

QCDNUM Upgrade

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Whats new in a nutshell

- PDFs now remember their evolution parameters
 - PDFs in memory are not anymore invalidated when a parameter is changed
 - Can have PDFs with different parameters simultaneously in memory, like unpolarised PDFs at LO, NLO and NNLO
 - When QCDNUM uses a PDF, it automatically uses its parameter set
- Can import extra PDFs in memory
 - PDF sets in internal memory always have at least 13 PDFs (gluon and q, qbar for 6 flavours)
 - Can also import n additional pdfs, photon for instance (13+n pdf set)

Latest release is QCDNUM-17-01/0i

What are evolution parameters?

- The evolution parameters in QCDNUM are:
 - Order of the evolution (LO, NLO, NNLO)
 - Input value and scale of α_s (α_0 and μ_0)
 - Number of flavours (3,4,5,6 = FFNS and 0 = VFNS)
 - Thresholds in the VFNS (μ_c, μ_b, μ_t)
 - Renormalisation scale parameters (a_r, b_r)
 - Cuts ($x_{\min}, \mu_{\min}, \mu_{\max}$)
- These affect the PDF evolution but also the α_s evolution and the subgrid structure of the PDF tables (via the thresholds)
- QCDNUM keeps track of this via α_s tables and pointer tables that are updated when an evolution parameter is changed

Latest (beta) release 17-01/0i

- Can have up to 24 (was 9) different sets in memory
 - Set (1,2,3) = (unpol,pol,frag) created by EVOLFG
 - Set 4 = customised DGLAP created by EVOLFG (presently disabled)
 - Set 5-24 = external pdf set created by PDFCPY or PDFEXT or EVPCOPY
- Can copy set 1-3 to set 5-24 with PDFCPY
 - This allows you to store unpol/pol/frag in memory, evolved with different parameters
- Import external pdfs to set 5-24 with PDFEXT
 - Can import g,q,qbar (13 pdfs) plus any number of extra pdfs (e.g. photon)
 - One should take care that the evolution parameters are set correctly
- Import toolbox pdfs (from EVDGLAP) to set 5-24 with EVPCOPY
 - Can import g,q,qbar (13 pdfs) plus any number of extra pdfs (e.g. photon)
 - One should take care that the evolution parameters are set correctly

Imported PDFs allow you to use the QCDNUM interpolation routines and the structure function packages ZMSTF and HQSTF

Replaced routines in 17-01/0i

- PDFINP → PDFEXT
 - Routine to import pdf set from external source is modified to allow for import of pdfs beyond gluon and (anti)quarks
- EVFCOPY → EVPCOPY
 - Same modification to import extra pdfs from toolbox workspace
- GETALFN → ALTABN
 - Access to internal α_s tables (was toolbox routine)
- NFLAVOR → NFLAVS
 - Access to number of flavours at μ^2 (was toolbox routine)

As usual, error messages will inform you about obsolete routines and by what to replace them

New routines in 17-01/0i

- CPYPAR(array, n, iset)
 - Copy the evolution parameters of a pdf set to an array
- USEPAR(iset)
 - Use (activate) the parameters of a pdf set
- KEYPAR(iset)
 - Get the key (unique identifier) of a parameter set
 - Parameter keys are used in QCDNUM to quickly check if parameter sets are equal (then the keys are equal)
- PUSHPAR (toolbox routine)
 - Pushes current parameter set onto a LIFO buffer
- PULLPAR (toolbox routine)
 - Pulls current parameter set from a LIFO buffer

Useful if you want to manage parameter sets

How to access the extra PDFs

- With PDFEXT and EVPCOPY you can import extra PDFs in internal memory, beyond the gluon and (anti)quarks
- The only way to access these extra PDFs is via the interpolation routines FSNSXQ and FSNSIJ
- In a future release the interpolation routines will be re-written so that all of them give access to these extra PDFs

Remark about α_s

- The function ASFUNC gives α_s at the renormalisation scale μ_R
- The expansion coefficient used by QCDNUM is α_s at the factorisation scale μ_F
- This is calculated via the truncated Taylor expansion Eq. (2.17)
- The truncation depends on the perturbative expansion:
 - $\alpha, \alpha^2, \alpha^3, \dots$ (splitting functions)
 - $1, \alpha, \alpha^2, \dots$ (structure functions)
- QCDNUM maintains tables of α^n at μ_F and uses these in the evolution and structure function routines
- The tables depend on all evolution params (except cuts)
- You have access to the tables via the routine ALTABN

You should think carefully about which α_s to use

Whats next

- Re-enable cuts
- Evolution with intrinsic charm (or bottom,top)
- Re-enable user DGLAP (iset = 4)
- New (fast) interpolation routines
- Investigate time-like evolution
- Improved stability of backward evolution
- ...

A few more beta releases 17-01/xx before the next stable release QCDNUM-18-00 (yes, 18)