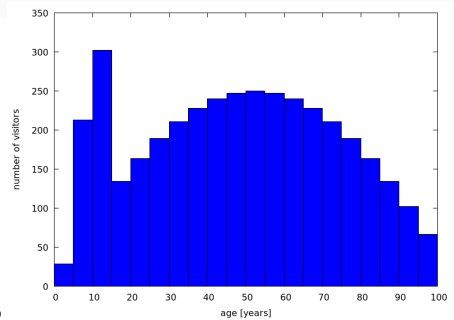
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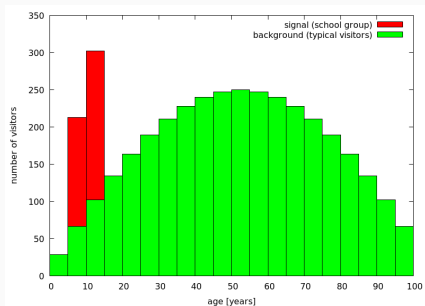
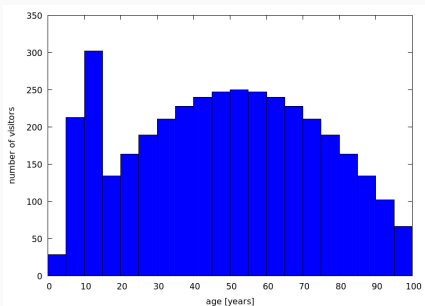


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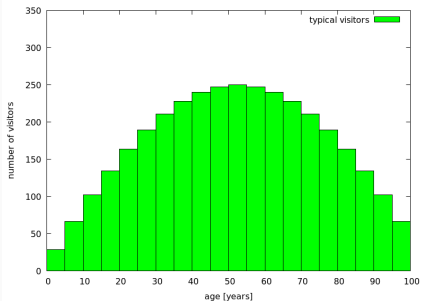
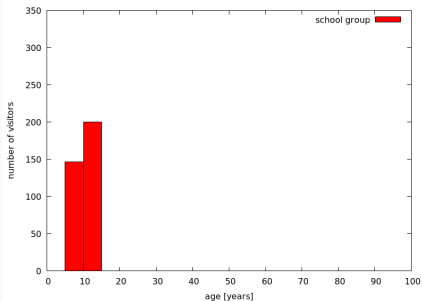
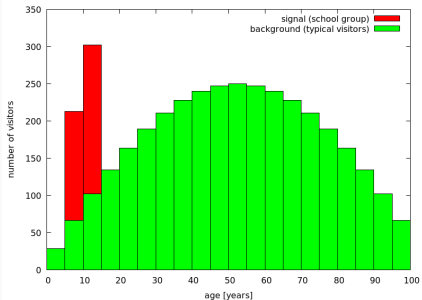
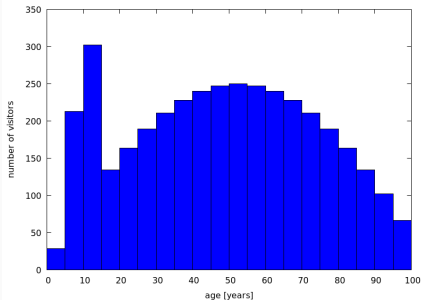


What conclusions can we draw?

"Signal" and "background"



"Signal" and "background"



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Command	Description
<code>root -h</code>	show help for root command
<code>root [-l]</code>	open ROOT
<code>root [-l] file.root</code>	open ROOT and load a file
<code>.?</code>	show help in interactive ROOT
<code>.q[qq[qq[qq]]]</code>	close ROOT (more q 's – more violently)
<code>.ls</code>	list present ROOT directory
<code>tree->Show(2)</code>	show 3rd (!) tree entry
<code>tree->Scan()</code>	print entries as a table
<code>tree->Scan("n:x:y:z", "x>2")</code>	specify variables to show and condition
<code>new TBrowser</code>	open TBrowser
<code>ntuple->StartViewer()</code>	open an analysis GUI

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C++ program

Program

```
#include <iostream>
#include "TCanvas.h"
#include "TF1.h"
using namespace std;
int main (){
    cout << "hello, world" << endl;
    TCanvas c("can1", "Canvas title", 800, 600);
    TF1 f("fun1", "sin(x)", -5, 5);
    f.Draw();
    c.SaveAs("sin.png");
    return 0;
}
```

Running:

```
g++ program.C -o program[.exe] `root-config --cflags`
--glibs`
./program[.exe]
```

C++ macro

```
void macro(){
    cout << "hello, world" << endl;
    TCanvas c("can1", "Canvas title", 800, 600);
    TF1 f("fun1", "sin(x)", -5, 5);
    f.Draw();
    c.SaveAs("sin.png");
}
```

Function name = file name
(w/o extension)

Running:

```
root [-l] [-b] [-q] macro.C[+[+]]
```

or

```
root [-l] [-b]
.x macro.C[+[+]]
```


Python (PyROOT)

```
#!/usr/bin/env python

import ROOT
print "hello, world"
c = ROOT.TCanvas("can1", "Canvas_title", 800, 600)
f = ROOT.TF1("fun1", "sin(x)", -5, 5)
f.Draw()
c.SaveAs("sin.png")
```

Running:

```
python script.py
or
root [-l] [-b]
.x macro.C[+[+]]
```

C++: object vs pointer

Objects:

```
void macro(){
    cout << "hello, world" << endl;
    TCanvas c("can1", "Canvas title", 800, 600);
    TF1 f("fun1", "sin(x)", -5, 5);
    f.Draw();
    c.SaveAs("sin.png");
}
```

Pointers:

```
void macronew(){
    cout << "hello, world" << endl;
    TCanvas * c = new TCanvas("can1", "Canvas title", 800, 600);
    TF1 * f = new TF1("fun1", "sin(x)", -5, 5);
    f->Draw();
    c->SaveAs("sin.png");
}
```

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All you need and more can be found at

`root.cern.ch`