

Preparation for the tutorials

Roy Stegeman

The Higgs Centre for Theoretical Physics, University of Edinburgh

Advanced Artificial Intelligence
for precision High Energy Physics

17 July 2023



General remarks

We have to leave the villa at 1800 each day

The villa cannot be accessed during the weekend, though Milan is only a 40 minute train ride away!

Schedule

Week 1

Lecture topics:

- Quantum Chromodynamics
- Machine Learning techniques

Tutorial topics:

1. Code installation
2. (NLO) theory predictions
3. DGLAP evolution
4. ML 101: regression and classification
5. ML for HEP (jets and PDFs)

Week 2

Lecture topics:

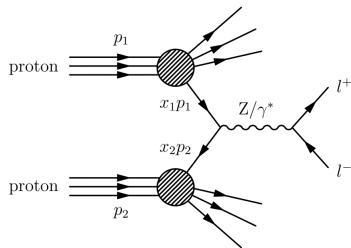
- Bayesian methods and data analysis
- Quantum Machine Learning

Tutorial topics:

1. Bayesian statistics
2. Monte Carlo
3. Quantum Computing
4. Quantum Machine Learning
5. No tutorial on Friday

Factorization: a quick reminder

High-energy scattering experiments such as performed at the LHC involves processes with **hadrons in the initial state**

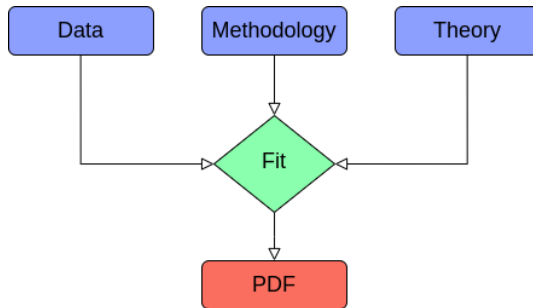


Total cross-section is **factorized** into a **hard part**, $\hat{\sigma}$, and process-independent **parton distribution functions (PDFs)**, $f_{i/h}$, providing the distribution of partons inside the hadron h :

$$\sigma = \sum_{i,j} \int_0^1 dx_1 dx_2 f_{i/h_1}(x_1, \mu_F^2) f_{j/h_2}(x_2, \mu_F^2) \hat{\sigma}_{ij \rightarrow X}(x_1 p_1, x_2 p_2, \mu_F^2)$$

How are PDFs determined?

PDF determination



- **Theory:** partonic cross-sections and DGLAP (Tuesday and Wednesday)
- **Methodology:** regression and neural nets (Thursday and Friday)
- **Data:** From experiments

Preparing your laptops

Requirements as stated in the e-mail:

- Ubuntu 20.04 or higher / macOS 11 or higher
- Working LHAPDF installation (hopefully)
- Python 3.8, 3.9, or 3.10

The goal for this afternoon is to set up the environments for the next two weeks

Preparing your laptops

1. Clone/download the repository <https://github.com/NNPDF/como-2023>
2. Set up the environments
 - This can be done by initializing a virtual environment (in this case theory) using

```
$ python -m venv $REPO/envs/theory
```

then activating it:

```
$ source $REPO/envs/theory/bin/activate
```

and finally install the required packages:

```
$ pip install -r $REPO/envs/theory/requirements.txt
```

Alternative environment managers are also fine
 - If you used conda to install LHAPDF, you can use this environment as the machine learning (ml) environment:

```
$ conda install --file $REPO/envs/ml/requirements.txt
```
 - Make sure the LHAPDF installation can be found inside your environments paths
3. Test the environments by running example notebooks

```
$ jupyter lab [jupyter notebook]
```

If this is successful, we'll see you again tomorrow!