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Übungen zu Teilchenphysik I

Wintersemester 2024/25

Exercise 1

To be worked on until November 7, 2024

General Information and Environment Setup

- The ILIAS webpage

https://ilias.studium.kit.edu/ilias.php?baseClass=ilrepositorygui&ref_id=2496643

gradually updated during the semester will be used to provide additional information, material and links for these exercises, so please add it to the bookmarks in your web browser.

- To work on the exercises, a **Jupyter** Hub server is provided which can be accessed from any device via a web browser under the link

<https://jupytermachine.etp.kit.edu>.

Please use your KIT account credentials to log in, which must be registered for access to the Physik-Pool beforehand. In case you do not have access yet, please register your account under

<https://comp.physik.kit.edu/Account/>.

On this page you can also find a link for the prolongation of an existing account.

- Once logged on to the **jupytermachine**, you can spawn a server instance to work on. There are several choices available; for the time-being please choose the **Datenanalyse** image.
- Depending on the particular exercise, you need to choose a specific server image from the following list:
 - **Datenanalyse**: suitable for the introductory exercise, and the analyses exercises on flavour physics, Higgs boson discovery, and top physics.

- **Herwig**: server image for the event generator exercise with HERWIG 7
- **Geant4**: image for the exercise covering the detector simulation with GEANT4
- To change an image loaded already at log in, you can stop the server by going to **File -> Hub Control Panel** in the upper panel, and clicking on the **Stop My Server** button. Then you should wait until the button **Start My Server** appears, click on it, and then click on the button **Launch Server** when it appears. After that, you will arrive at the menu, where you can choose again a server image to be loaded.
- From the chosen server instance, you will be able to access your home directory of the Physik-Pool in the File browser on the left side of your Jupyter Lab window.
- The exercises will be provided as Python 3 Jupyter Notebooks in the following repository:
https://gitlab.etp.kit.edu/Lehre/tp1_forstudents,
 and will be updated each week to contain the current exercise.
- Please clone this repository to your Jupyter server instance by going to **Git -> Clone a Repository** in the upper panel. A pop-up window should appear, where you can enter https://gitlab.etp.kit.edu/Lehre/tp1_forstudents, and press **CLONE** after that. The repository will be created in the directory you are currently in, which is your user directory in the Physik-Pool by default. The directory **tp1_forstudents** containing the exercises should appear in the file browser on the left.
- To change to the directory, you can click on the folder and will see different subfolders for the exercises appear.
- To get the newest exercises, you need to update the **tp1_forstudents** repository. To do so, go to **Git -> Pull from Remote** while in the **tp1_forstudents** directory. A green pop-up window should appear at the bottom right of your web browser, stating that everything was **Successfully pulled**.

Reminder: Useful Terminal Commands

In this exercise course, it is assumed that you have participated in the lectures and exercises of *Rechnernutzung in der Physik*, *Computergestützte Datenauswertung* and *Praktikum* from the bachelor in physics, such that you are expected to be familiar with basics in Linux, Python and LaTeX.

To refresh this knowledge, let us have at first a look at some useful terminal commands and make use of them within the Jupyter environment you have just set up. To start a terminal, please click on the **Terminal** button in the **Launcher** in the main window of your Jupyter environment in the web browser.

- At first, please figure out, in which directory you are in the terminal with **pwd**.

- In case this is not `/home/${USER}/tp1_forstudents/Exercise01`, please change to this directory with `cd`.
- To find out, what is in this directory, you can perform the `ls` command. Often, it is good to see additional information like access rights, modification time, etc.. For this purpose, you can use `ls -lrth`. To check specific files, you can also add wildcards (`*`,`?`) to the command.
- To manipulate (remove, create, rename, etc.) files, links and directories, please get familiar with the commands `cp`, `mv`, `rm`, `ln`, `mkdir`, `rmdir`.
- To access `bash` command history, you can use cursor keys or `Ctrl-R`.
- The tabulator key provides completion of partially typed words. Try some of the above exercises again. (With the tabulator completion you can save a lot of time).
- Search online for examples for commands `find`, `grep` and `diff`, which are extremely useful to find files, search for expressions contained in them, and to find out the differences between two files.
- A starting point to search for terminal commands is e.g. <https://ubuntuusers.de/>.

As an exercise, please find a text file `test.txt` in the `/data_share/tp1_forstudents/Exercise01/` folder and copy it over to your current directory. Edit it by navigating to the appropriate directory in the file browser on the left, and clicking on the name of the file. It will be opened in the main window. As a last step, please show the difference between the original and your file.

Working with Jupyter: Python, Markdown, and LaTeX

Jupyter allows to unify all ingredients you need to obtain and document your results in a nice format, including executable code, text formatting and formula formatting. In the context of this exercise course, you will make use the following languages:

- **Python:** Interpreted programming language. You will make use of already familiar libraries like `numpy` and `matplotlib`, but also learn about other packages like `pandas` which allows to process efficiently a big amount of data, stored e.g. in `.csv` format, and `iminuit` suitable for statistical inference and parameter optimization.
- **Markdown:** Web text formatting language to display text in a browser, usually stored in `.md` files (e.g. `README.md` in github repositories)
- **LaTeX:** Text formatting language very convenient for formatting mathematical expressions. In Jupyter notebooks, you can display a LaTeX formula via `$$your-latex-formula$$`.

As an exercise, please work through the Pandas tutorial provided by the Jupyter notebook `Exercise01.ipynb`, which you can find in the `Exercise01` subdirectory of your `tp1_forstudents` directory.

More material and links to refresh and extend the knowledge on python and Jupyter can be found on the webpage of Prof. Dr. G. Quast:

<https://web.etp.kit.edu/~quast/jupyter/jupyterTutorial.html>.

The webpage <https://web.etp.kit.edu/~quast/> also contains hints how to install the necessary software on your own linux system, or how to run your own docker container or a virtual machine with all the software installed.