

Hydroinformatik II - SoSe 2024

HyBHW-S2-01-V06: Übungen: Übersicht und Werkzeuge

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Dresden, 21.06.2024

Zeitplan: Hydroinformatik II - SoSe 2024

Datum	HI	II	Thema	Typ
14.06.2024	14	2-01	Einführung in die Lehrveranstaltung - Teil 2	L
14.06.2024	15	2-02	Werkzeuge Tools	L
14.06.2024	16	2-03	Grundlagen: Kontinuumsmechanik	L
21.06.2024	17	2-04	Grundlagen: Hydromechanik	L
21.06.2024	18	2-05	Grundlagen: Partielle Partialgleichungen	L
21.06.2024	19	2-06	Übung: Analytische Lösungen	E
28.06.2024*	20	2-07	Grundlagen: Näherungsverfahren	L
28.06.2024*	21	2-08	Übung: Jupyter Diffusionsprozess	E
02.07.2024*	22	2-09	Numerik: Finite-Differenzen-Methode (explizit)	L
02.07.2024*	23	2-10	Numerik: Finite-Differenzen-Methode (implizit)	L
12.07.2024	24	2-11	Übung: Finite-Differenzen-Methoden	E
12.07.2024	25	2-12	Grundlagen: Gerinnehydraulik	L
12.07.2024	26	2-13	Übung: Gerinnehydraulik	E
19.07.2024	27	2-14	Ausblick: Grundwassermodellierung	E
19.07.2024	28	2-15	Klausur/Beleg: Besprechung zur Vorbereitung	L

*online Vorlesung

1 Zwischenfazit: Theoretischer Teil

2 Tutorial

3 Tools

Mechanik (Physik) $\frac{d}{dt} \int_V \Psi dV = \int_{\partial V} \frac{\partial \Psi}{\partial t} d\Omega + \int_{\partial V} \nabla \cdot \Phi d\Omega = \int_V q^\Psi dV$
 (Lagrange) $\frac{d}{dt} \int_V \Psi dV = \int_{\partial V} \frac{\partial \Psi}{\partial t} d\Omega + \int_{\partial V} \nabla \cdot \Phi d\Omega = \int_V q^\Psi dV$
 (Euler) $\frac{\partial \Psi}{\partial t} + \nabla \cdot \Phi = q^\Psi$ 1D: $\frac{\partial \Psi}{\partial t} + v_x \frac{\partial \Psi}{\partial x} - \frac{\partial}{\partial x} (D_{xx} \frac{\partial \Psi}{\partial x}) = q^\Psi$ $\Psi(t, x)$
 Mathematik (PDE) $\frac{\partial \Psi}{\partial t} + \nabla \cdot \Phi = q^\Psi$ $\frac{\partial}{\partial x} (D_{xx} \frac{\partial \Psi}{\partial x}) = 0$ $\Psi(x)$
 Lösungen (analytisch) $\rightarrow$ Heterogenität $\frac{d^2 \Psi}{dx^2} = 0$ $\Psi(x) = ax + b$
 $\rightarrow$ Instationär $q^\Psi(t)$ $\frac{d\Psi}{dx} = a$ $\frac{d^2 \Psi}{dx^2} = 0$
 $\rightarrow$ Nichtlinearität $D^\Psi(\Psi)$

Numerische Verfahren $\rightarrow$ exakte Lösung $\Psi \rightarrow L(\Psi) = 0$
 (PDE) $\rightarrow$ Näherungslösung $\hat{\Psi} \rightarrow L(\hat{\Psi}) \neq 0$

Lehre-Webseite → Tutorial

<https://www.overleaf.com/read/vyxbhdmfczpf>

The screenshot displays the Overleaf online LaTeX editor interface. The left sidebar shows a file explorer with a project named 'figures' containing files like '01-tools.tex', '02-exercises.tex', 'commands.tex', 'main.tex', 'packages.tex', 'publications.tex', and 'references.bib'. The main editor area shows the LaTeX source code for 'main.tex', which includes document class settings, package loading, and a table of contents. The right pane shows the compiled PDF output, which features the title 'Online Tutorial', a subtitle 'Tools & Exercises', the 'OpenGeoSys teaching' logo, and logos for 'TECHNISCHE UNIVERSITÄT DRESDEN' and 'UFZ HELMHOLTZ Centre for Environmental Research'.

```
1 %
2 \documentclass[11pt,a4paper]{article}
3 \documentclass[openright]{book}
4 \input{packages}
5 \usepackage[scaled]{beramono}
6 \usepackage[T1]{fontenc}
7 \newcommand{\lbera}[1]{\fontfamily{\lbera}\selectfont #1}
8 \input{commands}
9 %
10 \title{\textbf{Online Tutorial} \rule{0.4\textwidth}{1pt} \textbf{Tools
11 \begin{figure}[ht]
12 \centering
13 \includegraphics[width=0.5\textwidth]{ogs-teaching.png}
14 \end{figure}
15 \vspace{6cm}
16 \begin{figure}[ht]
17 \centering
18 \includegraphics[width=0.25\textwidth]{figures/tu-dresden-blue.png}
19 \includegraphics[width=0.5\textwidth]{figures/ufz-new-long.jpg}
20 \end{figure}
21 %
22 \author{UFZ / TU Dresden thanks!}
23 \date{\today \url{https://www.overleaf.com/read/vyxbhdmfczpf}}
24 % \comment if you change the bibliography heading/title
25 \renewcommand{\bibname}[References]
26 % \comment if you want to include the bibliographies at the end of each
27 % \usepackage{notoc}[tocbibind]
28 %
29 \begin{document}
30 \listoftodos
31 \frontmatter
32 \linenumbers
33 \maketitle
34 \tableofcontents
35 %
```

Werkzeuge

- Editor: Notepad++
 - Compiler: MinGW (C++)
-
- Repository: Git
 - Python: Simulation und (einfache) Grafik
 - Jupyter-Notebook: Workflows
 - (Visualisierung: ParaView)

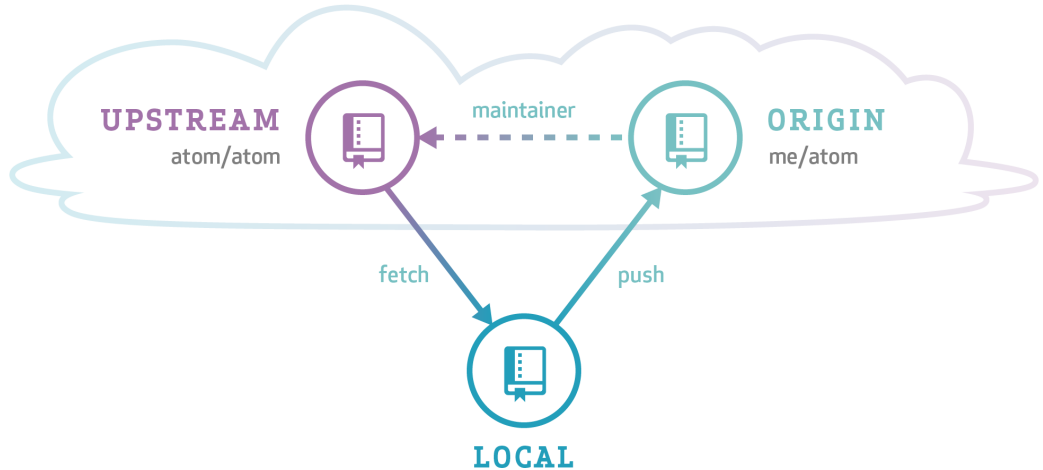
- Editor: Notepad++
 - Compiler: MinGW (C++)
-
- Repository: Git
 - Python: Simulation und (einfache) Grafik
 - Jupyter-Notebook: Workflows
 - (Visualisierung: ParaView)



GitHub

- "GitHub ist ein netzbasierter Dienst zur Versionsverwaltung für Software-Entwicklungsprojekte ..."
- Webseite: <https://github.com/>
- Vorteil: Webbasiert (und damit Plattform-unabhängig)
- ... wir nutzen GitHub zum archivieren unserer Übungen (>> Demo)
- Webseite:
<https://github.com/OlafKolditz>
<https://github.com/OlafKolditz/HYDROINFORMATIK-II>





The screenshot shows the GitHub web interface for the repository `OlafKolditz/HYDROINFORMATIK-I`. The browser's address bar shows the URL `https://github.com/OlafKolditz/HYDROINFORMATIK-I`. The repository page features a large light blue and green banner with the text "Learn Git and GitHub without any code!" and "Using the Hello World guide, you'll start a branch, write comments, and open a pull request." Below this is a green button labeled "Read the guide".

The repository name `OlafKolditz / HYDROINFORMATIK-I` is displayed, along with statistics: 1 Unwatch, 0 Stars, and 0 Forks. The navigation bar includes links for Code, Issues, Pull requests, Actions, Projects, Wiki, Security, Insights, and Settings.

Below the navigation bar, the repository's main branch is `main`, with 1 branch and 0 tags. A "Go to file" button and an "Add file" button are visible. A list of files is shown, including `EX01-main-function.cpp`, which was added 6 minutes ago. The "About" section on the right describes the repository as a teaching repository for the Hydroinformatics I Course at TU Dresden.

git

- Versionsmanagement

- Versionsmanagement für Repositories (github)
- Tutorial, Abschnitt 1.1



```
1 //Go to the directory where do you want clone the repository
2
3 cd my-repositories
4
5 git clone https://github.com/OlafKolditz/HYDROINFORMATIK-II.git
6
7 //There will be a local copy of the repository in
8 //my-repositories/HYDROINFORMATIK-II
```

There will be a created subdirectory: my-repositories/HYDROINFORMATIK-II

Go to the subdirectory: my-repositories/HYDROINFORMATIK-II

```
1 //Go the directory where your local repo copy is
2 cd ~/my-repositories/HYDROINFORMATIK-II
3
4 //Check, if there are new files in the repository
5 git fetch --all
6
7 //Copy/Update new files from the repository
8 git pull
```

Listing: Updating from an existing repository

Python

- "Python is a programming language that lets you work more quickly and integrate your systems more effectively."
- Webseite: <https://www.python.org>
- Vorteil: funktioniert auf allen Rechnern (>> Demo)



Python: Installation



The screenshot shows the Python.org website with a dark blue header and navigation bar. The main content area has a dark blue background with a large illustration of two parachutes carrying boxes. The text is white and yellow.

Python PSF Docs PyPI Jobs Community

python™

Donate Search GO Socialize

About Downloads Documentation Community Success Stories News Events

Download the latest version for Windows

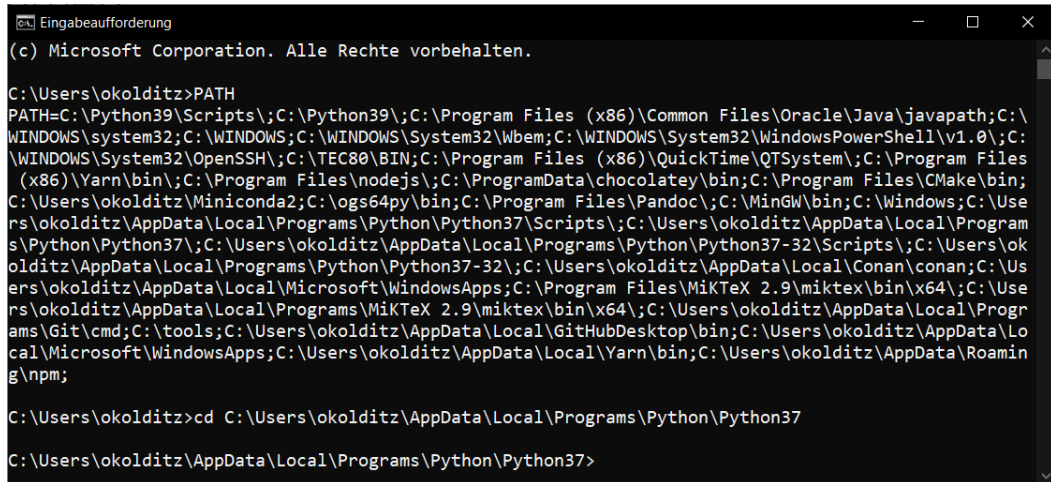
Download Python 3.8.3

Looking for Python with a different OS? Python for [Windows](#), [Linux/UNIX](#), [Mac OS X](#), [Other](#)

Want to help test development versions of Python? [Prereleases](#), [Docker images](#)

Looking for Python 2.7? See below for specific releases

PATH



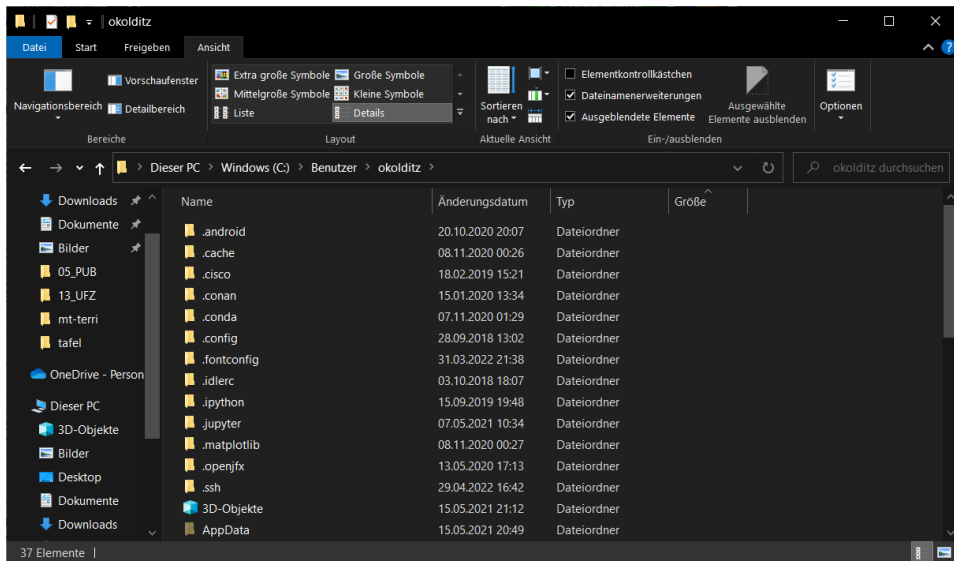
```
Eingabeaufforderung
(c) Microsoft Corporation. Alle Rechte vorbehalten.

C:\Users\okolditz>PATH
PATH=C:\Python39\Scripts\;C:\Python39\;C:\Program Files (x86)\Common Files\Oracle\Java\javapath;C:\
WINDOWS\system32;C:\WINDOWS;C:\WINDOWS\System32\Wbem;C:\WINDOWS\System32\WindowsPowerShell\v1.0\;C:
\WINDOWS\System32\OpenSSH\;C:\TEC80\BIN;C:\Program Files (x86)\QuickTime\QTSystem\;C:\Program Files
(x86)\Yarn\bin\;C:\Program Files\nodejs\;C:\ProgramData\chocolatey\bin;C:\Program Files\CMake\bin;
C:\Users\okolditz\Miniconda2;C:\ogs64py\bin;C:\Program Files\Pandoc\;C:\MinGW\bin;C:\Windows;C:\Use
rs\okolditz\AppData\Local\Programs\Python\Python37\Scripts\;C:\Users\okolditz\AppData\Local\Program
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ams\Git\cmd;C:\tools;C:\Users\okolditz\AppData\Local\GitHubDesktop\bin;C:\Users\okolditz\AppData\Lo
cal\Microsoft\WindowsApps;C:\Users\okolditz\AppData\Local\Yarn\bin;C:\Users\okolditz\AppData\Roamin
g\npm;

C:\Users\okolditz>cd C:\Users\okolditz\AppData\Local\Programs\Python\Python37

C:\Users\okolditz\AppData\Local\Programs\Python\Python37>
```

Python: Installation

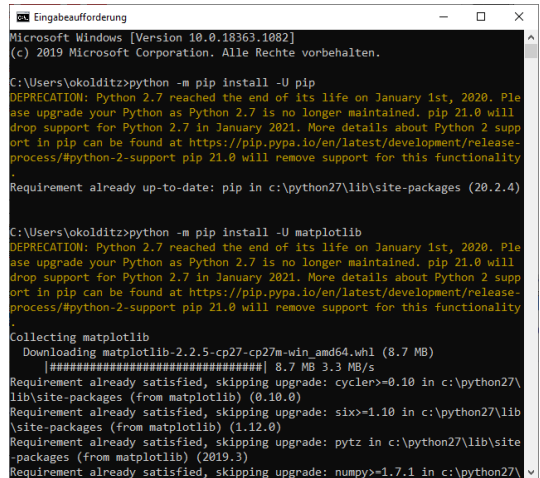


Python: Module installieren

matplotlib

- 1 `python -m pip install -U pip`
- 2 `python -m pip install -U matplotlib`

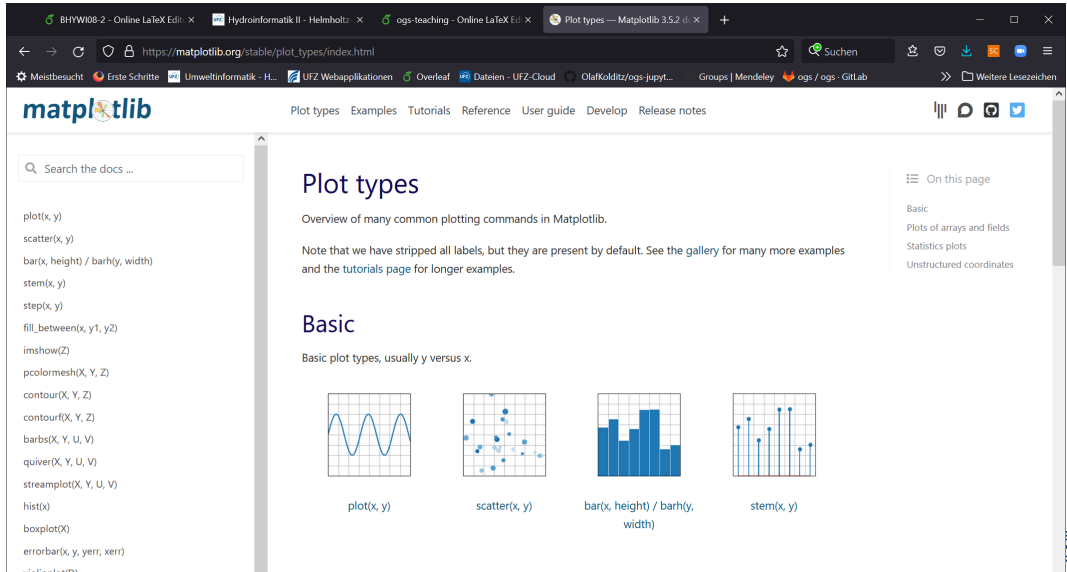
Listing: Installieren von der Konsole



```
Eingabeaufforderung
Microsoft Windows [Version 10.0.18363.1082]
(c) 2019 Microsoft Corporation. Alle Rechte vorbehalten.

C:\Users\okolditz>python -m pip install -U pip
DEPRECATION: Python 2.7 reached the end of its life on January 1st, 2020. Please upgrade your Python as Python 2.7 is no longer maintained. pip 21.0 will drop support for Python 2.7 in January 2021. More details about Python 2 support in pip can be found at https://pip.pypa.io/en/latest/development/release-process/#python-2-support pip 21.0 will remove support for this functionality
Requirement already up-to-date: pip in c:\python27\lib\site-packages (20.2.4)

C:\Users\okolditz>python -m pip install -U matplotlib
DEPRECATION: Python 2.7 reached the end of its life on January 1st, 2020. Please upgrade your Python as Python 2.7 is no longer maintained. pip 21.0 will drop support for Python 2.7 in January 2021. More details about Python 2 support in pip can be found at https://pip.pypa.io/en/latest/development/release-process/#python-2-support pip 21.0 will remove support for this functionality
Collecting matplotlib
  Downloading matplotlib-2.2.5-cp27-cp27m-win_amd64.whl (8.7 MB)
    [#####] 8.7 MB 3.3 MB/s
Requirement already satisfied, skipping upgrade: cycler>=0.10 in c:\python27\lib\site-packages (from matplotlib) (0.10.0)
Requirement already satisfied, skipping upgrade: six>=1.10 in c:\python27\lib\site-packages (from matplotlib) (1.12.0)
Requirement already satisfied, skipping upgrade: pytz in c:\python27\lib\site-packages (from matplotlib) (2019.3)
Requirement already satisfied, skipping upgrade: numpy>=1.7.1 in c:\python27\lib\site-packages (from matplotlib) (1.17.0)
```



The screenshot shows the Matplotlib website's 'Plot types' page. The browser's address bar displays https://matplotlib.org/stable/plot_types/index.html. The page features a navigation bar with links to 'Plot types', 'Examples', 'Tutorials', 'Reference', 'User guide', 'Develop', and 'Release notes'. A search bar is located on the left side of the page. The main content area is titled 'Plot types' and provides an overview of common plotting commands. It includes a note about default labels and links to a 'gallery' and 'tutorials' page. Below this, the 'Basic' section is introduced, followed by four example plots: a line plot, a scatter plot, a bar chart, and a stem plot. A sidebar on the right lists 'On this page' with links to 'Basic', 'Plots of arrays and fields', 'Statistics plots', and 'Unstructured coordinates'.

Search the docs ...

plot(x, y)
scatter(x, y)
bar(x, height) / barh(y, width)
stem(x, y)
step(x, y)
fill_between(x, y1, y2)
imshow(Z)
pcolormesh(X, Y, Z)
contour(X, Y, Z)
contourf(X, Y, V)
barbs(X, Y, U, V)
quiver(X, Y, U, V)
streamplot(X, Y, U, V)
hist(x)
boxplot(X)
errorbar(x, y, yerr, xerr)
pie(x)

Plot types

Overview of many common plotting commands in Matplotlib.

Note that we have stripped all labels, but they are present by default. See the [gallery](#) for many more examples and the [tutorials](#) page for longer examples.

Basic

Basic plot types, usually y versus x.

plot(x, y)

scatter(x, y)

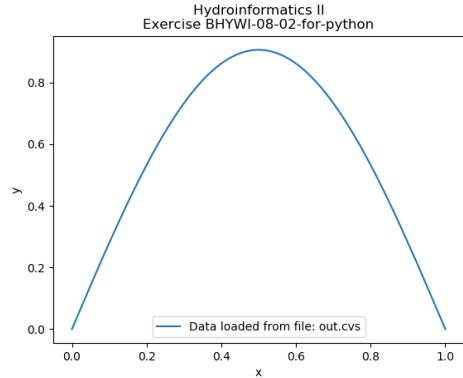
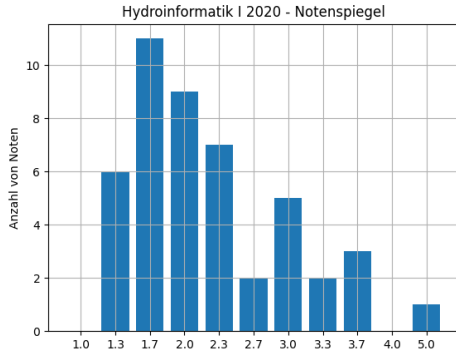
bar(x, height) / barh(y, width)

stem(x, y)

On this page

- Basic
- Plots of arrays and fields
- Statistics plots
- Unstructured coordinates

Python: Plotting (matplotlib)



Python: Plotting bar charts

Übung: Hydroinformatik-I-Noten.py

```
1 from matplotlib.ticker import FuncFormatter
2 import matplotlib.pyplot as plt
3 import numpy as np
4
5 year = np.arange(11)
6 publications = [1,1,7,4,8,7,6,7,3,2,3]
7 fig, ax = plt.subplots()
8 ax.set_title('Hydroinformatik I 2019 - Notenspiegel')
9 ax.set_ylabel('Anzahl von Noten')
10 plt.bar(year, publications)
11 plt.xticks(year, ('1.0', '1.3', '1.7', '2.0', '2.3', '2.7', '3.0', '3.3', '3.7',
12                  '4.0', '5.0'))
13 plt.grid(True)
14 plt.show()
```

Listing: Python example for bar charts: Hydroinformatik-I-Noten.py

Diffusionsgleichung: Analytische Lösung Tutorial: Abschnitt 2.2

- Repo: BHYWI-08-02-E-Script
- C++ Variante
- C++ / Python Variante
- Python Variante

MinGW + Python: Function plotter (analytical solution) #1

Übung: BHYWI-08-02-E-Script: Skript

```
1 echo Compilation
2 g++ main.cpp
3 echo Execution
4 a.exe
5 echo Ploting
6 data_from_file.py
7 echo End
```

Listing: Script file for entire workflow

MinGW + Python: Function plotter (analytical solution) #2

Übung: BHYWI-08-02-E-Script: C++

```
1 #include <cmath>
2 #include <fstream>
3 #define PI 3.14159265358979323846
4 int main(int argc, char *argv[])
5 {
6     //1-Definitionen
7     int numPoints = 1000;
8     double x,y,alpha=1.,t=0.01;
9     std::ofstream out_file;
10    out_file.open("out.csv");
11    //2-Berechnung
12    for (int i = 0; i < numPoints+1; ++i)
13    {
14        x = double(i)/double(numPoints);
15        y=sin(PI*x) * exp(-alpha*PI*PI*t);
16        out_file << x << "," << y << std::endl;
17    }
18    //3-Ausgabe
19 }
```

Listing: C++ program for analytical solution

MinGW + Python: Function plotter (analytical solution) #3

Übung: BHYWI-08-02-E-Script: File reading and data plotting

```
1 import matplotlib.pyplot as plt
2 import csv
3
4 x = []
5 y = []
6 with open('out.csv','r') as csvfile:
7     plots = csv.reader(csvfile, delimiter=',')
8     for row in plots:
9         x.append(float(row[0]))
10        y.append(float(row[1]))
11
12 plt.plot(x,y, label='Data loaded from file: out.csv')
13 plt.xlabel('x')
14 plt.ylabel('y')
15 plt.title('Hydroinformatics II\nExercise BHYWI-08-02-for-python')
16 plt.legend()
17 plt.savefig("diffusion-equation.png.png")
18 plt.show()
```

Listing: File reading and data plotting

```
1 import math
2 import matplotlib.pyplot as plt
3 PI = 3.14159265358979323846
4 numPoints = 10
5 alpha = 1.0
6 t = [0.1,0.5,1.0,2.0]
7 x = []
8 y = []
9 for n in t:
10     for i in range(0,numPoints+1):
11         x.append(float(i)/float(numPoints))
12         y.append(math.sin(PI*x[i]) * math.exp(-alpha*n*n))
13     plt.plot(x,y,color='red',marker="o")
14     x = []
15     y = []
16 plt.xlabel('x')
17 plt.ylabel('u')
18 plt.savefig("diffusion-equation.png")
19 plt.show()
```

Listing: Analytical solution

??

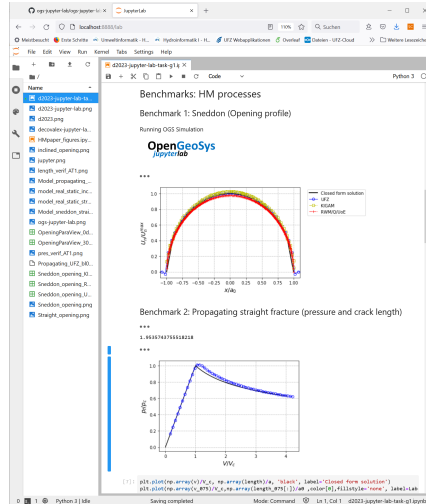
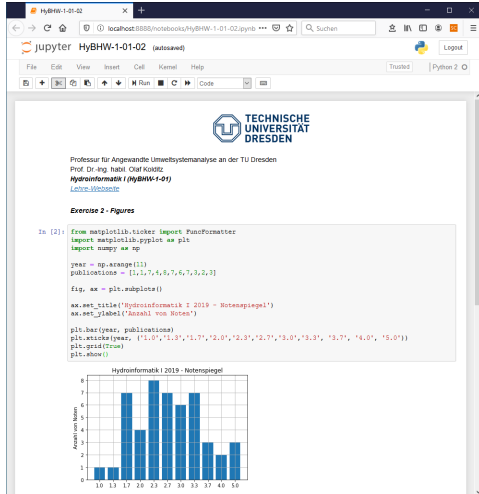
Jupyter

- Jupyter Notebook
- Jupyter Lab
- Browser-basiert

- "The Jupyter Notebook · The Jupyter Notebook is an open-source web application that allows you to create and share documents that contain live code, equations, ..."
- Webseite: <https://jupyter.org/>
- Vorteil: funktioniert auf allen Rechnern
- ... ein Teil unserer (neuen) Übungen machen wir mit Jupyter Notebooks (>> Demo)



Jupyter: Example



Nächste Veranstaltung am 27.05.2022 ist online

Hausaufgaben

- git und python Übungen selbständig wiederholen
- Installation Jupyter **Notebook** (siehe Tutorial)

`https://jupyter.org/install`