

Time	Group	Submission in Moodle; Mails with subject: [SMD2022]
Th. 12:15–13:00	A	lukas.beiske@udo.edu and jean-marco.alameddine@udo.edu
Fr. 8:15–9:00	B	samuel.haefts@udo.edu and stefan.froese@udo.edu
Fr. 10:15–11:00	C	david.venker@udo.edu and lucas.witthaus@udo.edu

**Exercise 27** *Error propagation*

5 p.

The parameters of a regression line  $y = a_0 + a_1 x$  were determined to be  $a_0 = 1.0 \pm 0.2$  and  $a_1 = 1.0 \pm 0.2$ . The correlation coefficient is  $\rho = -0.8$ . Determine the uncertainty of a value  $y$  as a function of  $x$ .

- (a) Determine the result analytically both considering the correlation and neglecting the correlation.
- (b) Determine the result numerically with a Monte Carlo simulation. Visualise the parameters  $a_0$  and  $a_1$  in a scatter plot.
- (c) Determine the predictions  $y$  (mean and standard deviation) for fixed  $x = -3, 0, +3$  numerically as well as analytically and compare them.

**Exercise 28** *Particle traces*

5 p.

In a particle physics experiment, 2 planes of drift chambers are placed perpendicular to the  $z$ -axis at the positions  $z_1$  and  $z_2$ . The detector is operating in a vacuum and the magnetic field is zero. You measure the respective  $x$ -position ( $x_1$  and  $x_2$ ) of a charged particle passing through with the errors  $\sigma_{x_1}$  and  $\sigma_{x_2}$  without correlation.

- (a) Calculate the linear equation

$$x = az + b,$$

which describes the motion of the particle in the  $x$ - $z$ -plane, as well as the errors, the covariance matrix and the correlation coefficients of  $a$  and  $b$ .

- (b) The measurements in the two drift chamber planes at  $z_1$  and  $z_2$  are now used to predict the position of the particle in the next detector element. Let this be another drift chamber plane parallel to the first two at  $z = z_3$ . With the help of the equation determined in (a), calculate the position  $x_3$  and its error at  $z = z_3$ .
- (c) How does the error of  $x_3$  change if you mistakenly do not take into account the correlation between  $a$  and  $b$ ?