

The *Best Python Cheat Sheet

Just what you need

Built-in functions ()	Execution ()	Operator ()	String ()
Bytes ()	Flow control ()	Regex ()	Testing ()
Class ()	Generator ()	Resources ()	Time ()
Debugging ()	Iterator ()	Scope ()	Tuple ()
Decorator ()	Keyword ()	Sequence ()	
Dictionary ()	List ()	Set ()	
Exception ()	Math / Number ()	Standard library ()	

Keyword

and	del	global	nonlocal	type ⁰
as	elif	if	not	while
assert	else	import	or	with
break	except	in	pass	yield
case ⁰	False	is	raise	_ ⁰
class	finally	lambda	return	
continue	for	match ⁰	True	
def	from	None	try	

⁰Soft keywords

Built-in functions

abs()	Absolute value of number	complex()	Complex number with the value real + imag*1j
aiter()	Asynchronous iterator for an asynchronous iterable	delattr()	Delete the named attribute, if object allows
all()	True if all elements of iterable are true (all([]) == True)	dict()	Create new dictionary
any()	True if any element of iterable is true (any([]) == False)	dir()	List of names in the local scope
ascii()	A string with a printable representation of an object	divmod()	Pair of numbers (quotient, remainder)
bin()	Convert integer number to binary string	enumerate()	Enumerate object as (n, item) pairs
bool()	Boolean value	eval()	Execute expression
breakpoint()	Drop into debugger at call site	exec()	Execute Python code
bytearray()	New array of bytes	filter()	Make iterator from an iterable, return True
bytes()	New bytes object	float()	Floating point number from number or string
callable()	True if the argument is callable	format()	Formatted representation
chr()	One character string for unicode ordinal i (0 <= i <= 0x10ffff)	frozenset()	New frozenset object
classmethod()	Transform method into class method	getattr()	Get value of named attribute of object
compile()	Compile source into code or AST object	globals()	Dictionary of current module namespace
		hasattr()	True if object has named attribute

<code>hash()</code>	Hash value of object	<code>ord()</code>	Integer representing Unicode code point of character
<code>help()</code>	Built-in help system	<code>pow()</code>	Return base to the power exp.
<code>hex()</code>	Convert integer to lowercase hexadecimal string	<code>print()</code>	Print object to text stream file
<code>id()</code>	Return unique integer identifier of object	<code>property()</code>	Property decorator
<code>__import__()</code>	Invoked by the import statement	<code>range()</code>	Generate integer sequence
<code>input(prompt='')</code>	Read string from stdin, with optional prompt	<code>repr()</code>	String representation of object for debugging
<code>int()</code>	Create integer from number or string	<code>reversed()</code>	Reverse iterator
<code>isinstance()</code>	True if object is instance of given class	<code>round()</code>	Number rounded to ndigits precision after decimal point
<code>issubclass()</code>	True if class is subclass of given class	<code>set()</code>	New set object
<code>iter()</code>	Iterator for object	<code>setattr()</code>	Set object attribute value by name
<code>len()</code>	Length of object	<code>slice()</code>	Slice object representing a set of indices
<code>list()</code>	Create list	<code>sorted()</code>	New sorted list from the items in iterable
<code>locals()</code>	Dictionary of current local symbol table	<code>staticmethod()</code>	Transform method into static method
<code>map()</code>	Apply function to every item of iterable	<code>str()</code>	String description of object
<code>max()</code>	Largest item in an iterable	<code>sum()</code>	Sums items of iterable
<code>memoryview()</code>	Access internal object data via buffer protocol	<code>super()</code>	Proxy object that delegates method calls to parent or sibling
<code>min()</code>	Smallest item in an iterable	<code>tuple()</code>	Create a tuple
<code>next()</code>	Next item from iterator	<code>type()</code>	Type of an object
<code>object()</code>	New featureless object	<code>vars()</code>	dict attribute for any other object with a dict attribute
<code>oct()</code>	Convert integer to octal string	<code>zip()</code>	Iterate over multiple iterables in parallel
<code>open()</code>	Open file object		

Scope

Scope levels:

Builtin	Names pre-assigned in <i>builtins</i> module	Enclosing (closure)	Names defined in any enclosing functions
Module (global)	Names defined in current module Code in global scope cannot access local variables		

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 <i>global</i> <name> grants read/write access to specified module name <i>nonlocal</i> <name> grants read/write access to specified name in closest enclosing function defining that name	Comprehension	Names contained within comprehension
		Class	Names shared across all instances
		Instance	Names contained within a specific instance
		Method	Names contained within a specific instance method
Generator expression	Names contained within generator expression		

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

```

>>> global_variable = 1
>>> def read_global():
...     print(global_variable)
...     local_variable = "only available in this function"
...     print(local_variable)
>>> 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

```

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, subtract
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	comparison,
x is y x is not y	identity,
x in s x not in s	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

Splat * operator**Function definition**

```

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

```

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

```

Unpacking

```

head, *body = s               # unpack assignment
head, *body, tail = s
*body, tail = s
s = [*it, ...]                # unpack to list
s = (*it, ...)                 # unpack to tuple
s = {*it, ...}                 # unpack to set
d2 = {**d1, ...}               # unpack to dict

```

Walrus operator (Assignment expression)

Assign a value and return that value.

```

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

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

```

Flow control

```

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 expr raise AssertionError(message)

```

```

if condition:
    ...
[elif condition:
    ...]*
[else:
    ...]

<expression1> if <condition> else <expression2>

with <expression> [as name]:
    ...

```

Match

3.10+

```

match <expression>:
    case <pattern> [if <condition>]:
        ...
    case <pattern1> | <pattern2>:      # OR pattern
        ...
    case _:                          # default case
        ...

```

Match case pattern

1/'abc'/True/None/math.pi	Value pattern, match literal or dotted name
<type>()	Class pattern, match any object of that type
<type>(<name>=<pattern>, ...)	Class pattern, match object with matching attributes
<name>	Capture pattern, match any object, bind to name
_	Wildcard, match any object
<pattern> <pattern> [...]	Or pattern, match any of the patterns
<pattern> as <name>	As pattern, bind match to name

<code><pattern>[, ...[, *args]]</code>	Sequence pattern (list tuple) matches sequence with matching items
<code>{<value_pattern>: <pattern>[, ...[, **kwargs]]}</code>	Mapping pattern matches any dictionary with matching items

- Class patterns **do not** create a new instance of the class
- Patterns can be bracketed to override precedence `[| > as > ,]`
- Built-in types allow a single positional pattern that is matched against the entire object.
- Names bound in the matching case + names bound in its block are visible after the match statement

Context manager

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

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

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

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

Sequence

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

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

Indexing

Select items from sequence by index or slice.

```

>>> 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 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.

```

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.

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

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

List comprehension

```
result = [expression for item1 in sequence1 {if condition1}
           {for item2 in sequence2 {if condition2} ... for itemN in sequenceN {if conditionN}}]

# is equivalent to:

result = []
for item1 in sequence1:
    for item2 in sequence2:
        ...
        for itemN in sequenceN:
            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

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

Set

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

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

Bytes

Immutable sequence of bytes. Mutable version is *bytearray*.

<code>b'<str>'</code>	Create from ASCII characters and <code>\x00-\xff</code>	<code>bytes.fromhex('<hex>')</code>	Create from hex pairs (can be separated by whitespace)
<code>bytes(<ints>)</code>	Create from int sequence	<code><int> = <bytes>[<index>]</code>	Return int in range 0 to 255
<code>bytes(<str>, 'utf-8')</code> <code><str>.encode('utf-8')</code>	Create from string	<code><bytes> = <bytes>[<slice>]</code>	Return bytes even if only one element
<code><int>.to_bytes(1, length, order, signed=False)</code>	Create from int (order='big' 'little')	<code>list(<bytes>)</code>	Return ints in range 0 to 255

<code><bytes_sep>.join</code> (<code><byte_objs></code>)	Join <i>byte_objs</i> sequence with <i>bytes_sep</i> separator
<code>str(<bytes>, 'utf-8')</code>	Convert bytes to string
<code><bytes>.decode('utf-8')</code>	

<code>int.from_bytes(b</code> <code>ytes, order,</code> <code>signed=False)</code>	Return int from bytes (<code>order='big' 'little'</code>)
<code><bytes>.hex(sep=</code> <code>'',</code> <code>bytes_per_sep=2)</code>	Return hex pairs

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

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

Class

Instantiation

```
class C:
    def __init__(self, a):
        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):
        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

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

Instance property

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

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

Decorator

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

```
# 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, **kwargs):
        print(func.__name__, args, kwargs)
        return func(*args, **kwargs)
    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.

```
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

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

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

next(g)          # next item
list(g)          # list all items
yield from g     # delegate yield to another generator
```

String

Immutable sequence of characters.

<code><substring> in s</code>	True if string contains <i>substring</i>	<code>s.index(<substring>)</code>	Index of first match or raise <code>ValueError</code>
<code>s.startswith(<prefix>[, start[, end]])</code>	True if string starts with prefix, optionally search bounded substring	<code>s.lower()</code>	To lower case
<code>s.endswith(<suffix>[, start[, end]])</code>	True if string ends with suffix, optionally search bounded substring	<code>s.upper()</code>	To upper case
<code>s.strip(chars=None)</code>	Strip whitespace from both ends, or passed characters	<code>s.title()</code>	To title case (The Quick Brown Fox)
<code>s.lstrip(chars=None)</code>	Strip whitespace from left end, or passed characters	<code>s.capitalize()</code>	Capitalize first letter
<code>s.rstrip(chars=None)</code>	Strip whitespace from right end, or passed characters	<code>s.replace(old, new[, count])</code>	Replace <i>old</i> with <i>new</i> at most <i>count</i> times
<code>s.ljust(width, fillchar=' ')</code>	Left justify with fillchar	<code>s.translate(<table>)</code>	Use <code>str.maketrans(<dict>)</code> to generate table
<code>s.rjust(width, fillchar=' ')</code>	Right justify with fillchar	<code>chr(<int>)</code>	Integer to Unicode character
<code>s.center(width, fillchar=' ')</code>	Center with fillchar	<code>ord(<str>)</code>	Unicode character to integer
<code>s.split(sep=None, maxsplit=-1)</code>	Split on whitespace, or <i>sep</i> str at most <i>maxsplit</i> times	<code>s.isdecimal()</code>	True if <code>[0-9]</code> , <code>[๐-๙]</code> or <code>[᠐-᠙]</code>
<code>s.splitlines(keepends=False)</code>	Split lines on <code>[\n\r\f\v\x1c-\x1e\x85\u2028\u2029]</code> and <code>\r\n</code>	<code>s.isdigit()</code>	True if <code>isdecimal()</code> or <code>[᠐-᠙]</code>
<code><separator>.join(<strings>)</code>	Join sequence of <i>strings</i> with <i>separator</i> string	<code>s.isnumeric()</code>	True if <code>isdigit()</code> or <code>[¼½零〇一...]</code>
<code>s.find(<substring>)</code>	Index of first match or -1	<code>s.isalnum()</code>	True if <code>isnumeric()</code> or <code>[a-zA-Z...]</code>
		<code>s.isprintable()</code>	True if <code>isalnum()</code> or <code>[!]</code>
		<code>s.isspace()</code>	True if <code>[\t\n\r\f\v\x1c-\x1f\x85\xa0...]</code>
		<code>head, sep, tail = s.partition(<separator>)</code>	Search for separator from start and split
		<code>head, sep, tail = s.rpartition(<separator>)</code>	Search for separator from end and split

String formatting

f-string	Output
<code>f"{6/3}, {'a'+'b'}"</code> <code>{}, {}'.format(6/3, 'a'+'b')</code>	<code>'2, ab'</code>
<code>f'{1:<5}'</code>	<code>'1 '</code>
<code>f'{1:^5}'</code>	<code>' 1 '</code>
<code>f'{1:>5}'</code>	<code>' 1'</code>
<code>f'{1:.<5}'</code>	<code>'1....'</code>
<code>f'{1:.>5}'</code>	<code>'....1'</code>
<code>f'{1:0}'</code>	<code>'1'</code>
<code>f'{1+1=}'</code>	<code>'1+1=2' (= prepends)</code>
<code>f'{v!r}'</code>	<code>repr(v)</code>

f-string	Output
<code>f'{today:%d %b %Y}'</code>	<code>'21 Jan 1984'</code>
<code>f'{1.729:.2f}'</code>	<code>'1.73'</code>
<code>f'{1.7:04}'</code>	<code>'01.7'</code>
<code>f'{1.7:4}'</code>	<code>' 1.7'</code>
<code>f"{'abc':.2}"</code>	<code>'ab'</code>
<code>f"{'abc':6.2}"</code>	<code>'ab '</code>
<code>f"{'abc'!r:6}"</code>	<code>"""abc' """</code>
<code>f'{123456:,}'</code>	<code>'123,456'</code>
<code>f'{123456:_}'</code>	<code>'123_456'</code>
<code>f'{123456:+6}'</code>	<code>' +123'</code>
<code>f'{123456:=+6}'</code>	<code>'+ 123'</code>
<code>f'{1.234:.2}'</code>	<code>'1.2'</code>
<code>f'{1.234:.2f}'</code>	<code>'1.23'</code>
<code>f'{1.234:.2e}'</code>	<code>'1.230e+00'</code>
<code>f'{1.234:.2%}'</code>	<code>'123.40%'</code>
<code>f'{164:b}'</code>	<code>'10100100'</code>
<code>f'{164:o}'</code>	<code>'244'</code>
<code>f'{164:X}'</code>	<code>'A4'</code>
<code>f'{164:c}'</code>	<code>'ÿ'</code>
<code>f'{1 #comment}'</code>	<code>'1' (v3.12)</code>

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

<code>.</code>	Any character (newline if DOTALL)	<code>{m,n}?</code>	m to n repetitions, as few as possible
<code>^</code>	Start of string (every line if MULTILINE)	<code>[]</code>	Character set: e.g. <code>'[a-zA-Z]'</code>
<code>\$</code>	End of string (every line if MULTILINE)	<code>[^]</code>	NOT character set
<code>*</code>	0 or more of preceding	<code>\</code>	Escape chars <code>'*?+&\$ ()'</code> , introduce special sequences
<code>+</code>	1 or more of preceding	<code>\\</code>	Literal <code>'\'</code>
<code>?</code>	0 or 1 of preceding	<code> </code>	Or
<code>*?, +?, ??</code>	Same as <code>*</code> , <code>+</code> and <code>?</code> , as few as possible	<code>(...)</code>	Group
<code>{m,n}</code>	m to n repetitions	<code>(?:...)</code>	Non-capturing group
		<code>(?P<name>...)</code>	Named group

(?P=name)	Match text matched by earlier group	(?!...)	Non-match preceding, negative lookahead assertion
(?=...)	Match next, non-consumptive	(?(group)A B)	Conditional match - A if group previously matched else B
(?!...)	Non-match next, non-consumptive	(?letters)	Set flags for RE ('i', 'L', 'm', 's', 'u', 'x')
(?<=...)	Match preceding, positive lookahead assertion	(?#...)	Comment (ignored)
Regex special sequences			
\<n>	Match by integer group reference starting from 1	\s	Whitespace [\t\n\r\f\v]
\A	Start of string	\S	Non-whitespace
\b	Word boundary	\w	Alphanumeric (depends on LOCALE flag)
\B	Not word boundary	\W	Non-alphanumeric
\d	Decimal digit	\Z	End of string
\D	Non-decimal digit		
Regex flags			
I or IGNORECASE <=> (?i)	Case insensitive matching	S or DOTALL <=> (?s)	'.' matches ALL chars, including newline
L or LOCALE <=> (?L)	\w, \W, \b, \B depend on current locale	U or UNICODE <=> (?u)	\w, \W, \b, and \B dependent on Unicode database
M or MULTILINE <=> (?m)	Match every new line, not only start/end of string	X or VERBOSE <=> (?x)	Ignores whitespace outside character sets
Regex functions			
compile(pattern[, flag s=0])	Compiles Regular Expression Object	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	subn(pattern, repl, string[, count=0])	Like sub(), but returns (newString, numberOfSubsMade)
split(pattern, string[, maxsplit=0])	Splits by pattern, keeping splitter if grouped		
Regex objects			
flags	Flags	match(string[, pos][, endpos])	Match from start of target[pos:endpos]
groupindex	{group name: group number}	search(string[, pos][, endpos])	Match anywhere in target[pos:endpos]
pattern	Pattern	split(string[, maxsplit=0])	See split() function

<code>findall(string[, pos[, endpos]])</code>	See <code>findall()</code> function	<code>sub(repl, string[, count=0])</code>	See <code>sub()</code> function
<code>finditer(string[, pos[, endpos]])</code>	See <code>finditer()</code> function	<code>subn(repl, string[, count=0])</code>	See <code>subn()</code> function
Regex match objects			
<code>pos</code>	pos passed to search or match	<code>start(group)</code>	Indices of start & end of group match (None if group exists but didn't contribute)
<code>endpos</code>	endpos passed to search or match	<code>span(group)</code>	(<code>start(group), end(group)</code>); (None, None) if group didn't contribute
<code>re</code>	RE object	<code>string</code>	String passed to <code>match()</code> or <code>search()</code>
<code>group([g1, g2, ...])</code>	One or more groups of match One arg, result is a string Multiple args, result is tuple If <code>gi</code> is 0, returns the entire matching string If <code>1 <= gi <= 99</code> , 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 <code>len(tuple)==1</code>		

Math / Number

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

Functions

<code>pow(<num>, <num>)</code> <code><num> ** <num></code>	Power
<code>abs(<num>)</code>	Absolute
<code>round(<num>[, ±ndigits])</code>	Round

Mathematics

```
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 '%'

Exception

```
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 assigned
└ 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 insufficient 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 bytearrays
└ 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)
```

```
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	PYTHONPROFILEIMP ORTTIME	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
```