

PHYSTAT-SYSTEMATICS 2021

A remote Workshop devoted to the way systematics uncertainties are incorporated in data analyses in Particle Physics. Afternoons (CERN time) of November 1st - 3rd, 2021 with summary talks on November 10th

THEME OF MEETING:

- Almost every analysis in Particle Physics involves not only statistical uncertainties, but also systematic ones. While the assessment of statistical uncertainties can be relatively straightforward, the treatment of systematics in general requires far more effort, and can involve more arbitrary decisions on the part of the analysers. Furthermore, as experiments collect larger and larger amounts of data, the statistical uncertainties become smaller, and so systematic ones are relatively more important. We thus felt that it was appropriate to have a meeting concentrating on systematics.
- PHYSTAT-Systematics will thus be devoted to the ways in which different types of systematic uncertainty are incorporated into our analyses, and the relative merits of different approaches. Our systematics correspond roughly to Statisticians `nuisance parameters'. A description of the systematics in a very simple experiment is outlined in Section 1.1 of the article by Heinrich et al on `Systematic uncertainties'. This example does not involve any Particle Physics. A more relevant example of systematics for a Particle Physics example will be available shortly.

PHYSTAT SERIES:

- The PHYSTAT series of Workshops started in 2000. They were the first meetings devoted solely to the statistical issues that occur in analyses in Particle Physics and neighbouring fields. Further information can be found at the PHYSTAT homepage, which also contains links to the more recently inaugurated PHYSTAT Seminars.

List of Topics likely to be discussed at PHYSTAT-SYSTEMATICS 2021

Here is a list of some things which are likely to be discussed at the meeting. A version of this list, with annotations by Richard Lockhart, can be found in the section 'Message for Statisticians':

- Are systematics for event selection, parameter determination, discovery claims and upper limits dealt with differently?
- Some systematics have a statistical origin. Is it unimportant what they are called, so long as their correlations (with other possible measurements) are dealt with correctly?
- Are there situations where profiling a likelihood is better than marginalising a posterior probability?
- How do we deal with asymmetric uncertainties? e.g. How to combine several measurements with asymmetric uncertainties; calculating Goodness of Fit; etc.
- Do uncertainties in theory present special problems? And similarly when different theories make discrepant predictions.
- Are there issues in situations with thousands of nuisance parameters? Can we run into problems as pointed out in the [Neyman-Scott paper](#) (Econometrica, 1948);
- The various issues that arise when Monte Carlo simulation is compared with the data, e.g. M.C./data discrepancies; weighted M.C. events; reweighting M.C. or generating new M.C. as parameter(s) of M.C. are changed; limited M.C. data.
- If the effect of changing a nuisance parameter on the parameter of interest is $x \pm s$ (where s is an uncertainty on the estimate x , perhaps arising from limited number of events in the M.C.), what do we take as the contribution of this nuisance parameter to the total systematics?
- Relative merits of Bayesian and Frequentist (likelihood) ways of incorporating nuisance parameters.
- Validity of combining Bayes for nuisance parameters with frequentist methods for parameter of interest.
- Problems in the shift method for estimating the effect of nuisance parameters. This includes OPAT = changing One Parameter At a Time. How does it compare with changing all parameters simultaneously? Do possible non-linearities affect the choice?
- A [paper](#) by Dauncey et. al. deals with discrete nuisance parameters (e.g. the functional form chosen for fitting a spectrum) in analogy with the way continuous nuisance parameters are profiled. Is this a known statistical procedure?