What we will use:

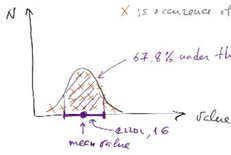
* Python 2.7, install Anaconda on your computer from continuum analytics
  We will use mainly numpy → collection of numerical methods, pandas → for the data

* Github will be used to store all files of our course and store programs that we will write

We have 2 servers and you will be given access to them

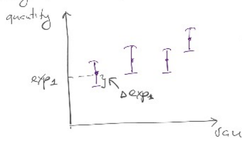
First lecture: Experimental data and fitting

What is experimental data? Result of the measurement of a certain quantity



The bell shaped curve is normal distribution in most cases, generically this hystogram is called probability density function „pdf"

Now imagine several experimental data



Suppose that there are N data points $i = 1, 2, 3, \ldots, N$ each has value exp_i, and error Δexp_i

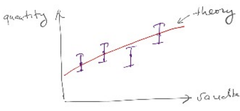
Suppose that we have a theory that should describe the data. This theory will depend on unknown parameters „a". We would like to study those parameters.

In order to do so one has to construct χ^2 function

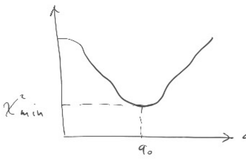
$$\chi^2(a) = \sum_{i=1}^{N} \left(\frac{th_i - exp_i}{\Delta exp_i} \right)^2$$

here th_i is theory prediction for experimental measurement of point i

Remember that „th" is a function of parameters „a" and variable



Minimizing $\chi^2(a)$ will yield values of parameters a_0 where χ^2 is minimal an equal χ^2_{min}



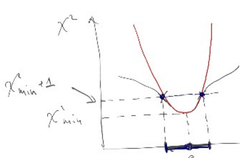
How can we study errors of a_0?

$$\chi^2(a) = \chi^2(a_0) + \underbrace{\frac{\partial \chi^2}{\partial a}(a_1)}_{=0 \text{ as we are at minimum}} (a - a_1) + \frac{1}{2} \frac{\partial \chi^2}{\partial a^2}(a_0)(a - a_1)^2 + \ldots$$

$$\Rightarrow \underbrace{\chi^2(a) = \chi^2(a_0) + \frac{1}{2} \frac{\partial \chi^2}{\partial a^2}(a_0)(a - a_0)^2}_{\text{quadratic approximation}}$$

Usually there will be minimizers already available in Python for us. We will need to program explicitely χ^2 function.

Let us see how quadratic approximation works:



The error on the parameter a (suppose that there is only one parameter) is defined as the spread of χ^2 if $\chi^2 = \chi^2_{min} + 1$

As you can see from the plot, sometimes this approximation will work fine, sometimes it will fail