TECHNISCHE UNIVERSITÄT DRESDEN

Fakultät Elektrotechnik und Informationstechnik Institut für Regelungs- und Steuerungstheorie

PYTHONKURS FÜR INGENIEUR:INNEN
PYTHON FOR ENGINEERS

Organisatorisches und Python-Grundlagen
Organisation and Python basics

Carsten Knoll,
Institut für Regelungs- und Steuerungstheorie
(Institute of Control Theory)

Dresden (online), 2022-10-14

Sprache / Laguange

This year the course is part of the module **Neural Networks and Memristive Hardware Accelerators**.
Module is in english $\Rightarrow$ course bilingual.

If there is a language barrier: **please ask!**

Wenn Sie etwas nicht verstehen: **Bitte fragen!**

Self Introduction

Carsten Knoll

- Postdoc at
  Institute of control theory

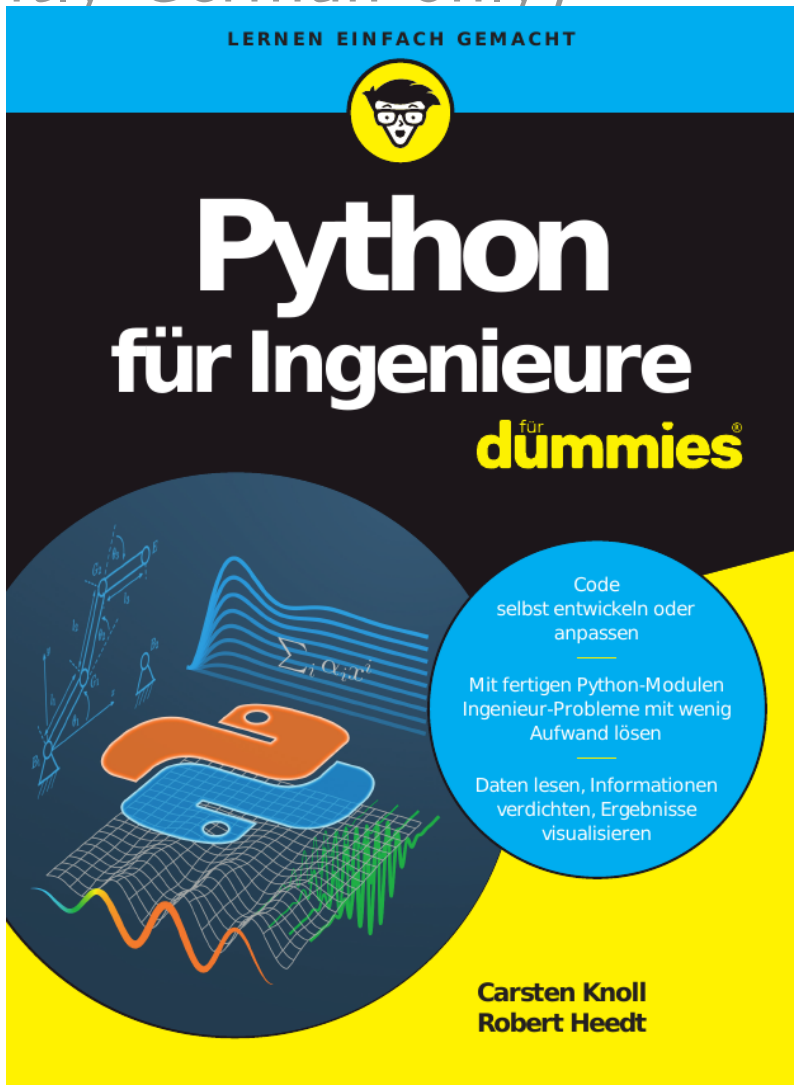
- Co-Founder
  Hochschulgruppe für Freie Software und Freies Wissen

- Co-Founder of
  Bits und Bäume Dresden

  Interested people are always welcome.

- First experience with Python in 2004, active usage since 2008

Book (currently German only)



https://python-fuer-ingenieure.de

History of the course

- Python usage of individual people → contact, exchange.
- Observation: lack of Python courses

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→ Personnel funds for the implementation of the „Blended Learning" concept: Self-learning phases- and online consultations in alternation

  - Self-learning phases: Knowledge transfer (screencasts), comprehension quizzes, exercises (to get an overview)
  - Online consultations: Complex exercises (in groups, with opportunity to ask questions)

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  - Online consultations: Complex exercises (in groups, with opportunity to ask questions)

- Different course names over time
- Since WiSe 17/18 gender-neutral title (in German) „... for engineers"
  (background)

Former Co-Creators

- Dipl.-Ing. Sebastian Voigt
- Dipl.-Ing. Christoph Statz
- Dipl.-Inf. Ingo Keller
- Dipl.-Ing. Peter Seifert

- Dr.-Ing. Ines Gubsch
- Andreas Kunze
- Dominik Pataky
- Victoria Vinis

- Many thanks to
  - M. Grabowski, C. J. Kleine (ZIH), ...

Why Python? (1)

Python as Programming language

- Clear, readable syntax (little „overhead“)
- Object-oriented, procedural, functionally programmable
- Useful built-in data types (`list`, `tuple`, `dict`, `set`, `...`)
- Easy modularization (`import this`)
- Good error management (exceptions)
- Extensive standard library
- Easy integration of external code (C, C++, Fortran)

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$\Rightarrow$

- Easy to learn
- Problem oriented (powerful and flexible)
- Motivation potential $\nearrow$, frustration potential $\searrow$

Also: cross-platform / free and open source / large & active community

Why Python? (2)

Python as a tool for engineers:

- Symbolic calculation (derive, integrate, solve equations, ...)
- Numerical calculation (lin. algebra, DGLn, optimization, ...)
- Visualization (2D, 3D, in publication quality)
- Graphical User Interface (GUI)
- Parallelization

- Communication with external devices (RS232, GPIB, ...)

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} prospective course content

- Communication with external devices (RS232, GPIB, ...)

- Python useful for other subjects/projects

$\Rightarrow$ Strengthened „research competence“ (study and master/diploma theses, ...)

Didactic concept

„Programming is learned by actively reading and writing code'"

self-learning phases (60-90min per week)

- Opal: teaching material + further links
- overview lecture as screencast (basic concepts, commands, traps) „finger exercises" → type along yourself (play around)
  Recommendation: download videos and play them in suitable media player (e.g. mplayer, VLC). (jump back, speed adjustment, ...)
- CodeQuiz: Comprehension questions (condition for certificate of achievement)
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- processing complex exercise task,
  - subdivision into manageable subtasks.
  - Providing source code fragments, detailed solution on the net
- Programming in groups (pair programming")
  - Enables and requires cooperation

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programming project (dt: „Beleg“) (manageable programming task)

- Condition for certificate of achievement (unfortunately without CP!)
- Last event: Presentation and short discussion about the program
- **Your own topic suggestions welcome**

Preparation and Installation

- **recommendation** Anaconda distribution, installed via the miniconda installer: https://docs.conda.io/en/latest/miniconda.html
- **assumption:** You can open a command line window (=„Console“ = „Terminal“) with the Conda environment enabled („Anaconda prompt“):
- Install relevant packages with

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# - Installation benötigter Zusatzpakete
pip install numpy scipy matplotlib ipydex ipywidgets symbtools
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- background information: We use Python >=3.8

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- Python 3.x is **not** 100% backward compatible (e. B. `print "hello"` → `print("hello")`) ⚠ you can still find a lot of 2.x code on the net, e.g. some screencasts of this course

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- Jupyter Notebook (with Python kernel)
  - command: `cd pykurs-wise2021-22; jupyter notebook .` (change to the course directory, then start the notebook server there)
  - backend: (local) web server; frontend: Interactive document in browser
  - notebooks combine source code, program output and documentation (incl. LaTeX formulas)

Jupyter

Key keyboard commands

command mode (`Esc` to enable)

- `Shift-Return` - execute cell, activate next one
- `h` - show keyboard commands
- `m` - change cell type to „markdown“
- `y` - change cell type to „code“
- `a` - new cell above
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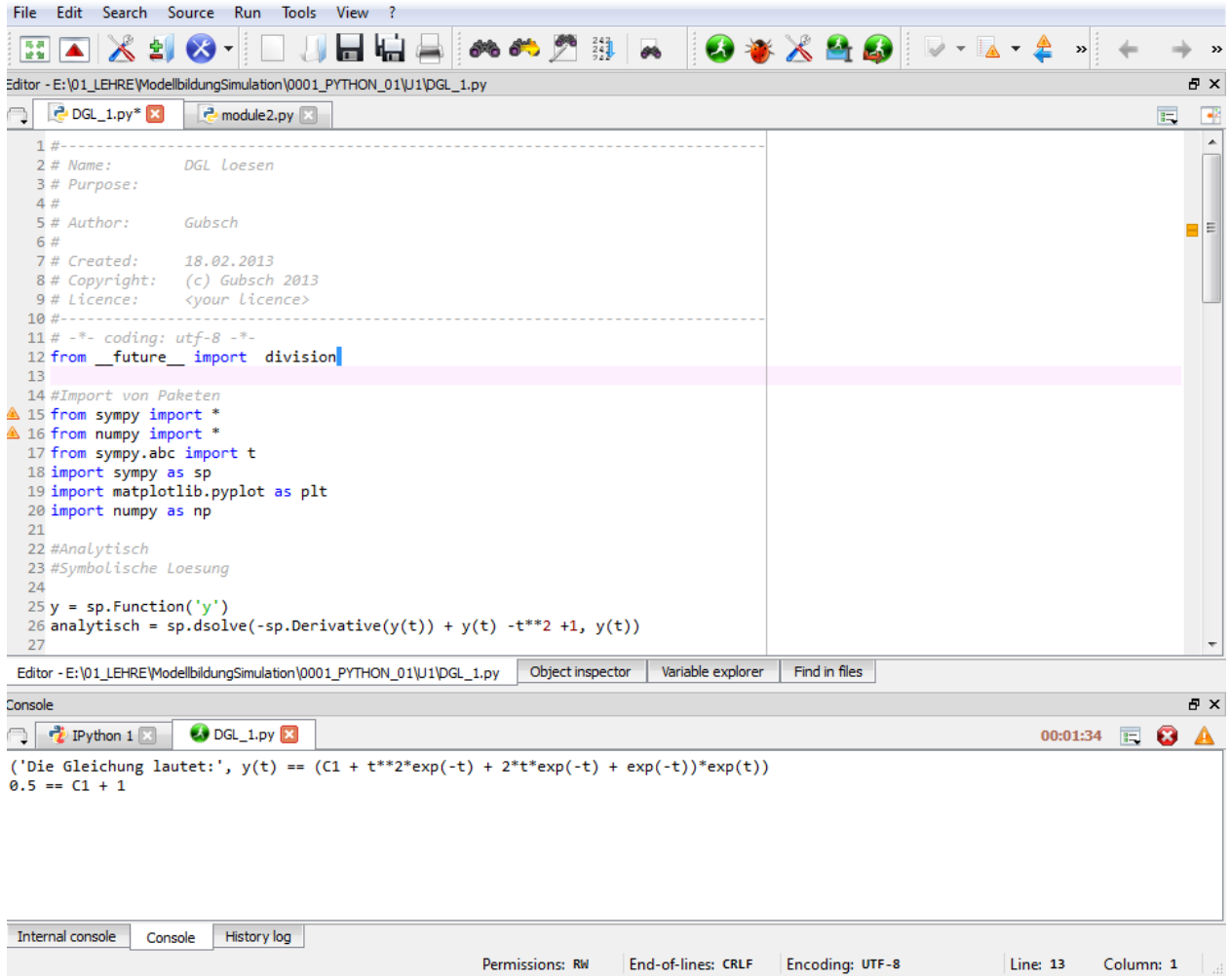
→ Start the server in the current directory: `jupyter notebook ./`
→ Trying `example-notebook1.ipynb`

Spyder Integraged Development Environment (IDE)



Code Example

Listing: hello-world.py

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import math
print("Hello World")
a = 10
b = 20.5
c = a + b + 3**2
print(math.sqrt(c))

while True: # start infinite loop
    x = input("Your name? ")  # returns a str-object
    if x == "q":
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- Python basics: see: `01_overview_Python_types_and_syntax.pdf`

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  - "exploring" new modules, features, ...
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- IPython = "Interactive Python" = improved Python shell
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→ Start scripts in external shell

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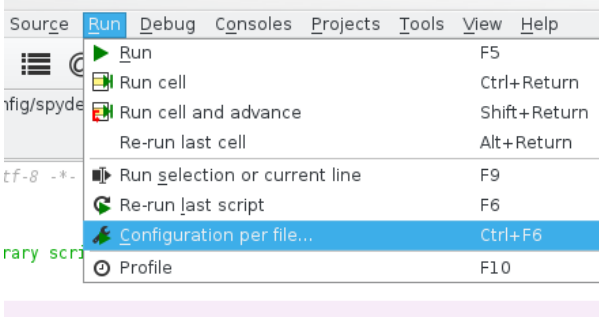

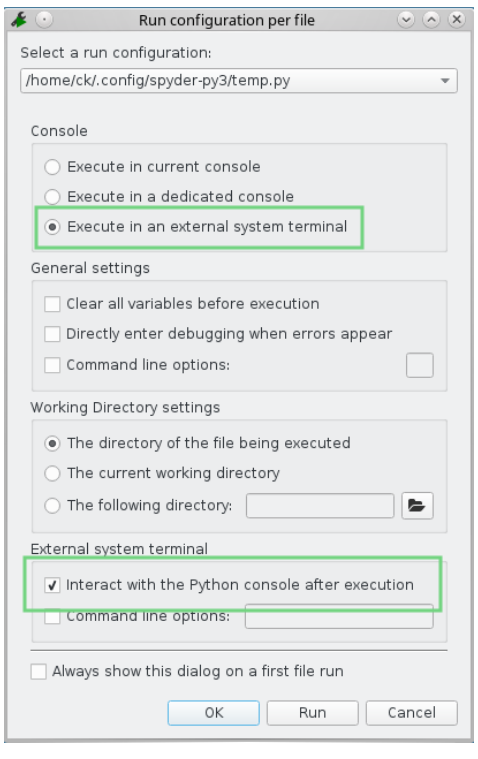

Excercise: Embedded IPython

Listing: ipython1.py

```
import math

# import embedded shell
from ipydex import IPS

a = 10
b = 20.5
c = a + b + 3**2
d = math.sqrt(c)

# run embedded shell
IPS()
# try: math.sqrt?, math.s<TAB>, history (up, down), %magic
# exit with CTRL-D
```

Summary + Outlook

What we talked about

- Course organization
- Usage of Jupyter-Notebook, Spyder
- Python basics (see `01_overview_Python_types_and_syntax.pdf`)
- Exercise

How to continue?

- Review of the material before the next lesson