Computer interactive exercise: Straight line trajectory fit
Solutions

Physics example: A muon track is measured in four layers of streamer tube detectors at x positions of 4., 5., 6. and 7. (in cm), with a measurement precision for y of 0.5 cm. The goal is to determine its trajectory, assuming it to be a straight line.

Macro StraightLineFit.C, accessible at
http://www.desy.de/~obehnke/stat/school_mar10/StraightLineFit.C
fits a straight line track trajectory through four measured points.

- Steering parameters in the macro:
  - $xmin$, $xmax$ = Interval of the trajectory displayed
- Output:
  - Histogram $data$ (it's of the type TGraphErrors)
  - Plots are drawn of the
    - fitted histogram with error bands
    - error ellipse of the two fitparameters

Tasks:

a) Run the macro as it is by .x StraightLineFit.C and fill the fit results for $p0$, $p1$, their errors and correlation into the table below

b) Precision of trajectory: Evaluate (by eye) from the shown error bands at which point roughly the trajectory is known best and with which precision (fill the results in the table below)

c) Precision of extrapolated trajectory: Evaluate the precision of the extrapolated trajectory at $x = 100$ (Hint: Change $xmax$ to large value and run the macro again)

d) Effect of shift of x coordinate origin: Shift all four $xVal$ points in the macro (simply by overwriting by hand) by a constant value -5.5, set $xmin = -4.$ and $xmax = 4.$ and run the macro again. Fill the fit results in the table. Can you explain why the correlation of $p0$ and $p1$ has changed?

e) Apply a very precise vertex constraint at the origin: Change N to 5 and add a new first point to the measurement points list with $xVal = 0.0$, $xErr = 0.0$, $yVal = 0.0$ and $yErr = 0.0001$ (just by hand). Run the macro again and write down the fitted results in the table. How much are the parameter errors reduced by adding this extra point?

	Straight line fit trough four points
Task a)	$p0 = 0.01 \pm 1.255$ $p1 = 1.03 \pm 0.224$ corr = -0.980
Task b)	x-best precision = 5.5 y-error = 0.3
Task c)	y-error($x = 100$) = 22 cm
Task d)	Shifting all x values by -5.5: $p0 = 5.7 \pm 0.25$ $p1 = 1.03 \pm 0.22$ corr = 0.0
Task e)	Adding vertex constraint at $x = 0$: $p0 = 0.0 \pm 0.0001$ $p1 = 1.032 \pm 0.044$ corr = 0.0