PDFs and FFs Tutorial

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Preliminaries

What you'll need:

- Linux OS
- Python
- Jupyter Notebook (Anaconda)
- LHAPDF library

(Can do this on Mac OS, but I never have.)

LHAPDF

- Library for Parton Distribution Functions (PDFs). (Also, FFs)
- Les Houches Accords (2001)
- Can use to get PDFs, FFs, their uncertainties, etc.
- Uses (x, Q^2) grid + interpolation

https://lhapdf.hepforge.org/index.html

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LHAPDF

Introduction

LHAPDF is the standard tool for evaluating parton distribution functions (PDFs) in high-energy physics. PDFs encode the flavour and momentum structure of composite particles, such as protons, pions and nuclei; most cross-section calculations are based on parton-level matrix-elements which must be connected to the real interacting particles, hence PDFs are an essential ingredient of phenomenological and experimental studies at hadron and heavy-ion colliders (e.g. LHC, HERA, Tevatron, EIC, FCC) and in cosmic-ray physics.

PDFs themselves are fitted to a range of data by various collaborations. LHAPDF provides the definitive community library of such fits, in a standard data-format, as well as C++ and Python interfaces for evaluating them. Written as a general purpose C++ interpolator for estimating PDFs from discretised data files, it has also found more general uses, such as for fragmentation functions (essentially the inverse of PDFs).

Installation instructions

Source file downloads

The source files can be downloaded from https://lhapdf.hepforge.org/downloads/

Quick start instructions

If you have a C++11 compiler, building LHAPDF >= 6.2 should be straightforward:

```
wget https://lhapdf.hepforge.org/downloads/?f=LHAPDF-6.X.Y.tar.gz -O LHAPDF-6.X.Y.tar.gz
# ^ or use a web browser to download, which will get the filename correct
tar xf LHAPDF-6.X.Y.tar.gz
cd LHAPDF-6.X.Y
./configure --prefix=/path/for/installation
make
make install
```

You will then need to install PDF data files, most easily using the "lhapdf" manager script but also possible by manual download. See the LHAPDF website for details.

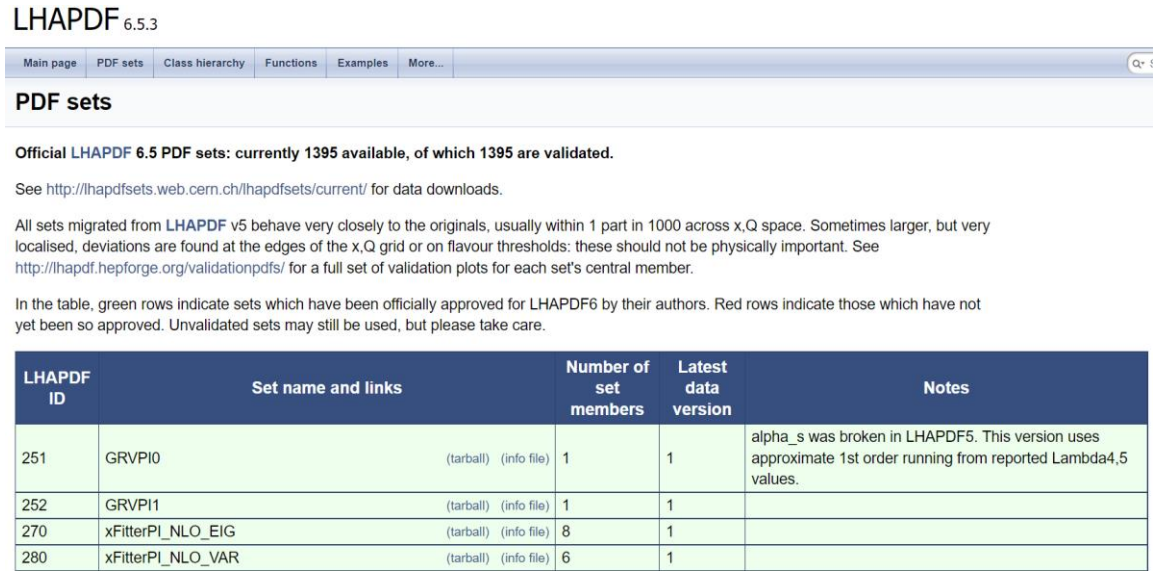
LHAPDF: PDF sets

- Currently 1395 sets

- Why so many?

Different groups, different interests, next generations, orders of approximation, parameterizations $(e.g.,\ \alpha_S(M_Z))$, etc.

- Set members have used for uncertainty calculations



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PDF sets

Official LHAPDF 6.5 PDF sets: currently 1395 available, of which 1395 are validated.

See http://lhapdfsets.web.cern.ch/lhapdfsets/current/ for data downloads.

All sets migrated from LHAPDF v5 behave very closely to the originals, usually within 1 part in 1000 across x,Q space. Sometimes larger, but very localised, deviations are found at the edges of the x,Q grid or on flavour thresholds: these should not be physically important. See http://lhapdf.hepforge.org/validationpdfs/ for a full set of validation plots for each set's central member.

In the table, green rows indicate sets which have been officially approved for LHAPDF6 by their authors. Red rows indicate those which have not yet been so approved. Unvalidated sets may still be used, but please take care.

LHAPDF ID	Set name and links	Number of set members	Latest data version	Notes
251	GRVPI0 (tarball) (info file)	1	1	alpha_s was broken in LHAPDF5. This version uses approximate 1st order running from reported Lambda4,5 values.
252	GRVPI1 (tarball) (info file)	1	1	
270	xFitterPI_NLO_EIG (tarball) (info file)	8	1	
280	xFitterPI_NLO_VAR (tarball) (info file)	6	1	

Virtual Machine?

- Thinking of just creating virtual machine with all dependencies

- Use Virtual Box