Preparation for the tutorials

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Advanced Artificial Intelligence
for precision High Energy Physics

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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:

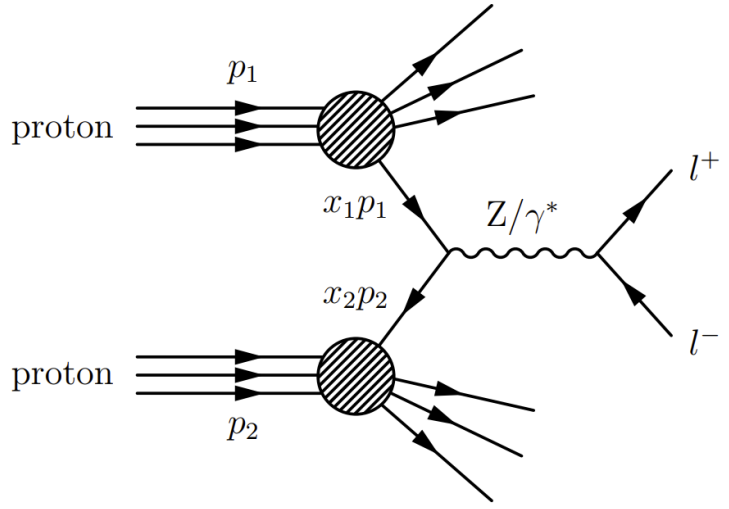
- Bayesian methods and data analysis
- Quantum Machine Learning

Tutorial topics:

1. Bayesian inference tools
2. Quantum Computing
3. Quantum Machine Learning
4. Exercise: SM Bayesian fit
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**

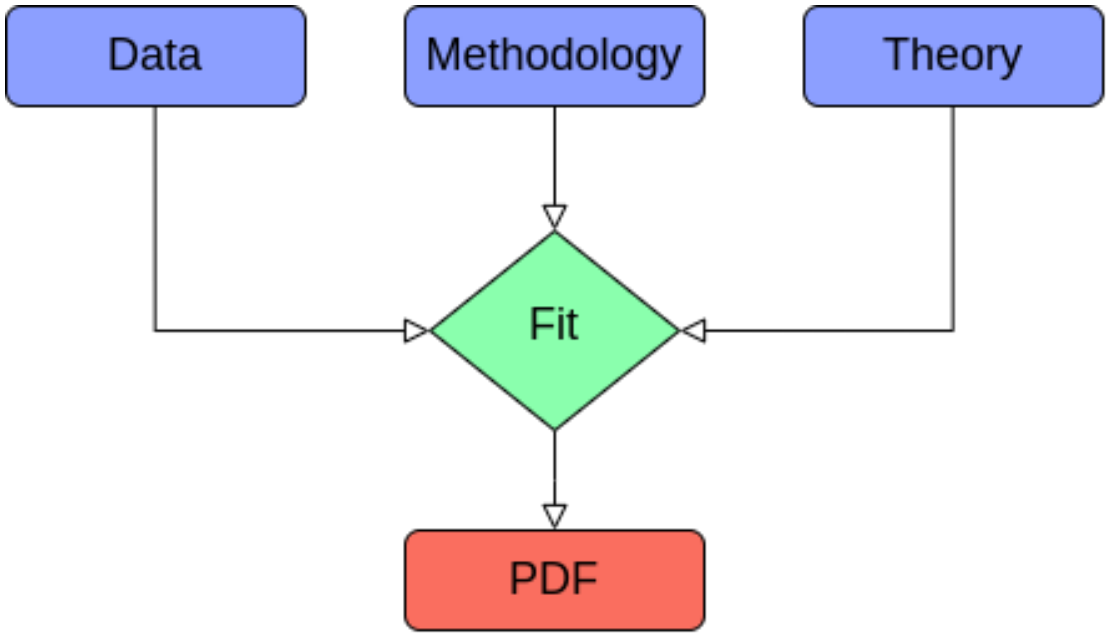


Total cross-section is **factorized** into a hard part, $\hat{\sigma}$, and process-independent parton distribution functions (PDFs), $f_{i/h}$, providing the distribution of partons inside the hadron h:

$$\sigma = \sum_{i,j} \int_0^1 \mathrm{d}x_1 \, \mathrm{d}x_2 f_{i/h_1}\left(x_1, \mu_F^2\right) f_{j/h_2}\left(x_2, \mu_F^2\right) \hat{\sigma}_{ij\to X}\left(x_1 p_1, x_2 p_2, \mu_F^2\right)$$

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]`
4. To save time tomorrow we can compile eko ahead of time by running
   `$ python Como-2023/w1t3-rge-pdfs/compile.py`

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