The *Best Python Cheat Sheet

Just what you need

Keyword

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

❶Soft keywords

Built-in

abs(number)	Absolute value of number	bytes(…)	New bytes object from byte-integers, string, bytes
aiter(async_iterable)	Asynchronous iterator for an asynchronous iterable	callable(object)	True if object is callable
all(iterable)	True if all elements of iterable are true (all([]) == True)	chr(i)	One character string for unicode ordinal i (0 <= i <= 0x10ffff)
any(iterable)	True if any element of iterable is true (any([]) == False)	classmethod(func)	Transform function into class method
ascii(object)	A string with a printable representation of an object	compile(source, …)	Compile source into code or AST object
		complex(real=0, imag=0)	Complex number with the value real + imag*1j
bin(number)	Convert integer number to binary string	delattr(object, name)	Delete the named attribute, if object allows
bool(object)	Boolean value	dict(…)	Create new dictionary
breakpoint(*args, **kwds)	Drop into debugger via sys.breakpointhook(*args, **kwds)	dir([object])	List of names in the local scope, or object.__dir__() or attributes
bytearray(…)	New array of bytes from byte-integers, string, bytes, object with buffer API	divmod(x, y)	Return (quotient x//y, remainder x%y)

enumerate(iterable, start=0)	Enumerate object as (n, item) pairs with n initialised to start value		issubclass(cls, cls_or_tuple)	True if class is subclass of given class(es)
eval(source, globals=None, locals=None)	Execute Python expression, string or code object from compile()		iter(object, …)	Iterator for object
			len(object)	Length of object
			list(…)	Create list
exec(source, globals=None, locals=None)	Execute Python statements, string or code object from compile()		locals()	Dictionary of current local symbol table
filter(func, iterable)	Iterator yielding items where func(item) is true, or bool(item) if func is None		map(func, *iterables)	Apply function to every item of iterable(s)
float(x=0)	Floating point number from number or string		max(…, key=func)	Largest item of iterable or arguments, optional key function extracts value
format(object, format_spec='')	Formatted representation			
frozenset(…)	New frozenset object		memoryview(object)	Access internal object data via buffer protocol
getattr(object, name[, default])	Get value of named attribute of object, else default or raise exception		min(…, key=func)	Smallest item of iterable or arguments, optional key function extracts value
globals()	Dictionary of current module namespace			
hasattr(object, name)	True if object has named attribute		next(iterator[, default])	Next item from iterator, optionally return default instead of StopIteration
hash(object)	Hash value of object (see object.__hash__())			
			object()	New featureless object
help(…)	Built-in help system		oct(number)	Convert integer to octal string
hex(number)	Convert integer to lowercase hexadecimal string		open(file, …)	Open file object
			ord(chr)	Integer representing Unicode code point of character
id(object)	Return unique integer identifier of object			
__import__(name, …)	Invoked by the import statement		pow(base, exp, mod=None)	Return *base* to the power of *exp*
input(prompt='')	Read string from stdin, with optional prompt		print(value, …)	Print object to text stream file
			property(…)	Property decorator
int(…)	Create integer from number or string		range(…)	Generate integer sequence
isinstance(object, cls_or_tuple)	True if object is instance of given class(es)		repr(object)	String representation of object for debugging

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reversed(sequence)	Reverse iterator	sum(iterable, start=0)	Sums items of iterable, optionally adding start value
round(number, ndigits=None)	Number rounded to ndigits precision after decimal point	super(…)	Proxy object that delegates method calls to parent or sibling
set(…)	New set object		
setattr(object, name, value)	Set object attribute value by name	tuple(iterable)	Create a tuple
slice(…)	Slice object representing a set of indices	type(…)	Type of an object, or build new type
sorted(iterable, key=None, reverse=False)	New sorted list from the items in iterable	vars([object])	Return object.__dict__ or locals() if no argument
staticmethod(func)	Transform function into static method	zip(*iterables, strict=False)	Iterate over multiple iterables in parallel, strict requires equal length
str(…)	String description of object		

Operator

Precedence (high->low)	Description
(…,) […,] {…,} {…:…,}	tuple, list, set, dict
s[i] s[i:j] s.attr f(…)	index, slice, attribute, function call
await x	await expression
+x, -x, ~x	unary positive, negative, bitwise NOT
x ** y	power
x * y, x @ y, x / y, x // y, x % y	multiply, maxtrix multiply, divide, floor divide, modulus
x + y, x - y	add, substract
x << y x >> y	bitwise shift left, right
x & y	bitwise and
x ^ y	bitwise exclusive or
x | y	bitwise or
x<y x<=y x>y x>=y x==y x!=y x is y x is not y x in s x not in s	comparison, identity, membership
not x	boolean negation
x and y	boolean and
x or y	boolean or
… if … else …	conditional expression
lambda	lambda expression
:=	assignment expression

Assignment	Usually equivalent
a = b	Assign object b to label a
a += b	a = a + b
a -= b	a = a - b
a *= b	a = a * b
a /= b	a = a / b (true division)
a //= b	a = a // b (floor division)
a %= b	a = a % b
a **= b	a = a ** b
a &= b	a = a & b
a |= b	a = a	b
a ^= b	a = a ^ b
a >>= b	a = a >> b
a <<= b	a = a << b

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Assignment expression

Assign a value and return that value using the *walrus operator*.

```python
if matching := pattern.search(data):
    do_something(matching)

count = 0
while (count := count + 1) < 5:
    print(count)

>>> z = [1, 2, 3, 4, 5]
>>> [x for i in z if (x:=i**2) > 10]
[16, 25]
```

Assignment unpacking

Unpack multiple values to a name using the *splat operator*.

```python
head, *body       = s        # assign first value of s to head, remainder to body
head, *body, tail = s        # assign first and last values of s to head and tail,
remainder to body
*body, tail       = s        # assign last value of s to tail, remainder to body
s  = [*iterable[, …]]        # unpack to list
s  = (*iterable[, …])        # unpack to tuple
s  = {*iterable[, …]}        # unpack to set
d2 = {**d1[, …]}             # unpack to dict
```

Flow control

```python
for item in <iterable>:
    …
[else:                       # if loop completes without break
    …]

while <condition>:
    …
[else:                       # if loop completes without break
    …]

break                        # immediately exit loop
continue                     # skip to next loop iteration
return[ value]               # exit function, return value | None
yield[ value]                # exit generator, yield value | None
assert <expr>[, message]     # if not expression raise AssertionError([message])
```

```python
if condition:
    …
[elif condition:
    …]*
[else:
    …]

<expression1> if <condition> else <expression2>

with <expression>[ as name]: # context manager
    …
```

Context manager

A *with* statement takes an object with special methods:

- *__enter__()* - locks resources and optionally returns an object
- *__exit__()* - releases resources, handles any exception raised in the block, optionally suppressing it by returning True

```python
class AutoClose:
    def __init__(self, filename):
        self.filename = filename
    def __enter__(self):
        self.f = open(self.filename)
        return self.f
    def __exit__(self, exc_type, exception, traceback):
        self.f.close()

>>> with open('test.txt', 'w') as f: …
...         f.write('Hello World!')
>>> with AutoClose('test.txt') as f: …
...         print(f.read())
Hello World!
```

Match

`3.10+`

```python
match <expression>:
    case <pattern>[ if <condition>]:  # conditional match, if "guard" clause
        …
    case <pattern1> | <pattern2>:      # OR pattern
        …
    case _:                            # default case
        …
```

Match case pattern

1/'abc'/True/None/math.pi	Value pattern, match literal or dotted name
<name>	Capture pattern, match any object and bind to name
_	Wildcard pattern, match any object
<type>()	Class pattern, match any object of that type
<type>(<attr>=<pattern|name>, …)	Class pattern, match object with matching attributes
<pattern> | <pattern> [| …]	Or pattern, match any of the patterns left to right
<pattern> as <name>	As pattern, bind match to name
[<pattern>[, …[, *args]]	Sequence pattern (list|tuple), match any sequence with matching items (but not string or iterator), may be nested
{<value_pattern>: <pattern>[, …[, **kwds]]}	Mapping pattern, match dictionary with matching items, may be nested
<builtin>(<name>)	Builtin pattern, shortcut for <builtin>() as <name> (e.g. str, int)

- Class patterns
  - **Do not** create a new instance of the class
  - Accept positional parameters if class defines __match_args__ special attribute (e.g. dataclass)
- Sequence patterns support assignment unpacking
- Names bound in a match statement are visible after the match statement

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Scope

Scope levels:

Builtin	Names pre-assigned in *builtins* module	Generator expression	Names contained within generator expression
Module (global)	Names defined in current module Code in global scope cannot access local variables	Comprehension	Names contained within comprehension
		Class	Names shared across all instances
Enclosing (closure)	Names defined in any enclosing functions	Instance	Names contained within a specific instance
Function (local)	Names defined in current function By default, has read-only access to module and enclosing function names By default, assignment creates a new local name *global <name>* grants read/write access to specified module name *nonlocal <name>* grants read/write access to specified name in closest enclosing function defining that name	Method	Names contained within a specific instance method

- *globals()* - return *dict* of module scope variables
- *locals()* - return *dict* of local scope variables

```python
>>> global_variable = 1
>>> def read_global():
...     print(global_variable)
...     local_variable = "only available in this function"
>>> read_global()
1
>>> def write_global():
...     global global_variable
...     global_variable = 2
>>> write_global()
>>> print(global_variable)
2
>>> def write_nonlocal():
...     x = 1
...     def nested():
...         nonlocal x
...         x = 2
...     nested()
...     print(x)
>>> write_nonlocal()
2
>>> class C:
...     class_variable = 1
...     def __init__(self):
...         self.instance_variable = 2
...     def method(self):
...         self.instance_variable = 3
...         C.class_variable = 3
...         method_variable = 1
```

Sequence

Operations on sequence types (Bytes, List, Tuple, String).

x in s	True if any s[i] == x	s.index(x[, start[, stop]])	Smallest i where s[i] == x, start/stop bounds search
x not in s	True if no s[i] == x		
s1 + s2	Concatenate s1 and s2	reversed(s)	Iterator on s in reverse order (for string use reversed(list(s)))
s*n, n*s	Concatenate n copies of s		
s.count(x)	Count of s[i] == x		
len(s)	Number of items	sorted(s1, cmp=func, key=getter, reverse=False)	New sorted list
min(s)	Smallest item		
max(s)	Largest item		

Indexing

Select items from sequence by index or slice.

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```
>>> s = [0, 1, 2, 3, 4]
>>> s[0]                # 0-based indexing
0
>>> s[-1]               # negative indexing from end
4
>>> s[slice(2)]         # slice(stop) - index from 0 until stop (exclusive)
[0, 1]
>>> s[slice(1, 5, 3)]   # slice(start, stop[, step]) - index from start to stop
(exclusive), with optional step size (+|-)
[1, 4]
>>> s[:2]               # slices are created implicitly when indexing with ':'
[start:stop:step]
[0, 1]
>>> s[3::-1]            # negative steps
[3, 2, 1, 0]
>>> s[1:3]
[1, 2]
>>> s[1:5:2]
[1, 3]
```

Comparison

- Sequence comparison: values are compared in order until a pair of unequal values is found. The comparison of these two values is then returned. If all values are equal, the shorter sequence is lesser.
- A sortable class should define `__eq__()`, `__lt__()`, `__gt__()`, `__le__()` and `__ge__()` comparison special methods.
- With *functools* *@total_ordering* decorator a class need only provide `__eq__()` and one other comparison special method.

```python
from functools import total_ordering

@total_ordering
class C:
    def __init__(self, a):
        self.a = a
    def __eq__(self, other):
        if isinstance(other, type(self)):
            return self.a == other.a
        return NotImplemented
    def __lt__(self, other):
        if isinstance(other, type(self)):
            return self.a < other.a
        return NotImplemented
```

Tuple

Immutable hashable sequence.

s = (1, 'a', 3.0) s = 1, 'a', 3.0	Create tuple
s = (1,)	Single-item tuple
s = ()	Empty tuple
(1, 2, 3) == (1, 2) + (3,)	Add makes new tuple
(1, 2, 1, 2) == (1, 2) * 2	Multiply makes new tuple

Named tuple

Tuple subclass with named items.

```
>>> from collections import namedtuple
>>> Point = namedtuple('Point', ('x', 'y')) # or namedtuple('Point', 'x y')
>>> p = Point(1, y=2)
Point(x=1, y=2)
>>> p[0]
1
>>> p.y
2
```

List

Mutable non-hashable sequence.

s = [1, 'a', 3.0] s = list(range(3))	Create list	s.extend(it) s[len(s):len(s)] = it	Add elements from iterable to end
s[i] = x	Replace item index i with x	s.insert(i, x) s[i:i] = [x]	Insert item at index i
s[<slice>] = it	Replace slice with iterable	s.remove(x) del s[s.index(x)]	Remove item
del s[<slice>] s[<slice>] = []	Delete slice	y = s.pop([i])	Remove and return last item, or indexed item
s.append(x) s += x s[len(s):len(s)] = [x]	Add element to end	s.reverse()	Reverse in place
		s.sort(cmp=func, key=getter, reverse=False)	Sort in place, default ascending

List comprehension

```
result = [expression for item1 in iterable1{ if condition1}
          {for item2 in iterable2{ if condition2} … for itemN in iterableN{ if
conditionN}}]

# is equivalent to:

result = []
for item1 in iterable1:
    for item2 in iterable2:

        …
        for itemN in iterableN:
            if condition1 and condition2 … and conditionN:
                result.append(expression)
```

Dictionary

Mutable non-hashable key:value pair mapping.

dict() {}	Empty dict	dict(zip(keys, values))	Create from sequences of keys and values
dict(<sequence|mapping>)	Create from key:value pairs	dict.fromkeys(keys, value=None)	Create from keys, all set to value
dict(**kwds)	Create from keyword arguments	d.keys()	Iterable of keys

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`d.values()`	Iterable of values	`d.clear()`	Remove all items
`d.items()`	Iterable of (key, value) pairs	`d.copy()`	Shallow copy
`d.get(key, default=None)`	Get value for key, or default	`collections.defaultdict(<type>)` `collections.defaultdict(lambda: 42)`	dict with default value <type>() e.g. dict with default value 42
`d.setdefault(key, default=None)`	Get value for key, add if missing	`d1.update(d2)` `d1 |= d2` `3.9+`	Add/replace key:value pairs from d2 to d1
`d.pop(key)`	Remove and return value for key, raise KeyError if missing	`d3 = d1	d2` `3.9+` `d3 = {**d1, **d2}`	Merge to new dict, d2 trumps d1
`d.popitem()`	Remove and return (key, value) pair (last-in, first-out)	`{k for k, v in d.items() if v==value}`	Set of keys with given value

Dict comprehension

```
# {k: v for k, v in <iterable>[ if <condition>]}

>>> {x: x**2 for x in (2, 4, 6) if x < 5}
{2: 4, 4: 16}
```

Set

Mutable (*set*) and immutable (*frozenset*) sets.

`set(iterable=None)` `{1, 2, 3}` `frozenset(iterable=None)`	New set from iterable, or empty But {} creates an empty dictionary (sad!)	`s1.intersection(s2[, s3…])` `s1 & s2`	New set of shared elements
`len(s)`	Cardinality	`s1.intersection_update(s2)` *[mutable]*	Update elements to intersection with s2
`v in s` `v not in s`	Test membership	`s1.union(s2[, s3…])` `s1	s2`	New set of all elements
`s1.issubset(s2)`	True if s1 is subset of s2	`s1.difference(s2[, s3…])` `s1 - s2`	New set of elements unique to s1
`s1.issuperset(s2)`	True if s1 is superset of s2	`s1.difference_update(s2)` *[mutable]*	Remove elements intersecting with s2
`s.add(v)` *[mutable]*	Add element	`s1.symmetric_difference(s2)` `s1 ^ s2`	New set of unshared elements
`s.remove(v)` *[mutable]*	Remove element (KeyError if not found)	`s1.symmetric_difference_update(s2)` *[mutable]*	Update elements to symmetric difference with s2
`s.discard(v)` *[mutable]*	Remove element if present	`s.copy()`	Shallow copy
`s.pop()` *[mutable]*	Remove and return arbitrary element (KeyError if empty)	`s.update(it1[, it2…])` *[mutable]*	Add elements from iterables
`s.clear()` *[mutable]*	Remove all elements		

Set comprehension

```
# {x for x in <iterable>[ if <condition>]}

>>> {x for x in 'abracadabra' if x not in 'abc'}
{'r', 'd'}
```

Bytes

Immutable <u>sequence</u> of bytes. Mutable version is *bytearray*.

`b'<str>'`	Create from ASCII characters and \x00-\xff	`<bytes> = <bytes>[<slice>]`	Return *bytes* even if only one element
`bytes(<ints>)`	Create from int sequence	`list(<bytes>)`	Return ints in range 0 to 255
`bytes(<str>, 'utf-8')` `<str>.encode('utf-8')`	Create from string	`<bytes_sep>.join (<byte_objs>)`	Join *byte_objs* sequence with *bytes_sep* separator
`<int>.to_bytes(length, order, signed=False)`	Create from int (order='big'|'little')	`str(<bytes>, 'utf-8')` `<bytes>.decode('utf-8')`	Convert bytes to string
`bytes.fromhex('<hex>')`	Create from hex pairs (can be separated by whitespace)	`int.from_bytes(bytes, order, signed=False)`	Return int from bytes (order='big'|'little')
`<int> = <bytes> [<index>]`	Return int in range 0 to 255	`<bytes>.hex(sep= '', bytes_per_sep=2)`	Return hex pairs

```python
def read_bytes(filename):
    with open(filename, 'rb') as f:
        return f.read()

def write_bytes(filename, bytes_obj):
    with open(filename, 'wb') as f:
        f.write(bytes_obj)
```

Function

Function definition

```python
def f(*args): …           # f(1, 2, 3)
def f(x, *args): …        # f(1, 2, 3)
def f(*args, z): …        # f(1, 2, z=3)

def f(**kwds): …          # f(x=1, y=2, z=3)
def f(x, **kwds): …       # f(x=1, y=2, z=3) | f(1, y=2, z=3)
def f(*args, **kwds): …   # f(x=1, y=2, z=3) | f(1, y=2, z=3) | f(1, 2, z=3) | f(1, 2, 3)
def f(x, *args, **kwds): … # f(x=1, y=2, z=3) | f(1, y=2, z=3) | f(1, 2, z=3) | f(1, 2, 3)
def f(*args, y, **kwds): … # f(x=1, y=2, z=3) | f(1, y=2, z=3)

def f(*, x, y, z): …      # f(x=1, y=2, z=3)
def f(x, *, y, z): …      # f(x=1, y=2, z=3) | f(1, y=2, z=3)
def f(x, y, *, z): …      # f(x=1, y=2, z=3) | f(1, y=2, z=3) | f(1, 2, z=3)
```

Function call

```python
args = (1, 2)           # *  expands sequence to positional arguments
kwds = {'x': 3, 'y': 4} # ** expands dictionary to keyword arguments
func(*args, **kwds)     # is the same as:
func(1, 2, x=3, y=4)
```

Class

Instantiation

```python
class C:
    """Class docstring."""
    def __init__(self, a):
        """Method docstring."""
        self.a = a
    def __repr__(self):
        """Used for repr(c), also for str(c) if __str__ not defined."""
        return f'{self.__class__.__name__}({self.a!r})'
    def __str__(self):
        """Used by str(c), e.g. print(c)"""
        return str(self.a)
    @classmethod
    def get_class_name(cls): # passed class rather than instance
        return cls.__name__
    @staticmethod
    def static(): # passed nothing
        return 1

>>> c = C(2) # instantiate

# under the covers, class instantiation does this:
obj = cls.__new__(cls, *args, **kwds)
if isinstance(obj, cls):
    obj.__init__(*args, **kwds)
```

Instance property

```python
class C:
    @property
    def f(self):
        if not hasattr(self, '_f'):
            return
        return self._f
    @f.setter
    def f(self, value):
        self._f = value
```

Class special methods

Operator	Method
self + other other + self self += other	__add__(self, other) __radd__(self, other) __iadd__(self, other)
self - other other - self self -= other	__sub__(self, other) __rsub__(self, other) __isub__(self, other)
self * other other * self self *= other	__mul__(self, other) __rmul__(self, other) __imul__(self, other)
self @ other other @ self self @= other	__matmul__(self, other) __rmatmul__(self, other) __imatmul__(self, other)
self / other other / self self /= other	__truediv__(self, other) __rtruediv__(self, other) __itruediv__(self, other)
self // other other // self self //= other	__floordiv__(self, other) __rfloordiv__(self, other) __ifloordiv__(self, other)
self % other other % self self %= other	__mod__(self, other) __rmod__(self, other) __imod__(self, other)
self ** other other ** self self **= other	__pow__(self, other) __rpow__(self, other) __ipow__(self, other)
self << other other << self self <<= other	__lshift__(self, other) __rlshift__(self, other) __ilshift__(self, other)
self >> other other >> self self >>= other	__rshift__(self, other) __rrshift__(self, other) __irshift__(self, other)
self & other other & self self &= other	__and__(self, other) __rand__(self, other) __iand__(self, other)
self | other other | self self |= other	__or__(self, other) __ror__(self, other) __ior__(self, other)
self ^ other other ^ self self ^= other	__xor__(self, other) __rxor__(self, other) __ixor__(self, other)
divmod(self, other) divmod(self, other)	__divmod__(self, other) __rdivmod__(self, other)

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Operator	Method
-self	__neg__(self)
+self	__pos__(self)
abs(self)	__abs__(self)
~self	__invert__(self) [bitwise]
self == other	__eq__(self) [default 'is', requires __hash__]
self != other	__ne__(self)
self < other	__lt__(self, other)
self <= other	__le__(self, other)
self > other	__gt__(self, other)
self >= other	__ge__(self, other)
item in self	__contains__(self, item)
bool(self)	__bool__(self)
bytes(self)	__bytes__(self)
complex(self)	__complex__(self)
float(self)	__float__(self)
int(self)	__int__(self)
round(self)	__round__(self[, ndigits])
math.ceil(self)	__ceil__(self)
math.floor(self)	__floor__(self)
math.trunc(self)	__trunc__(self)
dir(self)	__dir__(self)
format(self)	__format__(self, format_spec)
hash(self)	__hash__(self)
iter(self)	__iter__(self)
len(self)	__len__(self)
repr(self)	__repr__(self)
reversed(self)	__reversed__(self)
str(self)	__str__(self)
self(*args, **kwds)	__call__(self, *args, **kwds)
self[…]	__getitem__(self, key)
self[…] = 1	__setitem__(self, key, value)
del self[…]	__delitem__(self, key)
other[self]	__index__(self)
self.name	__getattribute__(self, name) __getattr__(self, name) [if AttributeError]
self.name = 1	__setattr__(self, name, value)
del self.name	__delattr__(self, name)
with self:	__enter__(self) __exit__(self, exc_type, exc_value, traceback)
await self	__await__(self)

Decorator

A decorator is a callable that manipulates and returns a function.

```python
# wraps decorator copies metadata of decorated function (func) to wrapped function
(out)
from functools import wraps

def show_call(func):
    """

    Print function name and arguments each time it is called.
    """
    @wraps(func)
    def out(*args, **kwds):
        print(func.__name__, args, kwds)
        return func(*args, **kwds)
    return out

@show_call
def add(x, y):
    return x + y
```

Iterator

An iterator implements the *__iter__()* method, returning an iterable that implements the *__next__()* method. The *__next__()* method returns the next item in the collection and raises *StopIteration* when done.

```python
def IterableIterator:
    def __iter__(self):
        """Make class iterable."""
        return self

    def __next__(self):
        """Implement to be iterable."""
        if at_the_end:
            raise StopIteration
        return next_item

c = IterableIterator()
it = iter(c) # get iterator
next(it)      # get next item
while value := next(it):
    print(value)
```

Generator

A function with a *yield* statement returns a generator iterator and suspends function processing. Each iteration over the generator iterator resumes function execution, returns the next yield value, and suspends again.

 Python 3.8+ | 9 Apr 2024

```
def gen():
    """Generator function"""
    for i in range(10):
        yield i
g = gen()

g = (expression for item in iterable if condition) # generator expression

next(g)              # next item
for i in g: …        # iterator over items
list(g)              # list all items
yield from g         # delegate yield to another generator
```

String

Immutable sequence of characters.

`<substring> in s`	True if string contains *substring*	`s.find(<substring>)`	Index of first match or -1
`s.startswith(<prefix> [, start[, end]])`	True if string starts with *prefix*, optionally search bounded substring	`s.index(<substring>)`	Index of first match or raise ValueError
		`s.lower()`	To lower case
`s.endswith(<suffix>[, start[, end]])`	True if string ends with *suffix*, optionally search bounded substring	`s.upper()`	To upper case
		`s.title()`	To title case (The Quick Brown Fox)
`s.strip(chars=None)`	Strip whitespace from both ends, or passed characters	`s.capitalize()`	Capitalize first letter
		`s.replace(old, new[, count])`	Replace *old* with *new* at most *count* times
`s.lstrip(chars=None)`	Strip whitespace from left end, or passed characters	`s.translate(<table>)`	Use *str.maketrans(<dict>)* to generate table
`s.rstrip(chars=None)`	Strip whitespace from right end, or passed characters	`chr(<int>)`	Integer to Unicode character
`s.ljust(width, fillchar=' ')`	Left justify with fillchar	`ord(<str>)`	Unicode character to integer
`s.rjust(width, fillchar=' ')`	Right justify with fillchar	`s.isdecimal()`	True if [0-9], [०-९] or [۹-٠]
`s.center(width, fillchar=' ')`	Center with fillchar	`s.isdigit()`	True if isdecimal() or [²³¹…]
`s.split(sep=None, maxsplit=-1)`	Split on whitespace, or *sep* str at most *maxsplit* times	`s.isnumeric()`	True if isdigit() or [¼½¾零〇一…]
		`s.isalnum()`	True if isnumeric() or [a-zA-Z…]
`s.splitlines(keepends =False)`	Split lines on [\n\r\f\v\x1c-\x1e\x85\u2028\u2029] and \r\n	`s.isprintable()`	True if isalnum() or [!#$%…]
`<separator>.join(<str ings>)`	Join sequence of *strings* with *separator* string	`s.isspace()`	True if [\t\n\r\f\v\x1c-\x1f\x85\xa0…]

| head, sep, tail = s.partition(<separator>) | Search for *separator* from start and split | s.removeprefix(<prefix>) `3.9+` | Remove *prefix* if present |
| head, sep, tail = s.rpartition(<separator>) | Search for *separator* from end and split | s.removesuffix(<suffix>) `3.9+` | Remove *suffix* if present |

String escapes

Sequence	Escape
Literal backslash	\\
Single quote	\'
Double quote	\"
Backspace	\b
Carriage return	\r
Newline	\n
Tab	\t
Vertical tab	\v
Null	\0
Hex value	\xff
Octal value	\o77
Unicode 16 bit	\uxxxx
Unicode 32 bit	\Uxxxxxxxx
Unicode name	\N{name}

String formatting

Format	f-string	Output
Expression	f"{6/3}, {'a'+'b'}" '{}, {}'.format(6/3, 'a'+'b')	'2, ab'
Justify left	f'{1:<5}'	'1 '
Justify center	f'{1:^5}'	' 1 '
Justify right	f'{1:>5}'	' 1'
Justify left with char	f'{1:.<5}'	'1....'
Justify right with char	f'{1:.>5}'	'....1'
Trim	f"{'abc':.2}"	'ab'
Trim justify left	f"{'abc':6.2}"	'ab '
ascii()	f'{v!a}'	ascii(v)
repr()	f'{v!r}'	repr(v)
str()	f'{v!s}'	str(v)
Justify left repr()	f"{'abc'!r:6}"	"'abc' "
Date format	f'{today:%d %b %Y}'	'21 Jan 1984'
f'{1+1=}'	f'{1+1=}'	'1+1=2' (= prepends)

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Format	f-string	Output
Significant figures	`f'{1.234:.2}'`	`'1.2'`
Fixed-point notation	`f'{1.234:.2f}'`	`'1.23'`
Scientific notation	`f'{1.234:.2e}'`	`'1.230e+00'`
Percentage	`f'{1.234:.2%}'`	`'123.40%'`
Pad with zeros	`f'{1.7:04}'`	`'01.7'`
Pad with spaces	`f'{1.7:4}'`	`' 1.7'`
Pad before sign	`f'{123456:+6}'`	`' +123'`
Pad after sign	`f'{123456:=+6}'`	`'+  123'`
Separate with commas	`f'{123456:,}'`	`'123,456'`
Separate with underscores	`f'{123456:_}'`	`'123_456'`
Binary	`f'{164:b}'`	`'10100100'`
Octal	`f'{164:o}'`	`'244'`
Hex	`f'{164:X}'`	`'A4'`
chr()	`f'{164:c}'`	`'ÿ'`

Regex

Standard library *re* module provides Python regular expressions.

```
>>> import re
>>> my_re = re.compile(r'name is (?P<name>[A-Za-z]+)')
>>> match = my_re.search('My name is Douglas.')
>>> match.group()
'name is Douglas'
>>> match.group(1)
'Douglas'
>>> match.groupdict()['name']
'Douglas'
```

Regex syntax

`.`	Any character (newline if DOTALL)		`|`	Or
`^`	Start of string (every line if MULTILINE)		`(…)`	Group
			`(?:…)`	Non-capturing group
`$`	End of string (every line if MULTILINE)		`(?P<name>…)`	Named group
`*`	0 or more of preceding		`(?P=name)`	Match text matched by earlier group
`+`	1 or more of preceding		`(?=…)`	Match next, non-consumptive
`?`	0 or 1 of preceding		`(?!…)`	Non-match next, non-consumptive
`*?, +?, ??`	Same as *, + and ?, as few as possible		`(?<=…)`	Match preceding, positive lookbehind assertion
`{m,n}`	m to n repetitions		`(?<!…)`	Non-match preceding, negative lookbehind assertion
`{m,n}?`	m to n repetitions, as few as possible		`(?(group)A|B)`	Conditional match - A if group previously matched else B
`[…]`	Character set: e.g. '[a-zA-Z]'			
`[^…]`	NOT character set		`(?letters)`	Set flags for RE ('i','L', 'm', 's', 'u', 'x')
`\`	Escape chars '*?+&$|()', introduce special sequences		`(?#…)`	Comment (ignored)
`\\`	Literal '\'			

Regex special sequences

\<n>	Match by integer group reference starting from 1	\s	Whitespace [\t\n\r\f\v] (see flag: ASCII)
\A	Start of string	\S	Non-whitespace (see flag: ASCII)
\b	Word boundary (see flag: ASCII|LOCALE)	\w	Alphanumeric (see flag: ASCII|LOCALE)
\B	Not word boundary (see flag: ASCII|LOCALE)	\W	Non-alphanumeric (see flag: ASCII|LOCALE)
\d	Decimal digit (see flag: ASCII)	\Z	End of string
\D	Non-decimal digit (see flag: ASCII)		

Regex flags

Flags modify regex behaviour. Pass to regex functions (e.g. *re.A | re.ASCII*) or embed in regular expression (e.g. *(?a)*).

(?a) | A | ASCII	ASCII-only match for \w, \W, \b, \B, \d, \D, \s, \S (default is Unicode)	(?m) | M | MULTILINE	Match every new line, not only start/end of string
(?i) | I | IGNORECASE	Case insensitive matching	(?s) | S | DOTALL	'.' matches ALL chars, including newline
(?L) | L | LOCALE	Apply current locale for \w, \W, \b, \B (discouraged)	(?x) | X | VERBOSE	Ignores whitespace outside character sets
		DEBUG	Display expression debug info

Regex functions

compile(pattern[, flags=0])	Compiles <u>Regular Expression Obj</u>	findall(pattern, string)	Non-overlapping matches as list of groups or tuples (>1)
escape(string)	Escape non-alphanumerics	finditer(pattern, string[, flags])	Iterator over non-overlapping matches
match(pattern, string[, flags])	Match from start	sub(pattern, repl, string[, count=0])	Replace count first leftmost non-overlapping; If repl is function, called with a MatchObj
search(pattern, string[, flags])	Match anywhere		
split(pattern, string[, maxsplit=0])	Splits by pattern, keeping splitter if grouped	subn(pattern, repl, string[, count=0])	Like sub(), but returns (newString, numberOfSubsMade)

Regex object

flags	<u>Flags</u>	search(string[, pos][, endpos])	Match anywhere in target[pos:endpos]
groupindex	{group name: group number}	split(string[, maxsplit=0])	See split() function
pattern	Pattern	findall(string[, pos[, endpos]])	See findall() function
match(string[, pos][, endpos])	Match from start of target[pos:endpos]	finditer(string[, pos[, endpos]])	See finditer() function

 Python 3.8+ | 9 Apr 2024

sub(repl, string[, count=0])	See sub() function
subn(repl, string[, count=0])	See subn() function

Regex match object

pos	pos passed to search or match	start(group), end(group)	Indices of start & end of group match (None if group exists but didn't contribute)
endpos	endpos passed to search or match	span(group)	(start(group), end(group)); (None, None) if group didn't contibute
re	RE object	string	String passed to match() or search()
group([g1, g2, ...])	One or more groups of match One arg, result is a string Multiple args, result is tuple If gi is 0, returns the entire matching string If 1 <= gi <= 99, returns string matching group (None if no such group) May also be a group name Tuple of match groups Non-participating groups are None String if len(tuple)==1		

Number

bool([object]) True, False	Boolean
int([float|str|bool]) 5	Integer
float([int|str|bool]) 5.1, 1.2e-4	Float (inexact, compare with math.isclose(<float>, <float>)
complex(real=0, imag=0) 3 - 2j, 2.1 + 0.8j	Complex
fractions.Fraction(<numerator>, <denominator>)	Fraction
decimal.Decimal([str|int])	Decimal (exact, set precision: decimal.getcontext().prec = <int>)
bin([int]) 0b101010 int('101010', 2) int('0b101010', 0)	Binary
hex([int]) 0x2a int('2a', 16) int('0x2a', 0)	Hex

Mathematics

Also see built-in functions abs, pow, round, sum, min, max.

```
from math import (e, pi, inf, nan, isinf, isnan,
                  sin, cos, tan, asin, acos, atan, degrees, radians,
                  log, log10, log2)
```

Statistics

```
from statistics import mean, median, variance, stdev, quantiles, groupby
```

Random

```
>>> from random import random, randint, choice, shuffle, gauss, triangular, seed
>>> random() # float inside [0, 1)
0.42
>>> randint(1, 100) # int inside [<from>, <to>]
42
>>> choice(range(100)) # random item from sequence
42
```

Time

The *datetime* module provides immutable hashable *date*, *time*, *datetime*, and *timedelta* classes.

Time formatting

Code	Output
%a	Day name short (Mon)
%A	Day name full (Monday)
%b	Month name short (Jan)
%B	Month name full (January)
%c	Locale datetime format
%d	Day of month [01,31]
%f	Microsecond [000000,999999]
%H	Hour (24-hour) [00,23]
%I	Hour (12-hour) [01,12]
%j	Day of year [001,366]
%m	Month [01,12]
%M	Minute [00,59]
%p	Locale format for AM/PM
%S	Second [00,61]. Yes, 61!
%U	Week number (Sunday start) [00(partial),53]
%w	Day number [0(Sunday),6]
%W	Week number (Monday start) [00(partial),53]
%x	Locale date format
%X	Locale time format
%y	Year without century [00,99]
%Y	Year with century (2023)
%Z	Time zone ('' if no TZ)
%z	UTC offset (+HHMM/-HHMM, '' if no TZ)
%%	Literal '%'

     Python 3.8+ | 9 Apr 2024

Exception

```python
try:
    …
[except [Exception[ as e]]:
    …]
[except:  # catch all
    …]
[else:    # if no exception
    …]
[finally: # always executed
    …]

raise exception[ from None] # stop exception chain

try:
    1 / 0
except ZeroDivisionError:
    raise TypeError("Stop chain") from None
```

```
BaseException                         Base class for all exceptions
├─ BaseExceptionGroup                 Base class for groups of exceptions
├─ GeneratorExit                      Generator close() raises to terminate iteration
├─ KeyboardInterrupt                  On user interrupt key (often 'CTRL-C')
├─ SystemExit                         On sys.exit()
└─ Exception                          Base class for errors
   ├─ ArithmeticError                 Base class for arithmetic errors
   │  ├─ FloatingPointError           Floating point operation failed
   │  ├─ OverflowError                Result too large
   │  └─ ZeroDivisionError            Argument of division or modulo is 0
   ├─ AssertionError                  Assert statement failed
   ├─ AttributeError                  Attribute reference or assignment failed
   ├─ BufferError                     Buffer operation failed
   ├─ EOFError                        input() hit end-of-file without reading data
   ├─ ExceptionGroup                  Group of exceptions raised together
   ├─ ImportError                     Import statement failed
   │  └─ ModuleNotFoundError          Module not able to be found
   ├─ LookupError                     Base class for lookup errors
   │  └─ IndexError                   Index not found in sequence
   │  └─ KeyError                     Key not found in dictionary
   ├─ MemoryError                     Operation ran out of memory
   ├─ NameError                       Local or global name not found
   │  └─ UnboundLocalError            Local variable value not asssigned
   ├─ OSError                         System related error
   │  ├─ BlockingIOError              Non-blocking operation will block
   │  ├─ ChildProcessError            Operation on child process failed
   │  ├─ ConnectionError              Base class for connection errors
   │  │  ├─ BrokenPipeError           Write to closed pipe or socket
   │  │  ├─ ConnectionAbortedError    Connection aborted
   │  │  ├─ ConnectionRefusedError    Connection denied by server
   │  │  └─ ConnectionResetError      Connection reset mid-operation
   │  ├─ FileExistsError              Trying to create a file that already exists
   │  ├─ FileNotFoundError            File or directory not found
   │  ├─ InterruptedError             System call interrupted by signal
   │  ├─ IsADirectoryError            File operation requested on a directory
   │  ├─ NotADirectoryError           Directory operation requested on a non-directory
   │  ├─ PermissionError              Operation has insuffient access rights
   │  ├─ ProcessLookupError           Operation on process that no longer exists
   │  └─ TimeoutError                 Operation timed out
   ├─ ReferenceError                  Weak reference used on garbage collected object
   ├─ RuntimeError                    Error detected that doesn't fit other categories
   │  ├─ NotImplementedError          Operation not yet implemented
   │  └─ RecursionError               Maximum recursion depth exceeded
   ├─ StopAsyncIteration              Iterator __anext__() raises to stop iteration
   ├─ StopIteration                   Iterator next() raises when no more values
   ├─ SyntaxError                     Python syntax error
   │  └─ IndentationError             Base class for indentation errors
   │     └─ TabError                  Inconsistent tabs or spaces
   ├─ SystemError                     Recoverable Python interpreter error
   ├─ TypeError                       Operation applied to wrong type object
   ├─ ValueError                      Operation on right type but wrong value
   │  └─ UnicodeError                 Unicode encoding/decoding error
   │     ├─ UnicodeDecodeError        Unicode decoding error
   │     ├─ UnicodeEncodeError        Unicode encoding error
   │     └─ UnicodeTranslateError     Unicode translation error
   └─ Warning                         Base class for warnings
      ├─ BytesWarning                 Warnings about bytes and bytesarrays
      ├─ DeprecationWarning           Warnings about deprecated features
      ├─ EncodingWarning              Warning about encoding problem
      ├─ FutureWarning                Warnings about future deprecations for end users
      ├─ ImportWarning                Possible error in module imports
      ├─ PendingDeprecationWarning    Warnings about pending feature deprecations
      ├─ ResourceWarning              Warning about resource use
      ├─ RuntimeWarning               Warning about dubious runtime behavior
      ├─ SyntaxWarning                Warning about dubious syntax
      ├─ UnicodeWarning               Warnings related to Unicode
      └─ UserWarning                  Warnings generated by user code
```

Execution

```
$ python [-bBdEhiIOqsSuvVWx?] [-c command | -m module-name | script | - ] [args]
$ python --version
Python 3.10.12
$ python --help[-all] # help-all [3.11+]
# Execute code from command line
$ python -c 'print("Hello, world!")'
# Execute __main__.py in directory
$ python <directory>
# Execute module as __main__
$ python -m timeit -s 'setup here' 'benchmarked code here'
# Optimise execution
$ python -O script.py

# Hide warnings
PYTHONWARNINGS="ignore"
# OR
$ python -W ignore foo.py
# OR
import warnings
warnings.filterwarnings("ignore", category=DeprecationWarning)
```

```python
if __name__ == '__main__': # run main() if file executed as script
    main()
```

Environment variables

PYTHONHOME	Change location of standard Python libraries	PYTHONOPTIMIZE	Optimise execution (-O)
PYTHONPATH	Augment default search path for module files	PYTHONWARNINGS	Set warning level [default/error/always/module/once/ignore] (-W)
PYTHONSTARTUP	Module to execute before entering interactive prompt	PYTHONPROFILEIMPORTTIME	Show module import times (-X)

sitecustomize.py / usercustomize.py

Before *__main__* module is executed Python automatically imports:

- sitecustomize.py in the system site-packages directory
- usercustomize.py in the user site-packages directory

```
# Get user site packages directory
$ python -m site --user-site

# Bypass sitecustomize.py/usercustomize.py hooks
$ python -S script.py
```