



Programming with Python

17. Listen

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Dies ist ein Kurs über das Programmieren mit der Programmiersprache Python an der Universität Hefei (合肥大学).

Die Webseite mit dem Lehrmaterial dieses Kurses ist <https://thomasweise.github.io/programmingWithPython> (siehe auch den QR-Kode unten rechts). Dort können Sie das Kursbuch (in Englisch) und diese Slides finden. Das Repository mit den Beispielprogrammen in Python finden Sie unter <https://github.com/thomasWeise/programmingWithPythonCode>.



Outline

1. Einleitung
2. Beispiele
3. Zusammenfassung





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Beispiele



Type Hints, Listen erstellen, Elemente anhängen, verbinden, und indizieren



- Listenvariablen werden mit dem Type Hint

`list[elementTyp]` annotiert, wobei `elementType` der Datentyp für die Elemente ist⁶.

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↓ python3 lists_1.py ↓

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2 There now are 4 fruits: ['apple', 'pear', 'orange', 'cherry']
3 The vegetables are: ['onion', 'potato', 'leek'].
4 Fruits and vegetables: ['apple', 'pear', 'orange', 'cherry', 'onion', '
  ↳ potato', 'leek']
5 len(food) = 7
6 food[0] = 'apple'
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Suchen, einfügen, löschen, sortieren, kopieren und vergleichen



- `a in lst` ist `True`, wenn Element `a` in Liste `lst` auftaucht.

```
1  """An example of creating, modifying, sorting, and copying lists."""
2
3  numbers: list[int] = [1, 7, 56, 2, 4] # Create the list.
4  print(f"The numbers are: {numbers}.") # Print the list.
5
6  print(f"is 7 in the list: {7 in numbers}") # Check if 7 is in the list.
7  print(f"is 2 NOT in the list: {2 not in numbers}") # the opposite check
8  print(f"7 ist at index {numbers.index(7)}.") # Search for number 7.
9  print(f"2 ist at index {numbers.index(2)}.") # Search for number 2.
10
11 numbers.insert(2, 12) # Insert the number 12 at index 2...
12 print(f"After inserting 12, the numbers are: {numbers}.") # and print.
13
14 numbers.remove(56) # Remove the number 56 from the list.
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Suchen, einfügen, löschen, sortieren, kopieren und vergleichen



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Suchen, einfügen, löschen, sortieren, kopieren und vergleichen



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Suchen, einfügen, löschen, sortieren, kopieren und vergleichen



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Suchen, einfügen, löschen, sortieren, kopieren und vergleichen



- `lst.remove(e)` löscht Element `e` aus der Liste `lst`.
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30 print(f"cpy is not numbers: {cpy is not numbers}.") # indeed, it is not
```

↓ python3 lists_2.py ↓

```
1 The numbers are: [1, 7, 56, 2, 4].
2 is 7 in the list: True
3 is 2 NOT in the list: False
4 7 ist at index 1.
5 2 ist at index 3.
6 After inserting 12, the numbers are: [1, 7, 12, 56, 2, 4].
7 After removing 56, numbers are: [1, 7, 12, 2, 4].
8 The sorted numbers are: [1, 2, 4, 7, 12].
9 The reversed numbers are: [12, 7, 4, 2, 1].
10 cpy == numbers: True.
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Suchen, einfügen, löschen, sortieren, kopieren und vergleichen



- `lst.remove(e)` löscht Element `e` aus der Liste `lst`.
- `lst.sort()` sortiert die Liste `lst`.
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- `==`, `!=`, `is` und `is not` funktionieren auch mit Listen.

```
1 The numbers are: [1, 7, 56, 2, 4].
2 is 7 in the list: True
3 is 2 NOT in the list: False
4 7 ist at index 1.
5 2 ist at index 3.
6 After inserting 12, the numbers are: [1, 7, 12, 56, 2, 4].
7 After removing 56, numbers are: [1, 7, 12, 2, 4].
8 The sorted numbers are: [1, 2, 4, 7, 12].
9 The reversed numbers are: [12, 7, 4, 2, 1].
10 cpy == numbers: True.
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Konkatenation, Addition, Multiplikation, Slices, und auspacken

- Die Addition `lst1 + lst2` von zwei Listen `lst1` und `lst2` erzeugt eine neue Liste mit den Elementen von `lst1` gefolgt von den Elementen von `lst2`.

```
1  """An example of more operations with lists."""
2
3  lst1: list[int] = [1, 2, 3, 4] # create first list
4  lst2: list[int] = [5, 6, 7] # create second list
5  lst3: list[int] = lst1 + lst2 # lst3 = concatenation of lst1 and lst2.
6  print(f"lst3 = lst1 + lst2 == {lst3}") # [1, 2, 3, 4, 5, 6, 7]
7
8  lst4: list[int] = lst2 * 3 # lst4 = lst2, repeated three times.
9  print(f"lst4 = lst2 * 3 == {lst4}") # [5, 6, 7, 5, 6, 7, 5, 6, 7]
10
11 lst5: list[int] = lst4[2:-2] # lst5 = lst4 from index 2 to 3rd from end
12 print(f"lst5 = lst4[2:-2] == {lst5}") # [7, 5, 6, 7, 5]
13
14 lst6: list[int] = lst4[1::2] # start at index 1, take every 2nd element
15 print(f"lst6 = lst4[1::2] == {lst6}") # [6, 5, 7, 6]
16
17 # Start copying lst4 at last element, move backwards take every 2nd
18 # element, and stop right before index=3.
19 lst7: list[int] = lst4[-1:3:-2]
20 print(f"lst7 = lst4[-1:3:-2] == {lst7}") # [7, 5, 6]
21
22 lst7[1] = 12 # Modify the slice lst7 originally from lst4.
23 print(f"{lst4 = }, {lst7 =}") # Shows that lst4 remains unchanged.
24
25 a, b, c = lst2 # store the three elements of lst2 into variables
26 print(f"{a = }, {b = }, {c =}") # a=5, b=6, c=7
```

Konkatenation, Addition, Multiplikation, Slices, und auspacken

- Die Addition `lst1 + lst2` von zwei Listen `lst1` und `lst2` erzeugt eine neue Liste mit den Elementen von `lst1` gefolgt von den Elementen von `lst2`.
- Die Multiplikation `lst * i` der Liste `lst` mit dem `int i` erzeugt eine neue Liste, in der die Elemente von `lst` `i`-Mal hintereinander vorkommen.

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7
8  lst4: list[int] = lst2 * 3 # lst4 = lst2, repeated three times.
9  print(f"lst4 = lst2 * 3 == {lst4}") # [5, 6, 7, 5, 6, 7, 5, 6, 7]
10
11 lst5: list[int] = lst4[2:-2] # lst5 = lst4 from index 2 to 3rd from end
12 print(f"lst5 = lst4[2:-2] == {lst5}") # [7, 5, 6, 7, 5]
13
14 lst6: list[int] = lst4[1::2] # start at index 1, take every 2nd element
15 print(f"lst6 = lst4[1::2] == {lst6}") # [6, 5, 7, 6]
16
17 # Start copying lst4 at last element, move backwards take every 2nd
18 # element, and stop right before index=3.
19 lst7: list[int] = lst4[-1:3:-2]
20 print(f"lst7 = lst4[-1:3:-2] == {lst7}") # [7, 5, 6]
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Konkatenation, Addition, Multiplikation, Slices, und auspacken

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- Listen können genauso ge-sliced werden wie Strings¹².

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11 lst5: list[int] = lst4[2:-2] # lst5 = lst4 from index 2 to 3rd from end
12 print(f"lst5 = lst4[2:-2] == {lst5}") # [7, 5, 6, 7, 5]
13
14 lst6: list[int] = lst4[1::2] # start at index 1, take every 2nd element
15 print(f"lst6 = lst4[1::2] == {lst6}") # [6, 5, 7, 6]
16
17 # Start copying lst4 at last element, move backwards take every 2nd
18 # element, and stop right before index=3.
19 lst7: list[int] = lst4[-1:3:-2]
20 print(f"lst7 = lst4[-1:3:-2] == {lst7}") # [7, 5, 6]
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22 lst7[1] = 12 # Modify the slice lst7 originally from lst4.
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26 print(f"{a = }, {b = }, {c = }") # a=5, b=6, c=7
```

Konkatenation, Addition, Multiplikation, Slices, und auspacken

- Die Multiplikation `lst * i` der Liste `lst` mit dem `int i` erzeugt eine neue Liste, in der die Elemente von `lst` `i`-Mal hintereinander vorkommen.
- Listen können genauso ge-sliced werden wie Strings¹².
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1  """An example of more operations with lists."""
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3  lst1: list[int] = [1, 2, 3, 4] # create first list
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8  lst4: list[int] = lst2 * 3 # lst4 = lst2, repeated three times.
9  print(f"lst4 = lst2 * 3 == {lst4}") # [5, 6, 7, 5, 6, 7, 5, 6, 7]
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11 lst5: list[int] = lst4[2:-2] # lst5 = lst4 from index 2 to 3rd from end
12 print(f"lst5 = lst4[2:-2] == {lst5}") # [7, 5, 6, 7, 5]
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↓ python3 lists_3.py ↓

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6  lst4 = [5, 6, 7, 5, 6, 7, 5, 6, 7], lst7 = [7, 12, 6]
7  a = 5, b = 6, c = 7
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2 lst4 = lst2 * 3 == [5, 6, 7, 5, 6, 7, 5, 6, 7]
3 lst5 = lst4[2:-2] == [7, 5, 6, 7, 5]
4 lst6 = lst4[1::2] == [6, 5, 7, 6]
5 lst7 = lst4[-1:3:-2] == [7, 5, 6]
6 lst4 = [5, 6, 7, 5, 6, 7, 5, 6, 7], lst7 = [7, 12, 6]
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- Listenvariablen sollten mit Type Hints annotiert werden.
- Listen können genau wie Zeichenketten (Strings) indiziert werden.
- Listen sind ein wichtiges Werkzeug, um dynamisch veränderliche Kollektionen von Objekten zu verarbeiten.



谢谢你们！

Thank you!

Vielen Dank!



References I



- [1] "Built-in Types". In: *Python 3 Documentation. The Python Standard Library*. Beaverton, OR, USA: Python Software Foundation (PSF), 2001–2025. URL: <https://docs.python.org/3/library/stdtypes.html> (besucht am 2024-08-22) (siehe S. 5–10).
- [2] "`collections.abc` – Abstract Base Classes for Containers". In: *Python 3 Documentation. The Python Standard Library*. Beaverton, OR, USA: Python Software Foundation (PSF), 2001–2025. URL: <https://docs.python.org/3/library/collections.abc.html> (besucht am 2024-08-22) (siehe S. 5–10).
- [3] "Data Model". In: *Python 3 Documentation. The Python Language Reference*. Beaverton, OR, USA: Python Software Foundation (PSF), 2001–2025. Kap. 3. URL: <https://docs.python.org/3/reference/datamodel.html> (besucht am 2024-08-22) (siehe S. 5–10).
- [4] John Hunt. *A Beginners Guide to Python 3 Programming*. 2. Aufl. Undergraduate Topics in Computer Science (UTICS). Cham, Switzerland: Springer, 2023. ISBN: 978-3-031-35121-1. doi:10.1007/978-3-031-35122-8 (siehe S. 54).
- [5] Łukasz Langa. *Literature Overview for Type Hints*. Python Enhancement Proposal (PEP) 482. Beaverton, OR, USA: Python Software Foundation (PSF), 8. Jan. 2015. URL: <https://peps.python.org/pep-0482> (besucht am 2024-10-09) (siehe S. 54).
- [6] Łukasz Langa. *Type Hinting Generics In Standard Collections*. Python Enhancement Proposal (PEP) 585. Beaverton, OR, USA: Python Software Foundation (PSF), 3. März 2019. URL: <https://peps.python.org/pep-0585> (besucht am 2024-10-09) (siehe S. 17–21).
- [7] Kent D. Lee und Steve Hubbard. *Data Structures and Algorithms with Python*. Undergraduate Topics in Computer Science (UTICS). Cham, Switzerland: Springer, 2015. ISBN: 978-3-319-13071-2. doi:10.1007/978-3-319-13072-9 (siehe S. 54).
- [8] Michael Lee, Ivan Levkivskiy und Jukka Lehtosalo. *Literal Types*. Python Enhancement Proposal (PEP) 586. Beaverton, OR, USA: Python Software Foundation (PSF), 14. März 2019. URL: <https://peps.python.org/pep-0586> (besucht am 2024-12-17) (siehe S. 54).
- [9] Jukka Lehtosalo, Ivan Levkivskiy, Jared Hance, Ethan Smith, Guido van Rossum, Jelle „JelleZijlstra“ Zijlstra, Michael J. Sullivan, Shantanu Jain, Xuanda Yang, Jingchen Ye, Nikita Sobolev und Mypy Contributors. *Mypy – Static Typing for Python*. San Francisco, CA, USA: GitHub Inc, 2024. URL: <https://github.com/python/mypy> (besucht am 2024-08-17) (siehe S. 54).
- [10] Mark Lutz. *Learning Python*. 6. Aufl. Sebastopol, CA, USA: O'Reilly Media, Inc., März 2025. ISBN: 978-1-0981-7130-8 (siehe S. 54).

References II



- [11] Yasset Pérez-Riverol, Laurent Gatto, Rui Wang, Timo Sachsenberg, Julian Uszkoreit, Felipe da Veiga Leprevost, Christian Fufezan, Tobias Ternent, Stephen J. Eglén, Daniel S. Katz, Tom J. Pollard, Alexander Kononov, Robert M. Flight, Kai Blin und Juan Antonio Vizcaíno. "Ten Simple Rules for Taking Advantage of Git and GitHub". *PLOS Computational Biology* 12(7), 14. Juli 2016. San Francisco, CA, USA: Public Library of Science (PLOS). ISSN: 1553-7358. doi:10.1371/JOURNAL.PCBI.1004947 (siehe S. 54).
- [12] "Sequences". In: *Python 3 Documentation. The Python Language Reference*. Beaverton, OR, USA: Python Software Foundation (PSF), 2001–2025. Kap. 3.2.5. URL: <https://docs.python.org/3/reference/datamodel.html#sequences> (besucht am 2024-08-24) (siehe S. 11–15, 37–43).
- [13] Anna Skoulikari. *Learning Git*. Sebastopol, CA, USA: O'Reilly Media, Inc., Mai 2023. ISBN: 978-1-0981-3391-7 (siehe S. 54).
- [14] *Python 3 Documentation. The Python Language Reference*. Beaverton, OR, USA: Python Software Foundation (PSF), 2001–2025. URL: <https://docs.python.org/3/reference> (besucht am 2025-04-27).
- [15] *Python 3 Documentation. The Python Standard Library*. Beaverton, OR, USA: Python Software Foundation (PSF), 2001–2025. URL: <https://docs.python.org/3/library> (besucht am 2025-04-27).
- [16] "Literals". In: *Static Typing with Python*. Hrsg. von The Python Typing Team. Beaverton, OR, USA: Python Software Foundation (PSF), 2021. URL: <https://typing.python.org/en/latest/spec/literal.html> (besucht am 2025-08-29) (siehe S. 54).
- [17] Mariot Tsitoara. *Beginning Git and GitHub: Version Control, Project Management and Teamwork for the New Developer*. New York, NY, USA: Apress Media, LLC, März 2024. ISBN: 979-8-8688-0215-7 (siehe S. 54).
- [18] Guido van Rossum und Łukasz Langa. *Type Hints*. Python Enhancement Proposal (PEP) 484. Beaverton, OR, USA: Python Software Foundation (PSF), 29. Sep. 2014. URL: <https://peps.python.org/pep-0484> (besucht am 2024-08-22) (siehe S. 54).
- [19] Thomas Weise (汤卫思). *Programming with Python*. Hefei, Anhui, China (中国安徽省合肥市): Hefei University (合肥大学), School of Artificial Intelligence and Big Data (人工智能与大数据学院), 2024–2026. URL: <https://thomasweise.github.io/programmingWithPython> (besucht am 2025-01-05) (siehe S. 54).

Glossary (in English) I



Git is a distributed Version Control Systems (VCS) which allows multiple users to work on the same code while preserving the history of the code changes^{13,17}. Learn more at <https://git-scm.com>.

GitHub is a website where software projects can be hosted and managed via the Git VCS^{11,17}. Learn more at <https://github.com>.

literal A literal is a specific concrete value, something that is written down as-is^{8,16}. In Python, for example, `"abc"` is a string literal, `5` is an integer literal, and `23.3` is a `float` literal. In contrast, `sin(3)` is not a literal. Also, while `5` is an integer literal, if we create a variable `a = 5` then `a` is not a literal either (it is a variable). Hence, literals are values that the Python interpreter reads directly from the source code and creates as objects in memory. They are not something that is the result from a computation or the result of a variable lookup. Python supports some type hints for literals, including the type `LiteralString` for string literals and the type `Literal[xyz]` for arbitrary literals `xyz`.

Mypy is a static type checking tool for Python⁹ that makes use of type hints. Learn more at <https://github.com/python/mypy> and in¹⁹.

Python The Python programming language^{4,7,10,19}, i.e., what you will learn about in our book¹⁹. Learn more at <https://python.org>.

type hint are annotations that help programmers and static code analysis tools such as Mypy to better understand what type a variable or function parameter is supposed to be^{5,18}. Python is a dynamically typed programming language where you do not need to specify the type of, e.g., a variable. This creates problems for code analysis, both automated as well as manual: For example, it may not always be clear whether a variable or function parameter should be an integer or floating point number. The annotations allow us to explicitly state which type is expected. They are *ignored* during the program execution. They are a basically a piece of documentation.

VCS A *Version Control System* is a software which allows you to manage and preserve the historical development of your program code¹⁷. A distributed VCS allows multiple users to work on the same code and upload their changes to the server, which then preserves the change history. The most popular distributed VCS is Git.