Statistics tutorial 6

Sebastian Wuchterl 331453, Peter Fackeldey 330532

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1 task 1

1.1 b)

method gives following results:

```
root found at x= -13.3458716092 with 1000 iterations
root found at x= -2.4919059572 with 52 iterations
root found at x= 3.63686265845 with 53 iterations
root found at x= 6.20091490793 with 50 iterations
```

2 task 2

2.1 a)

If one has $a == b$ one has found the root. But in the case $a == c$, you have to interpolate linearly, not quadratic, because you have only two points.
So for the remaining points a and b one gets:
$f(x) = \frac{f(b)-f(a)}{b-a}(x-b)+f(b)$ and the root (or guess) for this is $0 = \frac{f(b)-f(a)}{b-a}(x-b) + f(b)$.

2.2 c)

method gives following results:

```
root found at x= -13.3458716092 with 8 iterations
root found at x= -2.4919059572 with 7 iterations
root found at x= 3.63686265845 with 7 iterations
root found at x= 6.20091490793 with 8 iterations
```

2.3 d)

If one compares the results above, one sees that both find all roots, but the bisecton method does not reach the numpy accuracy for the first root. It stops at the max iteration cut.
And one can clearly state, that the brents method is in all cases much much faster with 7.5 iterations in average.

3 task 3

A function of the type $f(x) = ae^{b \cdot x} + c \cdot e^{\frac{(x-d)^2}{-2c^2}}$ was fitted. So the function has 5 free parameters.
These parameters are two normalisations (a,c), a decay parameter (b), and the mean (d) and sigma (c) of the gaussian shaped peak.
The fits gives the following results:

```
 FCN=73.3715 FROM MIGRAD    STATUS=CONVERGED     580 CALLS         581 TOTAL
 EDM=9.19994e-07    STRATEGY= 1  ERROR MATRIX UNCERTAINTY   2.3 per cent
  EXT PARAMETER                                   STEP         FIRST
  NO.   NAME      VALUE            ERROR          SIZE      DERIVATIVE
   1  p0           9.98738e+04   4.87043e+02  -5.70539e+00  -1.17016e-06
   2  p1           5.01894e-02   2.64578e-04   3.78286e-07  -1.05800e-01
   3  p2           1.56810e+03   2.41461e+01   1.01271e-02  -8.84870e-05
   4  p3           4.99769e+01   7.44006e-02  -1.59143e-04   1.25753e-02
   5  p4           5.09814e+00   6.83899e-02  -7.19201e-05   9.34979e-02
Info in <TCanvas::Print>: pdf file fit_solution.pdf has been created
chi2: 73.3715
chi2/ndof: 0.883994
```

In the generated plot one can also see, that according to the $\chi^2/ndof$ the fitted function describes the histogram very good.

A appendix

We worked on our solution together with Lukas Simon (332051).