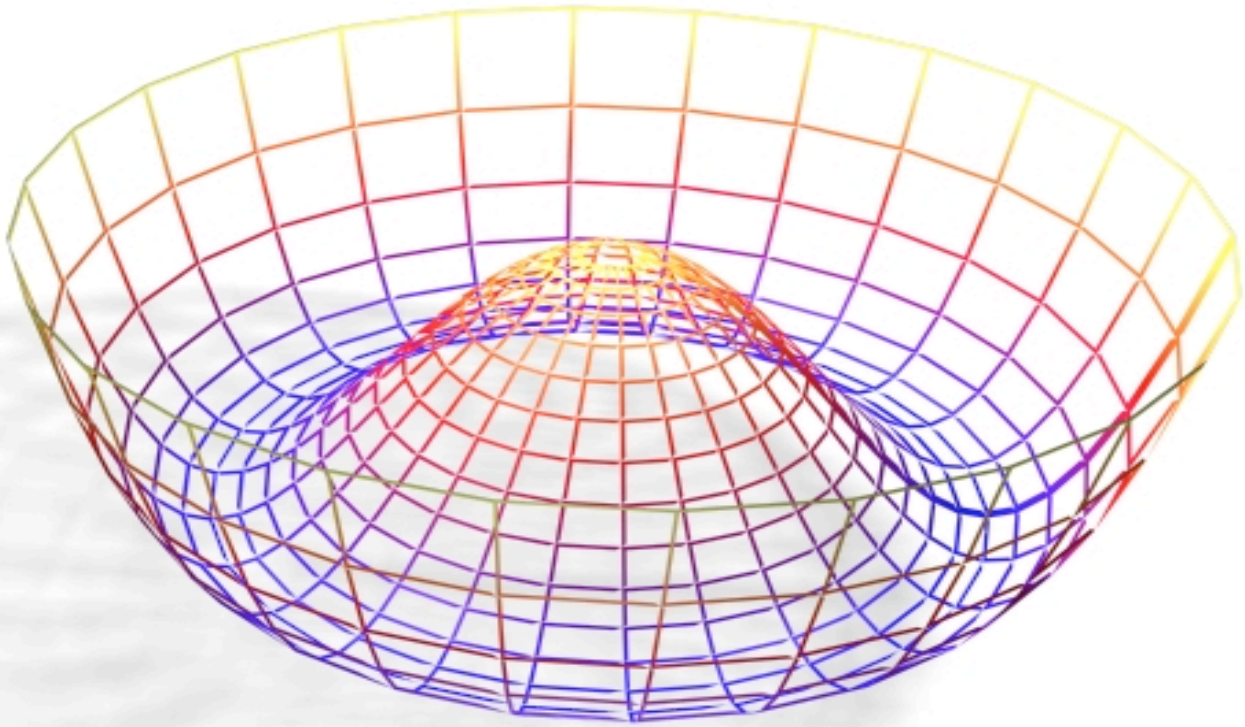
RooStats Developments



Kyle Cranmer & Wouter Verkerke

New email list

The ROOT talk forum did not support email subscriptions, and that is a problem.

- Decided not to use HyperNews based on our last meeting
- Set up a SIMBA2 list:
  - roostats-development@cern.ch
  - Sign up here: http://listboxservices.web.cern.ch/listboxservices/

I hope this will resolve some of our communication problems.

RooFit progress

Documentation

- Extensive set of 70 tutorial macros demonstrating about 95% of RooFit functionality now in ROOT 5.21/02
  - Tested on Linux,Mac,Windows in compiled and interpreted mode
- Good progress on update of Users Manual.
  - Aiming at document of ~170 pages (15 chapters + 4 appendices)
  - Will release first 10 chapters + 1 appendix (120 pages) immediately after next week [1 week delay due to travel schedule]
  - Remainder will follow in next 1-2 months

Code

- Miscellaneous small fixes
- Ability to run latest RooFit (v2.91) with ROOT 5.18.00d
  - LCG will bundle latest RooFit with their next distribution (which contains ROOT 5.18.00d) so that is available in LHC experimental releases (on request from LHCb)

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Wouter Verkerke, NIKHEF

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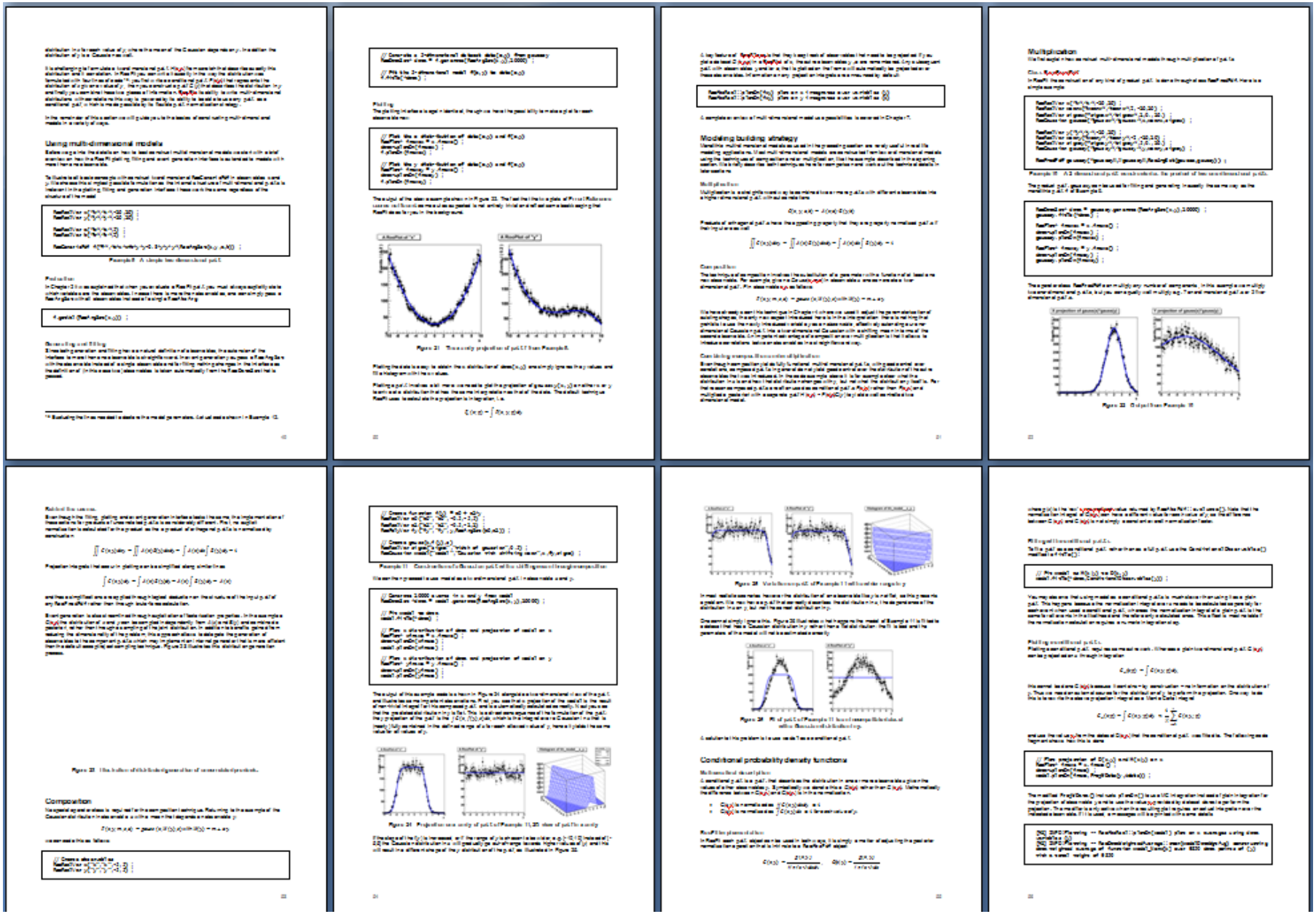


Wouter Verkerke, NIKHEF

Some notes from RooStats workshop June 26 & 27
Tools for a Combination

In attendance: Kyle Cranmer, Wouter Verkerke, Amir Farbin, Gregory Schott (phone), Maurizio Pierini, Lorenzo Moneta, Walter Bonivento, Danilo Piparo (phone), George Lewis

An example shown previously

A combination example

- Combining 'ATLAS' and 'CMS' result from persisted workspaces

Read ATLAS workspace

```
TFile* f = new TFile("atlas.root") ;
RooWorkspace *atlas = f->Get("atlas") ;
```

Read CMS workspace

```
TFile* f = new TFile("cms.root") ;
RooWorkspace *cms = f->Get("cms") ;
```

Construct combined LH

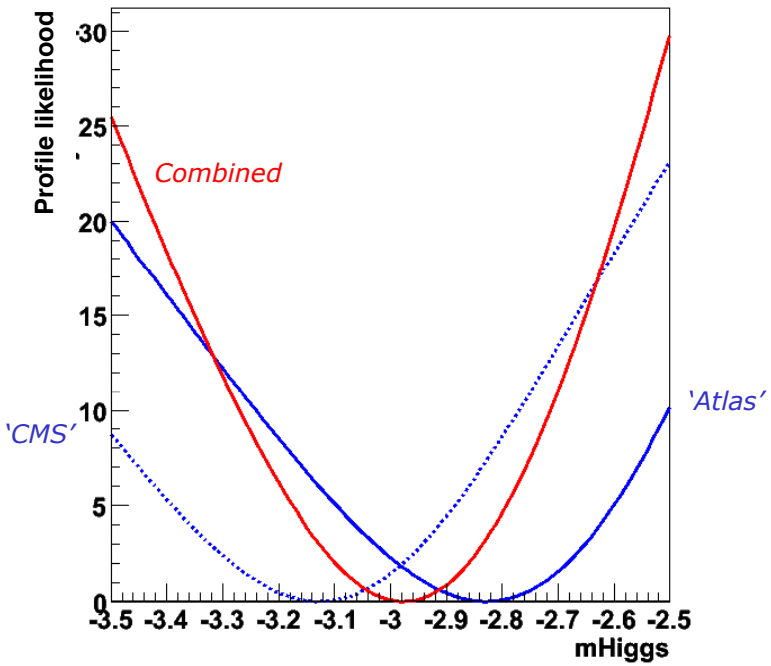
```
RooAddition nllCombi("nllCombi","nll CMS&ATLAS",
            RooArgSet(*cms->function("nll"),*atlas->function("n
```

Construct profile LH in mHiggs

```
RooProfileLL pllCombi("pllCombi","pll",nllCombi,*atlas->var("mH
```

Plot Atlas,CMS, combined profile LH

```
RooPlot* mframe = atlas->var("mHiggs")->frame(-3.5,-2.5) ;
atlas->function("nll")->plotOn(mframe)) ;
cms->function("nll")->plotOn(mframe),LineStyle(kDashed)) ;
pllCombi.plotOn(mframe,LineColor(kRed)) ;
mframe->Draw() ; // result on next slide
```



Wouter Ver

Wouter Verkerke, NIKHEF

RooFit provides two approaches, adding NLL or constructing a joint model and performing a simultaneous fit.

- Simultaneous fit more general, but also more cumbersome; need some utilities

Outlining steps for a combination

Based on some experience during the ATLAS Higgs combination, we identified issues that need to be completed and outlined the steps one would take:

1. Start with a bunch workspaces with no conventions (eg. naming, parametrization, etc.)
2. Import each model into a new workspace, start enforcing conventions
    1. exists: WS::import(RooAbsArg, RenameConflictNodes("sufix"), RenameVar())
3. Make top level pdf via:
        1. RooSimultaneous pdf("","", cat), where cat is a RooAbsCategoryLValue . eg. a supercategory
        2. pdf.addPdf(pdf,state) example state is "{Atlas;Htautau}"
        3. request: can't do RooSimultaneous of RooSimultaneous now
        4. goal: provide a higher-level tool to facilitate these steps based on a scripting language
4. Import data into workspace, start enforcing conventions if necessary
    1. exists: workspace::import(RooDataSet, Rename(), RenameVar())
5. make top level DataSet via:
    1. request: workspace::joinData which will:
        1. create CompositeDataset pointing to input DataSets
        2. add a supercategory to eep track of the source of the DataSets needed for simultaneous fits
6. Feed top level PDF and DataSet to higher level statistical tools for significance, limits, etc..
    1. goal: desire to have a loose coupling between model implementation and steering

Primitives for a Factory

We discussed for some time the idea of a factory and related ideas for a scripting or configuration language

- My worry is that there are at least 4 groups working on this
  - also worry that a scripting "language" can get out of hand
  - many approaches to the factory are tightly coupled to RooFit classes (eg. hardcoded utilities), want something more generic
- We had some short presentations/discussions about existing code and what their goals are

Wouter presented a proof-of-concept for a generic factory that uses RooFit's introspection

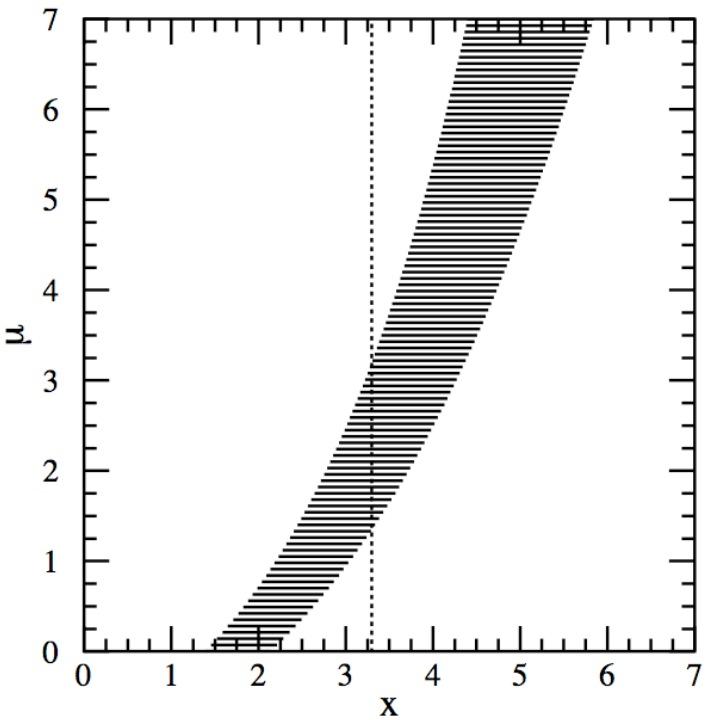
- definitely a much nicer solution
- target is ROOT 5.21-XX or 5.22

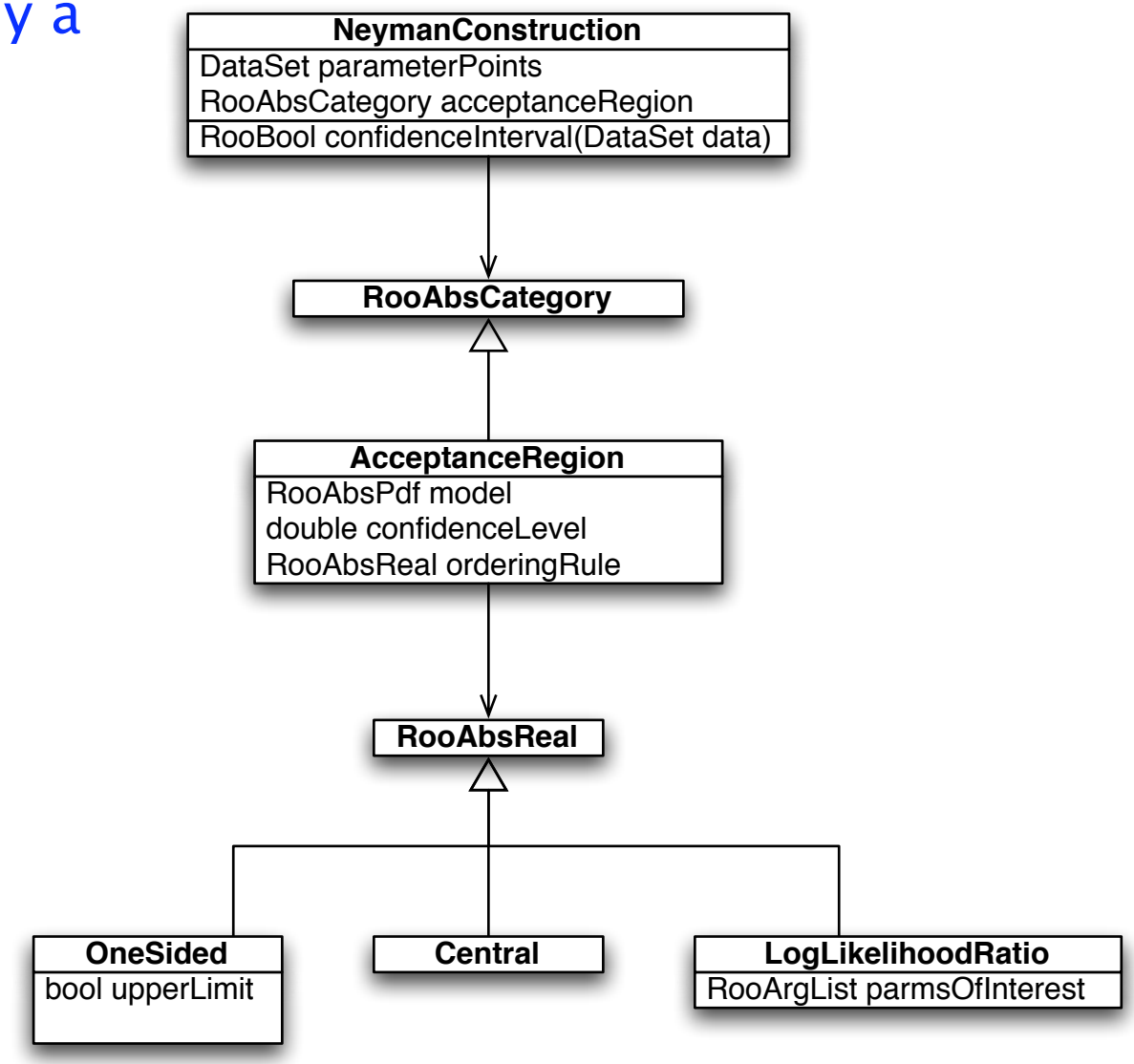
Together with existing tools like renaming and replacing of nodes in the model, we convinced ourselves that a RooFit should provide a few basic primitives and a "language" can be built on top of those

In Development: Neyman Construction

Neyman Construction is simply a set of acceptance regions corresponding to parameter points

- Acceptance region needs ordering rule + pdf + confidence level





- A few approaches for nuisance parameters will be possible

More on nuisance parameters in Neyman Construction

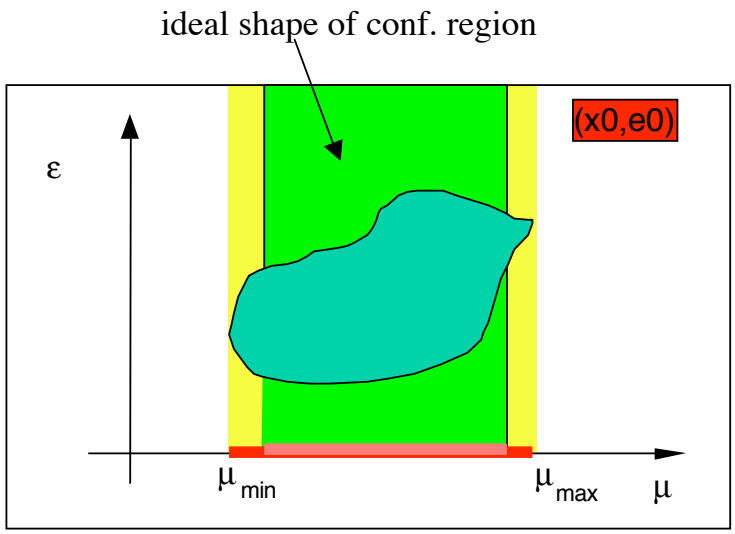
When generalizing the Neyman Construction to include nuisance parameters, there are a few options:

- Full Construction:
  - extend construction to include nuisance parameters
  - project onto space of parameters of interest
    - causes over coverage
- "Profile Construction" / Hybrid Resampling:
  - only perform construction on sub-space defined by constrained MLE of Nuisance parameters
  - proceed as normal for each point
    - approximate, can under-cover for some values of the Nuisance parameter
- Calibrated "Profile Construction"
  - only perform construction on sub-space defined by constrained MLE of Nuisance parameters
  - Adjust cutoff on the ordering rule so that it covers for EVERY value of the nuisance parameters

Overcoverage

The issue with overcoverage

- ***Projecting*** on μ enlarges the CR $\Rightarrow$ overcoverage.
- BUT: we chose to ignore information on ε $\Rightarrow$ we may be able to trade a part of it for additional info on μ, but some overcoverage may just be a natural consequence.
- No basis to assume there is an intrinsic weakness in the projection method: it may well be that ***any*** algorithm that covers can't avoid some overcoverage (as in the discretization effect)
- Real Question: how can I find the smallest μ interval that does not *undercover ?*
- => You want to make the confidence region as close as possible to a rectangle
- Difficulty: the band is build in the x-e plane, but the results are seen in the μ-ε plane. Not very intuitive, also considering that the minimum non-trivial dimensionality is 4



G. Punzi - PHYSTAT 05 - Oxford, UK

Calibrated Profile

Confidence Intervals with Nuisance Parameters

Bodhisattva Sen & Michael Woodroofe
Department of Statistics
University of Michigan

July 18, 2006

Method

Another look at construction of CI's

- *Correct interpretation* of Confidence level

$$P_{\theta,\eta}(\Lambda_\theta(X) \geq c_\alpha(\theta)) \geq 1-\alpha \text{ for all } \theta, \eta$$

- Equivalently: $\min_\eta P_{\theta,\eta}(\Lambda_\theta(X) \geq c_\alpha(\theta)) \geq 1-\alpha$ for each θ
- Thus $c_\alpha(\theta)$ should be the *largest* value of c for which

$$\min_\eta P_{\theta,\eta}(\Lambda_\theta(X) \geq c) \geq 1-\alpha$$

- Can we *analytically* find $c_\alpha(\theta)$?

Conclusion

A combination utility has been outlined at mini Workshop

- requires some new feature requests targeted for next ROOT release

Higher level tools (Neyman Construction, Markov Chain MC, etc.) in development.

- Some overlap in efforts.
  - Plan on stopping MCMC development given Karlsruhe developments
  - Want to insist that Neyman Construction can support all strategies towards dealing with Nuisance Parameters
  - Want to insist that it can use multiple ordering rules
- Now that we have email list, I hope that we can iron out:
  - How is PLScan different than profile likelihood provided by RooFit?
  - Want to converge on factor ideas