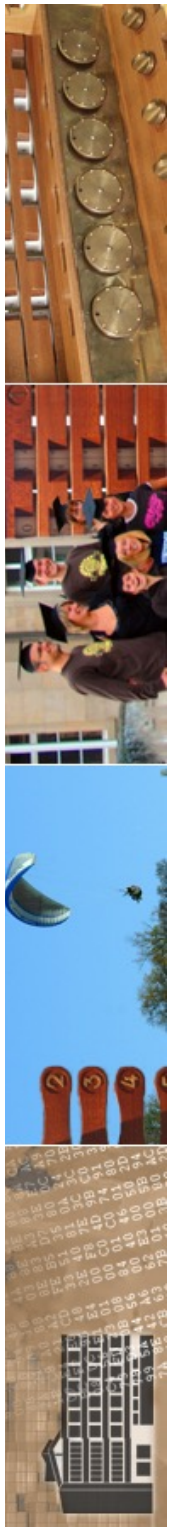

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MATHEMATISCH-
NATURWISSENSCHAFTLICHE FAKULTÄT
FACHBEREICH INFORMATIK
INFORMATIONSDIENSTE

Real Python

# Grundlagen Internet-Technologien

INF3171

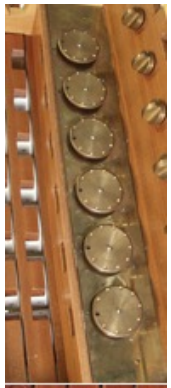
## Serverseitige Web-Programmierung mit CGI, Teil I: Einführung in Python

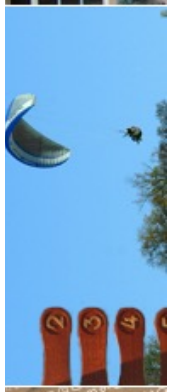
Version 1.0

16.05.2024

python™

python™






# PyTorch: Eigene Bildgenerierungs-KI mit Python bauen

Künstliche Intelligenz muss nicht kompliziert sein. Mit der PyTorch-Bibliothek bauen Sie Ihren eigenen KI-Bildgenerator in Python. Wir erklären, wie das geht.

Artikel verschenken NEU 10

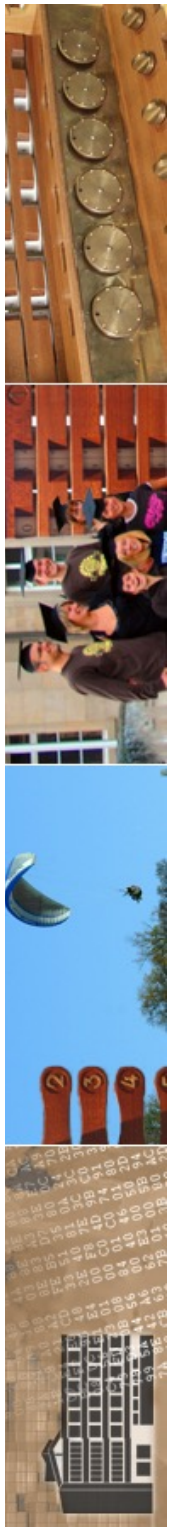
Erstellt mit Midjourney durch heise online.

**08.05.2024, 14:33 Uhr** **Lesezeit: 16 Min.** | **heise+ exklusiv**

*Von Lea Reinhart*

INHALTSVERZEICHNIS

Mithilfe von KI-Bildgeneratoren kann jeder zu einem digitalen Monet oder Picasso werden. Dienste wie Midjourney, Dall-E und Adobe Firefly erzeugen nach einem Kommandozeilenbefehl (Prompt) Bilder, die teils sogar die eigene Vorstellungskraft sprengen. All diese Tools haben etwas gemeinsam: Sie sind an eine Rechen-Cloud angebunden, benötigen folglich zwingend einen



# Missing Link: 5 Jahre DSGVO – "Die gezielte Panikmache hat sich gelegt"

Seit dem 25. Mai 2018 gilt die Datenschutz-Grundverordnung. Sie hat hiesige Grundsätze wie Datenminimierung bekannt gemacht und entzweit bis heute die Gemüter.

Lesezeit: **16 Min.** In Pocket speichern 128

(Bild: mixmagic/Shutterstock.com)

**08:05 Uhr**

*Von Stefan Krempl*

In wenigen Tagen, am 25. Mai 2023, ist die Datenschutz-Grundverordnung (DSGVO) seit genau fünf Jahren in Kraft. Das Normenwerk mit 99 Artikeln und 173 erläuternden Erwägungsgründen polarisiert bis heute: Für die einen ist es ein Ausbund an Bürokratie, die aufgrund der enthaltenen Einwilligungsklausel im nervtötenden Abklicken von Cookie-Bannern gipfelt. Andere sehen in der Verordnung, deren Beschluss von einem heftigen Lobby-Streit begleitet war, einen weltweiten Goldstandard beim Absichern der Privatsphäre der Bürger.

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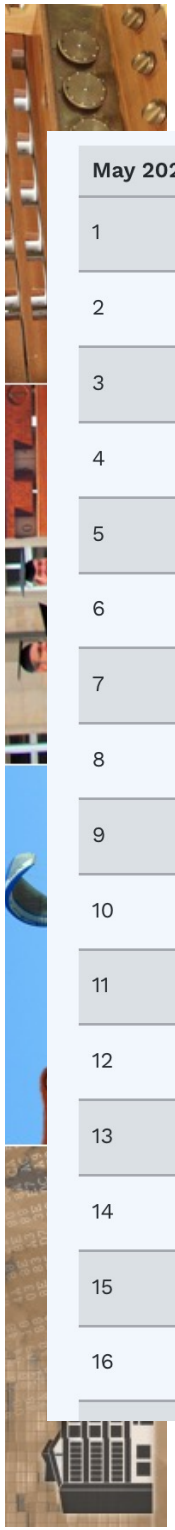
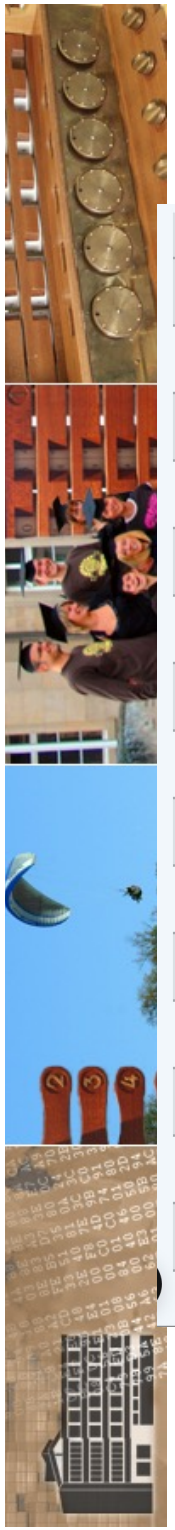
pyodide.org/en/stable/console.html

Apps | U Tü | HIS | IT | MacBook | Leica | Z | Wilier | Inissio | EU-DSGVO | PetitMouton | Bookmarks

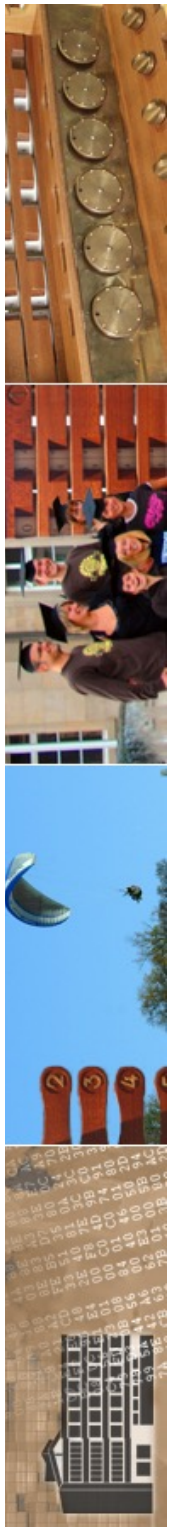
```
Welcome to the Pyodide terminal emulator 🐍
Python 3.10.2 (main, Apr  9 2022 20:52:01) on WebAssembly VM
Type "help", "copyright", "credits" or "license" for more information.
>>>
```



| May 2023 | May 2022 | Change | Programming Language | Ratings | Change |
|---|---|---|---|---|---|
| 1 | 1 | | Python | 13.45% | +0.71% |
| 2 | 2 | | C | 13.35% | +1.76% |
| 3 | 3 | | Java | 12.22% | +1.22% |
| 4 | 4 | | C++ | 11.96% | +3.13% |
| 5 | 5 | | C# | 7.43% | +1.04% |
| 6 | 6 | | Visual Basic | 3.84% | -2.02% |
| 7 | 7 | | JavaScript | 2.44% | +0.32% |
| 8 | 10 | ↑ | PHP | 1.59% | +0.07% |
| 9 | 9 | | SQL | 1.48% | -0.39% |
| 10 | 8 | ↓ | Assembly language | 1.20% | -0.72% |
| 11 | 11 | | Delphi/Object Pascal | 1.01% | -0.41% |
| 12 | 14 | ↑ | Go | 0.99% | -0.12% |
| 13 | 24 | ⇈ | Scratch | 0.95% | +0.29% |
| 14 | 12 | ↓ | Swift | 0.91% | -0.31% |
| 15 | 20 | ⇈ | MATLAB | 0.88% | +0.06% |
| 16 | 13 | ↓ | R | 0.82% | -0.39% |

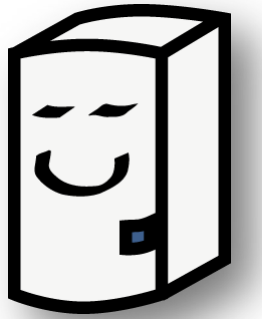


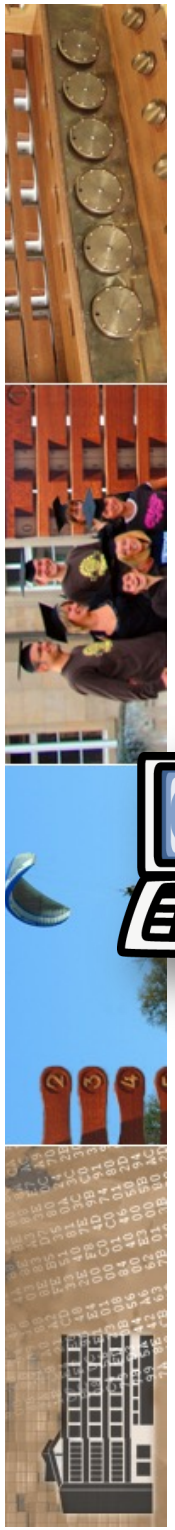
| May 2024 | May 2023 | Change | Programming Language | Ratings | Change |
|---|---|---|---|---|---|
| 1 | 1 | | Python | 16.33% | +2.88% |
| 2 | 2 | | C | 9.98% | -3.37% |
| 3 | 4 | ↑ | C++ | 9.53% | -2.43% |
| 4 | 3 | ↓ | Java | 8.69% | -3.53% |
| 5 | 5 | | C# | 6.49% | -0.94% |
| 6 | 7 | ↑ | JavaScript | 3.01% | +0.57% |
| 7 | 6 | ↓ | Visual Basic | 2.01% | -1.83% |
| 8 | 12 | ⇈ | Go | 1.60% | +0.61% |
| 9 | 9 | | SQL | 1.44% | -0.03% |
| 10 | 19 | ⇈ | Fortran | 1.24% | +0.46% |
| 11 | 11 | | Delphi/Object Pascal | 1.24% | +0.23% |
| 12 | 10 | ↓ | Assembly language | 1.07% | -0.13% |
| 13 | 18 | ⇈ | Ruby | 1.06% | +0.26% |
| 14 | 15 | ↑ | MATLAB | 1.06% | +0.18% |
| 15 | 14 | ↓ | Swift | 1.01% | +0.09% |
| 16 | 8 | ⇊ | PHP | 0.97% | -0.62% |



# Dynamik im Web

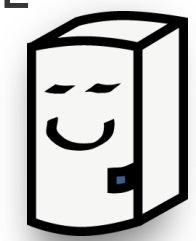
- Dynamik beim Client
  - **JavaScript**
  - Flash
  - Silverlight
  - Java Applets
- Dynamik beim Server
  - CGI (mit Python, Perl, C, …)
  - PHP
  - Java Servlets
- Klassiker google, ebay, amazon, facebook, …

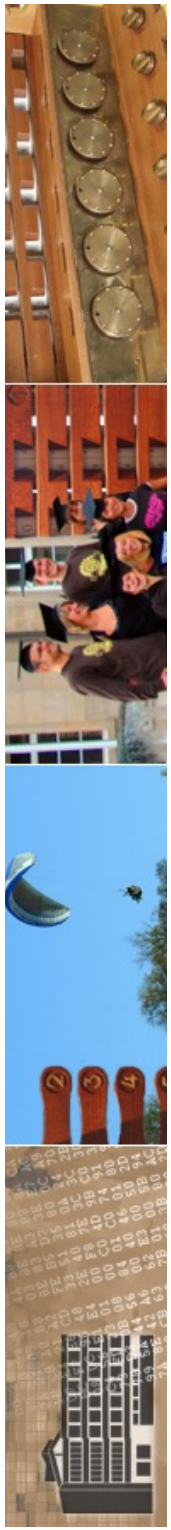




# Client versus Server

- Client
  - direkte Interaktion
  - keine Netzbelastung
  - CPU des Clients
  - keine DB-Aktion
  - Gefahr für Client
  - verschiedene Clients führen zu verschiedenen Ergebnissen
  - Sourcecode wird ausgeliefert: Kopie
- Server
  - Diensteanbieter hat alles in der Hand
  - Datenbankanbindung
  - zum Client wird nur HTML übertragen
  - Performance: alle teilen sich Server-CPU
  - keine Interaktion





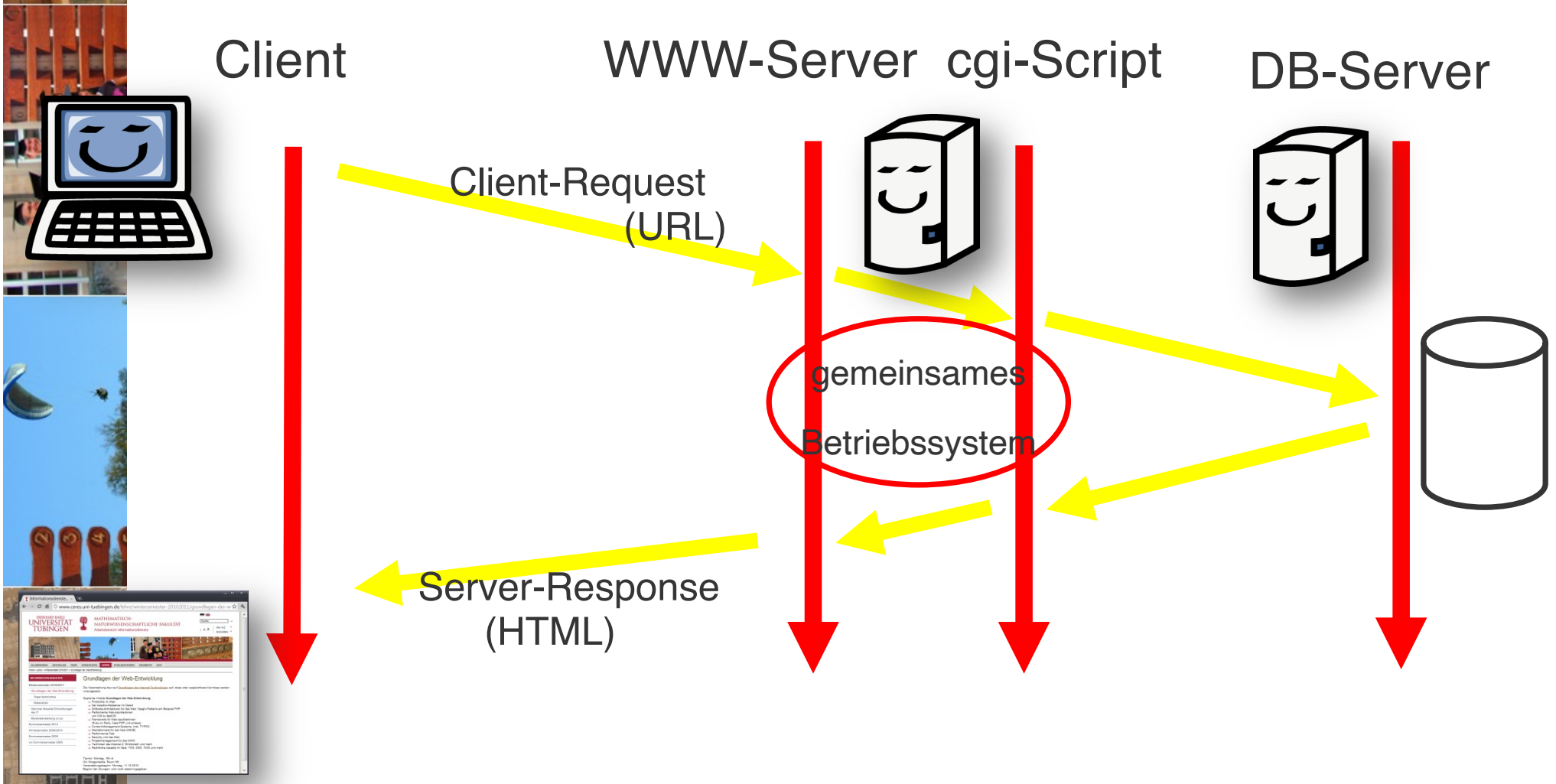
# einfach(st)e Servertechnik

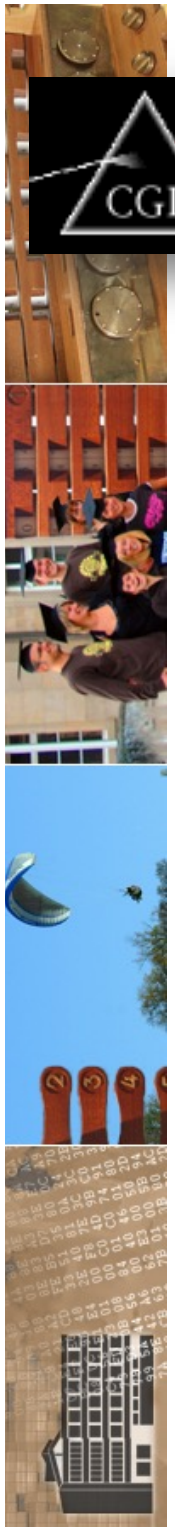
- **Common Gateway Interface** (CGI)

  Möglichkeit, um im WWW serverseitig Programme bereitzustellen, die von "HTML-Seiten gestartet werden" und HTML-Code produzieren

  – Entwicklung ab 1993 (!)

# Strukturen einer HTTP-Transaktion mit cgi und Datenbank





# cgi: Voraussetzungen

- Webserver ;-)
  - ...der cgi unterstützt (und auf dem cgi erlaubt ist...)
  - Verzeichnis für die Programme (default meist **cgi-bin**)
  - cgi-Umgebunsgvariablen des Webservers

- aktuell cgi Version 1.1 (und das schon lange) http://www.w3.org/CGI/
  - Version 1.2 seit November 1997 “in Diskussion”



www.w3.org/CGI/

W3C

# CGI: Common Gateway Interface

**Note:** This page is no longer maintained. It is left here for historical purposes. Unfortunately, over time, some links may break that are not maintained by the entities managing those resources.

An HTTP server is often used as a gateway to a legacy information system; for example, an existing body of documents or an existing database application. The Common Gateway Interface is an agreement between HTTP server implementors about how to integrate such gateway scripts and programs.

It is typically used in conjunction with HTML forms to build database applications.

See also: WWW and OOP for more on building distributed applications on the web.

## Specs and Documentation

CGI 1.2 specification (in progress)
: This directory is the repository for the effort (reactivated in November of 1997) to turn the de facto Common Gateway Interface "standard" into an actual Informational RFC.

The WWW Common Gateway Interface Version 1.1
: 16th October 1995. David Robinson. An attempt to update the CGI spec.

Apache Module mod_cgi

Using CGI in the CERN httpd
: Configuring CERN httpd to use CGI scripts with the Exec directive.

Setting up CGI in NCSA httpd
: A description of using CGI scripts with the NCSA httpd, using ScriptAlias and CGI files.

## Discussion

comp.infosystems.www.authoring.cgi
: This newsgroup is a good place to find example scripts and discuss problems with other CGI developers.

www-talk
: If you have technical comments or questions about the development of the CGI spec itself, www-talk is a good place for them.

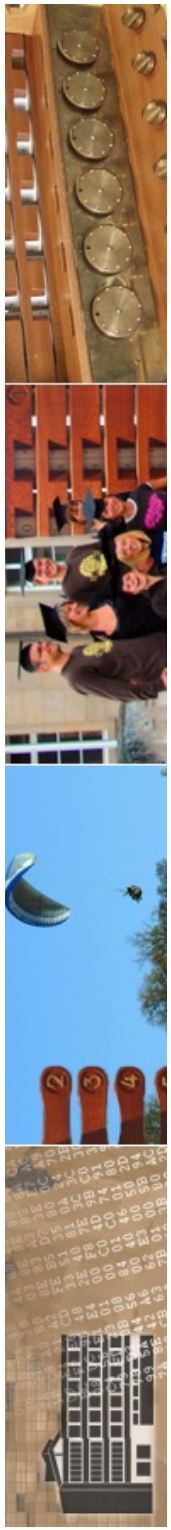
## Next-Generation APIs

See also: WWW and OOP for info on using CORBA and ILU in place of CGI.

Fast-CGI
: using the CGI programming model in combination with multiplexed network connections.

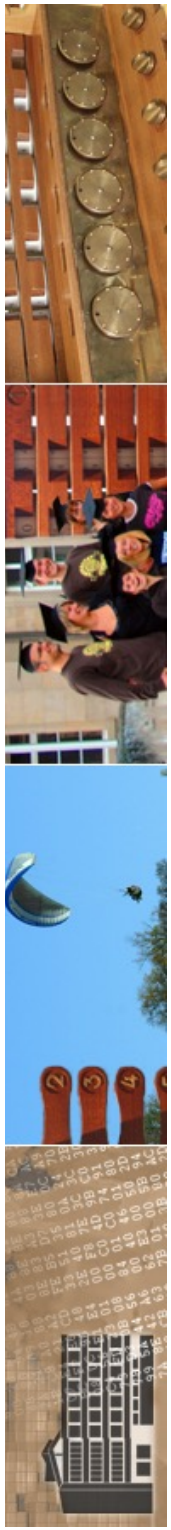
ILU Requestor
: an approach using distributed objects

Apache API



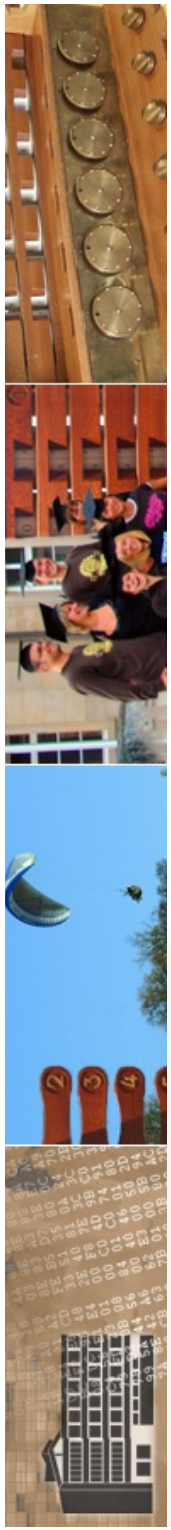
# serverseitige Voraussetzungen

- für den Apache-Webserver: Modul **mod_cgi**
  - wird defaultmäßig integriert
- entsprechende Konfiguration in den Apache-Konfigurationsdateien: **`httpd.conf`**
- Scripte
  - entweder in einem cgi-bin-Verzeichnis (Standard)
    - oder Kennung durch Dateiendung bei entsprechender Konfiguration des Apache



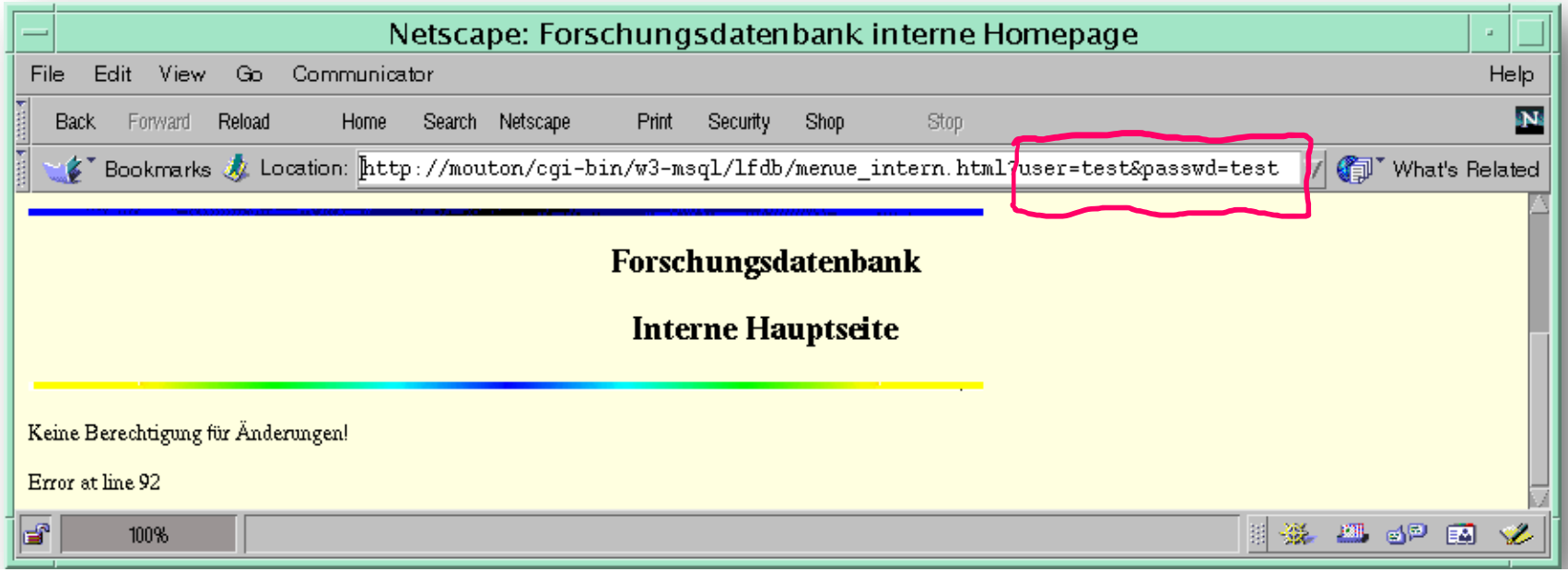
# cgi: Aufruf aus HTML

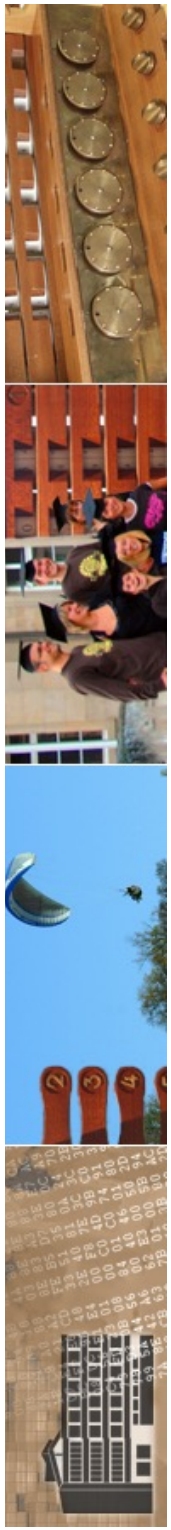
- normaler Hyperlink
  - `<A HREF="/cgi-bin/counter.pl">Zähler</A>`
- über Formulare (➔ Übungen)
- Grafikreferenzen (img, src)
- **SSI**: Server-Side-Includes
  - SSI ist eine einfache und effiziente Form für aktive Websites → später



# cgi-Datenübergabe an den Server

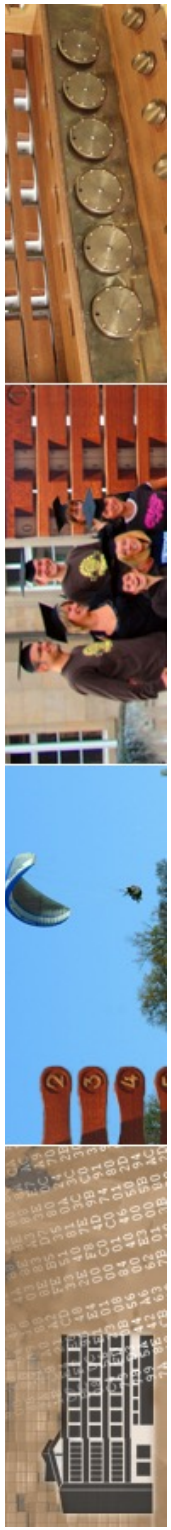
- *unterschiedliches* Vorgehen bei den HTTP-Methoden **`GET`** und **`POST`**
  - GET: Codierung der Eingabefelder in URL; Syntax:
    - **`&`** (&) trennt Feldnamen
    - **`=`** trennt Name von Wert
    - **`?`** leitet Datenteil ein





# cgi-Datenübergabe an den Server

- Nachteile bei GET:
  - URLs beliebiger Länge???
  - Codierung der »Sonderzeichen«
  - Speichern in Browser-History (➔ Kennwörter?!)
- **POST**: Daten werden über separate I/O-Ströme weitergeleitet, nicht über URL



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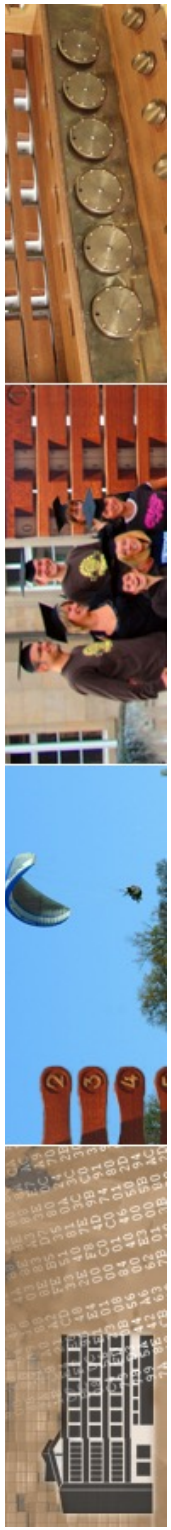
# Beispiel Zoom

- Kennwort kann verschlüsselt an Zoom-IRL angefügt werden:

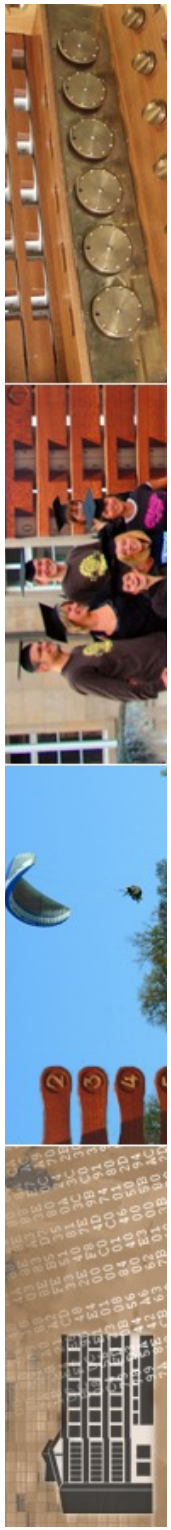
  https://zoom.us/j/96118146729?pwd=...

  – Optional zu aktivieren/deaktivieren



# cgi Lifecycle

- ein cgi-Aufruf hat folgenden Lifecycle:
  - **mit jedem http-Request wird ein cgi-Prozeß gestartet, der danach wieder beendet wird**
- als Konsequenz ist cgi für viele Anfragen nicht performant, weshalb (viele) Alternativen entwickelt wurden
  - fastCGI, Servlets, Webserver-Module, cgid, ...



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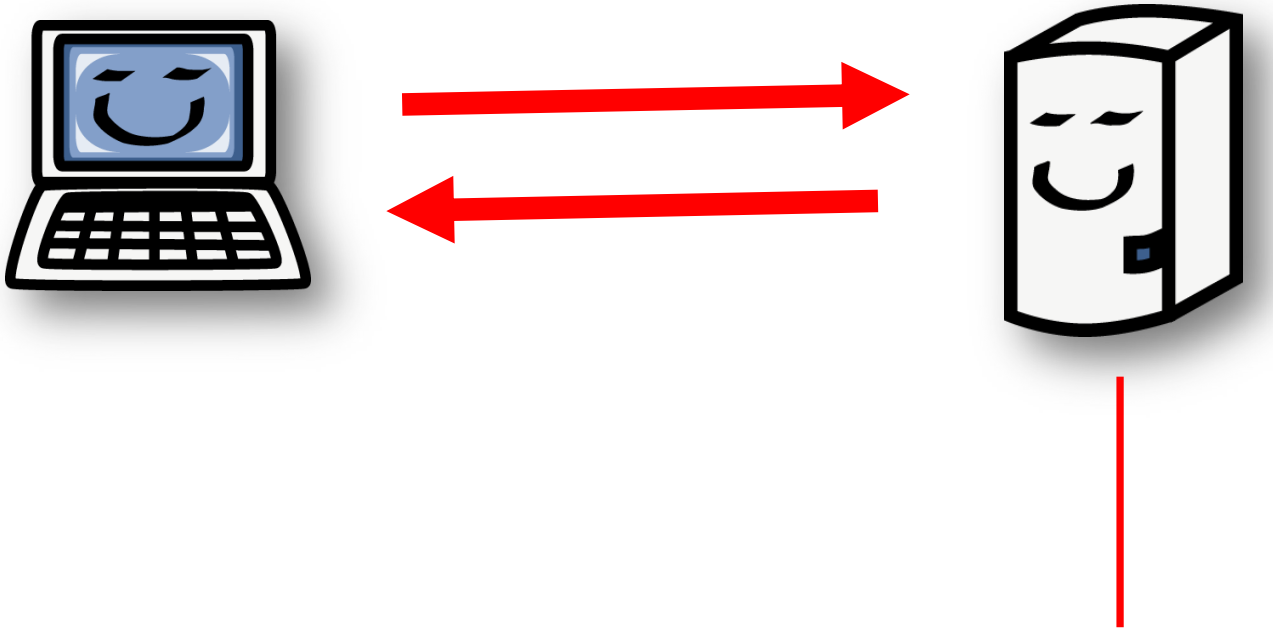
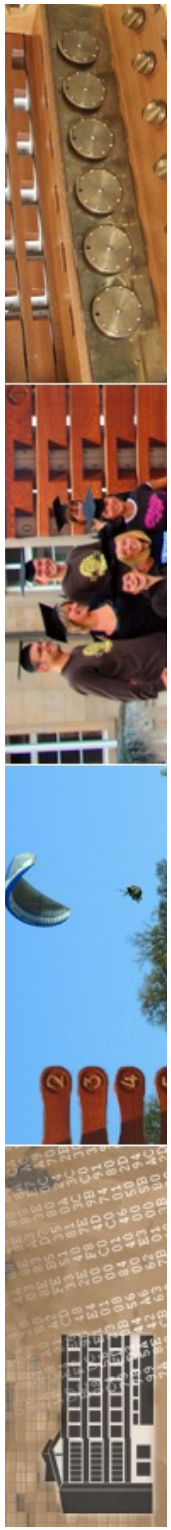
# cgi – das Prinzip

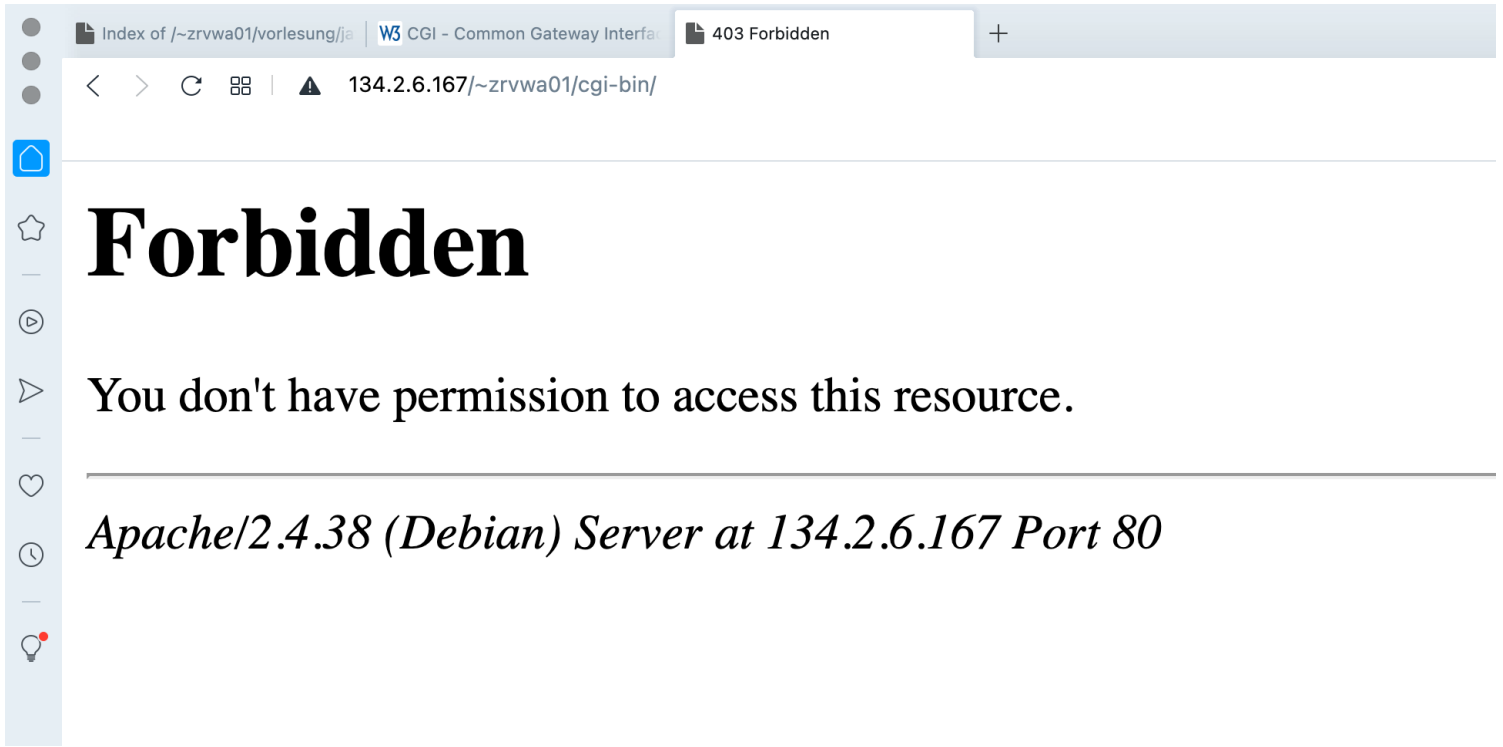
- Web-Client „startet“ cgi-Programm auf Server



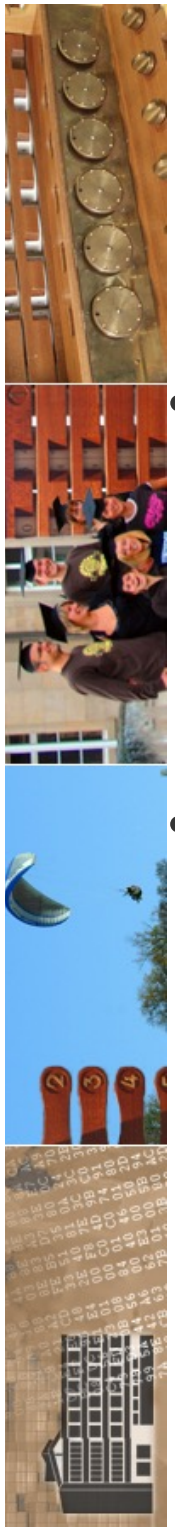


# ganz wichtig…

- cgi ist immer auch eine Gefahr (für den Server)



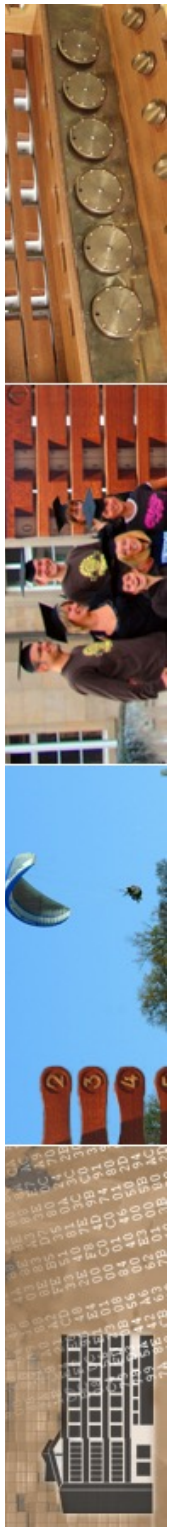

- *keine Übersicht* über Skripte ausliefern



# cgi: Umgebungsvariablen

- Server legt bei Aufruf des cgi-Programms spezielle **Umgebungsvariablen** fest, die dem cgi-Programm die notwendigen Informationen liefern
(interner Mechanismus der Datenübergabe)

- einige dieser Umgebungsvariablen:
  - **`SERVER_NAME, SERVER_PROTOCOL, SERVER_PORT`**
  - **`PATH_INFO, SCRIPT_NAME, QUERY_NAME`**
  - **`REMOTE_HOST, REMOTE_ADDR, REMOTE_USER`**



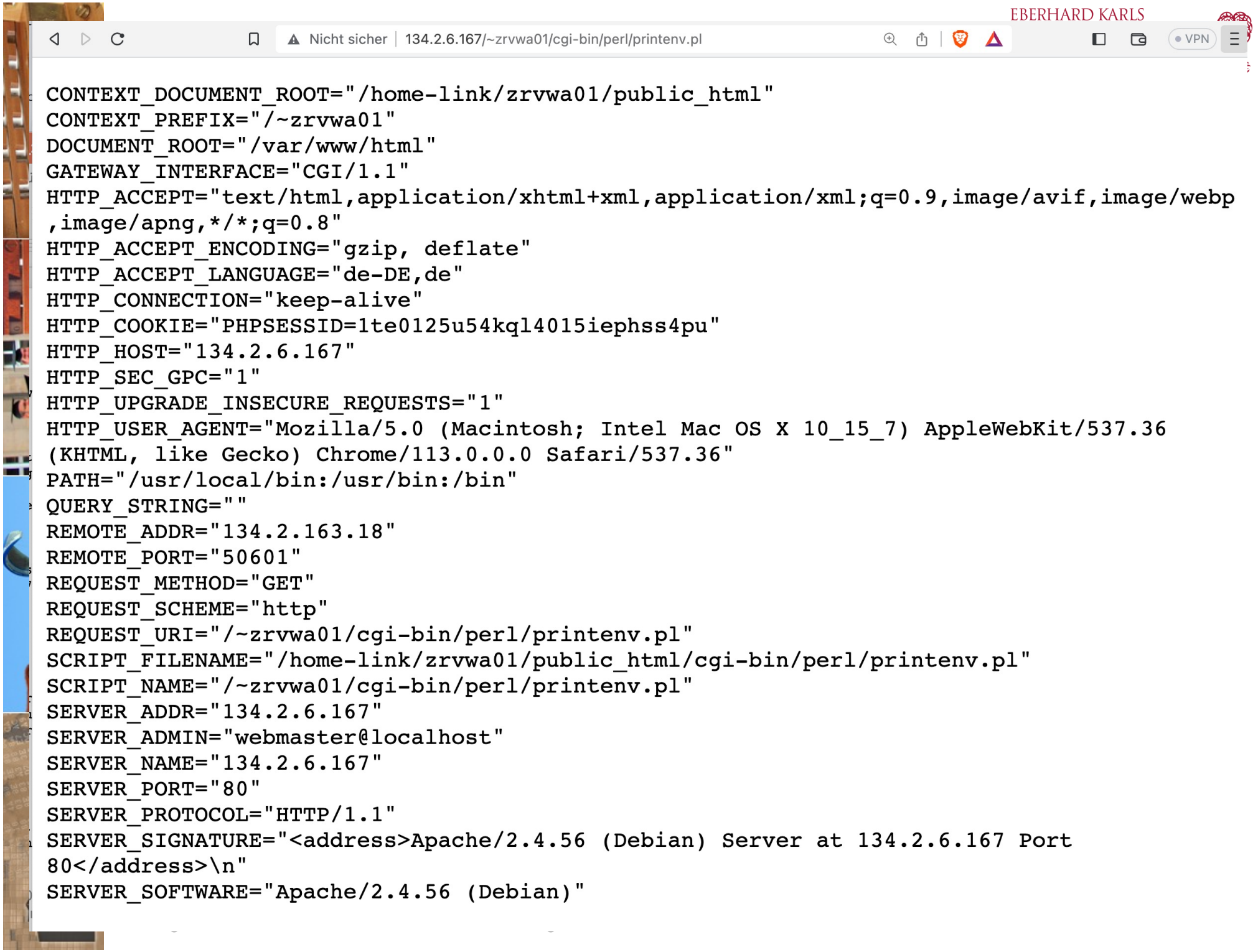
# Standardscipt

- mit Apache wird das Script

  **`printenv.pl`**

  ausgeliefert

- gibt Überblick über alle Umgebungsvariablen des Servers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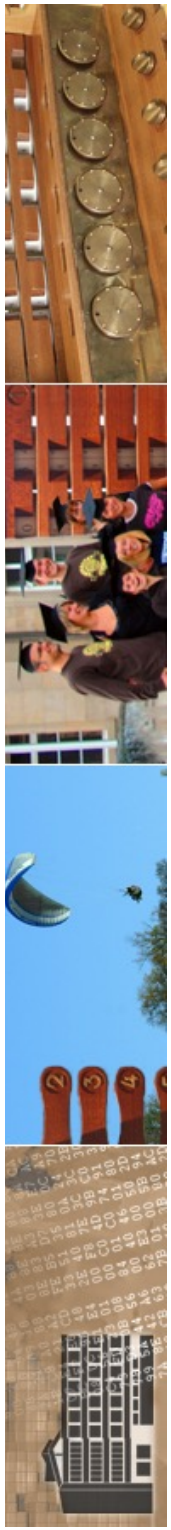
Nicht sicher | 134.2.6.167/~zrvwa01/cgi-bin/perl/printenv.pl
VPN
CONTEXT_DOCUMENT_ROOT="/home-link/zrvwa01/public_html"
CONTEXT_PREFIX="/~zrvwa01"
DOCUMENT_ROOT="/var/www/html"
GATEWAY_INTERFACE="CGI/1.1"
HTTP_ACCEPT="text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp
,image/apng,*/*;q=0.8"
HTTP_ACCEPT_ENCODING="gzip, deflate"
HTTP_ACCEPT_LANGUAGE="de-DE,de"
HTTP_CONNECTION="keep-alive"
HTTP_COOKIE="PHPSESSID=1te0125u54kql4015iephss4pu"
HTTP_HOST="134.2.6.167"
HTTP_SEC_GPC="1"
HTTP_UPGRADE_INSECURE_REQUESTS="1"
HTTP_USER_AGENT="Mozilla/5.0 (Macintosh; Intel Mac OS X 10_15_7) AppleWebKit/537.36
(KHTML, like Gecko) Chrome/113.0.0.0 Safari/537.36"
PATH="/usr/local/bin:/usr/bin:/bin"
QUERY_STRING=""
REMOTE_ADDR="134.2.163.18"
REMOTE_PORT="50601"
REQUEST_METHOD="GET"
REQUEST_SCHEME="http"
REQUEST_URI="/~zrvwa01/cgi-bin/perl/printenv.pl"
SCRIPT_FILENAME="/home-link/zrvwa01/public_html/cgi-bin/perl/printenv.pl"
SCRIPT_NAME="/~zrvwa01/cgi-bin/perl/printenv.pl"
SERVER_ADDR="134.2.6.167"
SERVER_ADMIN="webmaster@localhost"
SERVER_NAME="134.2.6.167"
SERVER_PORT="80"
SERVER_PROTOCOL="HTTP/1.1"
SERVER_SIGNATURE="<address>Apache/2.4.56 (Debian) Server at 134.2.6.167 Port
80</address>\n"
SERVER_SOFTWARE="Apache/2.4.56 (Debian)"



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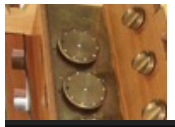
# Beispiel für CGI mit C

- mit C bekommen wir eine **direkt ausführbare Binärdatei**
- Beispiel **webkompendium.c** gibt nur HTML-formatierte Ausgabe aus

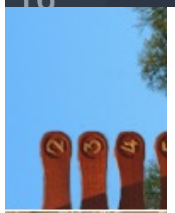


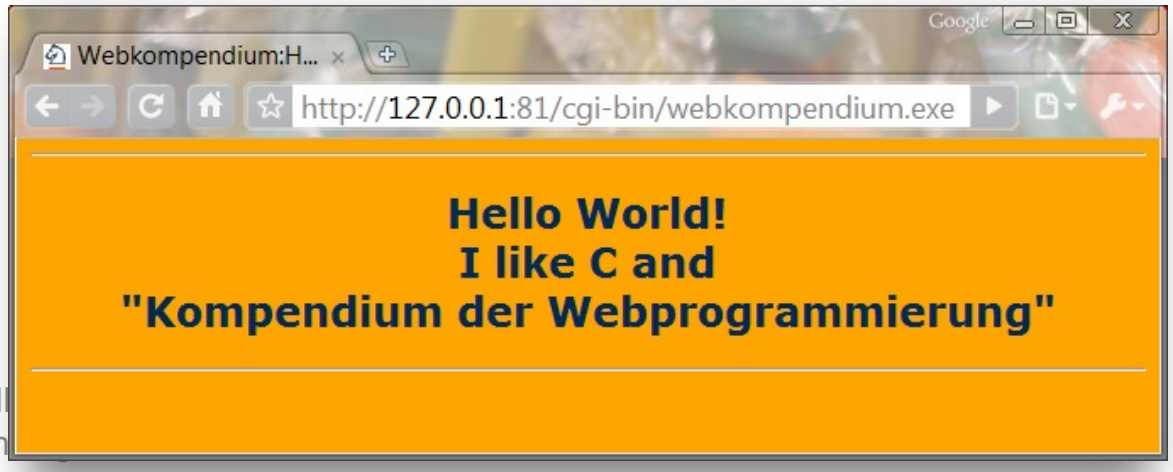


```c
// Grundlagen Internet-Technologien
// CGI-Beispiel in C

#include <stdio.h>

main()
{
  printf("Content-type: text/html\n\n");
  printf("<HTML><HEAD><TITLE>Grundlagen Internet-Technologien:Hello World als C-cgi</TITLE>"
  printf("<link rel=\"stylesheet\" type=\"text/css\"");
  printf("href=\"/css/webkompendium.css\">");
  printf("<BODY><HR><CENTER><H2>Hello World!<BR>");
  printf("I like C and<BR>\"Grundlagen Internet-Technologien\"");
  printf("</H2></CENTER><HR></BODY></HTML>");
}
```








python

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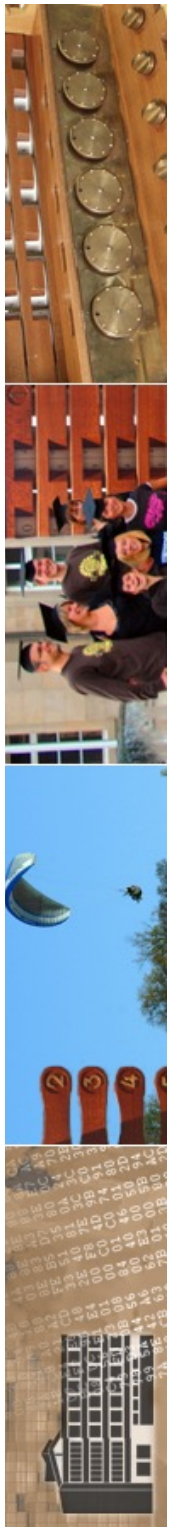

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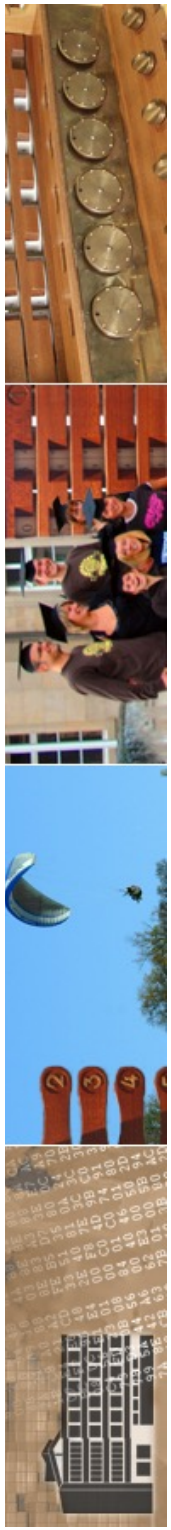
# cgi Essentials

- cgi-Programm muss **ausführbar** sein
- liegt auf dem Server im Unterordner cgi-bin
- Ausgabe beginnt mit:

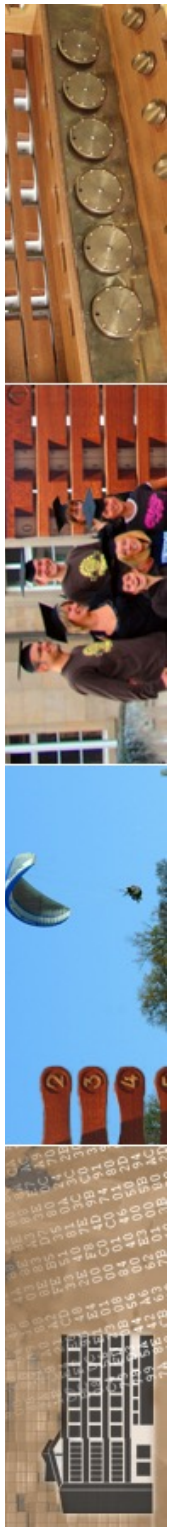
```
Content-type: text/html
\n
```

- Zugriff: URL beginnt mit **cgi-bin**



# Sprachen für CGI

- alles „ausführbare“
- alle compilierten Sprachen (C, C++, C#, …)
- beliebt: Scriptsprachen wie Perl, Python, Ruby
  - Java ist **nicht** direkt möglich – warum?



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# Scriptsprachen für CGI

- Scriptsprache: interpretierte, nichttypisierte Sprache
- relevant für CGI
  - **Python**
  - PERL: der ewige Klassiker
  - Ruby

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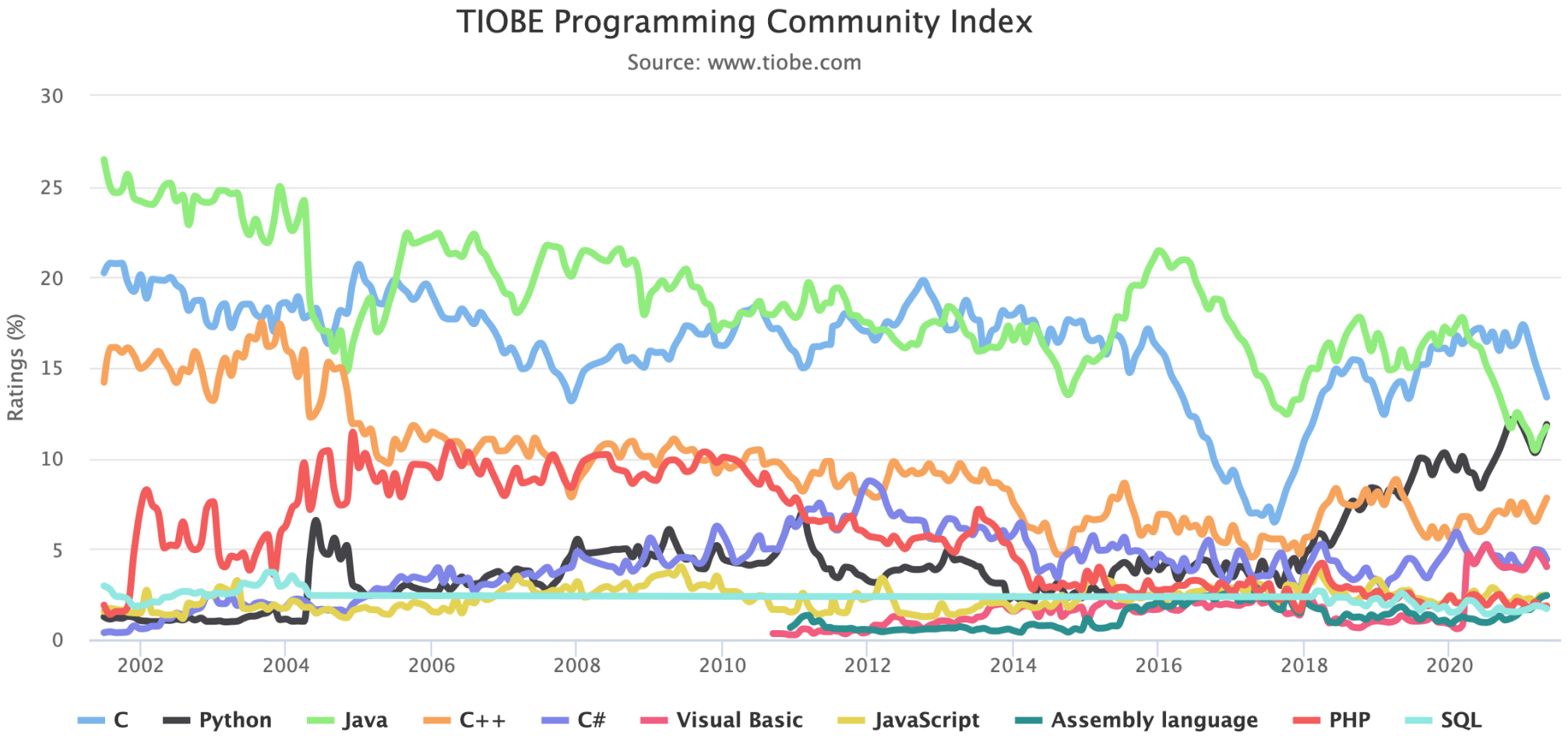
# TIOBE Index May 2021

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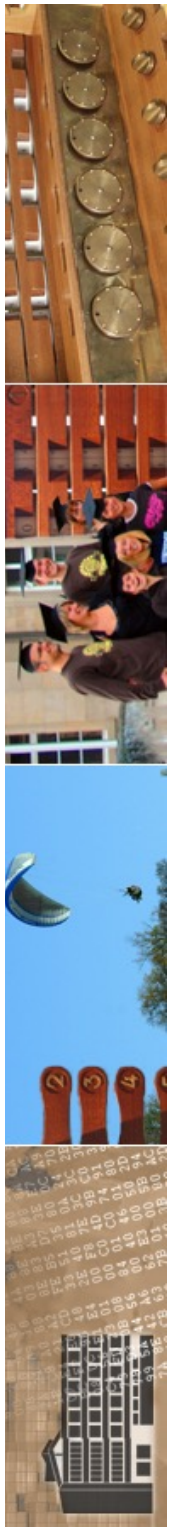

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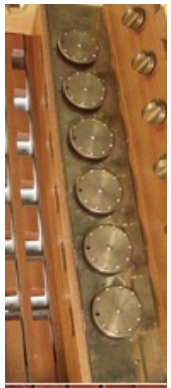
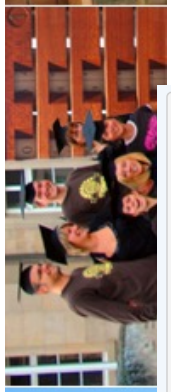
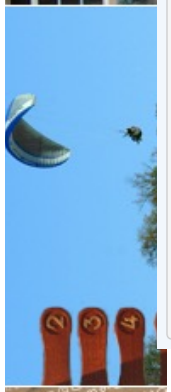
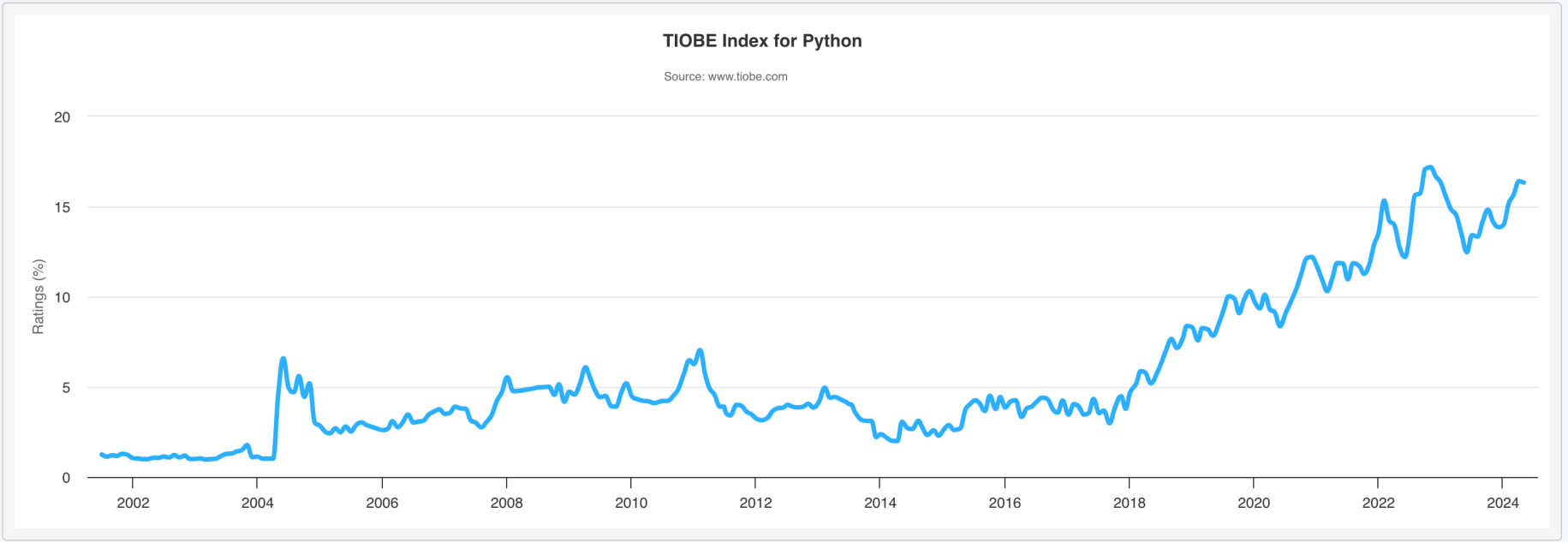
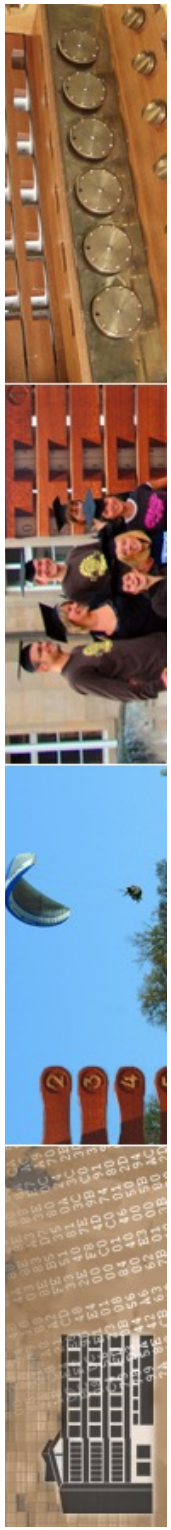
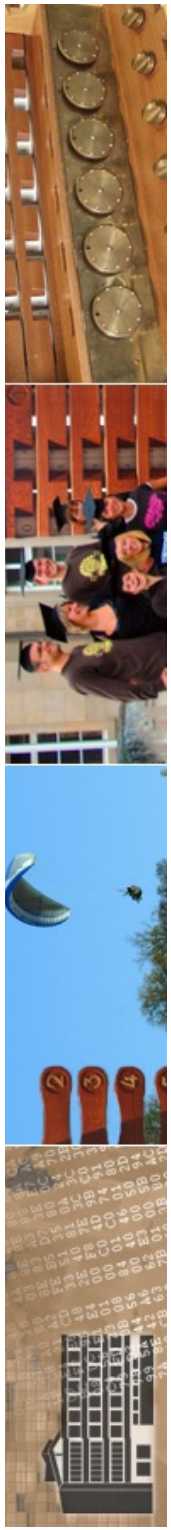
|---|---|---|---|---|---|
| 1 | 1 | | Python | 16.33% | +2.88% |
| 2 | 2 | | C | 9.98% | -3.37% |
| 3 | 4 | ↑ | C++ | 9.53% | -2.43% |
| 4 | 3 | ↓ | Java | 8.69% | -3.53% |
| 5 | 5 | | C# | 6.49% | -0.94% |
| 6 | 7 | ↑ | JavaScript | 3.01% | +0.57% |
| 7 | 6 | ↓ | Visual Basic | 2.01% | -1.83% |
| 8 | 12 | ⇈ | Go | 1.60% | +0.61% |
| 9 | 9 | | SQL | 1.44% | -0.03% |
| 10 | 19 | ⇈ | Fortran | 1.24% | +0.46% |
| 11 | 11 | | Delphi/Object Pascal | 1.24% | +0.23% |
| 12 | 10 | ↓ | Assembly language | 1.07% | -0.13% |
| 13 | 18 | ⇈ | Ruby | 1.06% | +0.26% |
| 14 | 15 | ↑ | MATLAB | 1.06% | +0.18% |
| 15 | 14 | ↓ | Swift | 1.01% | +0.09% |
| 16 | 8 | ⇊ | PHP | 0.97% | -0.62% |



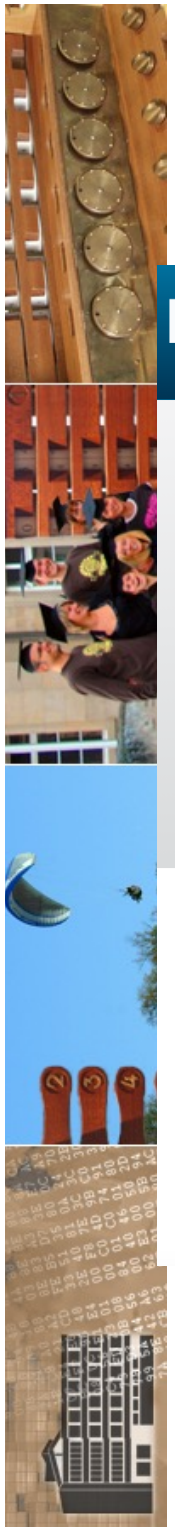


# die Scriptsprache Perl

- **PERL: Practical Extraction and Report Language**
  (Praktische Sprache für Datenextraktion und -ausgabe)
  oder:
  **Pathologically Electic Rubbish Lister** ;-)
  (krankhaft zusammengeschustertes Auflistungsprogramm für wirres Zeug)

- »Erfinder« Larry Wall, 1987

- aktuelle Version: 5.38.2 und (endlich) 6.0.x
  (verwenden Sie mindestens 5.004)



Perl

ABOUT | DOWNLOAD 5.38.2 | LEARN | DOCS | CPAN | COMMUNITY

## That's why we love Perl

25,000 extensions on CPAN

Perl is a highly capable, feature-rich programming language with over 36 years of development.

DOWNLOAD AND GET STARTED

### Learning

With free online books, over 25,000 extension modules, and a large developer community, there are many ways to learn Perl.

### Community

Perl has an active world wide community with over 230 local groups, mailing lists and support/discussion websites.

### Docs

Core documentation, FAQs and translations.

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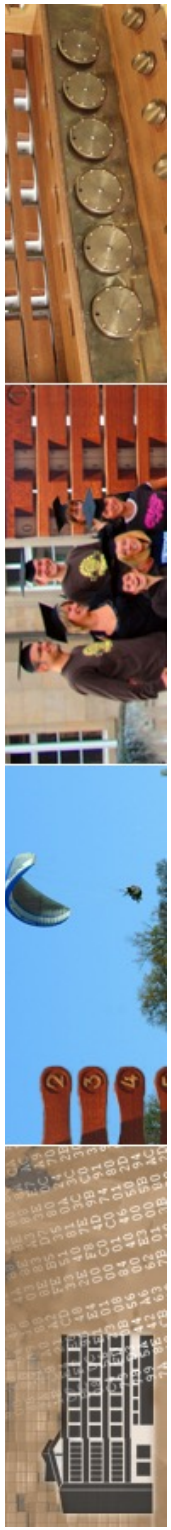

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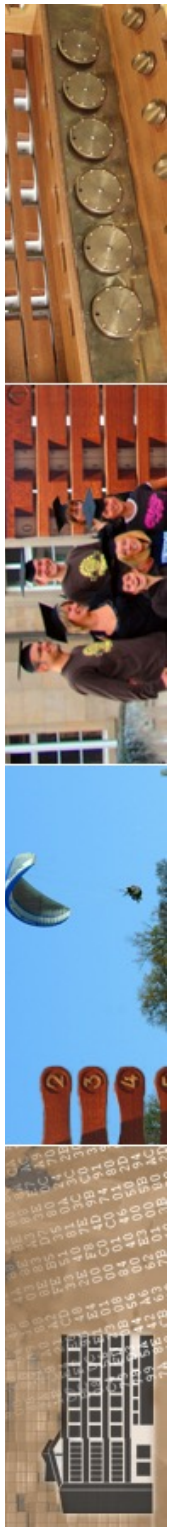
# die Scriptsprache RUBY

- Erfinder Yukihiro (Matz) Matsumoto
  - Entwicklung ab 1993, erste Veröffentlichung 1995
  - erst seit ~2000 englischsprachige Dokumentation
  - Name ist Anspielung auf PERL

  - stark objektorientiert
  - Grundlage für Ruby on Rails
  - aktuell **3.2.2**/3.1.4/3.0.6/2.7.8

Ruby
DER BESTE FREUND EINES PROGRAMMIERERS



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Ruby
A PROGRAMMER'S BEST FRIEND

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## Ruby is...

A dynamic, open source programming language with a focus on simplicity and productivity. It has an elegant syntax that is natural to read and easy to write.

Download Ruby or Read More...

```
# The famous Hello World
# Program is trivial in
# Ruby. Superfluous:
#
# * A "main" method
# * Newline
# * Semicolons
#
# Here is the Code:

puts "Hello World!"
```

### Ruby 3.3.2 Released

Ruby 3.3.2 has been released.

Continue Reading...

Posted by k0kubun on 30 May 2024

### Datadog provides OSS community support for ruby-lang.org

We are excited to announce that Ruby's official website, ruby-lang.org, has adopted Datadog for monitoring by Datadog OSS community support.

Continue Reading...

Posted by hsbt on 30 May 2024

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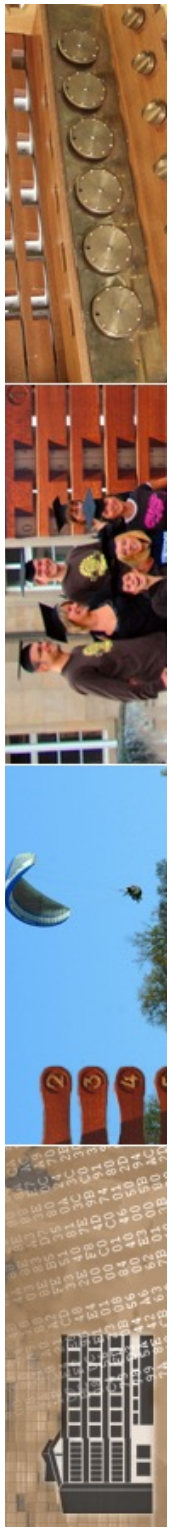
**Get Started**, it's easy!

- Try Ruby! (in your browser)
- Ruby in Twenty Minutes
- Ruby from Other Languages

**Explore** a new world...

- Documentation
- Academic Research
- Libraries
- Success Stories



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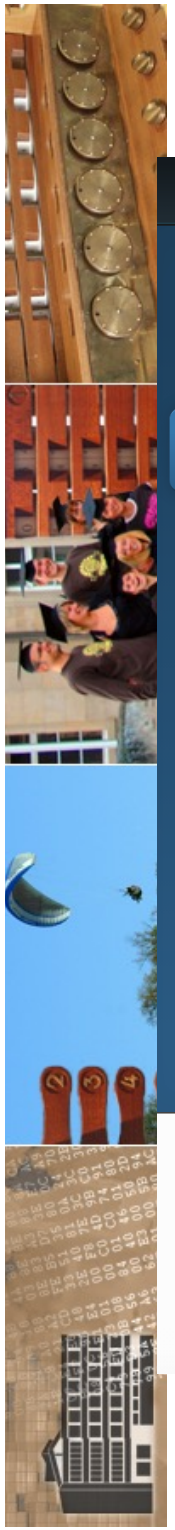
# die Scriptsprache PYTHON

- Erfinder Guido van Rossjm
  - Centrum voor Wiskunde en Informatica (CWI), Amsterdam `http://www.cwi.nl`
- Entwicklung ab 1989
- zentrale Quelle:
  www.python.org
- Pflege und Lizenz:
  Python Software Foundation PSF



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```
# Python 3: List comprehensions
>>> fruits = ['Banana', 'Apple', 'Lime']
>>> loud_fruits = [fruit.upper() for fruit in
fruits]
>>> print(loud_fruits)
['BANANA', 'APPLE', 'LIME']

# List and the enumerate function
>>> list(enumerate(fruits))
[(0, 'Banana'), (1, 'Apple'), (2, 'Lime')]
```

**Compound Data Types**

Lists (known as arrays in other languages) are one of the compound data types that Python understands. Lists can be indexed, sliced and manipulated with other built-in functions. More about lists in Python 3

1 2 3 4 5

Python is a programming language that lets you work quickly and integrate systems more effectively. »» Learn More

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Whether you're new to programming or an experienced developer, it's easy to learn and

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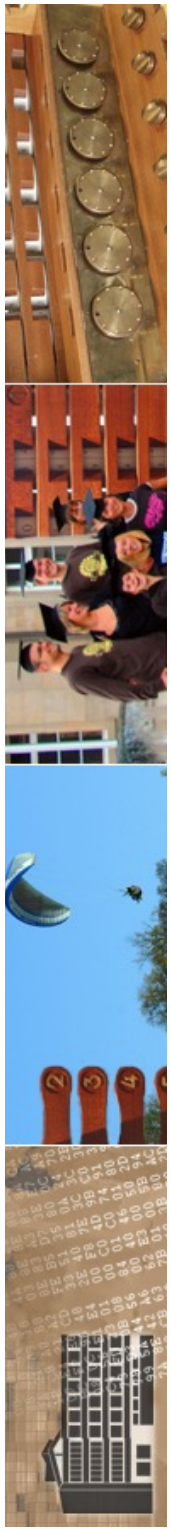
download for all versions!

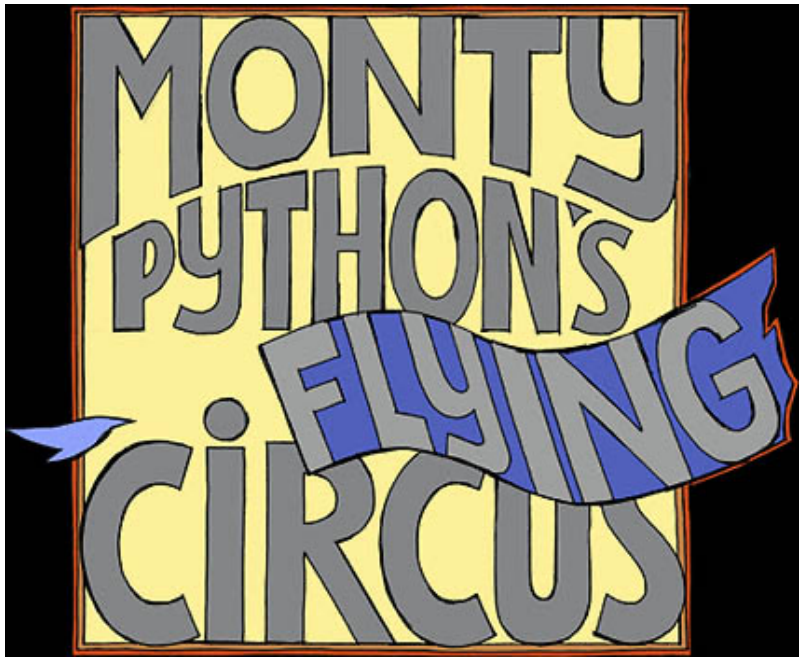
**Docs**
Documentation for Python's standard library, along with tutorials and guides, are

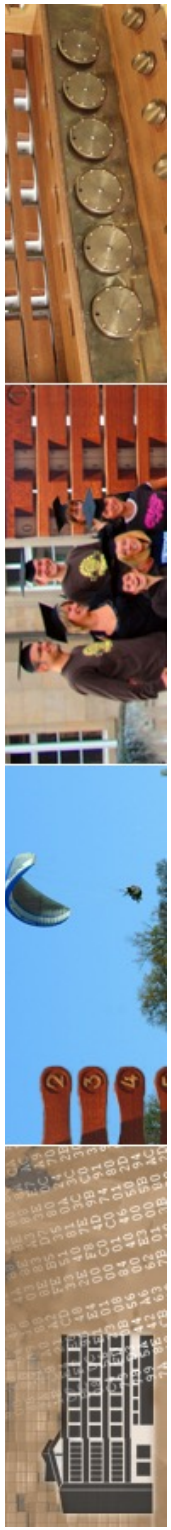
**Jobs**
Looking for work or have a Python related position that you're trying to hire for? Our



# zum Namen

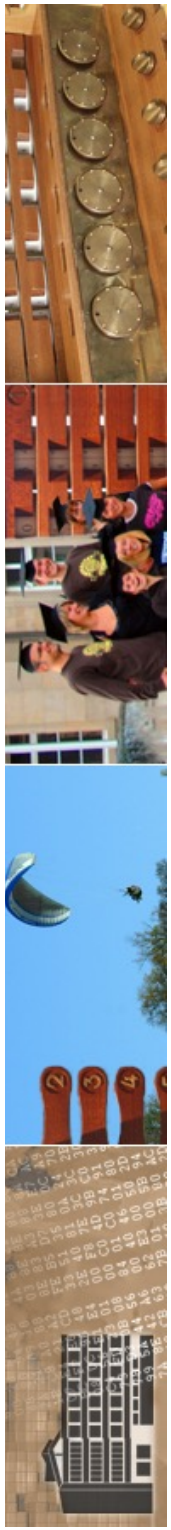
- der Name »Python« kommt *nicht* von der gleichnamigen Schlange, sondern ist ein Bezug zur englischen Comedy-Gruppy **Monty Python** (Das Leben des Brian, Monty Pythons Flying Circus, ...)





# Warum PYTHON?

- moderne Scriptsprache (»PERL++«)
  - plattformunabhängig, da interpretiert
- objektorientiert
- netzwerkzentriert
- ...für CGI geeignet, aber auch für mehr!
- ähnlich wie in PERL sind viele Module verfügbar
- frei unter GPL



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# aktuelle Version

- aktuelle Version: PYTHON 3.12.3
  - für alle gängigen Betriebssysteme verfügbar

## What's New In Python 3.10

| | |
|---|---|
| **Release:** | 3.10.4 |
| **Date:** | May 20, 2022 |
| **Editor:** | Pablo Galindo Salgado |

This article explains the new features in Python 3.10, comp

For full details, see the changelog.

### Summary – Release highlights

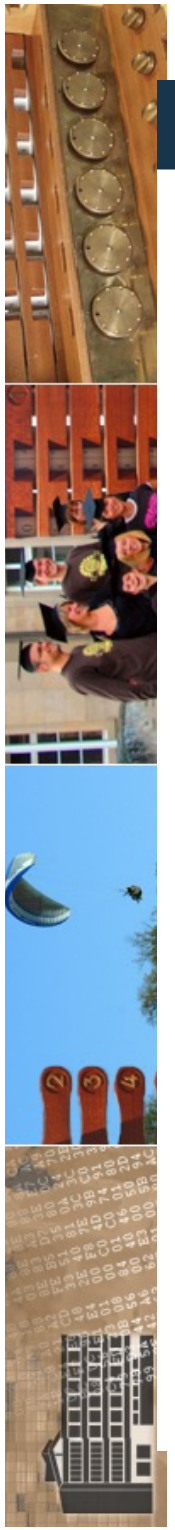
New syntax features:

- PEP 634, Structural Pattern Matching: Specification
- PEP 635, Structural Pattern Matching: Motivation and Rationale
- PEP 636, Structural Pattern Matching: Tutorial

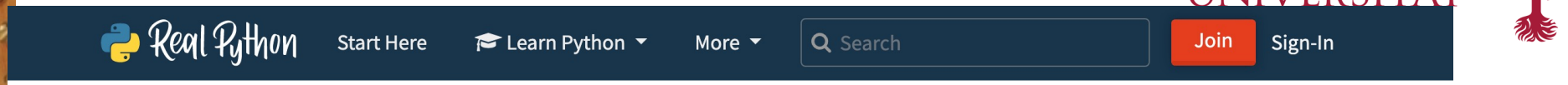
```
thomas@u-163-c018 =>
thomas@u-163-c018 =>
thomas@u-163-c018 =>
thomas@u-163-c018 =>
thomas@u-163-c018 => python3 -V
Python 3.11.3
thomas@u-163-c018 =>
thomas@u-163-c018 =>
thomas@u-163-c018 =>
```

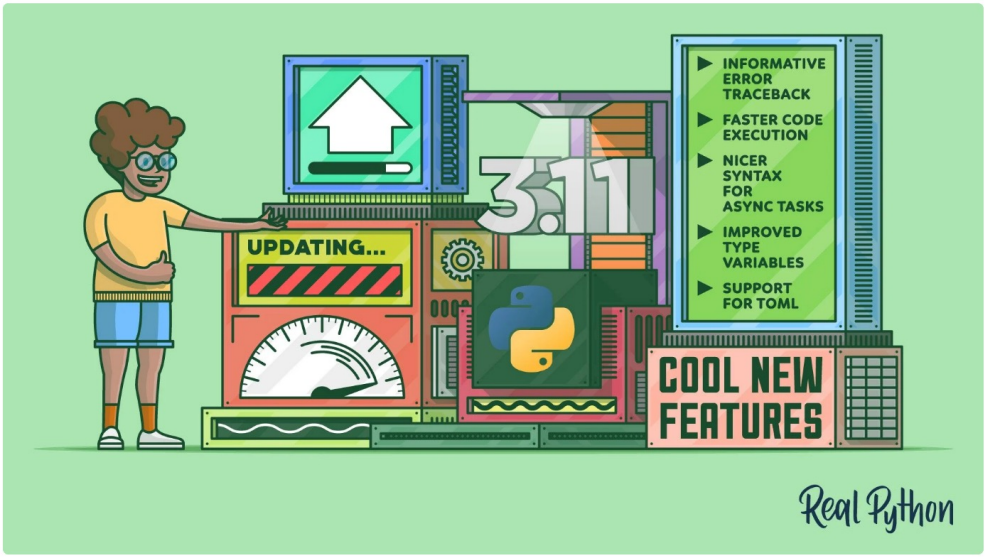
```
C:\Users\thomas\Documents>python -V
Python 3.4.3

C:\Users\thomas\Documents>
```

- PEP 626, Precise line numbers for debugging and other tools.








# Python 3.11: Cool New Features for You to Try

by Geir Arne Hjelle Oct 24, 2022 16 Comments

intermediate python

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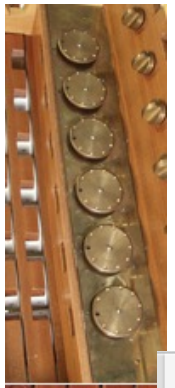
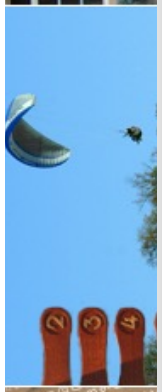
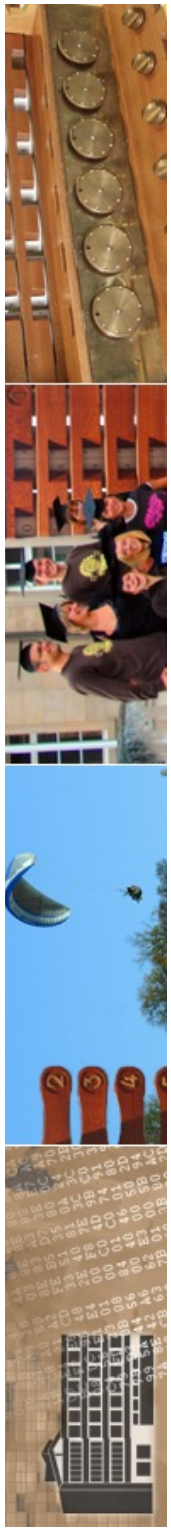





Python 3.11

| Name | Änderungsdatum | Größe | Art |
|---|---|---|---|
| Python Documentation.html | Heute, 21:07 | 99 Byte | Alias |
| IDLE.app | Heute, 21:07 | 188 KB | Programm |
| Install Certificates.command | 05.04.2023, 02:25 | 1 KB | Termina...ll-Skript |
| License.rtf | 05.04.2023, 02:25 | 15 KB | RTF-Dokument |
| Python Launcher.app | Heute, 21:07 | 402 KB | Programm |
| ReadMe.rtf | 05.04.2023, 02:25 | 3 KB | RTF-Dokument |
| Update Shell Profile.command | 05.04.2023, 02:25 | 3 KB | Termina...ll-Skript |

Macintosh HD › Programme › Python 3.11



# Python 3.10.4

**Release Date:** March 24, 2022

# Browse the docs online or download a copy of your own.

Python's documentation, tutorials, and guides are constantly evolving.
Get started here, or scroll down for documentation broken out by type and subject.

Python Docs

See also Documentation Releases by Version

## Beginner

- Beginner's Guide
- Python FAQs

## Moderate

- Python Periodicals
- Python Books

## Advanced

- Python Packaging User Guide
- In-development Docs
- Guido's Essays

## General

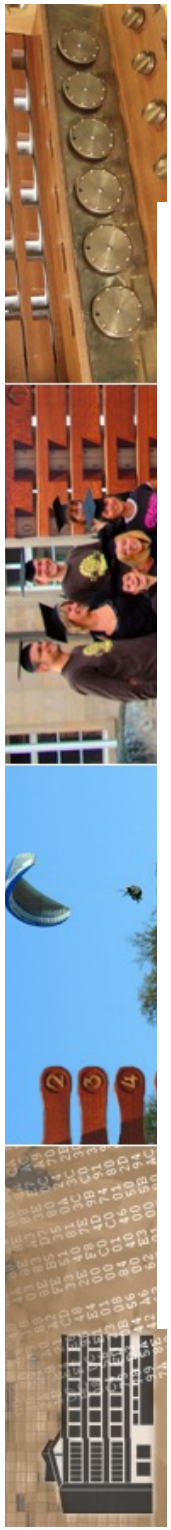
- PEP Index
- Python Videos
- Developer's Guide

## Python 3.x Resources

- Browse Python 3.9.5 Documentation - (Module Index)
  - What's new in Python 3.9
  - Tutorial
  - Library Reference
  - Language Reference
  - Extending and Embedding
  - Python/C API
  - Using Python

## Porting from Python 2 to Python 3

- FAQ: Sunsetting Python 2
- Final Python 2.7 Release Schedule
- Python 3 Statement
- Porting Python 2 Code to Python 3
  - Determine what projects are blocking you from porting to Python 3
  - Python 2 Support and Migration







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Docs by version

Python 3.14 (in development)
Python 3.13 (pre-release)
Python 3.12 (stable)
Python 3.11 (security-fixes)
Python 3.10 (security-fixes)
Python 3.9 (security-fixes)
Python 3.8 (security-fixes)
Python 3.7 (EOL)
Python 3.6 (EOL)
Python 3.5 (EOL)
Python 3.4 (EOL)
Python 3.3 (EOL)
Python 3.2 (EOL)
Python 3.1 (EOL)
Python 3.0 (EOL)
Python 2.7 (EOL)
Python 2.6 (EOL)
All versions

Other resources

PEP Index
Beginner's Guide
Book List
Audio/Visual Talks
Python Developer's Guide

# Python 3.12.3 documentation

Welcome! This is the official documentation for Python 3.12.3.

**Documentation sections:**

### What's new in Python 3.12?
*Or all "What's new" documents since Python 2.0*

### Tutorial
*Start here: a tour of Python's syntax and features*

### Library reference
*Standard library and builtins*

### Language reference
*Syntax and language elements*

### Python setup and usage
*How to install, configure, and use Python*

### Python HOWTOs
*In-depth topic manuals*

### Installing Python modules
*Third-party modules and PyPI.org*

### Distributing Python modules
*Publishing modules for use by other people*

### Extending and embedding
*For C/C++ programmers*

### Python's C API
*C API reference*

### FAQs
*Frequently asked questions (with answers!)*

**Indices, glossary, and search:**

### Global module index
*All modules and libraries*

### General index
*All functions, classes, and terms*

### Glossary

### Search page
*Search this documentation*

### Complete table of contents
*Lists all sections and subsections*

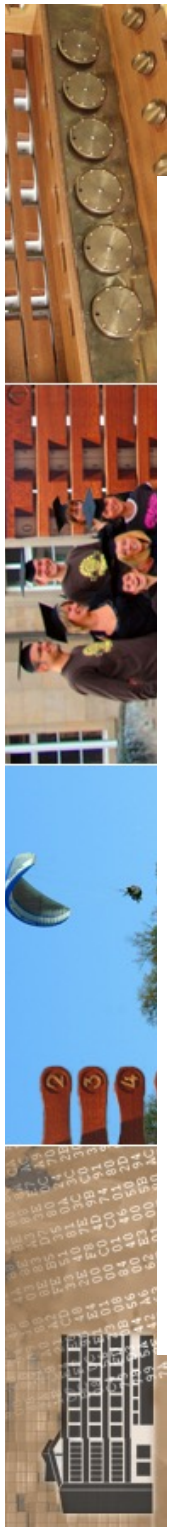






Table of Contents



# What's New In Python 3.11

| | |
|---|---|
| **Release:** | 3.11.3 |
| **Date:** | May 22, 2023 |
| **Editor:** | Pablo Galindo Salgado |

This article explains the new features in Python 3.11, compared to 3.10.

For full details, see the changelog.

## Summary – Release highlights

- Python 3.11 is between 10-60% faster than Python 3.10. On average, we measured a 1.25x speedup on the standard benchmark suite. See Faster CPython for details.

New syntax features:

- PEP 654: Exception Groups and except*

New built-in features:

- PEP 678: Exceptions can be enriched with notes

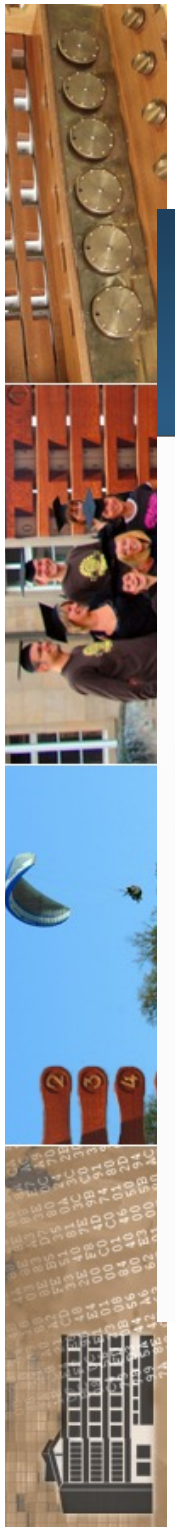
New standard library modules:

- **PEP 680**: `tomllib` — Support for parsing TOML in the Standard Library

Interpreter improvements:

- PEP 657: Fine-grained error locations in tracebacks
- New `-P` command line option and `PYTHONSAFEPATH` environment variable to disable automatically prepending potentially unsafe paths to `sys.path`

New typing features:



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# Python 3.12.3

**Release Date:** April 9, 2024

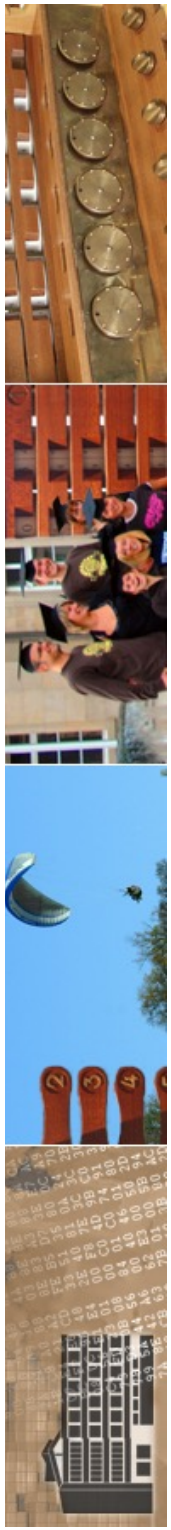
## This is the third maintenance release of Python 3.12

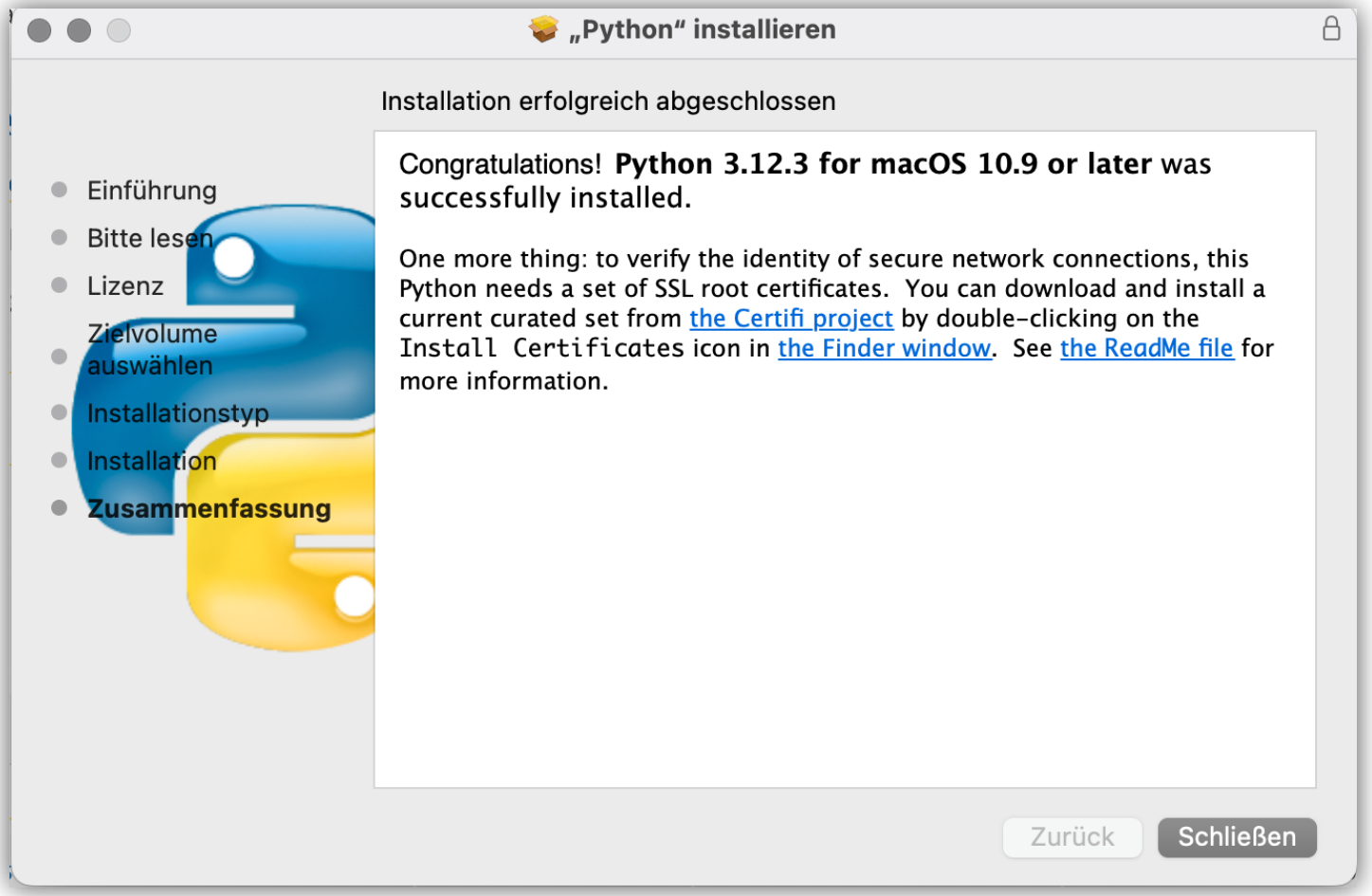
Python 3.12 is the newest major release of the Python programming language, and it contains many new features and optimizations. 3.12.3 is the latest maintenance release, containing more than 300 bugfixes, build improvements and documentation changes since 3.12.2.

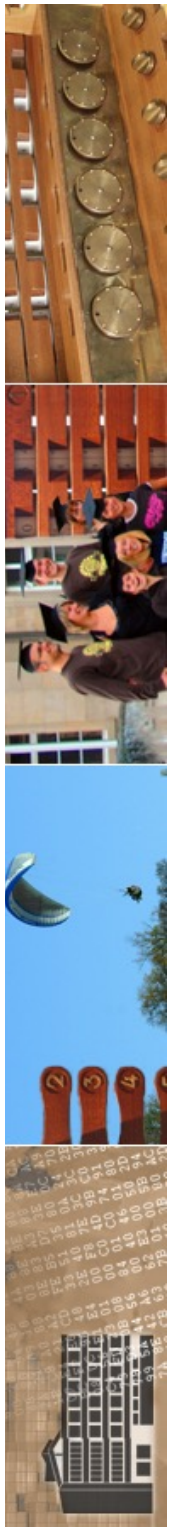
## Major new features of the 3.12 series, compared to 3.11

### New features

- More flexible f-string parsing, allowing many things previously disallowed (PEP 701).
- Support for the buffer protocol in Python code (PEP 688).
- A new debugging/profiling API (PEP 669).
- Support for isolated subinterpreters with separate Global Interpreter Locks (PEP 684).
- Even more improved error messages. More exceptions potentially caused by typos now make suggestions to the user.
- Support for the Linux `perf` profiler to report Python function names in traces.
- Many large and small performance improvements (like PEP 709 and support for the BOLT binary optimizer), delivering an estimated 5% overall performance improvement.




„Python“ installieren
Installation erfolgreich abgeschlossen
Einführung
Bitte lesen
Lizenz
Zielvolume auswählen
Installationstyp
Installation
Zusammenfassung
Congratulations! Python 3.12.3 for macOS 10.9 or later was successfully installed.
One more thing: to verify the identity of secure network connections, this Python needs a set of SSL root certificates. You can download and install a current curated set from the Certifi project by double-clicking on the Install Certificates icon in the Finder window. See the ReadMe file for more information.
Zurück
Schließen



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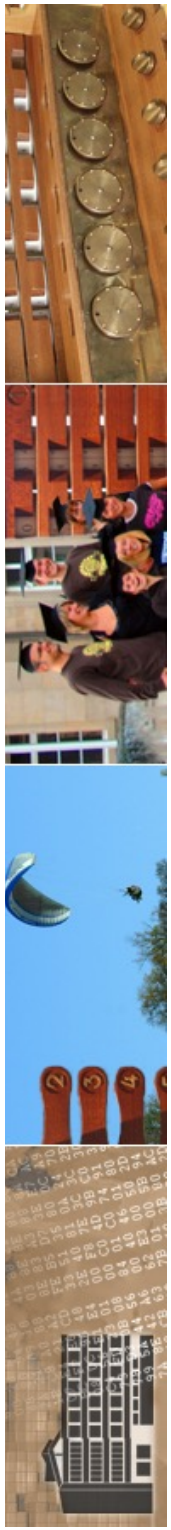
```
[thomas@PetitMouton =>
[thomas@PetitMouton =>
[thomas@PetitMouton =>
[thomas@PetitMouton => python3 -V
 Python 3.12.3
[thomas@PetitMouton =>
[thomas@PetitMouton =>
```



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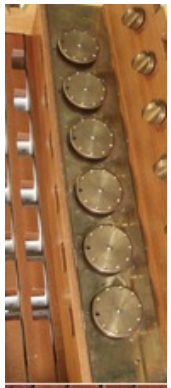
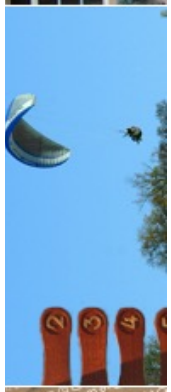
# Dokumentation

- zentral für Dokumentation:

  https://www.python.org/doc/



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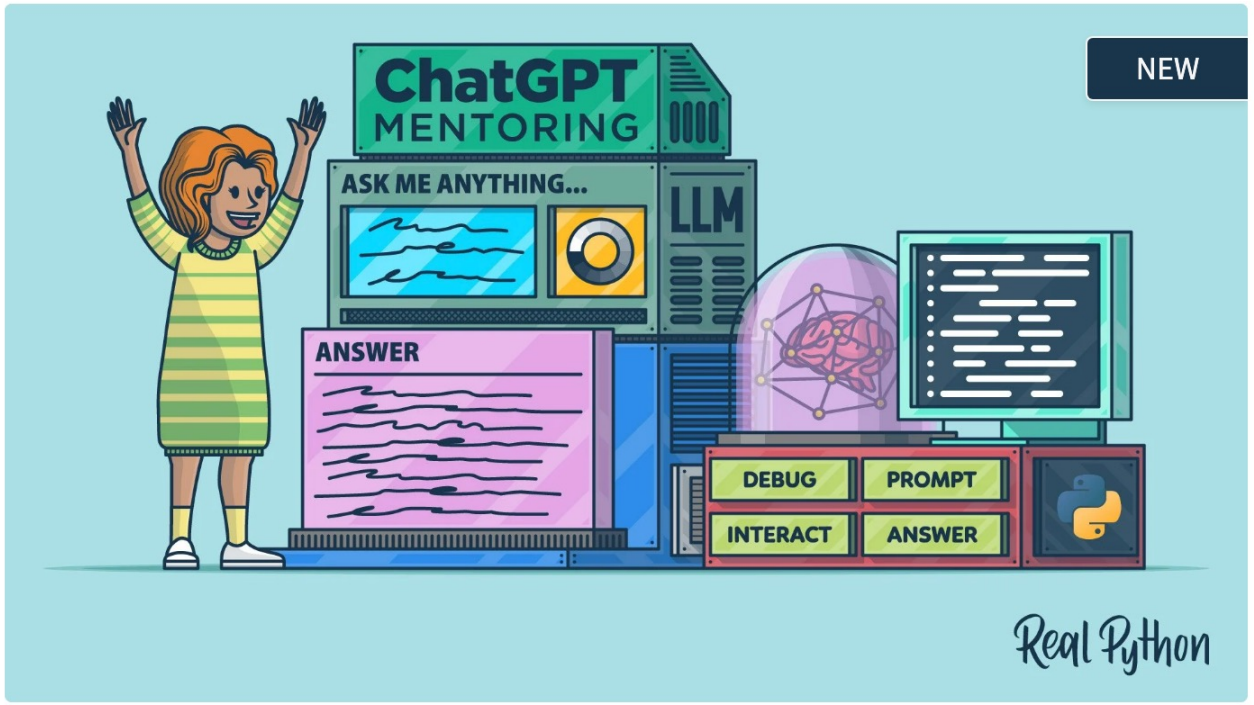
Real Python | Start Here | Learn Python | More | Search

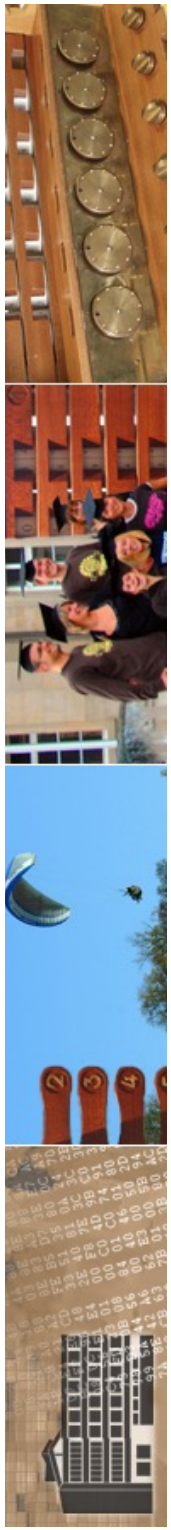
# Real Python Tutorials




## ChatGPT: Your Personal Python Coding Mentor

Large language models have gained popularity since OpenAI released ChatGPT. In this tutorial, you'll learn how to use ChatGPT as your Python coding mentor. You'll study a variety of use cases, learn how to interpret results, and see that you need to beware of incorrect and irrelevant responses.

May 17, 2023 basics best-practices



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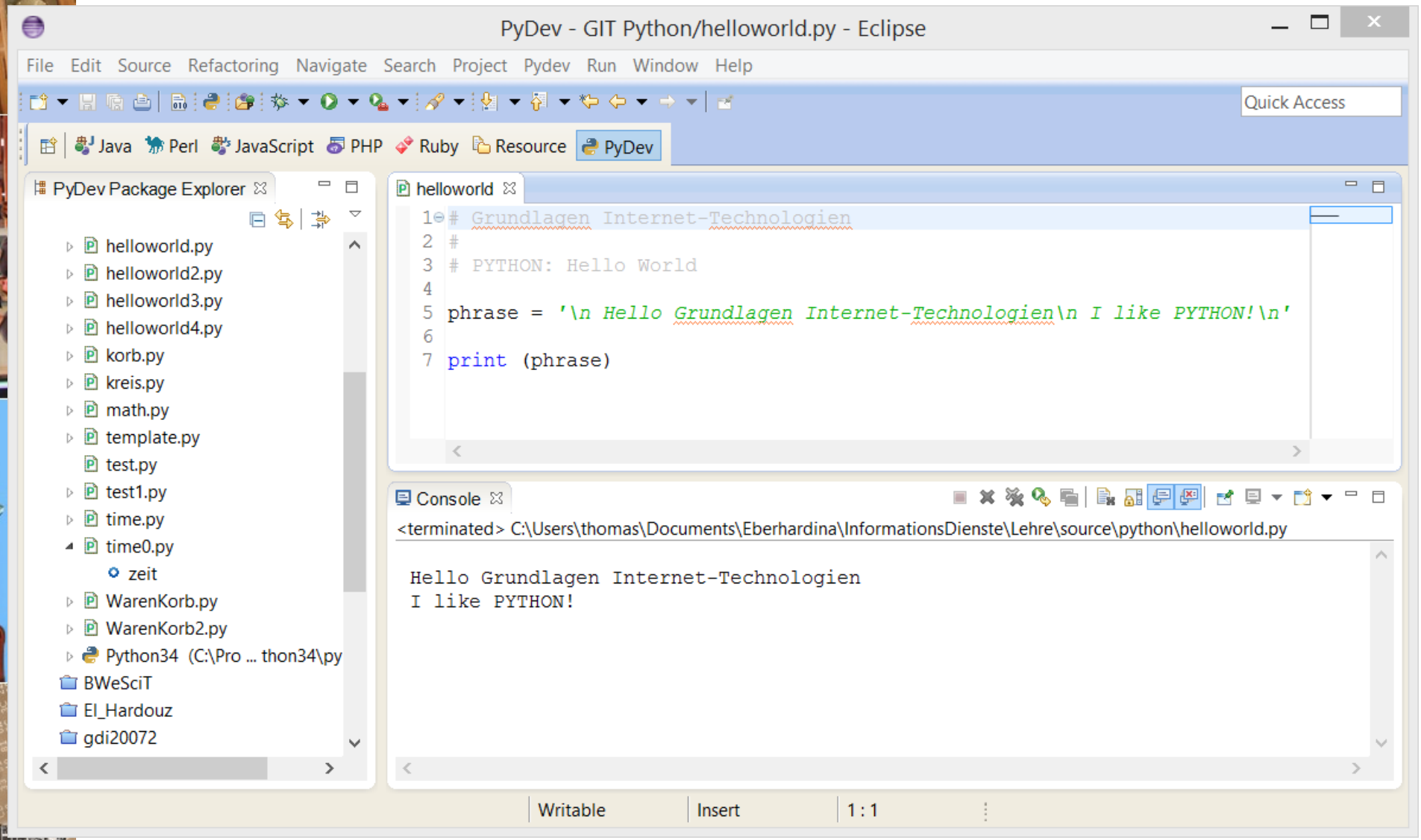
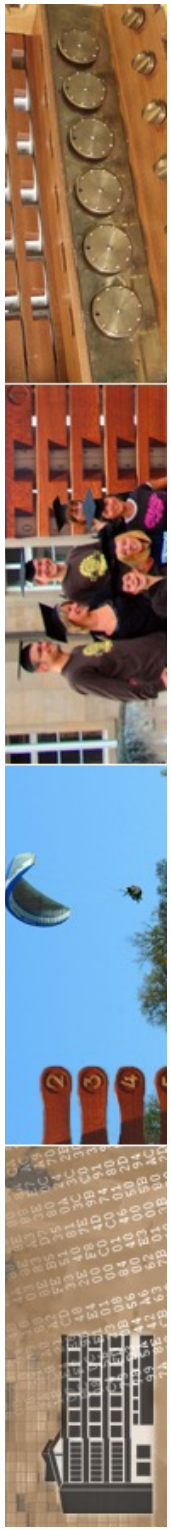
# Entwicklungsumgebung

- es gibt (wenige) Python-Plugins für Eclipse
- frei und empfehlenswert: Pydev
  **http://pydev.sf.net**
  - Installation über Eclipse-Update-Manager
  - damit pydev-Projekte
  - eigene Python-Perspektive


PyDev - GIT Python/helloworld.py - Eclipse
File Edit Source Refactoring Navigate Search Project Pydev Run Window Help
Quick Access
Java Perl JavaScript PHP Ruby Resource PyDev
PyDev Package Explorer
helloworld.py
helloworld2.py
helloworld3.py
helloworld4.py
korb.py
kreis.py
math.py
template.py
test.py
test1.py
time.py
time0.py
zeit
WarenKorb.py
WarenKorb2.py
Python34 (C:\Pro ... thon34\py
BWeSciT
El_Hardouz
gdi20072
helloworld
1 # Grundlagen Internet-Technologien
2 #
3 # PYTHON: Hello World
4
5 phrase = '\n Hello Grundlagen Internet-Technologien\n I like PYTHON!\n'
6
7 print (phrase)
Console
<terminated> C:\Users\thomas\Documents\Eberhardina\InformationsDienste\Lehre\source\python\helloworld.py
Hello Grundlagen Internet-Technologien
I like PYTHON!
Writable
Insert
1 : 1



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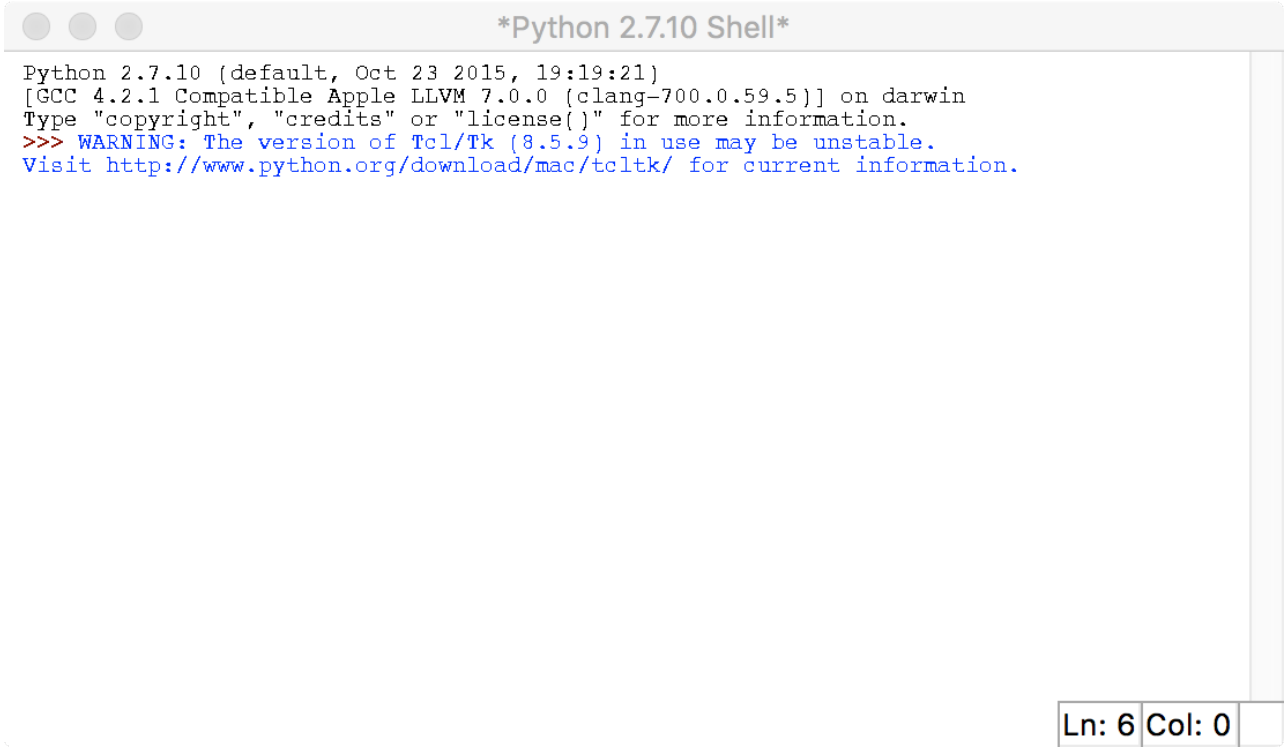
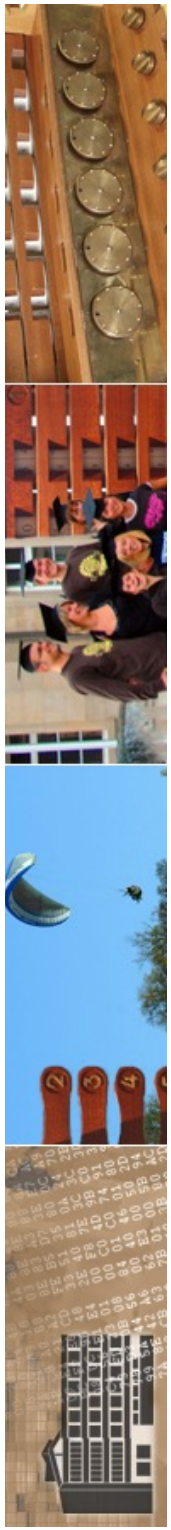
# IDLE

- Python kommt mit einfacher DIE:
  IDLE: Integreted DeveLopment Environment





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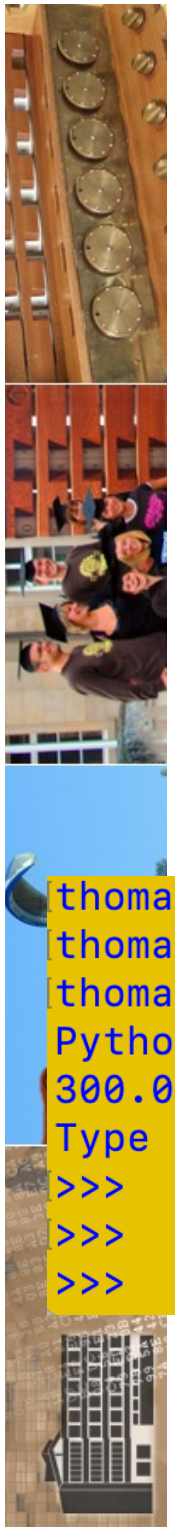
# IDLE3

IDLE Shell 3.9.5

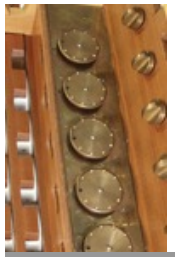
```
Python 3.9.5 (v3.9.5:0a7dcbdb13, May  3 2021, 13:17:02)
[Clang 6.0 (clang-600.0.57)] on darwin
Type "help", "copyright", "credits" or "license()" for more information.
>>> 
```



# erste Schritte, Grundprinzip

- Python hat einen »interaktiven Modus« - direktes Arbeiten mit dem Interpreter
  - (Beenden durch <STRG>Z , <STRG>D oder exit() )

```
thomas@u-163-c018 =>
thomas@u-163-c018 =>
thomas@u-163-c018 => python3
Python 3.11.3 (v3.11.3:f3909b8bc8, Apr  4 2023, 20:12:10) [Clang 13.0.0 (clang-1
300.0.29.30)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>>
>>>
>>>
```



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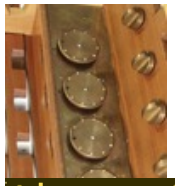
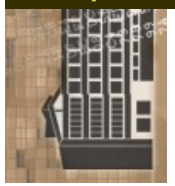
DOS Shell - python

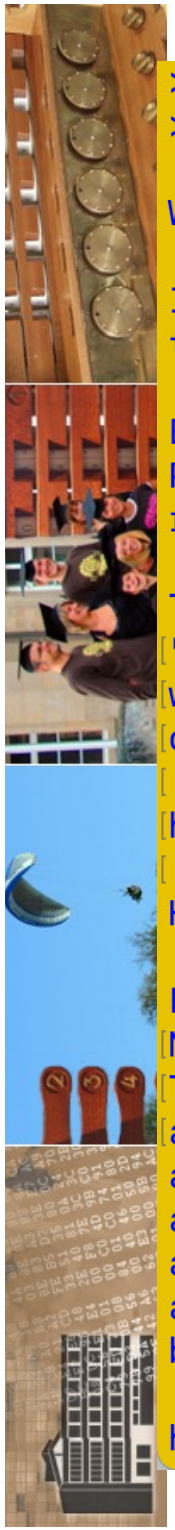
```
C:\Users\thomas\Documents>
C:\Users\thomas\Documents>
C:\Users\thomas\Documents>python
Python 3.4.3 (v3.4.3:9b73f1c3e601, Feb 24 2015, 22:44:40) [MSC v.1600 64 bit (AM
D64)] on win32
Type "help", "copyright", "credits" or "license" for more information.
>>> help()

Welcome to Python 3.4's help utility!

If this is your first time using Python, you should definitely check out
the tutorial on the Internet at http://docs.python.org/3.4/tutorial/.

Enter the name of any module, keyword, or topic to get help on writing
Python programs and using Python modules.  To quit this help utility and
return to the interpreter, just type "quit".

To get a list of available modules, keywords, symbols, or topics, type
"modules", "keywords", "symbols", or "topics".  Each module also comes
with a one-line summary of what it does; to list the modules whose name
or summary contain a given string such as "spam", type "modules spam".

help>
```



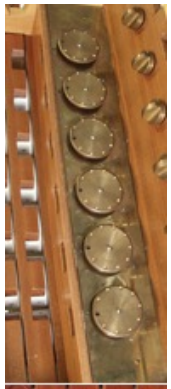


```
thomas@PetitMouton-2 =>
thomas@PetitMouton-2 => python3
Python 3.8.3 (v3.8.3:6f8c8320e9, May 13 2020, 16:29:34)
[Clang 6.0 (clang-600.0.57)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>>
>>> help()

Welcome to Python 3.8's help utility!

If this is your first time using Python, you should definitely check out
the tutorial on the Internet at https://docs.python.org/3.8/tutorial/.

Enter the name of any module, keyword, or topic to get help on writing
Python programs and using Python modules.  To quit this help utility and
return to the interpreter, just type "quit".

To get a list of available modules, keywords, symbols, or topics, type
"modules", "keywords", "symbols", or "topics".  Each module also comes
with a one-line summary of what it does; to list the modules whose name
or summary contain a given string such as "spam", type "modules spam".

help>
```





```
>>>
>>> help()

Welcome to Python 3.11's help utility!

If this is your first time using Python, you should definitely check out
the tutorial on the internet at https://docs.python.org/3.11/tutorial/.

Enter the name of any module, keyword, or topic to get help on writing
Python programs and using Python modules.  To quit this help utility and
return to the interpreter, just type "quit".

To get a list of available modules, keywords, symbols, or topics, type
"modules", "keywords", "symbols", or "topics".  Each module also comes
with a one-line summary of what it does; to list the modules whose name
or summary contain a given string such as "spam", type "modules spam".

help> keywords

Here is a list of the Python keywords.  Enter any keyword to get more help.

False               class               from                or
None                continue            global              pass
True                def                 if                  raise
and                 del                 import              return
as                  elif                in                  try
assert              else                is                  while
async               except              lambda              with
await               finally             nonlocal            yield
break               for                 not

help>
```

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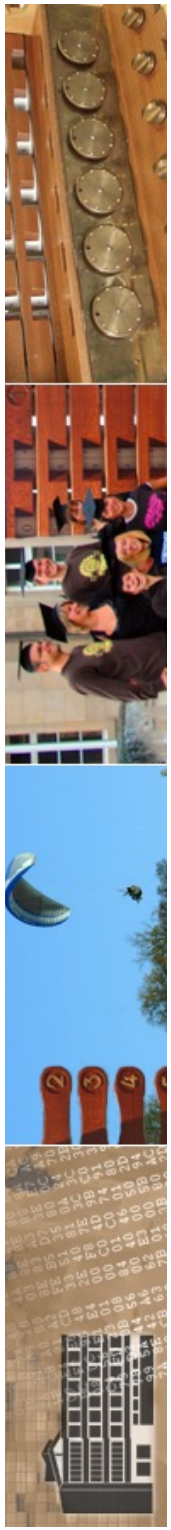
# ein erstes Python-Script

```
thomas@uni-vpn229 =>
thomas@uni-vpn229 =>
thomas@uni-vpn229 => more helloworld.py
# Grundlagen Internet-Technologien
#
# PYTHON: Hello World

phrase = '\n Hello Einführung Internet-Technologien\n I like PYTHON!\n'

print (phrase)
thomas@uni-vpn229 =>
thomas@uni-vpn229 =>
```



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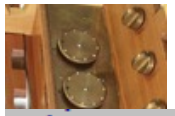
```
[thomas@uni-vpn229 =>
[thomas@uni-vpn229 =>
[thomas@uni-vpn229 =>
[thomas@uni-vpn229 => python3 helloworld.py

 Hello Einführung Internet-Technologien
 I like PYTHON!

[thomas@uni-vpn229 =>
[thomas@uni-vpn229 =>
[thomas@uni-vpn229 =>
 thomas@uni-vpn229 =>
```

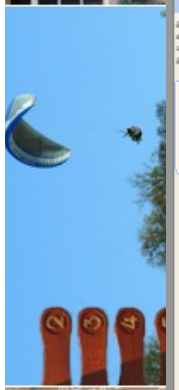


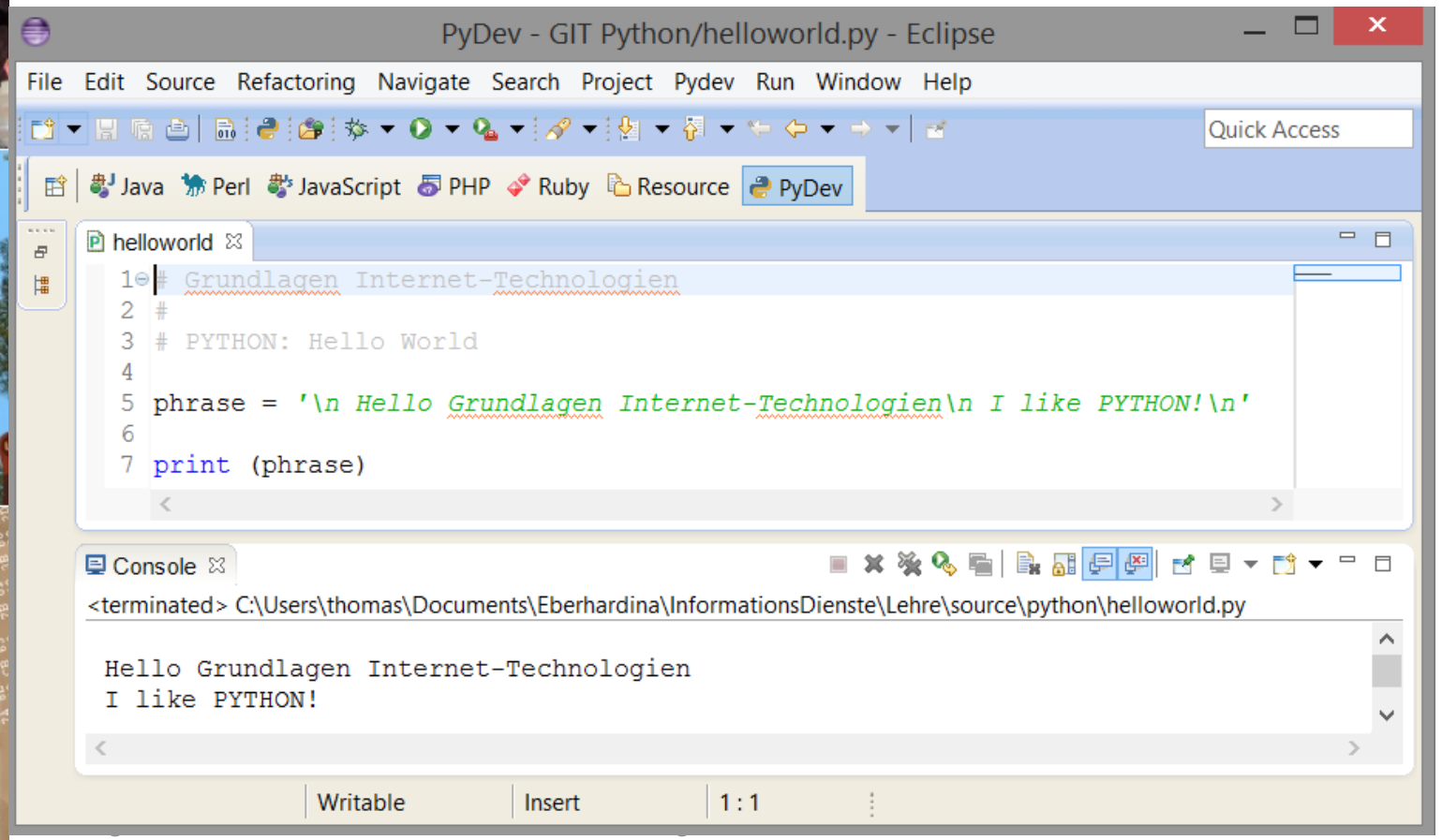


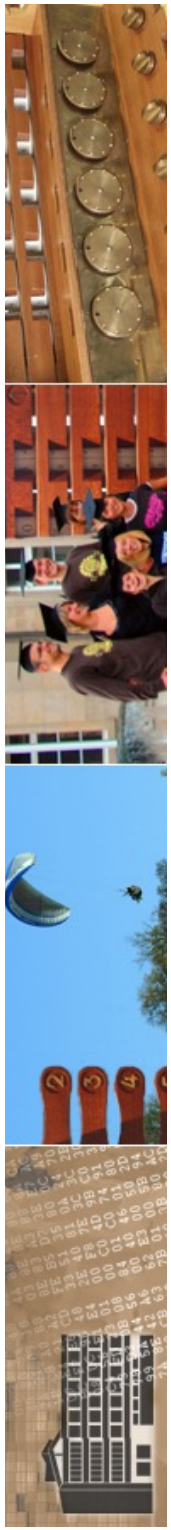
```
C:\Users\thomas\Documents\Eberhardina\InformationsDienste\Lehre\source\python>
C:\Users\thomas\Documents\Eberhardina\InformationsDienste\Lehre\source\python>py
thon helloworld.py

 Hello Grundlagen Internet-Technologien
 I like PYTHON!


C:\Users\thomas\Documents\Eberhardina\InformationsDienste\Lehre\source\python>
C:\Users\thomas\Documents\Eberhardina\InformationsDienste\Lehre\source\python>
```







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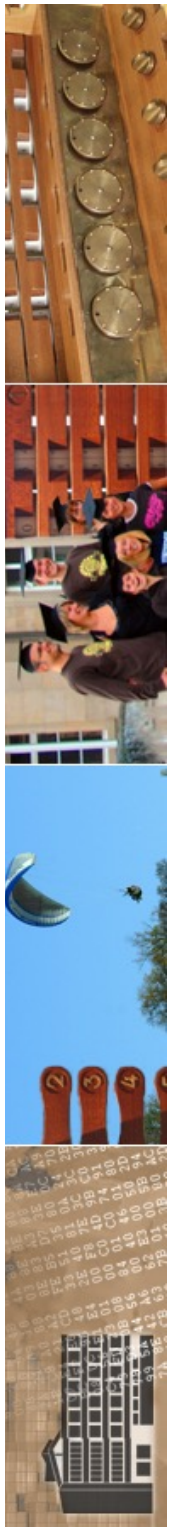
```
thomas@PetitMouton =>
thomas@PetitMouton => python3 helloGIT.py

 Hello Grundlagen Internet-Technologien
 Freedom and peace for Ukraine

thomas@PetitMouton =>
thomas@PetitMouton =>
```



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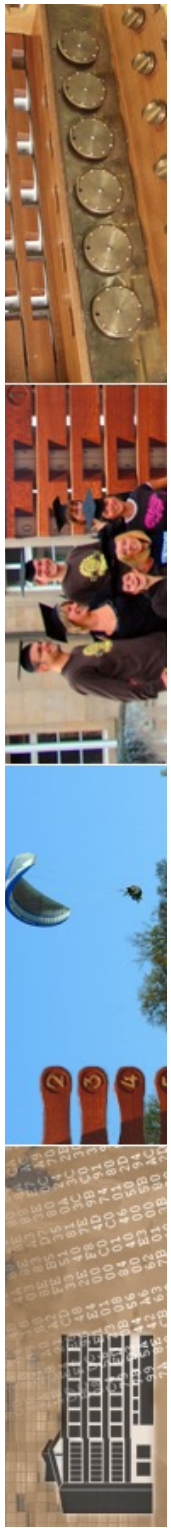
# Beispielanwendung

- Eingabe des Radius eines Kreises, Berechnung von Fläche und Umfang
  - Tastatur-Eingabe mittels

```
input(prompt)
```



```
thomas@uni-vpn229 =>
thomas@uni-vpn229 => more kreis.py
# Grundlagen Internet-Technologien
#
# Beispiel: Kreisberechnung von Python
#

### Tastatureingabe mit Prompt und Cast nach Gleitkomma
radius = float(input ("\n Bitte Radius eingeben: "));

pi = 3.1415926;

umfang  = 2.0 * pi * radius;
flaeche = pi * radius * radius;

print ("\n Die Flaeche des Kreises betraegt: " , flaeche , "\n");
print (" Der Umfang des Kreises betraegt:  " , umfang , "\n\n");
thomas@uni-vpn229 =>
thomas@uni-vpn229 =>
thomas@uni-vpn229 => python3 kreis.py

 Bitte Radius eingeben: 3

 Die Flaeche des Kreises betraegt:  28.274333400000003

 Der Umfang des Kreises betraegt:   18.849555600000002


thomas@uni-vpn229 =>
thomas@uni-vpn229 =>
```

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# Konsole im Browser

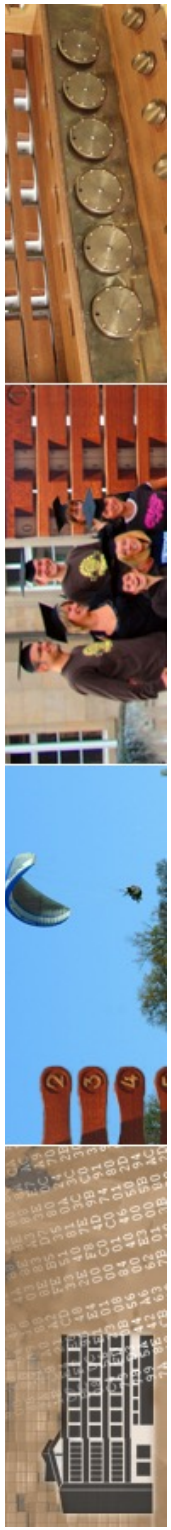
https://pyodide.org/en/stable/c

pyodide.org/en/stable/console.html

Apps | U Tü | HIS | IT | MacBook | Leica | Z | Wilier | Inissio | EU-DSGVO | PetitM

```
Welcome to the Pyodide terminal emulator 🐍
Python 3.10.2 (main, Apr  9 2022 20:52:01) on WebAssembly VM
Type "help", "copyright", "credits" or "license" for more information.
>>>
>>> phrase = 'Hello Grundlagen der Internet-Technologien!\n'
>>> print(phrase)
Hello Grundlagen der Internet-Technologien!

>>>
>>>
```



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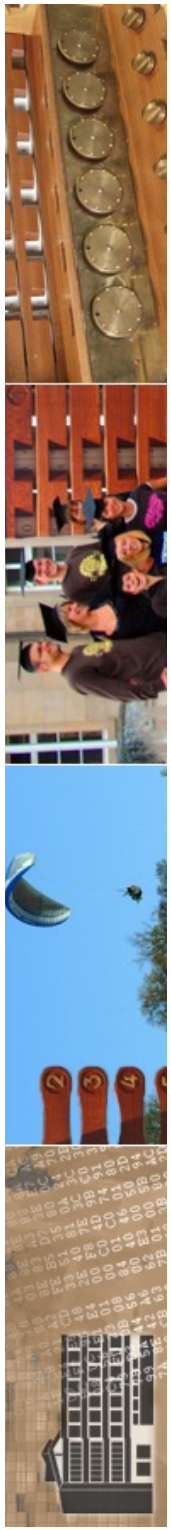
# Ein-/Ausgabe

- Python liefert ein recht komfortables IO-System
- Python2
  - Methode `input('Prompt')`
  - Methode `raw_input('Prompt') # Zeichenk.`
- Python3
  - Methode `eval('Prompt')`
  - Methode `input('Prompt') # Zeichenkette`



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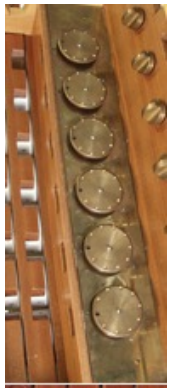
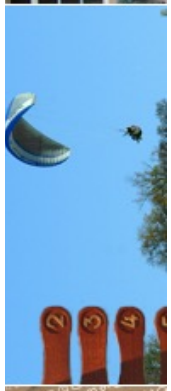
# Arbeitsweise des Interpreters

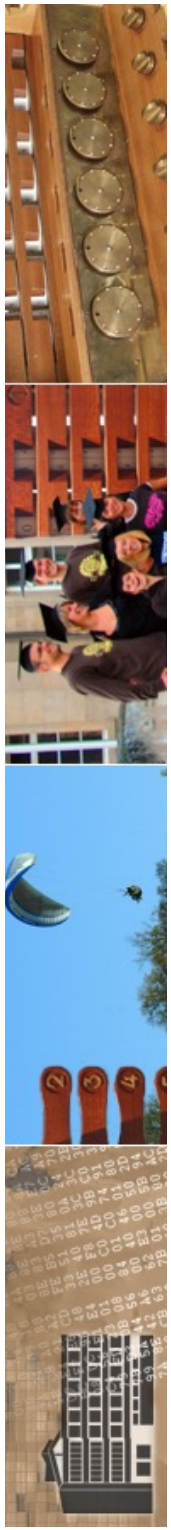
- Der Python-Interpreter arbeitet in 4 Schritten (vergleichbar dem PERL-»Interpreter«):
  - Einlesen der Datei (bzw. interaktive Eingabe) als 7-bit-ASCII-Strom
  - Lexikalische Analyse
  - Syntaktische Analyse durch Parser, Übersetzung in Bytecode
  - Interpretation des Bytecodes





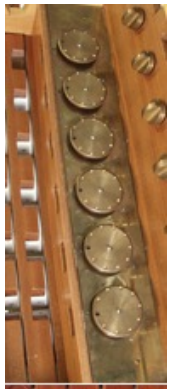

```
thomas@uni-vpn229 =>
thomas@uni-vpn229 => python3 -h
usage: /Library/Frameworks/Python.framework/Versions/3.9/bin/python3 [option] ... [-c cmd | -m mod | file | -] [arg] ...
Options and arguments (and corresponding environment variables):
-b     : issue warnings about str(bytes_instance), str(bytearray_instance)
         and comparing bytes/bytearray with str. (-bb: issue errors)
-B     : don't write .pyc files on import; also PYTHONDONTWRITEBYTECODE=x
-c cmd : program passed in as string (terminates option list)
-d     : turn on parser debugging output (for experts only, only works on
         debug builds); also PYTHONDEBUG=x
-E     : ignore PYTHON* environment variables (such as PYTHONPATH)
-h     : print this help message and exit (also --help)
-i     : inspect interactively after running script; forces a prompt even
         if stdin does not appear to be a terminal; also PYTHONINSPECT=x
-I     : isolate Python from the user's environment (implies -E and -s)
-m mod : run library module as a script (terminates option list)
-O     : remove assert and __debug__-dependent statements; add .opt-1 before
         .pyc extension; also PYTHONOPTIMIZE=x
-OO    : do -O changes and also discard docstrings; add .opt-2 before
         .pyc extension
-q     : don't print version and copyright messages on interactive startup
-s     : don't add user site directory to sys.path; also PYTHONNOUSERSITE
-S     : don't imply 'import site' on initialization
-u     : force the stdout and stderr streams to be unbuffered;
         this option has no effect on stdin; also PYTHONUNBUFFERED=x
-v     : verbose (trace import statements); also PYTHONVERBOSE=x
         can be supplied multiple times to increase verbosity
-V     : print the Python version number and exit (also --version)
         when given twice, print more information about the build
-W arg : warning control; arg is action:message:category:module:lineno
         also PYTHONWARNINGS=arg
-x     : skip first line of source, allowing use of non-Unix forms of #!cmd
-X opt : set implementation-specific option. The following options are available:

         -X faulthandler: enable faulthandler
         -X oldparser: enable the traditional LL(1) parser; also PYTHONOLDPARSER
         -X showrefcount: output the total reference count and number of used
             memory blocks when the program finishes or after each statement in the
             interactive interpreter. This only works on debug builds
         -X tracemalloc: start tracing Python memory allocations using the
             tracemalloc module. By default, only the most recent frame is stored in a
             traceback of a trace. Use -X tracemalloc=NFRAME to start tracing with a
             traceback limit of NFRAME frames
         -X importtime: show how long each import takes. It shows module name,
             cumulative time (including nested imports) and self time (excluding
             nested imports). Note that its output may be broken in multi-threaded
             application. Typical usage is python3 -X importtime -c 'import asyncio'
         -X dev: enable CPython's "development mode", introducing additional runtime
             checks which are too expensive to be enabled by default. Effect of the
             developer mode:
                * Add default warning filter, as -W default
                * Install debug hooks on memory allocators: see the PyMem_SetupDebugHooks() C function
                * Enable the faulthandler module to dump the Python traceback on a crash
                * Enable asyncio debug mode
                * Set the dev_mode attribute of sys.flags to True
                * io.IOBase destructor logs close() exceptions
         -X utf8: enable UTF-8 mode for operating system interfaces, overriding the default
             locale-aware mode. -X utf8=0 explicitly disables UTF-8 mode (even when it would
             otherwise activate automatically)
         -X pycache_prefix=PATH: enable writing .pyc files to a parallel tree rooted at the
             given directory instead of to the code tree
```



# Python Bytecode

- Python speichert den Bytecode in einer Datei mit **Suffix `.pyc`**
  - Bytecode von hello.py in Datei hello.pyc
- Python-Bytecode ist *plattformunabhängig*
- Python Bytecode ist (i.a.) temporär
- Python-Module können als Bytecode verteilt werden
  - Performance-Gewinn, da Compilation entfällt
  - Quellen müssen nicht offengelegt werden
  - Vorteil gegenüber PERL und vielen anderen Scriptsprachen
  - Analogie: Java-class-Datei: Bytecode für die JVM



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```
[thomas@PetitMouton-2 =>
[thomas@PetitMouton-2 => python3
Python 3.8.3 (v3.8.3:6f8c8320e9, May 13 2020, 16:29:34)
[Clang 6.0 (clang-600.0.57)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
[>>>
[>>>
[>>> import py_compile
[>>> py_compile.compile('WarenKorb.py')
'__pycache__/WarenKorb.cpython-38.pyc'
[>>>
```

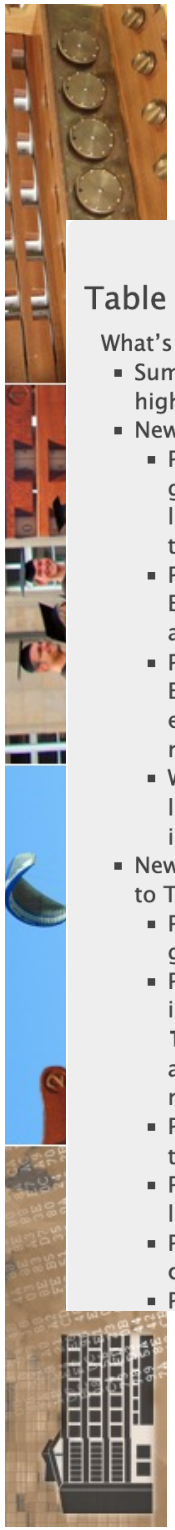




Table of Contents



# Faster CPython

CPython 3.11 is an average of 25% faster than CPython 3.10 as measured with the pyperformance benchmark suite, when compiled with GCC on Ubuntu Linux. Depending on your workload, the overall speedup could be 10–60%.

This project focuses on two major areas in Python: Faster Startup and Faster Runtime. Optimizations not covered by this project are listed separately under Optimizations.

## Faster Startup

### Frozen imports / Static code objects

Python caches bytecode in the __pycache__ directory to speed up module loading.

Previously in 3.10, Python module execution looked like this:

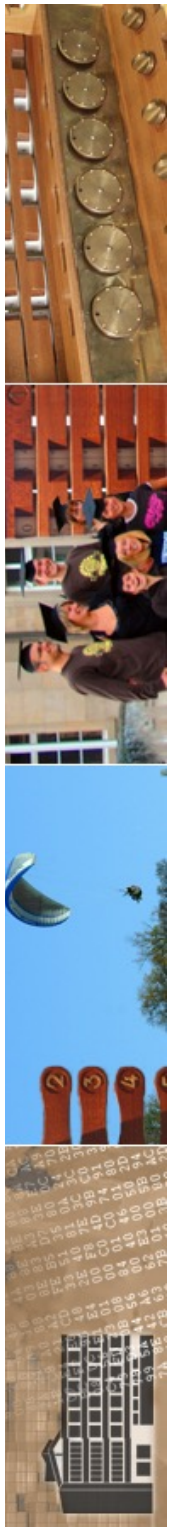
```
Read __pycache__ -> Unmarshal -> Heap allocated code object -> Evaluate
```

In Python 3.11, the core modules essential for Python startup are "frozen". This means that their Code Objects (and bytecode) are statically allocated by the interpreter. This reduces the steps in module execution process to:

```
Statically allocated code object -> Evaluate
```

Interpreter startup is now 10–15% faster in Python 3.11. This has a big impact for short-running programs using Python.

(Contributed by Eric Snow, Guido van Rossum and Kumar Aditya in many issues.)



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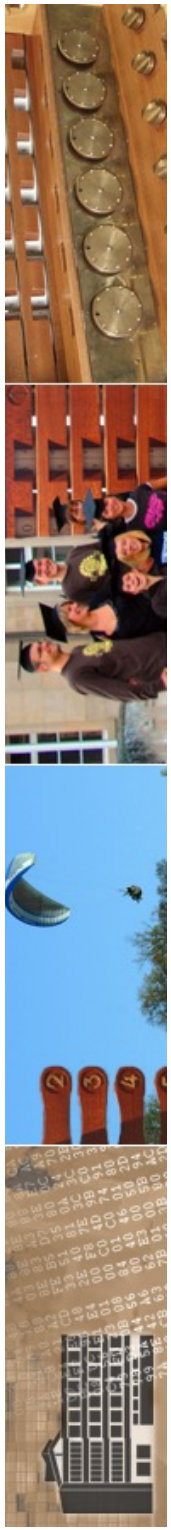
# das Semikolon in Python

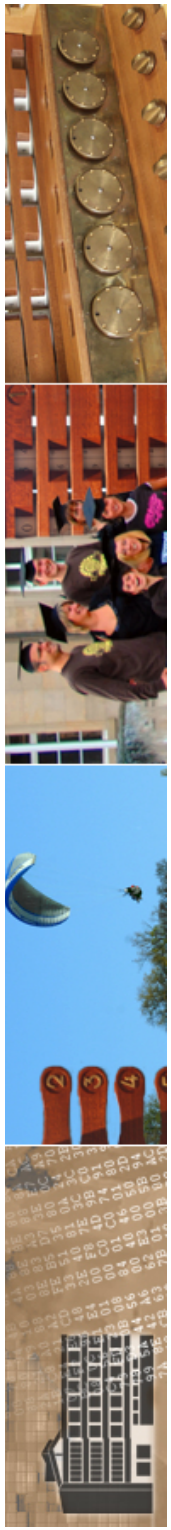
- das Semikolon ; ist in Python – im Gegensatz zu den meisten anderen Sprachen – *nicht* zum Abschluß einer Anweisung *notwendig*, es genügt das normale Zeilenende
- man kann es aber verwenden
- dafür müssen Anweisungen, die über mehrere Zeilen laufen, am Zeilenende durch ein \ zusammengefügt werden
- mit ; auch mehrere Anweisungen in einer Zeile

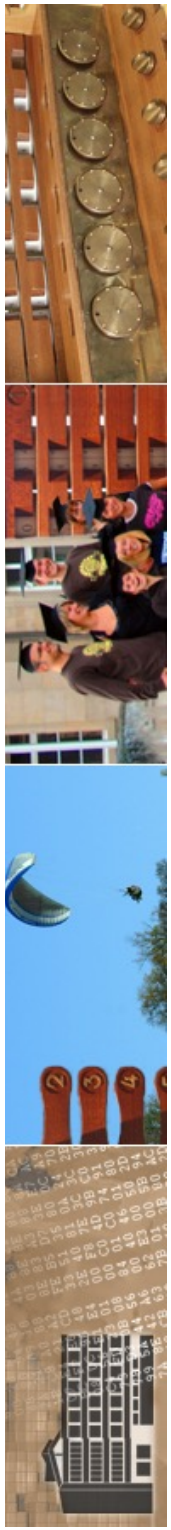


# Kommentare in Python

- Kommetare können (wie etwa in PERL auch) durch **#** eingeleitet werden
- sie schaden nie…
- es sind immer zu wenig… ;-)

- die “üblichen” Kommentare // und /* */ gibt es nicht, auch nicht in python3





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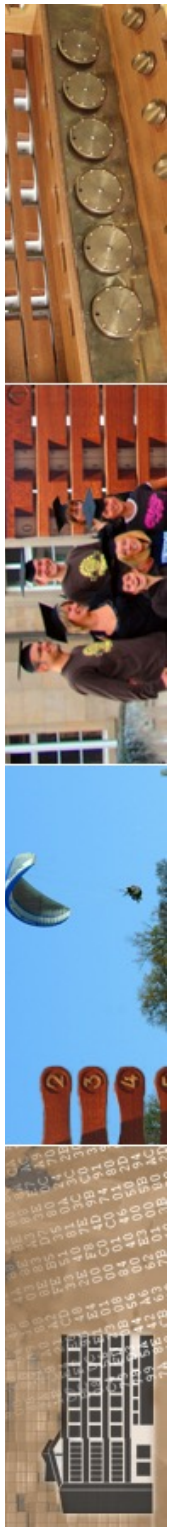
# numerische Literale

– Python3 unterscheidet *drei* (vier) Datentypen

- ganze Zahlen (beliebig groß)
  42, 4711, 0o32 (oktal), 0x1a2 (hexadeximal)
- Gleitkommazahlen
  3.1415, 5E24, 1.902e-19
- **imaginäre/komplexe Zahlen (imaginary)**
  imaginär: 3.14j, -2j
  komplex: 2 + 3j
- bool
  True oder False

  das j kommt von der Elektrotechnik

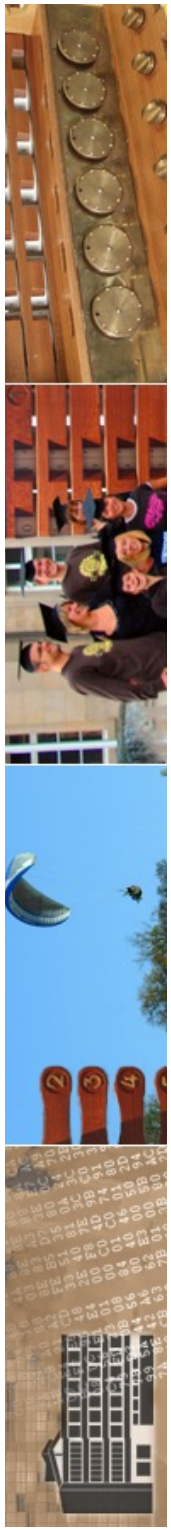
```
>>>
>>> c1 = 3 - 4j
>>> c2 = 5 + 6j
>>>
>>> c1 * c2
(39-2j)
>>>
>>> c1 / c2
(-0.14754098360655735-0.6229508196721312j)
>>>
```



# hexal, oktal, binär

- in Python3 wird verwendet
  - hexadezimal
    0x1a2b
  - oktal
    0o1234
  - binär
    0b10101011

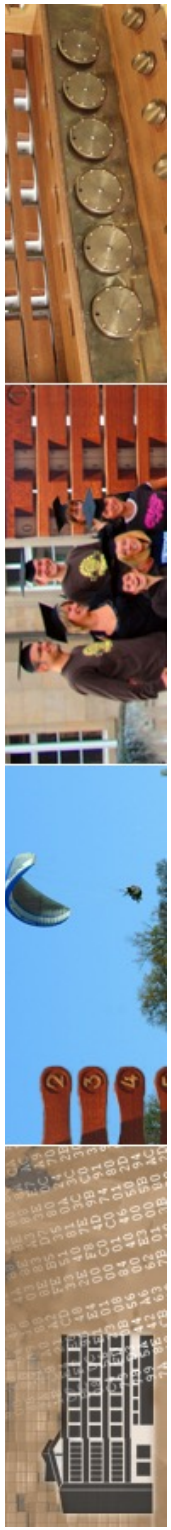
```
>>>
>>> a = 0b1010101
>>> a
 85
>>>
>>> b = 00717
>>> b
 463
>>>
>>> c = 0xCAFE
>>> c
 51966
>>>
```



# die Division

- bei zwei Ganzzahlargumenten
  - in Python2: / bedeutet div
  - in Python3: Gleitkommadivision div durch //

```
>>>
>>> 10/3
3.3333333333333335
>>>
>>> 10//3
3
>>>
```



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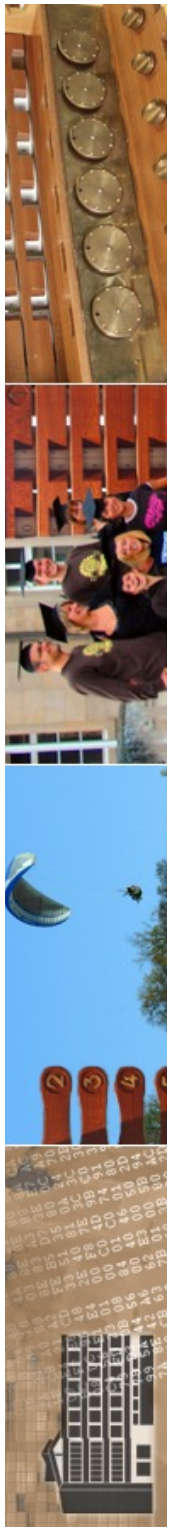
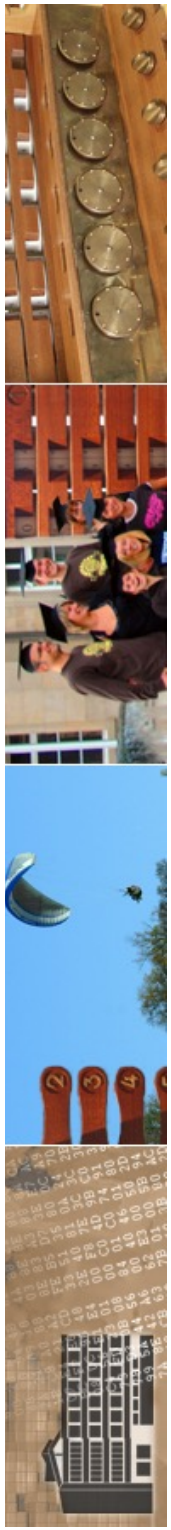
# Zeichenketten in Python

- Zeichenkettenliterale
  - kurze Zeichenkettenliterale werden durch ' oder " begrenzt
  - lange Zeichenkettenliterale können über mehrere Zeilen reichen; sie werden durch dreifache Folgen von ' oder " begrenzt
  - raw-Strings: `r"Zeilenumbruch: \n"`
  - Escape-Sequenzen: wie gewohnt
    - \\
    - \'
    - \"
    - \n
    - \a (Ton)
    - \t (Tabulator)

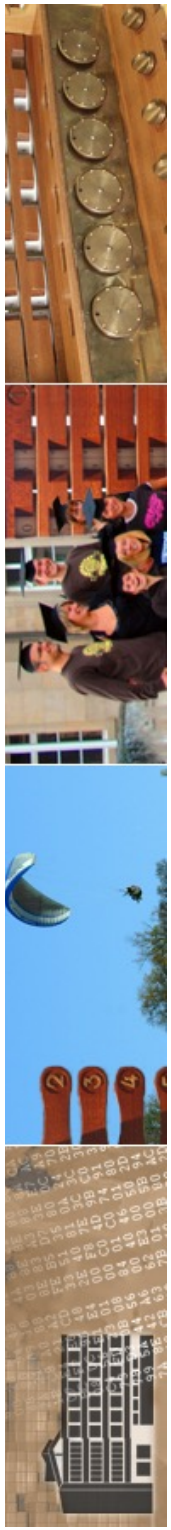


# Zeichenketten

- Verbinden von Zeichenketten mit +
- Python ist Unicode-fähig
- wie in Java Escape-Seqzenz \u
  - Unicode-String muss mit vorangestelltem „u“ gekennzeichnet werden

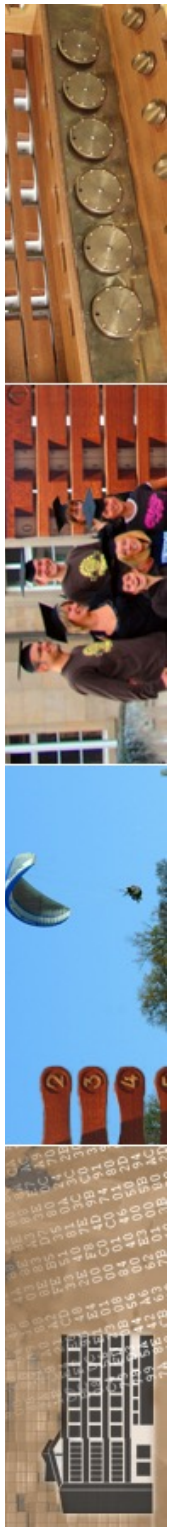


```
[thomas@uni-vpn229 =>
[thomas@uni-vpn229 => more unicode.py
# Grundlagen Internet-Technologien
#
# Beispiel: Unicode in Python


zeichenkette = u'100 \u20AC'

print ("\n" + zeichenkette+ "\n")
[thomas@uni-vpn229 =>
[thomas@uni-vpn229 =>
[thomas@uni-vpn229 =>
[thomas@uni-vpn229 => python3 unicode.py

100 €

[thomas@uni-vpn229 =>
[thomas@uni-vpn229 =>
```



# Zeichen

- ein Datentyp char ist in Python nicht implementiert
- sei s eine Zeichenkette der Länge n; dann ist
  - s [i]
    - für i = 0,1, ..., n-1 eine Zeichenkette der Länge 1, welche das Zeichen an der Position i der Zeichenkette s enthält
  - s [ i : j]
    - die Teilzeichenkette von der Position i bis zur Position j – 1
  - s [i:] und s [:j]
    - die Teilzeichenketten ab der Position i und bis zur Position j - 1



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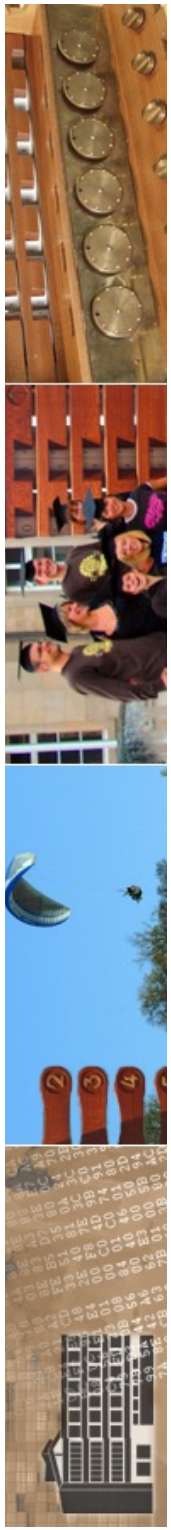
# Datentypen in Python3

- Python ist (im Gegensatz zu den meisten anderen Scriptsprachen) objektorientiert
- Bezeichner sind Referenzen auf Objekte

- Datentype None
- Numerische Variablen:
  - integer - beliebige Größe
  - float
  - complex



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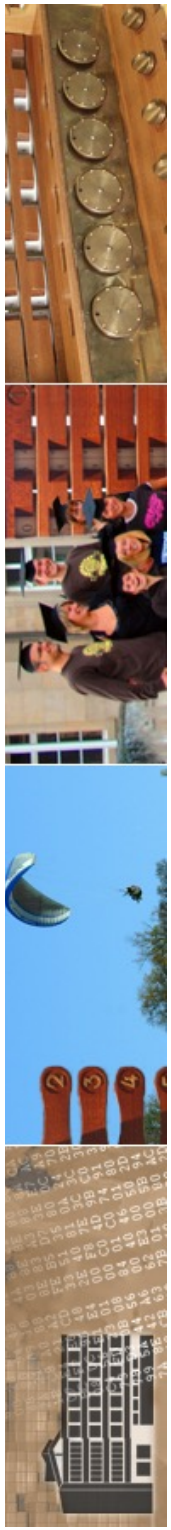
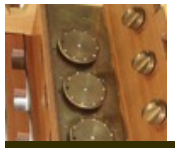
# Datentypen in Python3

- strukturierte Daten:
  - Listen (veränderbar)
  - Strings (nicht veränderbar)
  - assoziative Listen: Dictionary
- aufrufbare Typen
  - Funktionen & Methoden
  - Klassen
  - Klasseninstanzen
- andere Typen
  - Module
  - Klassen
  - Files



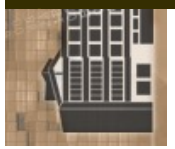
# arithmetische Ausdrücke

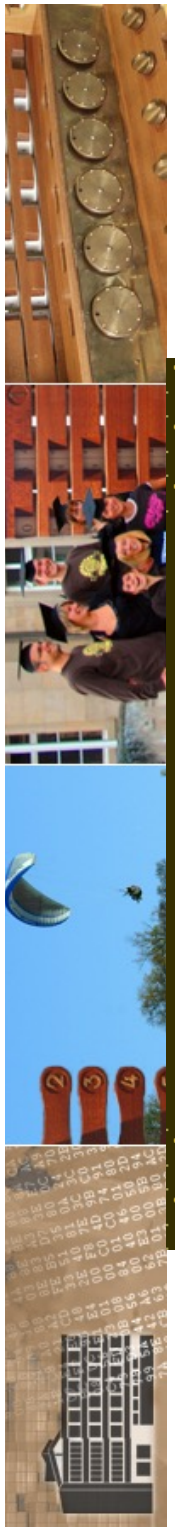
- wie »gewohnt«:
  - `a + b` `a - b` `a * b` `a / b` `a // b`
  - `a ** b` für die Potenz $a^b$
  - `abs (a)` für Betrag (a)
  - `int (a)` `float (a)` `long(a)` : Typumwandlung
  - `complex (a, b)` = `a + j b`
  - nachgestelltes L für long: `a = 4711L;`
  - `hex (i)` `oct (i)` `str (o)`



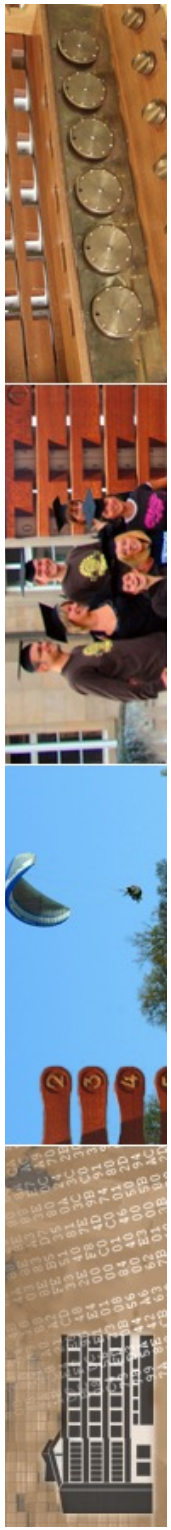


```
[thomas@PetitMouton-2 =>
[thomas@PetitMouton-2 => more math.py
# Grundlagen Internet-Technologien
#
# Verwendung der Python-Module math und cmath
# (math: mathematische Funktionen fuer R, cmath: mathematische Funktionen fuer C)

### Importe
###import math
import cmath

### Berechnung von exp(x)
eingabe = float(input('\n Bitte x zur Berechnung von e^x eingeben: '))
ergebnis1 = cmath.exp(eingabe)
print("\n exp(x) = "+str(ergebnis1))

### Berechnung der komplexen Exponentialfunktion
### nach Euler:
### e^(x + iy) = e^x * (cos y + i sin y)

eingaber =  float(input("\n Bitte Realteil von z zur Berechnung von e^z eingeben: "))
eingabei =  float(input("\n Bitte Imaginaerteil von z zur Berechnung von e^z eingeben: "))
z = complex(eingaber, eingabei)
ergebnis2 = cmath.exp(z)
print("\n exp(z) = "+str(ergebnis2));
[thomas@PetitMouton-2 =>
[thomas@PetitMouton-2 =>
```





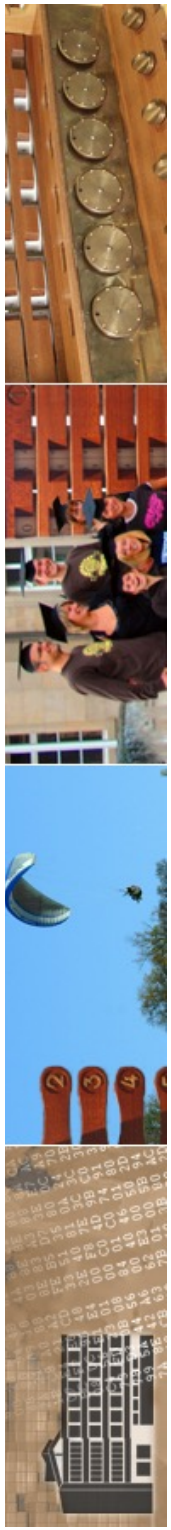
```
thomas@PetitMouton-2 =>
thomas@PetitMouton-2 =>
thomas@PetitMouton-2 => python3 math.py

 Bitte x zur Berechnung von e^x eingeben: 2

 exp(x) = (7.389056098930650+0j)

 Bitte Realteil von z zur Berechnung von e^z eingeben: 2

 Bitte Imaginaerteil von z zur Berechnung von e^z eingeben: -1

 exp(z) = (3.992324048441272-6.217676312367968j)
thomas@PetitMouton-2 =>
thomas@PetitMouton-2 =>
```



# logische Ausdrücke

- ebenfalls wie üblich in Scriptsprachen gewohnt
- 0 entspricht false, alles andere entspricht true
  - a < b  a > b  a == b  a != b
  - and, or, not
  - jeder von 0 verschiedene Zahlenwert entspricht true
  - None und die leere Zeichenkette sind false, alle anderen true

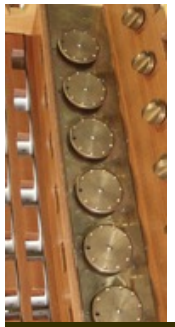
    123 < 21  false, aber  "123" < "21"  true



# Listen

- Python verfügt wie üblich für Scriptsprachen über einen lässigen Umgang mit Arrays, die direkt als Listen implementiert sind

```
– a = [1, 2, 3, 4]
– len (a)                ###    4
– a [1] = 'zwei';        ###    [1,'zwei',3,4]
```



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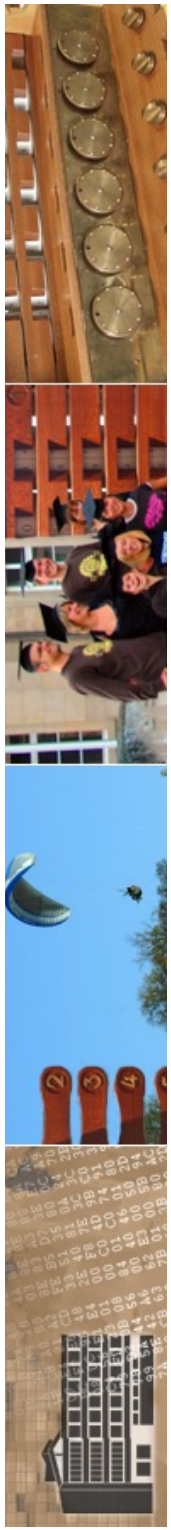
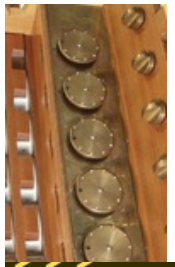
```
Python 3.8.3 (v3.8.3:6f8c8320e9, May 13 2020, 16:29:34)
[Clang 6.0 (clang-600.0.57)] on darwin
Type "help", "copyright", "credits" or "license" for more informat
>>>
>>>
>>>
>>>
>>> liste = [1, 2, 3, "Hello GIT", 3 - 4j]
>>> print(liste)
[1, 2, 3, 'Hello GIT', (3-4j)]
>>> print(liste[3])
Hello GIT
>>>
```



# Listen

- im Gegensatz zu Arrays können Python-Listen erweitert werden:
  - `a.append ('fünf')  ### push`
- weitere Listenoperation
  - `a.pop ()` : Gibt zuletzt abgelegtes Element zurück
- es stehen somit pop und push zur Verfügung
  - ➔ **LIFO**



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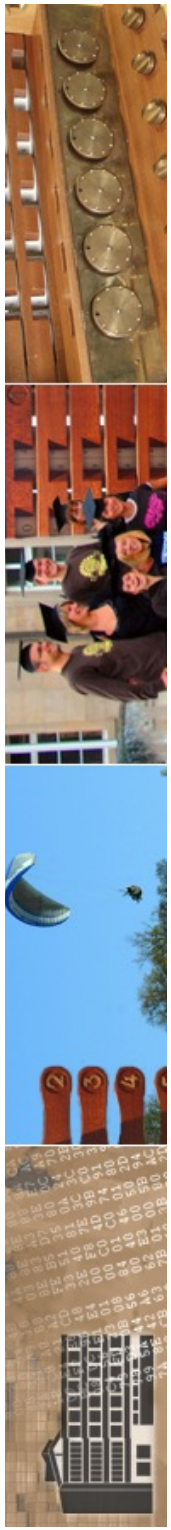
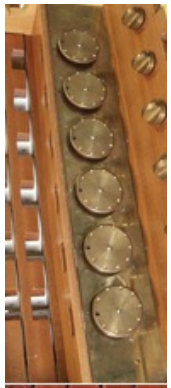
```
>>>
>>> liste.append("Tuebingen")
>>>
>>>
>>> print(liste)
[1, 2, 3, 'Hello GIT', (3-4j), 'Tuebingen']
>>>
>>> liste.append("Corona")
>>>
>>> liste.append("Corona")
>>>
>>>
>>> print(liste)
[1, 2, 3, 'Hello GIT', (3-4j), 'Tuebingen', 'Corona', 'Corona']
>>>
```

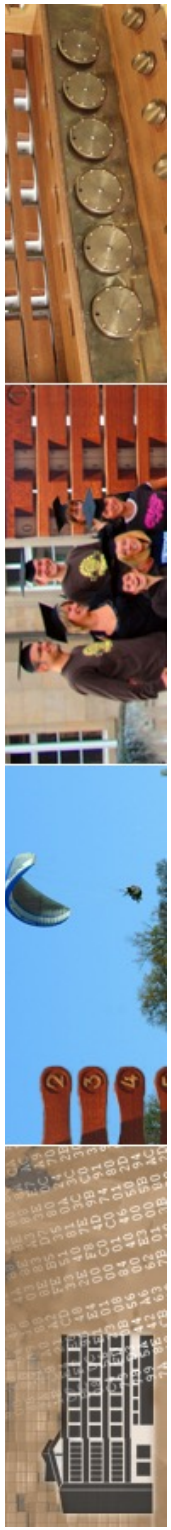


# mehrdimensionale Listen

- ein Listenelement selbst kann auch wieder eine Liste sein ➔ mehrdimensionale Listen

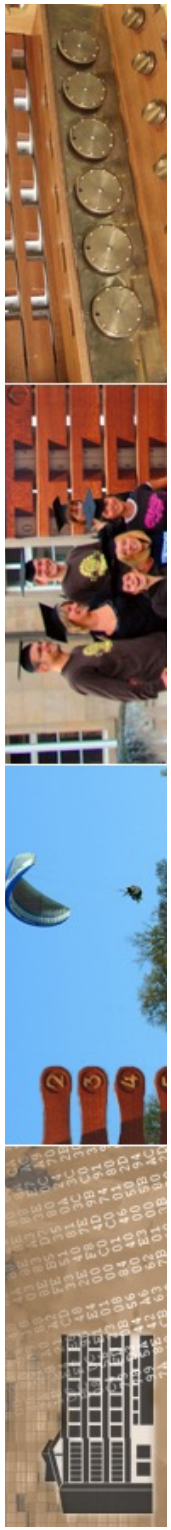



```
>>>
>>>
>>>
>>> dim2 = [["Medizininformatik", "SARS-CoV2"], 4711, 313, liste]
>>>
>>> print(dim2)
[['Medizininformatik', 'SARS-CoV2'], 4711, 313, [1, 2, 3, 'Hello GIT', (3-4j),
'Tuebingen', 'Corona', 'Corona']]
>>>
>>>
```

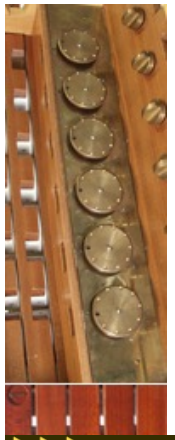
# Methoden für Listen

- es gibt die „üblichen“ Methoden für Listen wie
  - `reverse()`
  - `sort()`
  - …



# assoziative Listen (Dictionary)

- Syntax:
  - `hash = { key1:value1, key2:value2, ..., keyN:valueN}`
- Methoden
  - `items ()` : Liste mit 2-Tupeln
  - `keys ()` : Liste der Keys
  - `values ()` : Liste der Values
  - `has_key (k)` : Überprüft, ob Key k vorhanden
  - `update (hash2)` : fügt hash2 an



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# Dictionary

```
>>>
>>>
>>> hash = {'tuebingen':'Medizininformatik', 'stuttgart': 'Medizintechnik',
313:4711}
>>>
>>> print(hash)
{'tuebingen': 'Medizininformatik', 'stuttgart': 'Medizintechnik', 313: 4711}
>>>
>>> print(hash['tuebingen'])
Medizininformatik
>>>
>>>
```

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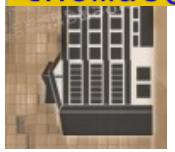
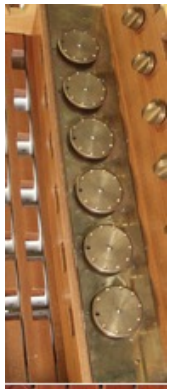
```
thomas@uni-vpn229 =>
thomas@uni-vpn229 => more assozListe.py
# Grundlagen Internet-Technologien
#
# Beispiel: assoziative Liste mit Python

hashBeispiel = {"liebling":"MediaFotografie", "auchGut":"Web-Kompendium"}

### erweiterung des Hash
hashBeispiel["klassiker"] = "Brecht: Dreigroschenoper"

print ("\n Anzahl der Elemente in Liste: ",len(hashBeispiel))
print ("\n ein Element: ",hashBeispiel["liebling"])
print ("\n Die komplette Liste: ",hashBeispiel)
thomas@uni-vpn229 =>
thomas@uni-vpn229 =>
thomas@uni-vpn229 => python3 assozListe.py

 Anzahl der Elemente in Liste:  3

 ein Element:  MediaFotografie

 Die komplette Liste:  {'liebling': 'MediaFotografie', 'auchGut': 'Web-Kompendium',
'klassiker': 'Brecht: Dreigroschenoper'}
thomas@uni-vpn229 =>
thomas@uni-vpn229 =>
```



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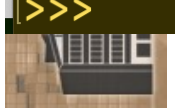
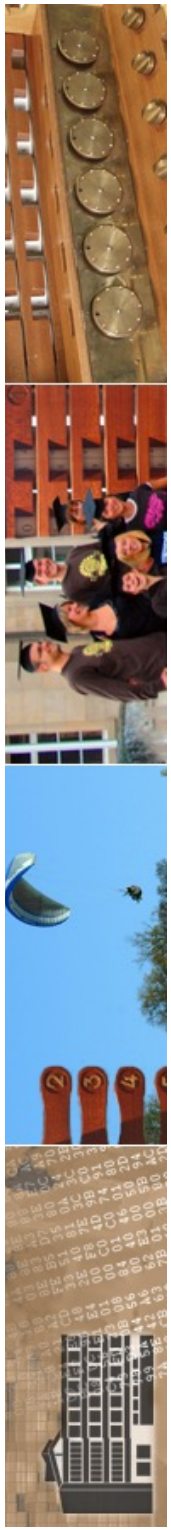
# Mengen

- in Python Datenstruktur „Menge“ (Datentyp set)
  - set enthält jedes Element nur ein mal

```
>>>
>>> mySet = {"Informatik", "Medizininformatik", "Bioinformatik", "Medieninformatik"}
>>>
>>> print(mySet)
{'Bioinformatik', 'Informatik', 'Medizininformatik', 'Medieninformatik'}
>>>
>>> "BWL" in mySet
False
>>>
>>> "Medizininformatik" in mySet
True
>>>
>>>
```





# Mengen

- zahlreiche Operationen
  - & : Schnittmenge
  - | : Vereinigungsmenge
  - in : Element in Menge enthalten?
  - <= : Teilmenge
  - < : echte Teilmenge

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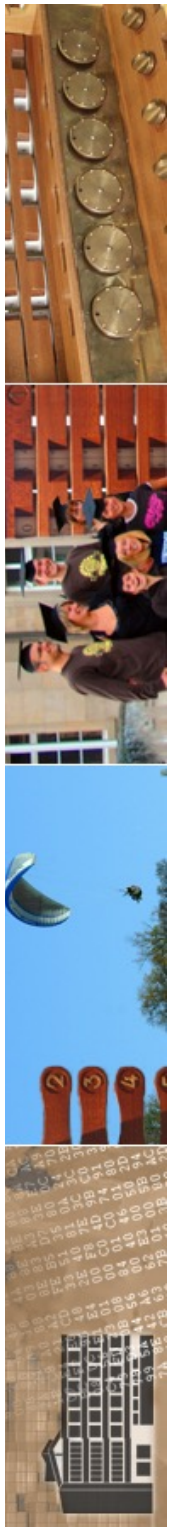
```
>>>
>>>
>>> myOtherSet = {"Medizin", "Medizintechnik", "Medizininformatik"}
>>>
>>>
>>> mySet & myOtherSet
{'Medizininformatik'}
>>>
>>> mySet | myOtherSet
{'Informatik', 'Medieninformatik', 'Medizintechnik', 'Bioinformatik', 'Medizininforma
tik', 'Medizin'}
>>>
>>>
>>> {"Informatik"} <= mySet
True
>>>
>>>
```



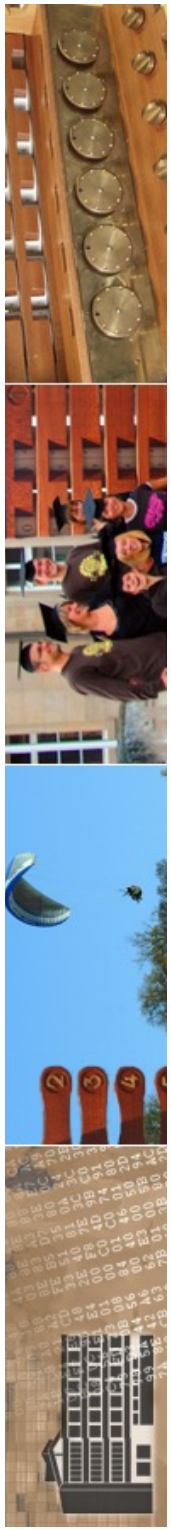
# noch zwei Methoden

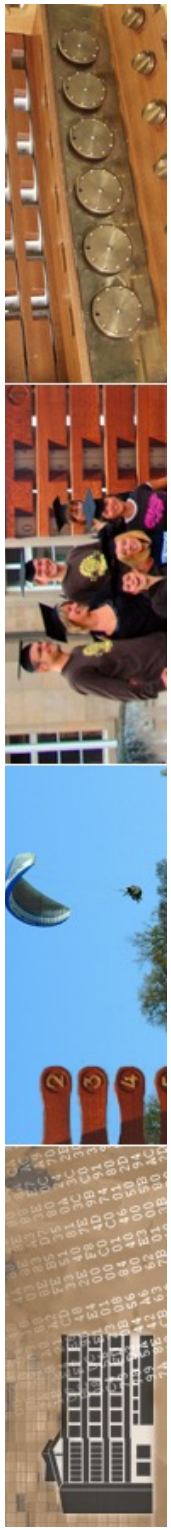
- **`type`** : gibt Datentyp zurück
  - `>>> type ("Hello World")`
    `<type 'string'>`

- **`in`** : Überprüft, ob Element in Struktur vorhanden ist
  - `>>> if "zwei" in a: print "ja"`

    `ja`

```
>>>
>>>
>>>
>>> type(mySet)
<class 'set'>
>>>
>>> z = 1 - 2j
>>> type(z)
<class 'complex'>
>>>
>>>
>>>
```



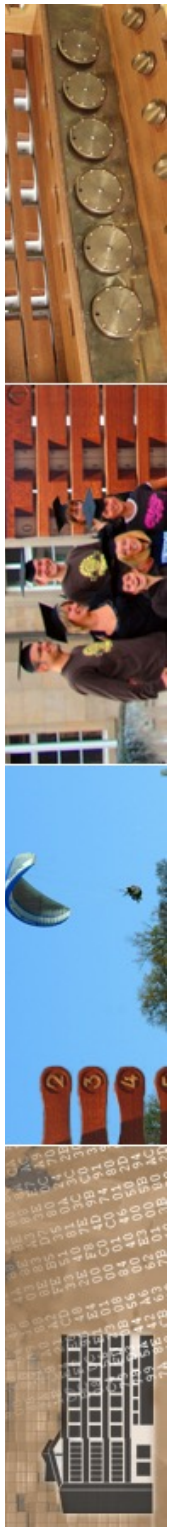


# Kontrollstrukturen

- Blöcke (sequentielle Komposition)
  - Blöcke werden in Python nicht wie üblich gebildet:

    Blöcke werden durch ***einfaches Einrücken*** gebildet!
    “Sequenzkopf” am Anfang

    Vorsicht beim Konvertieren Windows <-> Linux

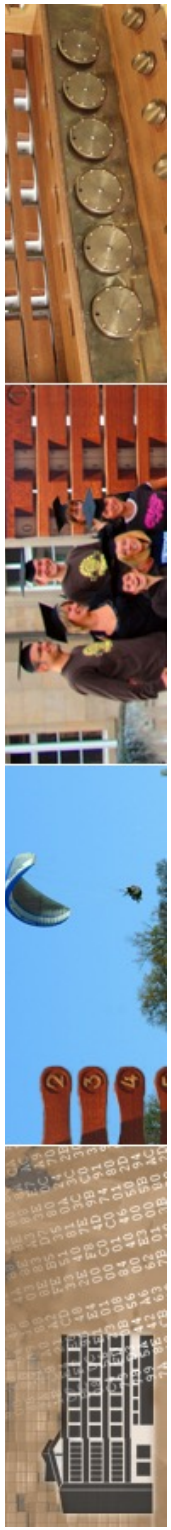


# Entscheidung

- Kontrollstruktur

```
if (boole) :
    wahr_anweisungen
else :
    falsch_anweisungen
```

  - es gibt noch zusätzlich elif (bool2)



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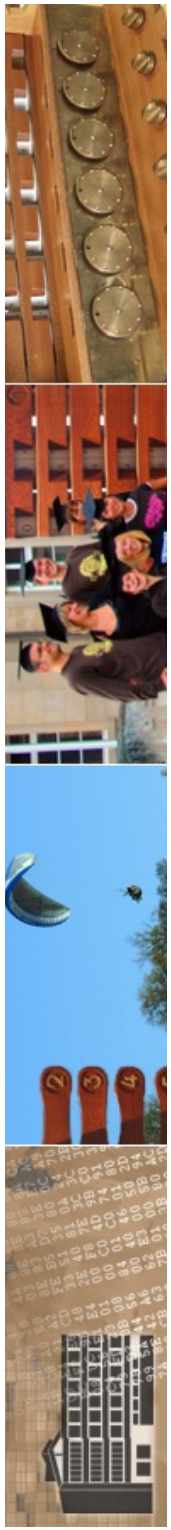
# Entscheidung

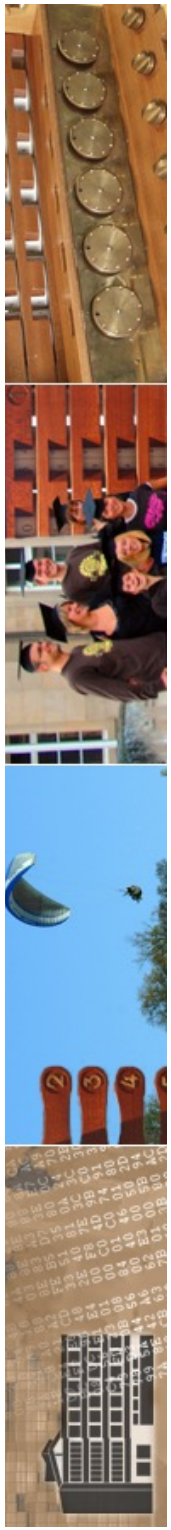
```
>>>
>>> x = 42
>>> y = 4711
>>>
>>> if (x < y) :
...     print("x ist kleiner als y")
... else :
...     print ("x ist groessergleich y")
...     y = x
...
x ist kleiner als y
>>>
>>>
>>>
```



# Schleifen

- die klassische Schleife: while
  - Syntax »wie zu erwarten«:

```
while (boole) :
      anweisungen;
```



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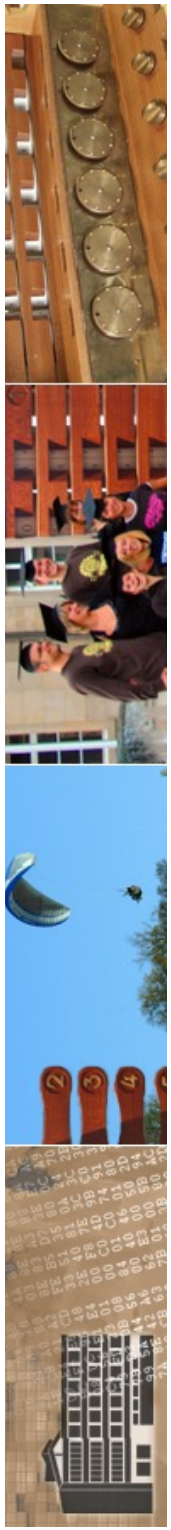
# while-Schleife

```
maximum = 100

summe = 0; i = 1;
while (i <= maximum):
    summe += i
    i+=1
print ("Summation mit while: ", summe,"\n")
```



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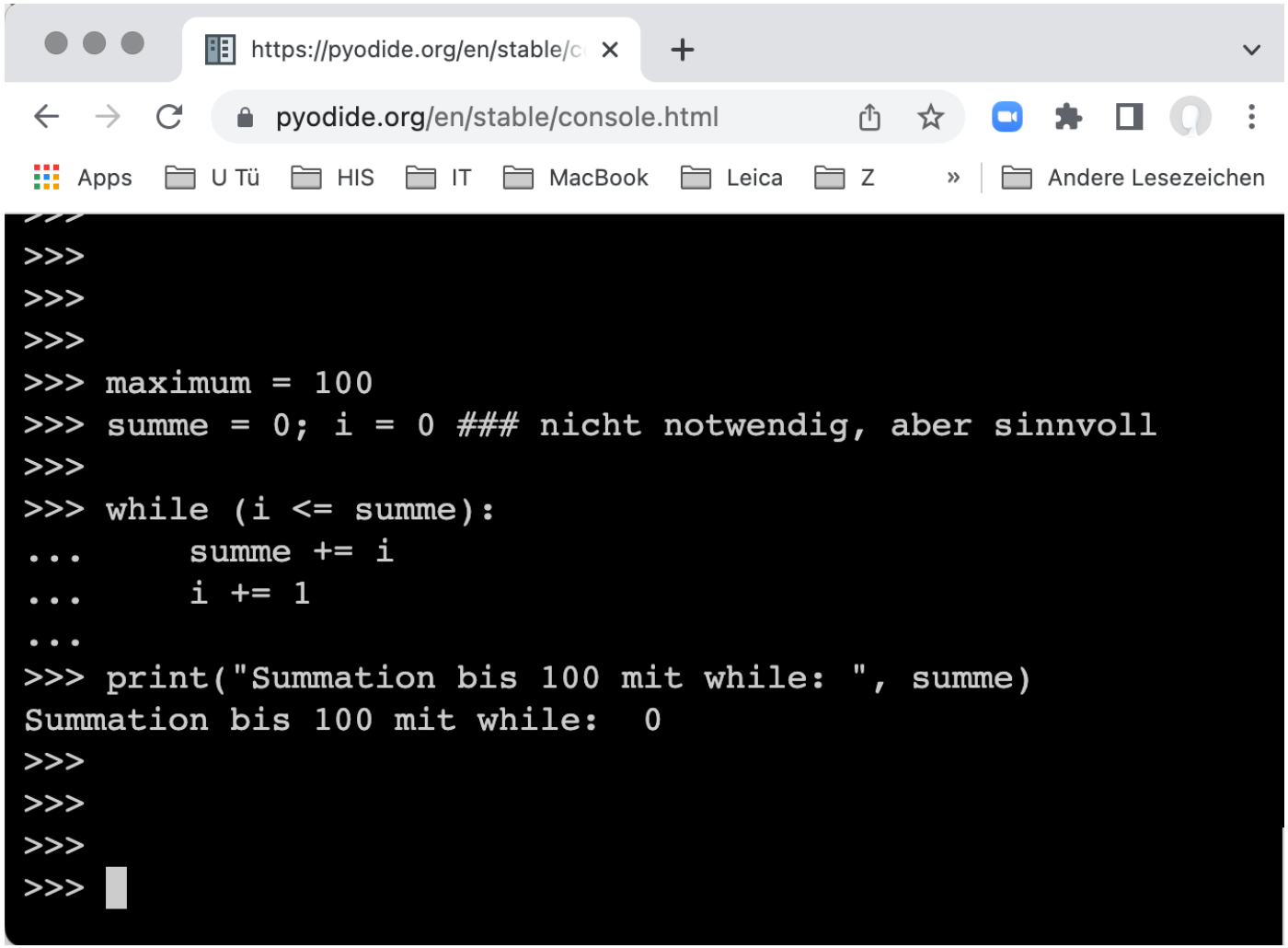
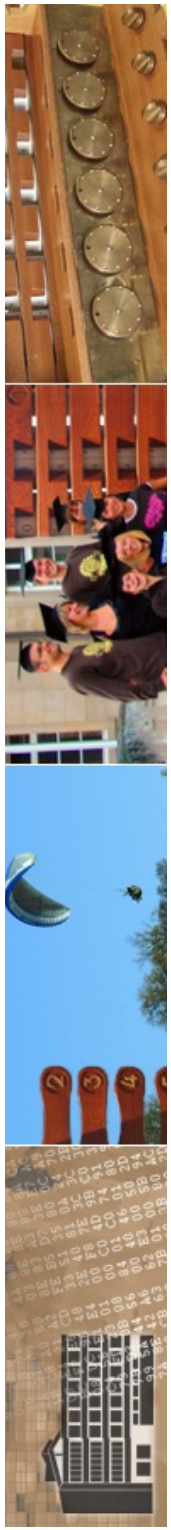
# while-Schleife im Browser



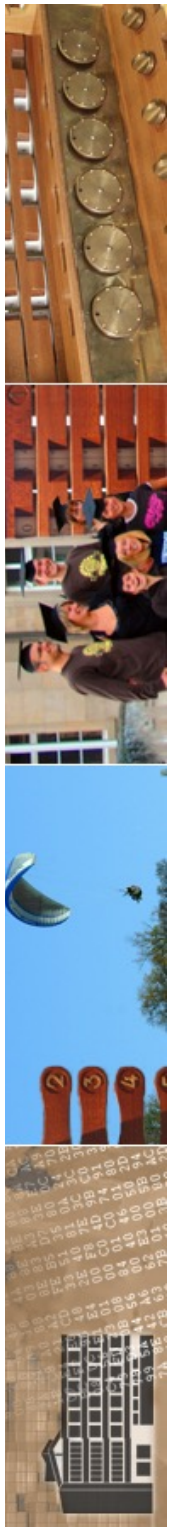


# Schleifen

- for hat ebenfalls eigene Implementierung
  - Syntax:

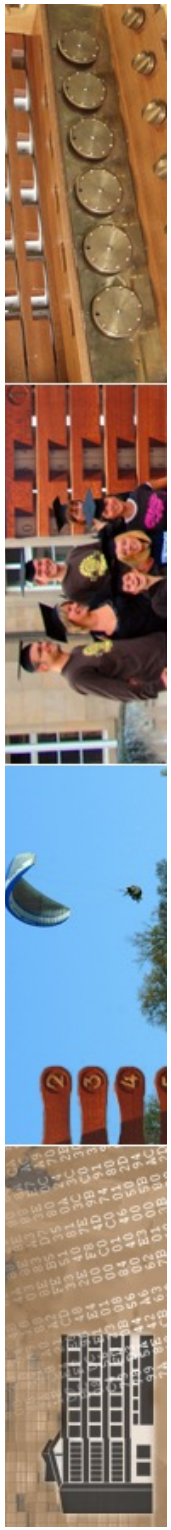
```
for variable in sammlung :
        anweisungen
```

(liste wird mit steigendem Index durchlaufen)



# for-Schleife

```
summe = 0
for i in list(range(1,101)):
    summe += i;
print ("Summation mit for:   ", summe,"\n")
[thomas@PetitMouton-2 =>
[thomas@PetitMouton-2 =>
```



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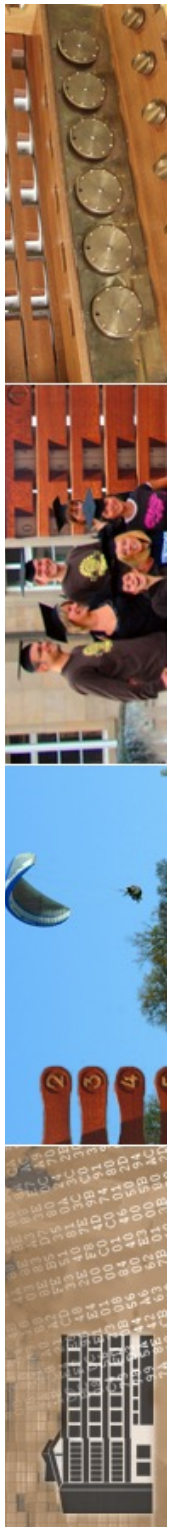
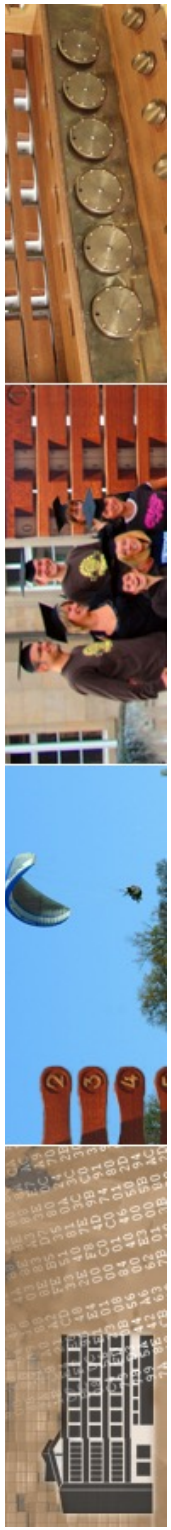
```
[thomas@uni-vpn229 => more schleifen.py
# Grundlagen Internet-Technologien
#
# Beispiel: Schleifen in Python

maximum = 100

summe = 0; i = 1;
while (i <= maximum):
    summe += i
    i+=1
print ("Summation mit while: ", summe,"\n")

summe = 0
for i in list(range(1,101)):
    summe += i;
print ("Summation mit for:   ", summe,"\n")
[thomas@uni-vpn229 =>
```

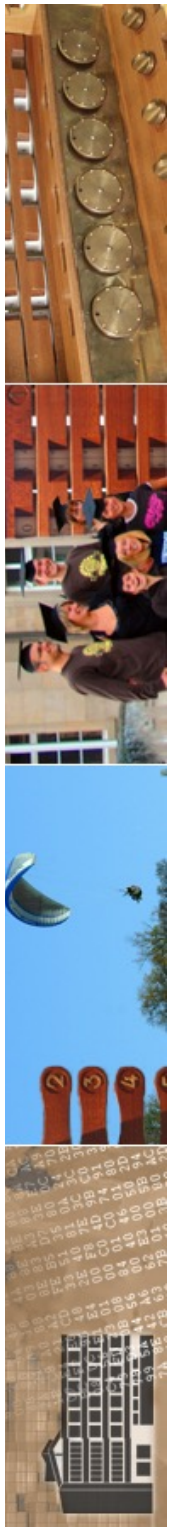


```
[thomas@PetitMouton =>
[thomas@PetitMouton =>
[thomas@PetitMouton => python3 schleifen.py
Summation mit while:  5050

Summation mit for:    5050

[thomas@PetitMouton =>
[thomas@PetitMouton =>
```



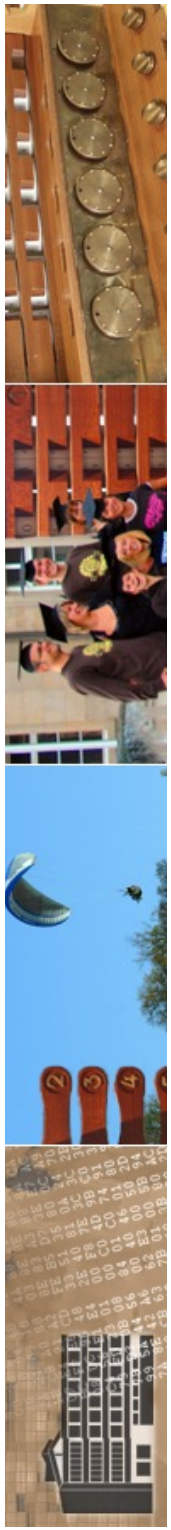
# praktisch: range

- Erzeugen einer liste mit
  - `range(ende)`
  - `range(start,ende)`
  - `range(start, ende, step)`



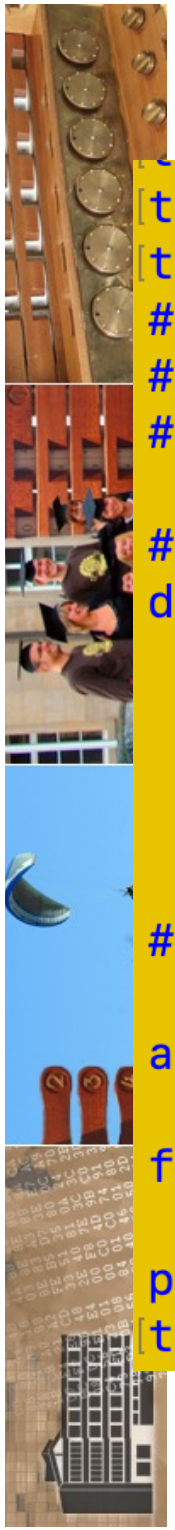
# `break` und `continue`

- ...diese sind nun wieder “wie üblich” (Java):
  - break  verlässt die Schleife
  - continue  startet mit neuem Schleifendurchlauf

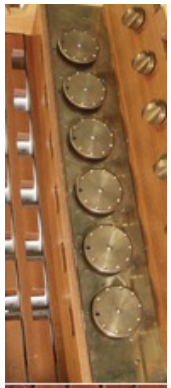


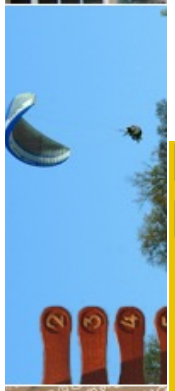
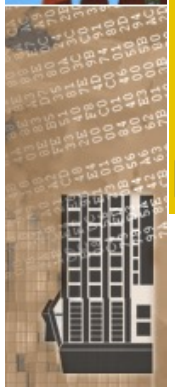
# Methoden

- Funktionen werden – moderner als in PERL - folgendermaßen deklariert:
  - `def funktionsname (argument1, ...) : anweisungen`
  - im Gegensatz zu PERL und php muss eine Funktion vor der ersten Verwendung bereits definiert sein



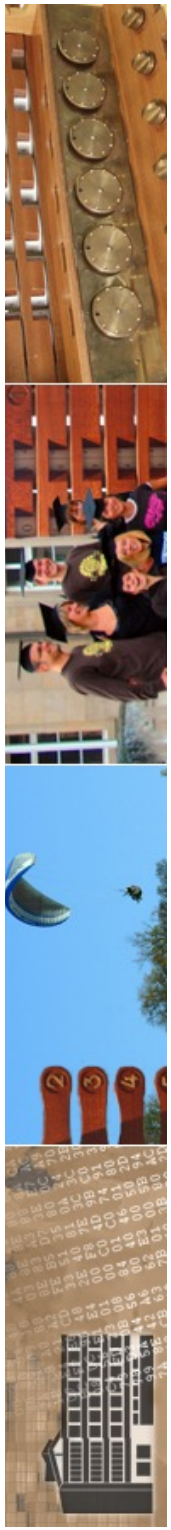
```
[thomas@uni-vpn229 =>
[thomas@uni-vpn229 => more fakultaet.py
# Grundlagen Internet-Technologien
#
# Beispiel: Methoden in Python

################################
def fakultaet(n) :
    f = 1
    while (n > 1) :
        f *= n
        n -= 1
    return f
################################

arg = int(input ("\n Bitte n eingeben: "));   ### Eingabe

fakultaet = fakultaet (arg)

print ("\n Die Fakultaet von n betraegt: ", fakultaet,"\n")
[thomas@uni-vpn229 =>
```



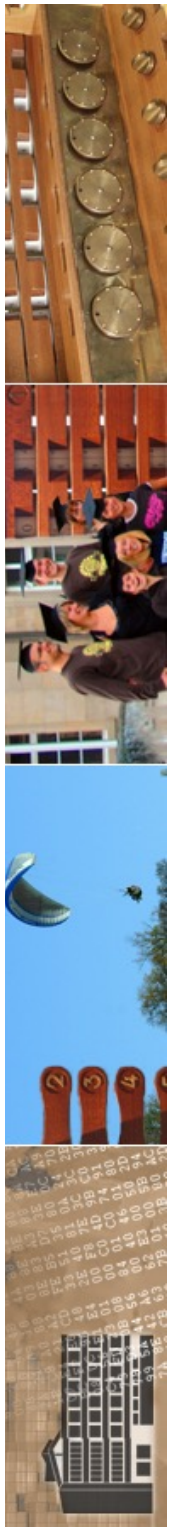
```
thomas@uni-vpn229 =>
thomas@uni-vpn229 => python3 fakultaet.py

 Bitte n eingeben: 5

 Die Fakultaet von n betraegt:  120

thomas@uni-vpn229 =>
thomas@uni-vpn229 =>
```

```
thomas@uni-vpn229 =>
thomas@uni-vpn229 => python3 fakultaet.py

 Bitte n eingeben: 25

 Die Fakultaet von n betraegt:  15511210043330985984000000

thomas@uni-vpn229 =>
```



# Methoden mit optionalen Parameter

- ein „Überladen“ durch Angabe eines Default-Parameters ist in Python möglich
  - `def funktionsname (argument1=arg1, ...) : anweisungen`
  - `def seiNett (arg1 = ”Frau Bundeskanzler!”) : print(” Guten Tag ”, arg1)`



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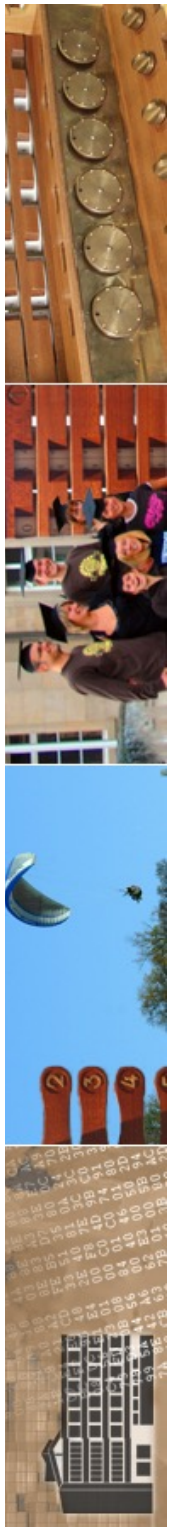
# Namensräume in Python

- es sind drei verschiedene Namensräume vorhanden:
  - lokal: gültig innerhalb eines Blockes
  - Modulweit: gültig in einem Modul
  - Python-Systemvariablen: überall gültig



# Namensräume

- **`global`** deklariert Variable als globale Variable (modulweit)

- **`globals()`** gibt Übersicht (als Hash) über die verwendeten globalen Variablen und ihre Belegung

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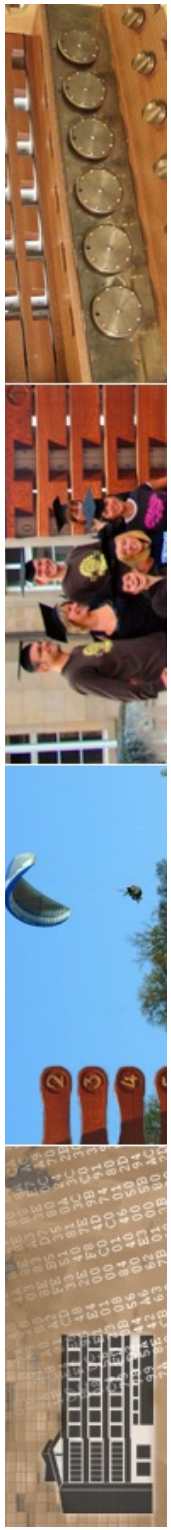
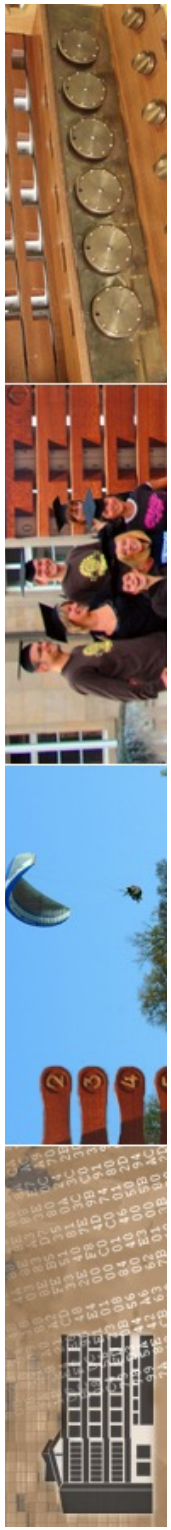
```
thomas@uni-vpn229 =>
thomas@uni-vpn229 => python3
Python 3.9.5 (v3.9.5:0a7dcbdb13, May  3 2021, 13:17:02)
[Clang 6.0 (clang-600.0.57)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>>
>>>
>>> globals()
{'__name__': '__main__', '__doc__': None, '__package__': None, '__loader__':
<class '_frozen_importlib.BuiltinImporter'>, '__spec__': None, '__annotations
__': {}, '__builtins__': <module 'builtins' (built-in)>}
>>>
>>>
```



# Dateien

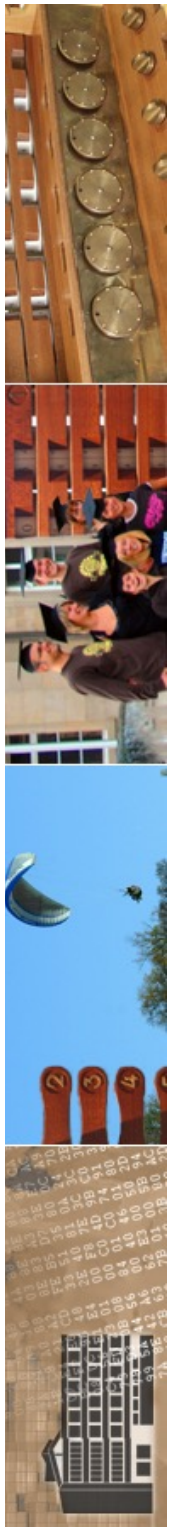
- mittels
  - `open (datei, attribute)`
- wird eine Datei geöffnet
- Mögliche Attribute:
  - r : Lesen
  - w : Schreiben
  - a : Anfügen
  - r+
  - w+
  - a+



# Dateien

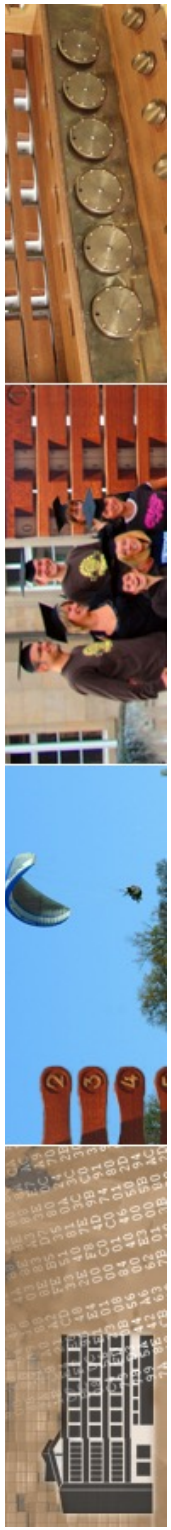
- `open` gibt – wie üblich – einen File-Handler zurück:
- `f = open ('text.txt', 'r')`

- Methoden zum Lesen:
  - `f.readline()` : Liest eine Zeile
  - `f.readlines()` : Liest alle Zeilen (als Liste)
  - `f.read(n)` : Liest n Zeichen (ohne n ganze Datei)



# Dateien

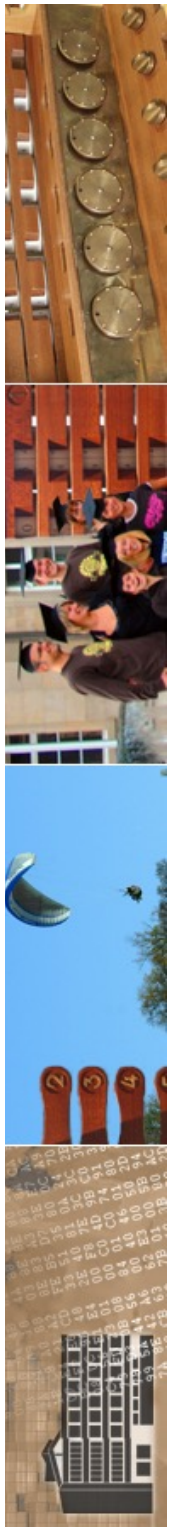
- Methoden zum Schreiben
  - `f.write (String)`
  - `f.writelines (ListeVonStrings)`
- Buffered Streams
  - Python verwendet prinzipiell buffered Streams
  - mittels `f.flush ()` wird Puffer geschrieben
- Datei schließen
  - `f.close ()` schließt Datei (und leert Buffer)



# Fehlerbehandlung in Python

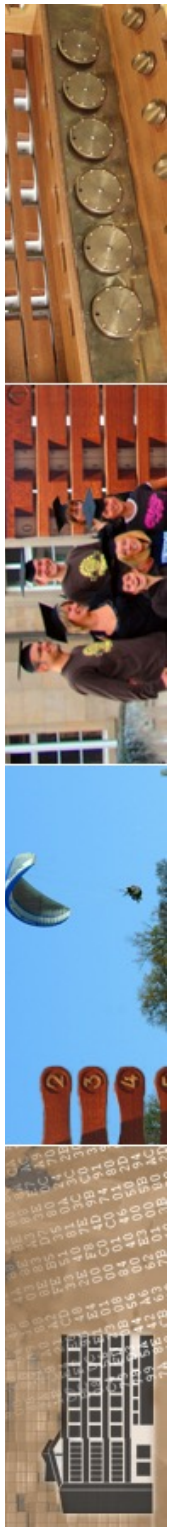
- Python verwendet wie Java **Exceptions**
  - es gibt try - catch - Blöcke in Python
    - auch mit else (!) und finally kombinierbar
  - Auslösen von Ausnahmen:

```
raise exception , argument
```



# Objektorientierung

- Python ist – natürlich – objektorientiert
- OO in Python geht weiter als in PERL, php und insbesondere JavaScript:
  - Datenkapselung möglich
  - Vererbung möglich (sogar Mehrfachvererbung)
  - Konstruktor und Destruktor vorhanden



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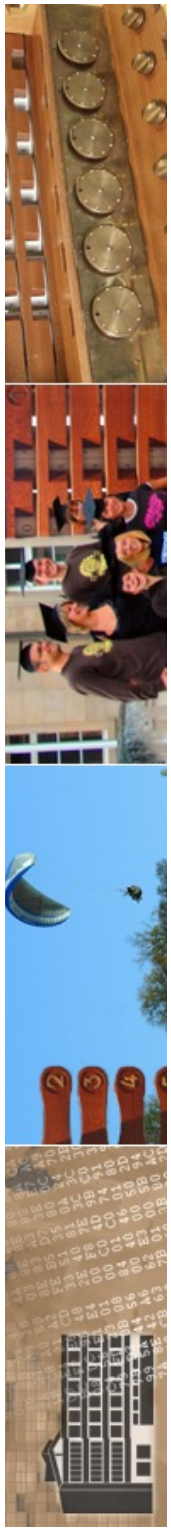
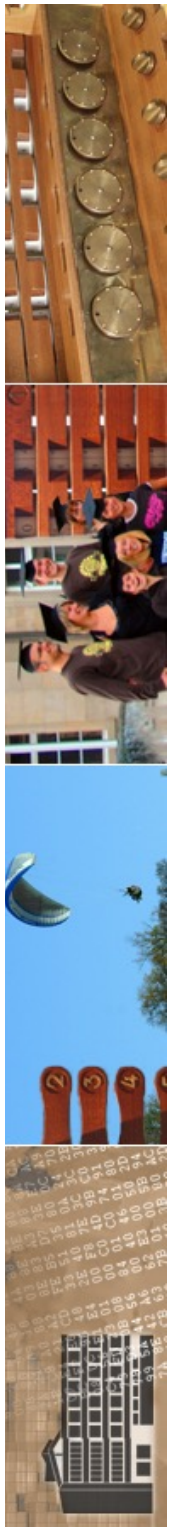
# Beispiel Warenkorb

```
class WarenKorb :
    def __init__ (self, inhalt=None) :
        self.inhalt = []
        if inhalt :
            self.inhalt.append (inhalt)
    def add (self, sache) :
        self.inhalt.append (sache)

    def show (self) :
        for element in self.inhalt :
            print (element)
```



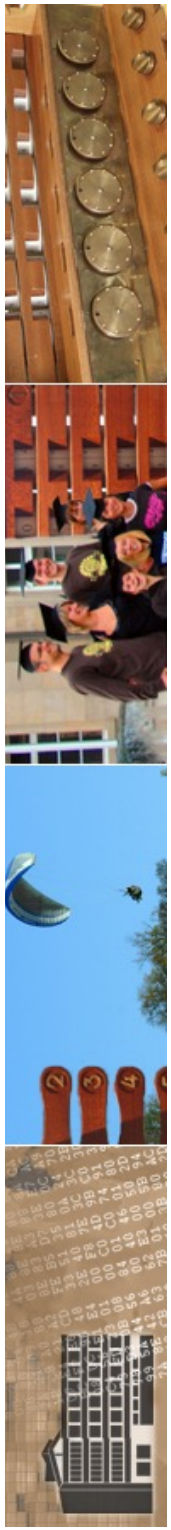


```
[thomas@uni-vpn229 =>
[thomas@uni-vpn229 => more WarenKorb.py
# Grundlagen Internet-Technologien
#
# Beispiel: OO in Python
# Basisklasse WarenKorb

class WarenKorb:

    ### Konstruktor ###
    def __init__ (self, content=None):
        self.inhalt = []
        if content:
            self.inhalt.append (content)

    def add (self, sache):
        self.inhalt.append (sache)

    def show (self):
        for element in self.inhalt:
            print (element)
[thomas@uni-vpn229 =>
```



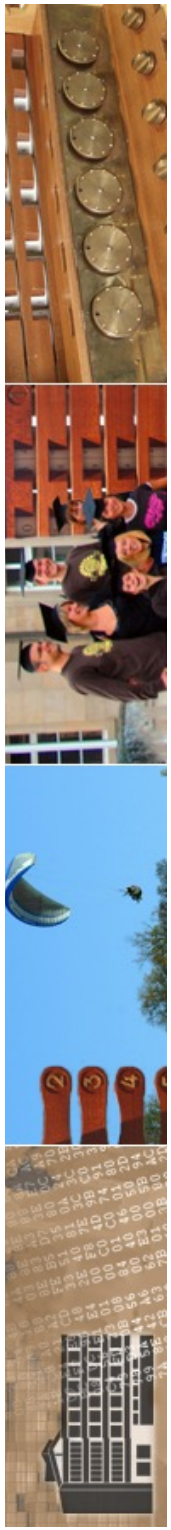
# Instanzen

- Python hat kein »new«, es wird direkt der Konstruktor verwendet
  - **`korb = WarenKorb ()`**
- mit und ohne Argument (hier kein Überladen, da default-Parameter)



```
[thomas@uni-vpn229 =>
[thomas@uni-vpn229 => more korb.py
# Grundlagen Internet-Technologien
#
# Beispiel: OO in Python

from WarenKorb import *

unserKorb = WarenKorb ()

unserKorb.add ('Buch "Einfuehrung in Python3"')
unserKorb.add ('Apple iPhone 12 pro plus max')
unserKorb.add ('Buch "Egan Bernal: Leiden am Berg"')

unserKorb.show()
[thomas@uni-vpn229 =>
[thomas@uni-vpn229 =>
```

```
[thomas@uni-vpn229 =>
[thomas@uni-vpn229 =>
[thomas@uni-vpn229 => python3 korb.py
Buch "Einfuehrung in Python3"
Apple iPhone 12 pro plus max
Buch "Egan Bernal: Leiden am Berg"
[thomas@uni-vpn229 =>
[thomas@uni-vpn229 =>
```



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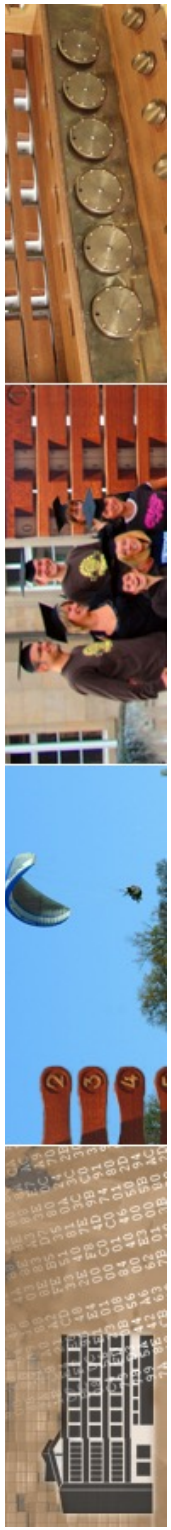
# wie findet Python die Klassen?

- anstelle des Klassenpfades (CLASSPATH) verwendet Python die Umgebungsvariable
  - **`PYTHONPATH`**
- zur Lokalisierung von Klassen
- durch das Einbinden wird Python-Bytecode persistent erzeugt und gespeichert: Wir erzeugen eine Datei **`WarenKorb.pyc`**



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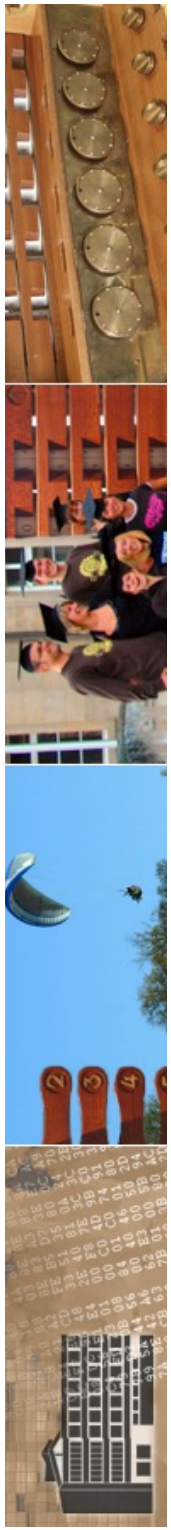
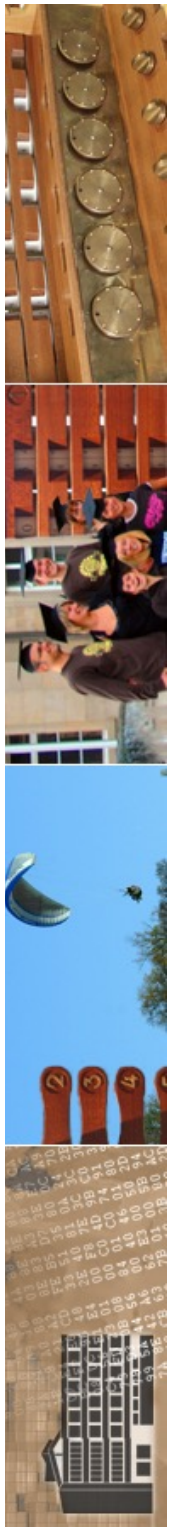
# die Referenz `self`

- self ist die Python-Version von »this«
- anstelle von **`unserKorb.add(artikel)`** auch:
- **`WarenKorb.add (unserKorb, artikel)`**



# Vererbung

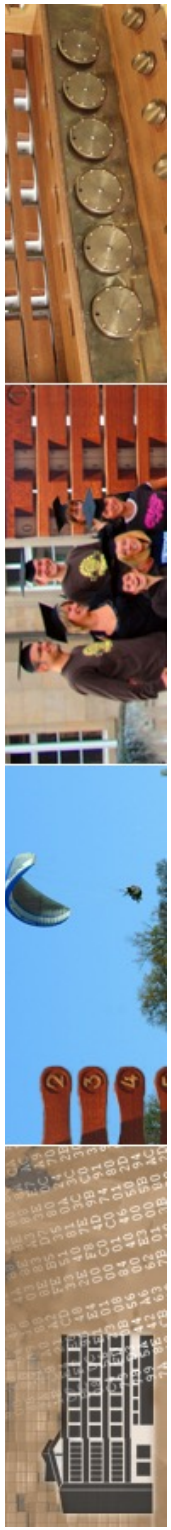
- Python hat elementare Mechanismen zur Vererbung
- Syntax:
  - `class KlassenName (ElternKlasse1 [, Elternklasse2, ...]):`
- auch Überschreiben von  Methoden möglich



# Datenkapselung

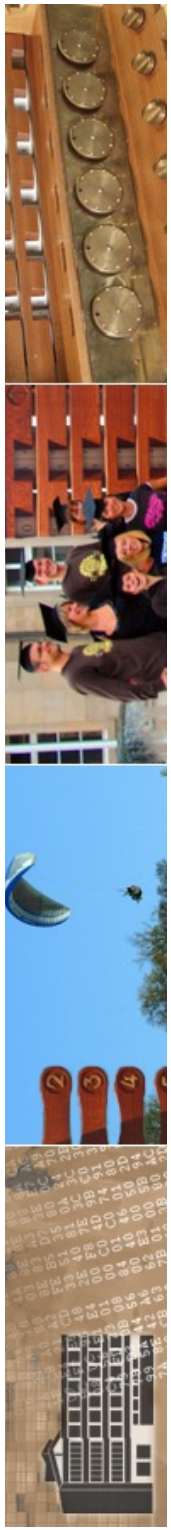
- Python bietet auch eine *Datenkapselung*
- Syntax:
  - `__inhalt_`
- ist privates Attribut

  ( 2 x _ am Anfang, 1 x _ am Ende)



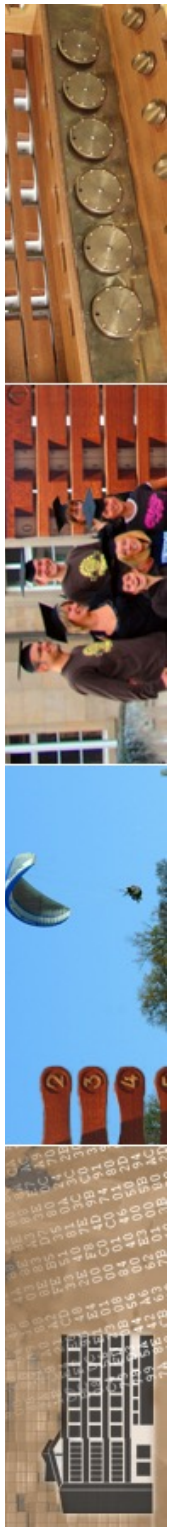


```
[thomas@uni-vpn229 =>
[thomas@uni-vpn229 => more WarenKorb2.py
# Grundlagen Internet-Technologien
#
# Beispiel: OO in Python

class WarenKorb2:

    ### Konstruktor ###
    def __init__ (self, content=None):
        self.__inhalt_ = []
        if content:
            self.__inhalt_.append (content)

    def add (self, sache):
        self.__inhalt_.append (sache)

    def show (self):
        for element in self.__inhalt_:
            print (element)
[thomas@uni-vpn229 =>
```



# einige spezielle OO-Methoden

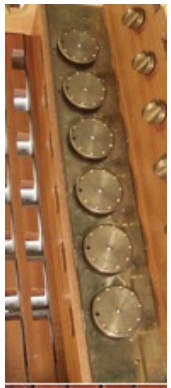
- `__init__ (self, args)` : Konstruktor
- `__del__ (self)` : Destruktor
- `__str__ (self)` : toString

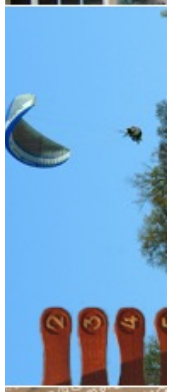


# weiteres Beispiel: Buch

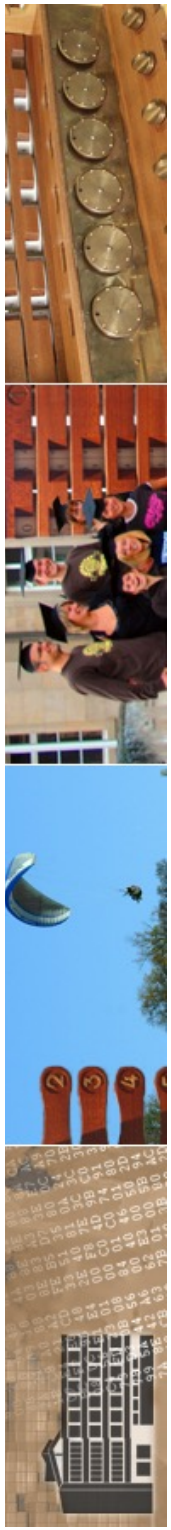
- Klasse Buch
- Instanz in Buchhandlung

- Klasse BuchPublisher erweitert Buch um weitere Attribute
- Instanz in Buchhandlung2





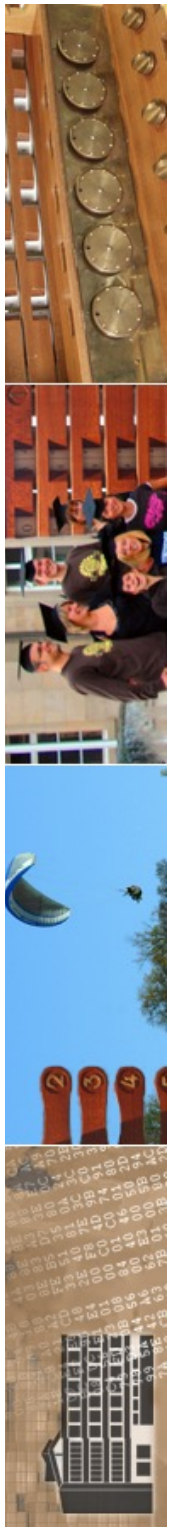

```
thomas@uni-vpn229 => more Book.py
# Grundlagen Internet-Technologien
#
# Programmierung mit Python
#
# Beispiel fuer Objektorientierung
# Klasse Buch: Konstruktor, gekapselte Attribute, Stringumwandlung

class Buch:

    ### Konstruktor ###
    def __init__ (self,titel,nname,vname):
        self.__titel_ = titel
        self.__nname_ = nname
        self.__vname_ = vname

    ### get-Methoden fuer private Attribute ###
    def getAutor(self):
        autor = self.__vname_ + " " + self.__nname_
        return autor

    def getTitel(self):
        return self.__titel_

    def getVerlag(self):
        return self.__verlag_

    ### __str__-Methode ###
    def __str__(self):
        return self.getAutor() + ": " + self.__titel_
thomas@uni-vpn229 =>
```



```
[thomas@uni-vpn229 => more Buchhandlung.py
# Grundlagen Internet-Technologien
#
# Einfuehrung in Python
# Instanz der Klasse Buch

from Book import Buch

meinNeuesBuch = Buch("Kompendium der Web-Programmierung", \
                     "Walter","Thomas")

print (meinNeuesBuch)
[thomas@uni-vpn229 =>
```

```
[thomas@uni-vpn229 =>
[thomas@uni-vpn229 => python3 Buchhandlung.py
 Thomas Walter: Kompendium der Web-Programmierung
[thomas@uni-vpn229 =>
```

```
thomas@uni-vpn229 => more BookPublisher.py
# Grundlagen Internet-Technologien
#
# Programmierung mit Python
#
# Beispiel fuer Vererbung
# Klasse Buch: Konstruktor, zwei zusaetzliche gekapselte Attribute,
#              Stringumwandlung

from Book import *

class BuchPublisher (Buch):

    ### Konstruktor ###
    def __init__ (self, titel, nname, vname,verlag="Springer",jahr=2021):
        Buch.__init__(self,titel,nname,vname)
        self.__verlag_ = verlag
        self.__jahr_ = jahr

    ### get-Methoden fuer private Attribute ###
    def getVerlag(self):
        return self.__verlag_

    def getJahr(self):
        return self.__jahr_

    ### __str__-Methode ###
    def __str__(self):
        return Buch.__str__(self) + " (" + \
                self.getVerlag() + ", " + str(self.getJahr()) + ")"
thomas@uni-vpn229 =>
```



# …und nun…

- haben wir die universelle Scriptsprache Python grundlegend kennen gelernt
  - Prinzip, Variablen, Kontrollstrukturen und mehr


- als nächstes:

Wir verwenden Python,
*um effizient*
*CGI-Programme*
*für serverseitige Web-*
*Applikationen zu schreiben*