Werkzeuge für das wissenschaftliche Arbeiten

Python for Machine Learning and Data Science

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Inhaltsübersicht

1. Programmiersprache Python
   a) *Einführung, Erste Schritte*
   b) *Grundlagen*
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2. Auszeichnungssprachen
   a) LaTeX, Markdown
3. Benutzeroberflächen und Entwicklungsumgebungen
   a) Jupyter Notebooks lokal und in der Cloud (Google Colab)
4. Versionsverwaltung
   a) Git, GitHub
5. Wissenschaftliches Rechnen
   a) NumPy, SciPy
6. Datenverarbeitung und -visualisierung
   a) Pandas, matplotlib, NLTK
7. Machine Learning (scikit-learn)
   a) Grundlegende Ansätze (Datensätze, Auswertung)
   b) Einfache Verfahren (Clustering, …)
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Themen

- Magic Methods
- Generatoren
- Erweiterte Schleifen
- Fehlerbehandlung
- Kontextmanager

- Lambda-Funktionen
- Typannotationen
- Variablen und Zeiger
- Dekoratoren

Magic Methods

```
class Vector():

  def __init__(self, a, b):
    self.a = a
    self.b = b

  def __add__(self, o):
    return Vector(self.a + o.a, self.b + o.b)

  def __sub__(self, o):
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  def __iadd__(self, o):
    self.a += o.a
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    return "({}, {})".format(self.a, self.b)
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x = Vector(1, 2)
print(x, str(x), x.__str__())


y = Vector(2, 3)
print(y)


print(x + y, x.__add__(y))


print(x - y)


x += y
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x -= y
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Warum geht es auch, obwohl __isub__ nicht definiert ist?

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Falls kein String, versucht `print()` einen mit `str()` zu erzeugen und bei einer Klasse geht dies per `__str__()`.

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Magic Methods

Mathe-matisch	__add__	+	Addition

https://docs.python.org/3/reference/datamodel.html
https://docs.python.org/3/library/operator.html#mapping-operators-to-functions

Magic Methods

Mathe-matisch	__add__	+	Addition
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Mathe-matisch	`__add__`	+	Addition
	`__sub__`	-	Subtraktion
	`__mul__`	*	Multiplikation

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	`__pow__`	`**`	Potenz

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Logisch	`__and__`	`&`	Bitweises Und

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Vergleichend	`__lt__`	<	Kleiner

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Klassen (-eigenschaften)	`__bool__`	Bool eines Objekts (`if obj:`)	

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Klassen (-eigenschaften)	`__bool__`	Bool eines Objekts (`if obj:`)	
	`__hash__`	Eindeutiger Hash des Objekts	

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Vergleichend	`__lt__`	`<`	Kleiner
	`__le__`	`<=`	Kleiner gleich
	`__eq__`	`==`	Gleich
	`__ne__`	`!=`	Ungleich
	`__gt__`	`>`	Größer
	`__ge__`	`>=`	Größer gleich
Klassen (-eigenschaften)	`__bool__`	Bool eines Objekts (`if obj:`)	
	`__hash__`	Eindeutiger Hash des Objekts	
	`__len__`	Länge des Objekts	

https://docs.python.org/3/reference/datamodel.html
https://docs.python.org/3/library/operator.html#mapping-operators-to-functions

Magic Methods

Mathe-matisch	`__add__`	`+`	Addition
	`__sub__`	`-`	Subtraktion
	`__mul__`	`*`	Multiplikation
	`__matmul__`	`@`	Matrixmultiplikation
	`__truediv__`	`/`	Division
	`__floordiv__`	`//`	Ganzzahldivision
	`__pow__`	`**`	Potenz
Logisch	`__and__`	`&`	Bitweises Und
	`__xor__`	`^`	Bitweises Entweder-Oder
	`__or__`	`|`	Bitweises Oder

Vergleichend	`__lt__`	`<`	Kleiner
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	`__hash__`	Eindeutiger Hash des Objekts	
	`__len__`	Länge des Objekts	
	`__str__`	String (Ausgabe)	

https://docs.python.org/3/reference/datamodel.html
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Magic Methods

Mathe-matisch	`__add__`	`+`	Addition
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	`__len__`	Länge des Objekts	
	`__str__`	String (Ausgabe)	
	`__del__`	Objekt löschen (`del obj`)	

https://docs.python.org/3/reference/datamodel.html
https://docs.python.org/3/library/operator.html#mapping-operators-to-functions

Magic Methods: dict & list

```
class DictContainer():

  def __init__(self):
    self.dict = {}

  def __setitem__(self, key, value):
    self.dict[key] = value

  def __getitem__(self, key):
    return self.dict[key]

  def __delitem__(self, key):
    del self.dict[key]

  def __contains__(self, key):
    return key in self.dict

  def __str__(self):
    return str(self.dict)
```

Magic Methods: dict & list

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    del self.dict[key]

  def __contains__(self, key):
    return key in self.dict

  def __str__(self):
    return str(self.dict)
```

```
dc = DictContainer()

dc["a"] = "A"
dc.__setitem__("b", "B")
print(dc)

print(dc["a"])
print(dc.__getitem__("b"))

del dc["a"]
print(dc)

print("2" in dc, "b" in dc)
```

Magic Methods: dict & list

```
class DictContainer():

  def __init__(self):
    self.dict = {}

  def __setitem__(self, key, value):
    self.dict[key] = value

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```

```
dc = DictContainer()

dc["a"] = "A"
dc.__setitem__("b", "B")
print(dc)

print(dc["a"])
print(dc.__getitem__("b"))

del dc["a"]
print(dc)

print("2" in dc, "b" in dc)
```

```
{'a': 'A', 'b': 'B'}
```

Magic Methods: dict & list

```python
class DictContainer():

  def __init__(self):
    self.dict = {}

  def __setitem__(self, key, value):
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```

```python
dc = DictContainer()

dc["a"] = "A"
dc.__setitem__("b", "B")
print(dc)

print(dc["a"])
print(dc.__getitem__("b"))

del dc["a"]
print(dc)

print("2" in dc, "b" in dc)
```

```
{'a': 'A', 'b': 'B'}

A
```

Magic Methods: dict & list

```python
class DictContainer():

  def __init__(self):
    self.dict = {}

  def __setitem__(self, key, value):
    self.dict[key] = value

  def __getitem__(self, key):
    return self.dict[key]

  def __delitem__(self, key):
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  def __contains__(self, key):
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```python
dc = DictContainer()

dc["a"] = "A"
dc.__setitem__("b", "B")
print(dc)

print(dc["a"])
print(dc.__getitem__("b"))

del dc["a"]
print(dc)

print("2" in dc, "b" in dc)
```

```
{'a': 'A', 'b': 'B'}
A
B
```

Magic Methods: dict & list

```python
class DictContainer():

  def __init__(self):
    self.dict = {}

  def __setitem__(self, key, value):
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  def __getitem__(self, key):
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    return key in self.dict

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```

```python
dc = DictContainer()

dc["a"] = "A"
dc.__setitem__("b", "B")
print(dc)

print(dc["a"])
print(dc.__getitem__("b"))

del dc["a"]
print(dc)

print("2" in dc, "b" in dc)
```

```
{'a': 'A', 'b': 'B'}
A
B
{'b': 'B'}
```

Magic Methods: dict & list

```python
class DictContainer():

  def __init__(self):
    self.dict = {}

  def __setitem__(self, key, value):
    self.dict[key] = value

  def __getitem__(self, key):
    return self.dict[key]

  def __delitem__(self, key):
    del self.dict[key]

  def __contains__(self, key):
    return key in self.dict

  def __str__(self):
    return str(self.dict)
```

```python
dc = DictContainer()

dc["a"] = "A"
dc.__setitem__("b", "B")
print(dc)
```

```
{'a': 'A', 'b': 'B'}
```

```python
print(dc["a"])
print(dc.__getitem__("b"))
```

```
A
B
```

```python
del dc["a"]
print(dc)
```

```
{'b': 'B'}
```

```python
print("2" in dc, "b" in dc)
```

```
False True
```

Generatoren

```
import timeit

lc_a = """
[i for i in range(2**10)]
"""
print(timeit.timeit(lc_a, number=20))
```

```
import timeit

g_a = """
(i for i in range(2**10))
"""
print(timeit.timeit(g_a, number=20))
```

```
lc_b = """
[i for i in range(2**20)]
"""
print(timeit.timeit(lc_b, number=20))
```

```
g_b = """
(i for i in range(2**20))
"""
print(timeit.timeit(g_b, number=20))
```

Generatoren

```
import timeit

lc_a = """
[i for i in range(2**10)]
"""
print(timeit.timeit(lc_a, number=20))
```

```
0.0007693090010434389
```

```
lc_b = """
[i for i in range(2**20)]
"""
print(timeit.timeit(lc_b, number=20))
```

```
0.9470873650006979
```

```
import timeit

g_a = """
(i for i in range(2**10))
"""
print(timeit.timeit(g_a, number=20))
```

```
1.0978999853250 57e-05
```

```
g_b = """
(i for i in range(2**20))
"""
print(timeit.timeit(g_b, number=20))
```

```
2.2750000425730832e-05
```

Generatoren

```
import timeit

lc_a = """
[i for i in range(2**10)]
"""
print(timeit.timeit(lc_a, number=20))
```

```
0.0007693090010434389
```

```
lc_b = """
[i for i in range(2**20)]
"""
print(timeit.timeit(lc_b, number=20))
```

```
0.9470873650006979
```

```
import timeit

g_a = """
(i for i in range(2**10))
"""
print(timeit.timeit(g_a, number=20))
```

```
1.0978999853250 57e-05
```

```
g_b = """
(i for i in range(2**20))
"""
print(timeit.timeit(g_b, number=20))
```

```
2.2750000425730832e-05
```

Links hängt die Dauer stark von der Anzahl ab, rechts nicht. Warum?

Generatoren

Generator Expression ( )
List Comprehension [ ]

```
import timeit

lc_a = """
[i for i in range(2**10)]
"""
print(timeit.timeit(lc_a, number=20))
```

```
0.0007693090010434389
```

```
lc_b = """
[i for i in range(2**20)]
"""
print(timeit.timeit(lc_b, number=20))
```

```
0.9470873650006979
```

```
import timeit

g_a = """
(i for i in range(2**10))
"""
print(timeit.timeit(g_a, number=20))
```

```
1.07899985325057e-05
```

```
g_b = """
(i for i in range(2**20))
"""
print(timeit.timeit(g_b, number=20))
```

```
2.2750000425730832e-05
```

Links hängt die Dauer stark von der Anzahl ab, rechts nicht. Warum?

Generatoren: `yield`

```
def list_range(until):
  l = []
  i = 0
  while i < until:
    l.append(i)
    i += 1
  return l

print(list_range(20))
for i in list_range(5):
  print(i)
```

Generatoren: `yield`

```
def list_range(until):
  l = []
  i = 0
  while i < until:
    l.append(i)
    i += 1
  return l

print(list_range(20))
for i in list_range(5):
  print(i)
```

```
[0, 1, 2, 3, 4, 5, … 18, 19]
0
1
2
3
4
```

Generatoren: `yield`

```python
def list_range(until):
  l = []
  i = 0
  while i < until:
    l.append(i)
    i += 1
  return l

print(list_range(20))
for i in list_range(5):
  print(i)
```

```
[0, 1, 2, 3, 4, 5, … 18, 19]
0
1
2
3
4
```

```python
def generate_range(until):
  i = 0
  while i < until:
    yield i
    i += 1

print(generate_range(20))
for i in generate_range(5):
  print(i)
```

Generatoren: `yield`

```python
def list_range(until):
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  return l

print(list_range(20))
for i in list_range(5):
  print(i)
```

```
[0, 1, 2, 3, 4, 5, … 18, 19]
0
1
2
3
4
```

```python
def generate_range(until):
  i = 0
  while i < until:
    yield i
    i += 1

print(generate_range(20))
for i in generate_range(5):
  print(i)
```

```
<generator object … at 0x10a3bc040>
0
1
2
3
4
```

neratoren: `yield`

Eine ganze Liste mit den einzelnen Zahlen wird erstellt und danach zurückgegeben.

```
def list_range(until):
  l = []
  i = 0
  while i < until:
    l.append(i)
    i += 1
  return l

print(list_range(20))
for i in list_range(5):
  print(i)
```

```
[0, 1, 2, 3, 4, 5, … 18, 19]
0
1
2
3
4
```

Es wird immer nur der nächste Wert erzeugt, dieser zurückgegben, verarbeitet und dann der nächste erzeigt.

```
def generate_range(until):
  i = 0
  while i < until:
    yield i
    i += 1

print(generate_range(20))
for i in generate_range(5):
  print(i)
```

```
<generator object … at 0x10a3bc040>
0
1
2
3
4
```

Iteration mit Generatoren

```
class FileReader():

  def __init__(self, filename):
    self.filename = filename

  def __iter__(self):
    t = open(self.filename + ".titles.txt", "r")
    c = open(self.filename + ".contents.txt", "r")

    t_l = t.readline()
    c_l = c.readline()

    while t_l and c_l:
      yield t_l.strip(), c_l.strip().split(",")

      t_l = t.readline()
      c_l = c.readline()

    t.close()
    c.close()
```

Iteration mit Generatoren

```
class FileReader():

  def __init__(self, filename):
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  def __iter__(self):
    t = open(self.filename + ".titles.txt", "r")
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    t_l = t.readline()
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    while t_l and c_l:
      yield t_l.strip(), c_l.strip().split(",")

      t_l = t.readline()
      c_l = c.readline()

    t.close()
    c.close()
```

e.contents.txt

```
Audi,BMW,Ford
Apple,Banana,Pear
Mouse,Screen,Keyboard
```

e.titles.txt

```
Car
Fruit
Computer
```

```
fr = FileReader("e")
for t, c in fr:
  print(t, c)
```

Iteration mit Generatoren

```
class FileReader():

  def __init__(self, filename):
    self.filename = filename

  def __iter__(self):
    t = open(self.filename + ".titles.txt", "r")
    c = open(self.filename + ".contents.txt", "r")

    t_l = t.readline()
    c_l = c.readline()

    while t_l and c_l:
      yield t_l.strip(), c_l.strip().split(",")

      t_l = t.readline()
      c_l = c.readline()

    t.close()
    c.close()
```

e.contents.txt

```
Audi,BMW,Ford
Apple,Banana,Pear
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e.titles.txt

```
Car
Fruit
Computer
```

```
fr = FileReader("e")
for t, c in fr:
  print(t, c)
```

```
Car ['Audi', 'BMW', 'Ford']
Fruit ['Apple', 'Banana', 'Pear']
Computer ['Mouse', 'Screen', 'Keyboard']
```

Iteration mit Generatoren

```
class FileReader():

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    t = open(self.filename + ".titles.txt", "r")
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    t_l = t.readline()
    c_l = c.readline()

    while t_l and c_l:
      yield t_l.strip(), c_l.strip().split(",")

      t_l = t.readline()
      c_l = c.readline()

    t.close()
    c.close()
```

Iteration über ein Objekt durch Nutzung von `yield`.

Auch bei großen Dateien bleibt der Speicherverbrauch konstant. Laufzeit erhöht sich aber leicht.

Implizierer Aufruf der *Magic Method* `__iter__()`.

e.contents.txt

```
Audi,BMW,Ford
Apple,Banana,Pear
Mouse,Screen,Keyboard
```

e.titles.txt

```
Car
Fruit
Computer
```

```
fr = FileReader("e")
for t, c in fr:
  print(t, c)
```

```
Car ['Audi', 'BMW', 'Ford']
Fruit ['Apple', 'Banana', 'Pear']
Computer ['Mouse', 'Screen', 'Keyboard']
```

Erweiterte Schleifen

- List Comprehensions für Wörterbücher

Erweiterte Schleifen

- List Comprehensions für Wörterbücher

```
{i : i**2 for i in range(5)}
```

```
{0: 0, 1: 1, 2: 4, 3: 9, 4: 16}
```

Erweiterte Schleifen

- List Comprehensions für Wörterbücher

```
{i : i**2 for i in range(5)}
```

```
{0: 0, 1: 1, 2: 4, 3: 9, 4: 16}
```

- „Break“ und „Continue“

Erweiterte Schleifen

- List Comprehensions für Wörterbücher

```
{i : i**2 for i in range(5)}
```

```
{0: 0, 1: 1, 2: 4, 3: 9, 4: 16}
```

- „Break“ und „Continue“

```
for i in range(20):
  if i < 2:
    continue
  elif i > 5:
    break

  print(i)
```

```
2
3
4
5
```

Erweiterte Schleifen

- List Comprehensions für Wörterbücher

```
{i : i**2 for i in range(5)}
```

```
{0: 0, 1: 1, 2: 4, 3: 9, 4: 16}
```

- „Else“ nach Schleifen

- „Break“ und „Continue“

```
for i in range(20):
  if i < 2:
    continue
  elif i > 5:
    break

  print(i)
```

```
2
3
4
5
```

Erweiterte Schleifen

- List Comprehensions für Wörterbücher

```
{i : i**2 for i in range(5)}
```

```
{0: 0, 1: 1, 2: 4, 3: 9, 4: 16}
```

- „Else“ nach Schleifen

```
for i in range(4):
  if i == 5:
    print("Found")
    break
else:
  print("Not found!")
```

```
Not found!
```

- „Break“ und „Continue“

```
for i in range(20):
  if i < 2:
    continue
  elif i > 5:
    break

  print(i)
```

```
2
3
4
5
```

Erweiterte Schleifen

- List Comprehensions für Wörterbücher

```
{i : i**2 for i in range(5)}
```

```
{0: 0, 1: 1, 2: 4, 3: 9, 4: 16}
```

- „Else“ nach Schleifen

```
for i in range(4):
  if i == 5:
    print("Found")
    break
else:
  print("Not found!")
```

```
Not found!
```

```
for i in range(8):
  if i == 5:
    print("Found")
    break
else:
  print("Not found!")
```

```
Found!
```

- „Break“ und „Continue“

```
for i in range(20):
  if i < 2:
    continue
  elif i > 5:
    break

  print(i)
```

```
2
3
4
5
```

Erweiterte Schleifen

- List Comprehensions für Wörterbücher

```
{i : i**2 for i in range(5)}
```

```
{0: 0, 1: 1, 2: 4, 3: 9, 4: 16}
```

- „Break“ und „Continue“

```
for i in range(20):
  if i < 2:
    continue
  elif i > 5:
    break

  print(i)
```

```
2
3
4
5
```

- „Else“ nach Schleifen

```
for i in range(4):
  if i == 5:
    print("Found")
    break
else:
  print("Not found!")
```

```
Not found!
```

```
for i in range(8):
  if i == 5:
    print("Found")
    break
else:
  print("Not found!")
```

```
Found!
```

Else unter einer Schleife wird also genau dann ausgeführt, wenn die Schleife durchgelaufen ist und nicht abgebrochen wurde.

Fehlerbehandlung

```
def divide(x, y):
  try:
    r = x / y
  except ZeroDivisionError:
    print("Division by zero!")
  except TypeError as e:
    print("TypeError:", e)
  else:
    print("{x} / {y} = {r}".format(
     x=x, y=y, r=r
    ))
  finally:
    print("Finally done ;)")
```


https://docs.python.org/3/tutorial/errors.html#defining-clean-up-actions

Fehlerbehandlung

```python
def divide(x, y):
  try:
    r = x / y
  except ZeroDivisionError:
    print("Division by zero!")
  except TypeError as e:
    print("TypeError:", e)
  else:
    print("{x} / {y} = {r}".format(
     x=x, y=y, r=r
    ))
  finally:
    print("Finally done ;)")
```

```python
divide(1, 2)
```

```python
divide(1, 0)
```

```python
divide("A", 2)
```

https://docs.python.org/3/tutorial/errors.html#defining-clean-up-actions

Fehlerbehandlung

```python
def divide(x, y):
  try:
    r = x / y
  except ZeroDivisionError:
    print("Division by zero!")
  except TypeError as e:
    print("TypeError:", e)
  else:
    print("{x} / {y} = {r}".format(
     x=x, y=y, r=r
    ))
  finally:
    print("Finally done ;)")
```

```python
divide(1, 2)
```

```
1 / 2 = 0.5
Finally done ;)
```

```python
divide(1, 0)
```

```
Division by zero!
Finally done ;)
```

```python
divide("A", 2)
```

```
TypeError: unsupported operand type(s) for /: 'str' and 'int'
Finally done ;)
```

Fehlerbehandlung

```python
def divide(x, y):
  try:
    r = x / y
  except ZeroDivisionError:
    print("Division by zero!")
  except TypeError as e:
    print("TypeError:", e)
  else:
    print("{x} / {y} = {r}".format(
     x=x, y=y, r=r
    ))
  finally:
    print("Finally done ;)")
```

```python
divide(1, 2)
```

```
1 / 2 = 0.5
Finally done ;)
```

```python
divide(1, 0)
```

```
Division by zero!
Finally done ;)
```

```python
divide("A", 2)
```

Fehlerbehandlung

```python
def divide(x, y):
  try:
    r = x / y
  except ZeroDivisionError:
    print("Division by zero!")
  except TypeError as e:
    print("TypeError:", e)
  else:
    print("{x} / {y} = {r}".format(
     x=x, y=y, r=r
    ))
  finally:
    print("Finally done ;)")
```

```
divide(1, 2)
```

```
1 / 2 = 0.5
Finally done ;)
```

```
divide(1, 0)
```

```
Division by zero!
Finally done ;)
```

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divide("A", 2)
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```
TypeError: unsupported operand type(s)
for /: 'str' and 'int'
Finally done ;)
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```
divide(1, 2)
```

```
1 / 2 = 0.5
Finally done ;)
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Division by zero!
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Wozu könnte `finally` nützlich sein?

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Division by zero!
Finally done ;)
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divide("A", 2)
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```
TypeError: unsupported operand type(s)
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Finally done ;)
```

Verschiedene Fehler werden unterschieden und könne als Variable abgegriffen werden.

Falls kein Fehler auftrat.

Immer, egal ob Fehler oder nicht.

Wozu könnte `finally` nützlich sein?

Fehlerbehandlung

- Fehler können mit `raise` ausgelöst werden
- Fehler sind Objekte der Klasse (einer Unterklasse von) `Exception`
  - Vordefinierte Fehler: https://docs.python.org/3/library/exceptions.html#concrete-exceptions
  - Eigene Fehler können als Unterklasse erstellt werden

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  - Eigene Fehler können als Unterklasse erstellt werden

```
class MyError(Exception):
  pass

raise MyError("Stopp")
```

```
Traceback (most recent call last):
  File "name.py", line 4, in <module>
    raise MyError("Stopp")
__main__.MyError: Stopp
```

Fehlerbehandlung

- Fehler können mit `raise` ausgelöst werden
- Fehler sind Objekte der Klasse (einer Unterklasse von) `Exception`
  - Vordefinierte Fehler: https://docs.python.org/3/library/exceptions.html#concrete-exceptions
  - Eigene Fehler können als Unterklasse erstellt werden

Wofür könnte eine solcher Fehlerklasse ohne weitere Implementierung nützlich sein?

```
class MyError(Exception):
  pass

raise MyError("Stopp")
```

```
Traceback (most recent call last):
  File "name.py", line 4, in <module>
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__main__.MyError: Stopp
```

Kontextmanager

```
try:

  t = open("example.titles.txt", "r")
  t.write("huhu")
  t.close()

except BaseException as e:
  print(e)
```

Kontextmanager

Wo ist hier der Fehler?

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```

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```

```
not writable

Car
```

Kontextmanager

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print(t.readline())
```

```
not writable

Car
```

```
try:

  with open("example.contents.txt", "r") as c:
    c.write("huhu")


except BaseException as e:
  print(e)

print(c.readline())
```

Wo ist hier der Fehler?

Kontextmanager

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  t = open("example.titles.txt", "r")
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Traceback (most recent call last):
  File "name.py", line 18, in <module>
    print(c.readline())
ValueError: I/O operation on closed file.
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Kontextmanager

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  t = open("example.titles.txt", "r")
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Intern durch die Magic Methods __enter__() und __exit__() realisiert.

Kontextmanager

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  t.write("huhu")
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  print(e)

print(t.readline())
```

```
not writable

Car
```

Wenn `t.write()` einen Fehler auslöst, dann wird `t.close()` nicht ausgeführt und die Datei bleibt offen!

```
try:

  with open("example.contents.txt", "r") as c:
    c.write("huhu")


except BaseException as e:
  print(e)

print(c.readline
```

```
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Traceback (most recent call last):
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Intern durch die Magic Methods `__enter__()` und `__exit__()` realisiert.

Lambda-Funktionen

```
def pow2(number):
  return number ** 2

numbers = [1, 2, 3, 4]
for i, n in enumerate(numbers):
  numbers[i] = pow2(n)
print(numbers)
```

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[1, 4, 9, 16]
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print(numbers)
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```

```
numbers = [1, 2, 3, 4]
numbers = map(pow2, numbers)
print(numbers, list(numbers))
```

```
<map object at 0x10e0a2830> [1, 4, 9, 16]
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Lambda-Funktionen

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Lambda-Funktionen

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```python
def pow2_f(number):
  return number ** 2

pow2_l = lambda n : n**2
```

Lambda-Funktionen

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def pow2_f(number):
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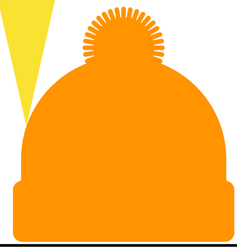
pow2_l = lambda n : n**2
```

Sehr praktisch für z.B.

```
sort(key=lambda o: o.name)
```



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```

```
def pow2_f(number):
  return number ** 2

pow2_l = lambda n : n**2
```

Zwei verschiedene Möglichkeiten eine Funktion zu erstellen!

Map nutzt intern einen Iterator und erzeugt somit nicht direkt eine Liste, sondern jeweils das nächste Element während der Iteration.

```
numbers = map(pow2, numbers)
print(numbers, list(numbers))
```

```
<map object at 0x10e0a2830> [1, 4, 9, 16]
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numbers = [1, 2, 3, 4]
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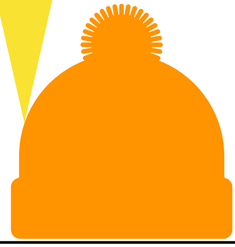

Map, Filter & Reduce

```python
numbers = [1, 2, 3, 4]

m = map(lambda n: n ** 3 if n < 3 else n ** 2, numbers)
print(list(m))



f = filter(lambda n: n % 2 == 0, numbers)
print(list(f))



from functools import reduce

r = reduce(lambda c, n: c + n, numbers, 0)
print(r)
```

Map, Filter & Reduce

```python
numbers = [1, 2, 3, 4]

m = map(lambda n: n ** 3 if n < 3 else n ** 2, numbers)
print(list(m))
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```

```
[n ** 3 if n < 3 else n ** 2 for n in numbers]
```

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```

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f = filter(lambda n: n % 2 == 0, numbers)
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[2, 4]
```

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```

```
[n for n in numbers if n % 2 == 0]
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10
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from functools import reduce

r = reduce(lambda c, n: c + n, numbers, 0)
print(r)
```

```
10
```

```python
c = 0
for n in numbers:
  c = c + n
  # c = (lambda c, n: c + n)(c, n)
```

Map, Filter & Reduce

```
numbers = [1, 2, 3, 4]

m = map(lambda n: n ** 3 if n < 3 else n ** 2, numbers)
print(list(m))
```

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[1, 8, 9, 16]
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```
[n ** 3 if n < 3 else n ** 2 for n in numbers]
```

Alternative Schreibweisen mit den gleichen Ergebnis

```
f = filter(lambda n: n % 2 == 0, numbers)
print(list(f))
```

```
[2, 4]
```

```
[n for n in numbers if n % 2 == 0]
```

```
from functools import reduce

r = reduce(lambda c, n: c + n, numbers, 0)
print(r)
```

```
10
```

Teilweise auch `fold()` genannt.

```
c = 0
for n in numbers:
  c = c + n
  # c = (lambda c, n: c + n)(c, n)
```

Intern wir quasi das Folgenden ausgeführt.

Typannotationen

```python
def str_repeat(s:str, n:int, sep:str=None) -> str:
  s = s + sep if sep else s
  return s * n

print(str_repeat("Hallo", 5))
print(str_repeat("Hallo", 2, ", "))
print(str_repeat(5, 5))
```

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Was passiert jeweils?

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```

```
HalloHalloHalloHalloHallo
Hallo, Hallo,
25
```

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```
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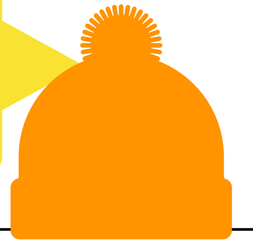
Was passiert jeweils?

Englisch „Type Hints“ und mehr als Hinweise sind es auch nicht, Python prüft Parameter nicht und führt die Funktion munter aus!



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```
HalloHalloHalloHalloHallo
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25
```

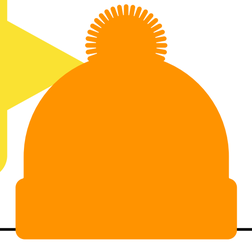
Was passiert jeweils?

```python
from pydantic import validate_arguments

@validate_arguments
def str_repeat(s:str, n:int, sep:str=None):
```

Mit dem externen Paket pydantic ist tatsächlich eine Prüfung der Typen möglich.

Englisch „Type Hints“ und mehr als Hinweise sind es auch nicht, Python prüft Parameter nicht und führt die Funktion munter aus!



Typannotationen

```python
from typing import NoReturn, Union, Optional

def hello(name:Optional[str]="") -> NoReturn:
  print("Hello " + name)

def divide(x:Union[int, float], y:int|float) -> float:
  return x / y
```

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```

```python
from typing import List, Dict, Tuple

Tuple[int, str] # (1, "a")
Tuple[int, ...] # (1, 1), (1, 2, 3)

List[str] # ["a", "b"]
List[Union[str, int]] # [1, "b"], ["a", 2]

Dict[str, str] # {"a" : "A", "b" : "B"}
```

Typannotationen

```python
from typing import NoReturn, Union, Optional

def hello(name:Optional[str]="") -> NoReturn:
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def divide(x:Union[int, float], y:int|float) -> float:
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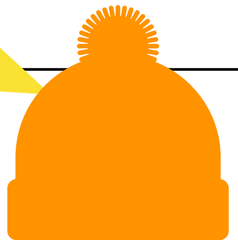
```

„Type Hints“ sind sehr praktisch für die Dokumentation des Codes!



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from typing import List, Dict, Tuple

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List[str] # ["a", "b"]
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from typing import NoReturn, Union, Optional

def hello(name:Optional[str]="") -> NoReturn:
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def divide(x:Union[int, float], y:int|float) -> float:
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Hier könnte man auch jeweils eine eigene Klasse als Typ nutzen.

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from typing import List, Dict, Tuple

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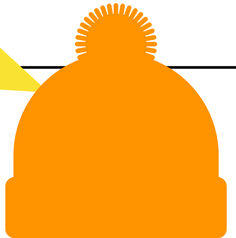
Tuple[int, ...] # (1, 1), (1, 2, 3)

List[str] # ["a", "b"]
List[Union[str, int]] # [1, "b"], ["a", 2]

Dict[str, str] # {"a" : "A", "b" : "B"}
```

„Type Hints“ sind sehr praktisch für die Dokumentation des Codes!



Funktionsparameter: ** und *

```python
def example(*args, **kwargs):
  print(type(args), args)
  print(type(kwargs), kwargs)


example("A", "B", "C", d="D", e="E")



p = "A", "B", "C"
kp = {"d" : "D", "e" : "E"}
example(*p, **kp)
```

Funktionsparameter: ** und *

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def example(*args, **kwargs):
  print(type(args), args)
  print(type(kwargs), kwargs)


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```

```
<class 'tuple'> ('A', 'B', 'C')
<class 'dict'> {'d': 'D', 'e': 'E'}
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<class 'tuple'> ('A', 'B', 'C')
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```

Sehr praktisch um Parameter an eine Oberklasse weiterzureichen.

Variablen und Zeiger (Pointer)

- Python nutzt *Call-by-Reference*

Variablen und Zeiger (Pointer)

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Call-by-Value: Funktionsaufrufe übertragen den Wert
Call-by-Reference: Funktionsaufrufe übertragen einen Zeiger auf ein Objekt/ den Wert

Variablen und Zeiger (Pointer)

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```
s = "Hallo"
print(id(s))    4517249328
s += "Welt"
print(id(s))    4517249200
```

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```
s = "Hallo"
print(id(s))    4517249328
s += "Welt"
print(id(s))    4517249200
```

```
l = ["Hallo"]
print(id(l))          4516668480
l.append("Welt")
print(id(l))          4516668480
```

Variablen und Zeiger

```python
def change(l):
  for i in range(len(l)//2):
    l[i], l[-(i+1)] = l[-(i+1)], l[i]

l = [1, 2, 3, 4, 5]
change(l)
print(l)
```

Variablen und Zeiger

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  for i in range(len(l)//2):
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```

```
[5, 4, 3, 2, 1]
```

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print(l)
```

```
[5, 4, 3, 2, 1]
```

```python
bools = [True] * 5
print(bools)
bools[2] = False
bools[3] = False
print(bools)
```

```python
lists = [[]] * 5
print(lists)
lists[2].append(2)
lists[3].append(3)
print(lists)
```

Variablen und Zeiger

```python
def change(l):
  for i in range(len(l)//2):
    l[i], l[-(i+1)] = l[-(i+1)], l[i]

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[5, 4, 3, 2, 1]
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```python
bools = [True] * 5
print(bools)
bools[2] = False
bools[3] = False
print(bools)
```

```
[True, True, True, True, True]
[True, True, False, False, True]
```

```python
lists = [[]] * 5
print(lists)
lists[2].append(2)
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```
[True, True, True, True, True]
[True, True, False, False, True]
```

```python
lists = [[]] * 5
print(lists)
lists[2].append(2)
lists[3].append(3)
print(lists)
```

```
[[], [], [], [], []]
[[2, 3], [2, 3], [2, 3], [2, 3], [2, 3]]
```

Variablen und Zeiger

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    l[i], l[-(i+1)] = l[-(i+1)], l[i]

l = [1, 2, 3, 4, 5]
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Warum ändern sich alle?!

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[True, True, False, False, True]
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lists = [[]] * 5
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```

```
[[], [], [], [], []]
[[2, 3], [2, 3], [2, 3], [2, 3], [2, 3]]
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```

```
[5, 4, 3, 2, 1]
```

Liste wird geändert, ohne zurückgegeben zu werden, denn ein Zeiger wurde übergeben!

Warum ändern sich alle?!

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bools = [True] * 5
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bools[3] = False
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```

```
[True, True, True, True, True]
[True, True, False, False, True]
```

Tatsächlich kann man auch änderbare Typen in einem unveränderbaren Typen verändern:

```
a = ([], [])
a[0].append(2)
```

```
lists = [[]] * 5
print(lists)
lists[2].append(2)
lists[3].append(3)
print(lists)
```

```
[[], [], [], [], []]
[[2, 3], [2, 3], [2, 3], [2, 3], [2, 3]]
```

Dekoratoren

```
@my_decorator
def example(name):
  print("Hallo " + name)


example("Magnus")
example("Otto")
```

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example("Magnus")      Hallo Magnus
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```

Dekoratoren

```
def my_decorator(some_function):
  print("Funktion laden")

  def my_wrapper(*args, **kwargs):
    print("Vor Ausführung der Funktion")
    v = some_function(*args, **kwargs)
    print("Nach Ausführung der Funktion")
    return v

  return my_wrapper


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Vor Ausführung der Funktion
Hallo Magnus
Nach Ausführung der Funktion

Vor Ausführung der Funktion
Hallo Otto
Nach Ausführung der Funktion
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Hallo Magnus
Nach Ausführung der Funktion

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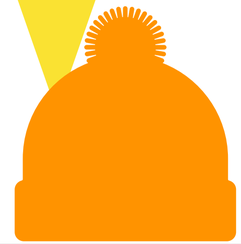
Hallo Otto
Nach Ausführung der Funktion
```

Achtung: Beim Erstellen von Dekoratoren gibt es noch ein paar Fallstricke!



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example("Otto")
```

Drei Einstiegspunkte, beim Laden der Funktion durch den Interpreter sowie nach und vor jeder Ausführung.

Die Dekoratoren können auch selbst Parameter haben.

```
Funktion laden

Vor Ausführung der Funktion
Hallo Magnus
Nach Ausführung der Funktion

Vor Ausführung der Funktion
Hallo Otto
Nach Ausführung der Funktion
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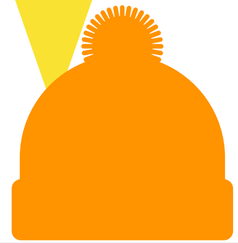

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- Eigentlich nicht
  - Aber man kann abstrakte Klassen mit Dekoratoren erstellen
  - Bzw. das Paket abc nutzen

```python
from abc import ABC, abstractmethod

class AbstractExample(ABC):

  def __init__(self, a):
    self.a = a

  @abstractmethod
  def abstract(self, a):
    pass

ae = AbstractExample()
```

Anwendung Dekoratoren: ABC

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class AbstractExample(ABC):

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```

```
Traceback (most recent call last):
  File "name.py", line 13, in <module>
    ae = AbstractExample()
  TypeError: Can't instantiate abstract
  class AbstractExample with abstract
  method abstract
```

Zusammenfassung

- Magic Methods
- Generatoren
- Erweiterte Schleifen
- Fehlerbehandlung
- Kontextmanager
- Lambda-Funktionen
- Typannotationen
- Variablen und Zeiger
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