

SoftwareLab_iPythonNotebooks

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1 Idea

In most courses about topics that involve programming it is tough to provide high quality exercises. Usually the theoretical background is provided in a script or lecture notes that is independent of the simulation code the student has to use or to write. The idea of jupyter notebooks is to combine lecture notes and code in one web-based ipython notebooks.

2 Goal

The power and sheer endless possibilities of combining notes and codes written in **Python** or **Matlab** directly in one notebook should proof incredibly useful for the design of **interactive exercises**. These should be implemented prototypical for the lecture **High Order Finite Elements and Isogeometric Analysis**. These exercises should clearly show the variety of benefits of this new approach. In the end the students should not only be experts in High Order Finite Elements but they should also be able to present the core topics in an appealing way using self-designed jupyter notebooks.

3 Tasks

To complete the tasks, students are required to learn about + Python and Jupiter Notebooks + Python Plotting libraries like Matplotlib or Plotly + High order finite elements and isogeometric analysis + any other topic that might be useful for designing interactive programming exercises

4 Supervisors

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5 References

- [Python](#)
- [Jupyter](#)
- [HOFEM](#)
- [Matplotlib](#)
- [Plotly](#)

6 Examples

6.1 Write some Latex formulas

1. $\frac{n!}{k!(n-k)!} = \binom{n}{k}$

2. $\int_0^\infty e^{-x} dx$
3. $P\left(A = 2 \mid \frac{A^2}{B} > 4\right)$

or write only Latex in one cell.

```
In [3]: %%latex
\begin{align}
M = \begin{bmatrix}
\frac{5}{6} & \frac{1}{6} & 0 \\
\frac{5}{6} & 0 & \frac{1}{6} \\
0 & \frac{5}{6} & \frac{1}{6}
\end{bmatrix}
\end{align}
```

$$M = \begin{bmatrix} \frac{5}{6} & \frac{1}{6} & 0 \\ \frac{5}{6} & 0 & \frac{1}{6} \\ 0 & \frac{5}{6} & \frac{1}{6} \end{bmatrix} \quad (1)$$

6.2 Calculate first 10 Fibonacci numbers in Python

```
In [2]: def fib(n):
    if n == 0:
        return 0
    elif n == 1:
        return 1
    else:
        return fib(n - 1) + fib(n - 2)

    print "First 10 Fibonacci numbers:", [fib(i) for i in range(10)]
```

First 10 Fibonacci numbers: [0, 1, 1, 2, 3, 5, 8, 13, 21, 34]

6.3 Use matplotlib for plotting

```
In [13]: %matplotlib inline
import sys
import time
from IPython.display import display, clear_output
import numpy as np
import matplotlib.pyplot as plt
from scipy.special import jn
x = np.linspace(0,5)
f, ax = plt.subplots()
ax.set_title("Bessel functions")

for n in range(1,10):
    time.sleep(1)
    ax.plot(x, jn(x,n))
    clear_output(wait=True)
    display(f)

# close the figure at the end, so we don't get a duplicate
# of the last plot
plt.close()
```

