PHYSTAT-Flavour 2020

Report of Contributions

https://indico.cern.ch/e/940874

Contribution ID: **1** Type: **not specified**

Statistical issues in modern beauty and charm flavour physics experiments

Monday 19 October 2020 14:05 (30 minutes)

We give an overview of common statistical issues discussed in the heavy flavour physics experiments LHCb and Belle. A focus will be put on limit setting in searches, the use of weighted events in inference (as computed with the sPlot technique), and the handling of systematic uncertainties.

Presenter: DEMBINSKI, Hans Peter (Max-Planck-Institute for Nuclear Physics, Heidelberg)

Session Classification: Session 1

Contribution ID: **2** Type: **not specified**

Approaches to evaluating and reporting systematic uncertainties in flavour physics

Monday 19 October 2020 14:45 (30 minutes)

The high luminosity and large cross sections enjoyed by LHC experiments means that statistical errors are minimal, and the rigorous treatment of systematic errors becomes very important - an area which lacks the “safety net” of chi squared and other goodness-of-fit measures. This entails including all uncertainties, estimating them properly, and not to inflating the error by including the results of consistency checks. This talk surveys recent papers by ATLAS, CMS and LHCb and examines how the collaborations handle the identification and estimation of systematic errors, the extent to which this is being done correctly, and what lessons can be learned.

Presenter: BARLOW, Roger (University of Huddersfield (GB))

Session Classification: Session 1

Contribution ID: **3** Type: **not specified**

Testing a point null hypothesis versus a continuous alternative hypothesis

Monday 19 October 2020 15:45 (30 minutes)

I will discuss aspects of the frequentist and Bayesian approaches to testing a point null hypothesis (say mu=0) versus a continuous alternative hypothesis (say mu>0). This test arises frequently in particle physics, where mu is the signal strength of a previously unobserved signal (within or beyond the Standard Model). The frequentist testing approach maps identically onto the frequentist theory of confidence intervals. Thus, as Feldman and Cousins eventually realized, the method advocated in their 1998 paper on confidence intervals maps identically onto the "classical" theory of likelihood ratio hypothesis tests in Kendall and Stuart (which in addition includes nuisance parameters). Meanwhile, the traditional Bayesian approach to hypothesis testing (due to Jeffreys) is completely separate from the Bayesian approach to credible intervals, with no corresponding mapping. Direct sensitivity to the prior pdf for mu, even in the asymptotic limit of large sample size, is a consequence, as is the Jeffreys-Lindley paradox (arXiv:1310.3791). My talk will draw on parts of my "Lectures on Statistics in Theory: Prelude to Statistics in Practice"(arXiv:1807.05996).

Presenter: COUSINS JR, Robert (University of California Los Angeles (US))

Session Classification: Session 1

Contribution ID: **4** Type: **not specified**

Interval Estimation, and the practice of Flavour Physics

Monday 19 October 2020 16:30 (30 minutes)

Interval estimation is one of the most common types of inference practiced by experimentalists, and the flavour sector is not less interested than high-pt physics. In fact, the physics of flavour brings to the table some quite interesting problems, with complex multi-dimensional parameter spaces, non-linearities, and significant systematic effects. While much has been written on the theoretical principles of interval estimation, oftentimes the practitioner meets with issues for which practical guidance is not easy to find. Amongst typical hurdles are the correct handling of systematic uncertainties in frequentist intervals, and optimization of data selection for "best sensitivity" in the double-sided problem of discovery vs limits. I will give a discussion of those problems in the light of real-life experience from flavour physics measurements.

Presenter: PUNZI, Giovanni (Universita & INFN Pisa (IT))

Session Classification: Session 1

Contribution ID: **5** Type: **not specified**

Using sWeights to disentangle signal and background

Wednesday 21 October 2020 14:00 (30 minutes)

When an observable density is a superposition of signal and background PDFs that each factorise in a ‘’discriminant” and a ‘’control” variable, sWeights allow one to determine the signal density in the control variable using information from only the discriminant variable.
After reviewing the basics of the method and casting the formalism into the framework of orthogonal functions, the talk will address numerical aspects of the method and how to deal with weighted events or factorisation breaking.

Presenter: SCHMELLING, Michael (Max-Planck-Gesellschaft (DE))

Session Classification: Session 3

Contribution ID: **6** Type: **not specified**

Fitting weighted events

Wednesday 21 October 2020 14:45 (30 minutes)

Fits of weighted events, for example to correct for acceptance effects or to statistically subtract background events using sWeights, have recently seen increasing use in the flavour physics community. This talk will discuss the determination of parameters and their uncertainties using weighted events, with particular focus on unbinned fits of weighted data.

Presenter: LANGENBRUCH, Christoph Michael (Rheinisch Westfaelische Tech. Hoch. (DE))

Session Classification: Session 3

Contribution ID: **7** Type: **not specified**

Estimation, Accuracy and the Bootstrap

Tuesday 20 October 2020 18:00 (30 minutes)

A brief introduction to boostrap estimates of accuracy, this talk does not assume familiarity with the topic. Bootstrap standard errors and confidence intervals are described using a small but genuine data set.

Presenter: Prof. EFRON, Brad (Stanford University)

Session Classification: Session 2

Contribution ID: **8** Type: **not specified**

Look-elsewhere effect in particle physics - knowns and unknowns

Tuesday 20 October 2020 15:45 (30 minutes)

The LEE, also known as multiple comparisons problem and addressed by a trials factor, has become an essential part of any analyst's toolkit in the last decade. It is much less esoteric and much more pervasive that one could naively think and we'll walking through a series of first hand recounts of appearances it has made in the LHC. We'll both discuss known techniques to deal with the effect as well as potential caveats in hitherto unseen problems. While some potential problems are related to physics, the future is highly multi-dimensional and that brings us to present-day statistics issues that, interestingly, particle physicists may end up being reasonably equipped to tackle.

Presenter: DAVID, André (CERN)

Session Classification: Session 2

Contribution ID: **9** Type: **not specified**

Practical concerns in statistical combinations at ATLAS and CMS

Tuesday 20 October 2020 14:00 (30 minutes)

The ATLAS and CMS collaborations have produced numerous results during the first two data-taking runs of the LHC, ranging from precision measurements of SM processes to searches for exotic phenomena and the discovery of the Higgs boson. These results make use of (often complex) statistical techniques, both for the publications and during the development and review of the data analysis/ In this talk, I will cover some of the common practices and tools used at both ATLAS and CMS to produce these results, and practical considerations for performing combinations across different channels or experiments.

Presenter: WARDLE, Nicholas (Imperial College (GB))

Session Classification: Session 2

Contribution ID: **10** Type: **not specified**

Global Fits

Wednesday 21 October 2020 16:30 (30 minutes)

Global fits are an indispensable tool in the search for New Physics (NP). On the one hand, they can provide interpretations of measurements that deviate from Standard Model (SM) predictions, and on the other hand, they allow using the wealth of experimental data for testing the viability of NP models. Being "global" means that these fits include hundreds of observables, whose theoretical predictions depend on a large number of nuisance parameters. Furthermore, the number of possible fit parameters in effective fields theories and explicit NP models can be huge. In this talk, I show how global fits are used in phenomenological analyses of flavour physics and other precision tests of the SM, I describe approximations that facilitate working with the large number of nuisance parameters, and I discuss issues and ambiguities related to the large number of possible fit parameters.

Presenter: STANGL, Peter (University of Bern)

Session Classification: Session 3

Contribution ID: **11** Type: **not specified**

Informative Goodness-of-Fit for Multivariate Distributions

Tuesday 20 October 2020 14:45 (30 minutes)

In any experimental science, the knowledge available on a given phenomenon is formalized into a statistical model. The latter encapsulates our understanding of its nature, its properties as well as our uncertainties. Experimental measurements are then collected and statistical tests of hypothesis are used to answer the important question: is our model valid? As a result, a variety of tests for goodness-of-fit (GOF) have been proposed in the literature to study multivariate distributions. Despite their usefulness, classical GOF methods are somehow limited by their confirmatory nature. Specifically, when the respective null hypothesis is rejected, they do not allow us to identify the underlying causes which invalidate the model postulated by the scientists, nor they give any indication on how the latter can be improved to obtain a closer representation of the true data distribution. In simple words, they do not provide any insights on what went wrong. In this talk, I will introduce an informative goodness-of-fit (iGOF) approach to study multivariate distributions and which aims to address this issue directly. Specifically, when the null model is rejected, iGOF allows us to identify the underlying sources of mismodelling and naturally equip practitioners with additional insights on the underlying data distribution.

Presenter: ALGERI, Sara (University of Minnesota)

Session Classification: Session 2

Contribution ID: **12** Type: **not specified**

Goodness of Fit for unbinned data

Wednesday 21 October 2020 15:45 (30 minutes)

Presenter: LE DIBERDER, Francois Rene

Session Classification: Session 3

Contribution ID: **13** Type: **not specified**

Final remarks and closing of the workshop

Wednesday 21 October 2020 17:15 (15 minutes)

Presenters: TONELLI, Diego (INFN Trieste, Italy); DEMBINSKI, Hans Peter (Max-Planck-Institute for Nuclear Physics, Heidelberg); LYONS, Louis (Imperial College (GB)); KENZIE, Matthew William (University of Warwick (GB)); BEHNKE, Olaf (Deutsches Elektronen-Synchrotron (DE))

Session Classification: Session 3

Contribution ID: **14** Type: **not specified**

Introduction and Welcome

Monday 19 October 2020 14:00 (5 minutes)

Presenter: BEHNKE, Olaf (Deutsches Elektronen-Synchrotron (DE))

Session Classification: Session 1