Advanced Data Analyses

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45 hours: 15 Lectures (15 hours), 15x2 hours of practical training

1. **random variable** (discrete and continuous random variables, its specific numerical values: mean, dispersion, median, mode, quintile, asymmetry, excess. Moments of the distribution, moment generating function).
2. **Measurement uncertainties** (estimating errors and uncertainties during data measurement, statistical and systematic uncertainties, combining of statistical and systematic uncertainties. Estimating uncertainties in indirect measurements. Data visualization - histogram, multidimensional histograms, graph, etc.).
3. **Multivariate analysis concept** (General overview of the problem, covariation, correlation, convolution).
4. **Some important distributions and their properties** (Geometric and binomial distributions, Poisson distribution, uniformly distributed random variable, normal, χ^2, Student, Cauchy, Breit-Wigner, Fisher, Weibul, Landau and Crystal ball distributions, Generating a random variable with a pre-defined distribution).
5. **Mathematical statistics** (Statistic vs probability, parameter point and interval estimation. Examples: mean value estimation in case normal distribution).
6. **Methods of analysing experimental data distributions** (Maximum likelihood method. Method of least squares. Minimisation in case of constraints, goodness of the fit, pool analyses).
7. **Machine learning** (General preview. Artificial Neural Network. Decision tree)

Literature:

1. G.Bohm, G.Zech. "Introduction to Statistics and Data Analysis for Physicists", Verlag Deutsches Elektronen-Synchrotron, 2010.
2. Luca Lista "Statistical Methods for Data Analyses in Particle Physics", Springer, 2016.
3. Frodesen, Skjeggestad and Tofte, "Probability ad Statistics in Particle Physics", Columbia University Press, 1979.