

Nuisance parameters (pars) for BIRS workshop 2021:  
Notation:  $\theta$  = pars of interest,  $\lambda$ =nuisance pars,  $\mathbf{x}$  = data  
 $L(\mathbf{x};\theta,\lambda)$  = Likelihood function

Frequentist inference with  $-2\ln L$

- Profiling  $\lambda$
- Input PDFs for  $\lambda$  (penalty terms)
- Toys vs. asymptotic formula
- Toys: assumed true values of  $\lambda$ ?
  - Parametric bootstrapping?

Bayesian inference with L

- Marginalizing  $\lambda$
- Priors for  $\lambda$

Hybrids

Coverage tests

- Construction of L (model building) Mapping of nuisance pars to Poisson expectation values
- Template morphing
- Treatment of nuisance parameters in event simulations
- Software tools

$L(\mathbf{x};\theta,\lambda)$

Machine learning

- What to gain on systematics?
- Likelihood free inference

Different types of nuisance pars:

- Experimental vs theory
- Continuous (e.g. jet energy scale) vs discrete (e.g.  $\nu$  mass hierarchy)
- Normalisation vs shape parameters
- Background shape: parametric vs non-parametric modelling

Specific issues:

- Non-linearities & simultaneous variation of several pars
- Information loss in marginalisation or profiling
- Problems with many nuisance pars
- Uncertainties on the Uncertainties