

# The Best\* Python Cheat Sheet

*Just what you need*

Built-in functions (18)	Exception (21)	List (16)	Set (17)
Bytes (18)	Execution / Environ (23)	Number / Math (14)	String (10)
Class (6)	Flow control (5)	Operator (3)	Testing (23)
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Debugging (23)	Iterator (9)	Regex (12)	Tuple (16)
Decorator (1)	Keyword (1)	Scope (1)	
Dictionary (17)	Library (23)	Sequence (15)	

## Keyword

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

<sup>0</sup>Soft keywords

## 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, **kwds):
        print(func.__name__, args, kwds)
        return func(*args, **kwds)
    return out

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

## 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>[&lt;pattern&gt;[, ...[, *args]]</code>	Sequence pattern (list tuple) matches sequence with matching items
<code>{&lt;value_pattern&gt;: &lt;pattern&gt;[, ...[, **kws]]}</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!
```

## 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 &lt; other</code>	<code>__lt__(self, other)</code>
<code>self &lt;= other</code>	<code>__le__(self, other)</code>
<code>self &gt; other</code>	<code>__gt__(self, other)</code>
<code>self &gt;= 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, **kwargs)</code>	<code>__call__(self, *args, **kwargs)</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>__getattr__(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>

## 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.

<substring> in s	True if string contains <i>substring</i>	s.ljust(width, fillchar=' ')	Left justify with fillchar
s.startswith(<prefix>[, start[, end]])	True if string starts with prefix, optionally search bounded substring	s.rjust(width, fillchar=' ')	Right justify with fillchar
s.endswith(<suffix>[, start[, end]])	True if string ends with suffix, optionally search bounded substring	s.center(width, fillchar=' ')	Center with fillchar
s.strip(chars=None)	Strip whitespace from both ends, or passed characters	s.rstrip(chars=None)	Strip whitespace from right end, or passed characters
s.lstrip(chars=None)	Strip whitespace from left end, or passed characters	s.split(sep=None, maxsplit=-1)	Split on whitespace, or sep str at most <i>maxsplit</i> times
s.rstrip(chars=None)	Strip whitespace from right end, or passed characters	s.splitlines(keepend s=False)	Split lines on <code>[\n\r\f\v\x1c-\x1e\x85\u2028\u2029]</code> and <code>\r\n</code>
		<separator>.join(<strings>)	Join <i>strings</i> with <i>separator</i>
		s.find(<substring>)	Index of first match or -1

<code>s.index(&lt;substring&gt;)</code>	Index of first match or raise <code>ValueError</code>	<code>s.isdecimal()</code>	True if <code>[0-9]</code> , <code>[o-9]</code> or <code>[᠐-᠑]</code>
<code>s.lower()</code>	To lower case	<code>s.isdigit()</code>	True if <code>isdecimal()</code> or <code>[᠐-᠑]</code>
<code>s.upper()</code>	To upper case	<code>s.isnumeric()</code>	True if <code>isdigit()</code> or <code>[᠐-᠑]</code>
<code>s.title()</code>	To title case (The Quick Brown Fox)	<code>s.isalnum()</code>	True if <code>isnumeric()</code> or <code>[a-zA-Z᠐-᠑]</code>
<code>s.capitalize()</code>	Capitalize first letter	<code>s.isprintable()</code>	True if <code>isalnum()</code> or <code>[!]</code>
<code>s.replace(old, new[, count])</code>	Replace <i>old</i> with <i>new</i> at most <i>count</i> times	<code>s.isspace()</code>	True if <code>[ \t\n\r\f\v\x1c-\x1f\x85\xa0]</code>
<code>s.translate(&lt;table&gt;)</code>	Use <code>str.maketrans(&lt;dict&gt;)</code> to generate table	<code>head, sep, tail = s.partition(&lt;separator&gt;)</code>	Search for separator from start and split
<code>chr(&lt;int&gt;)</code>	Integer to Unicode character	<code>head, sep, tail = s.rpartition(&lt;separator&gt;)</code>	Search for separator from end and split
<code>ord(&lt;str&gt;)</code>	Unicode character to integer		

## 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:&lt;5}'</code>	<code>'1     '</code>
<code>f'{1:^5}'</code>	<code>'      1      '</code>
<code>f'{1:&gt;5}'</code>	<code>'          1'</code>
<code>f'{1:.&lt;5}'</code>	<code>'1....'</code>
<code>f'{1:.&gt;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>
<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>

f-string	Output
<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

.	Any character (newline if DOTALL)		Or
^	Start of string (every line if MULTILINE)	(...)	Group
\$	End of string (every line if MULTILINE)	(?:...)	Non-capturing group
*	0 or more of preceding	(? P<name>...)	Named group
+	1 or more of preceding	(?P=name)	Match text matched by earlier group
?	0 or 1 of preceding	(?=...)	Match next, non-consumptive
*?, +?, ??	Same as *, + and ?, as few as possible	(?!...)	Non-match next, non-consumptive
{m,n}	m to n repetitions	(?<=...)	Match preceding, positive lookahead assertion
{m,n}?	m to n repetitions, as few as possible	(?<!...)	Non-match preceding, negative lookahead assertion
[ ]	Character set: e.g. '[a-zA-Z]'	(? (group)A  B)	Conditional match - A if group previously matched else B
[^ ]	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**

<code>\&lt;n&gt;</code>	Match by integer group reference starting from 1
<code>\A</code>	Start of string
<code>\b</code>	Word boundary
<code>\B</code>	Not word boundary
<code>\d</code>	Decimal digit
<code>\D</code>	Non-decimal digit

<code>\s</code>	Whitespace [ <code>\t\n\r\f\v</code> ]
<code>\S</code>	Non-whitespace
<code>\w</code>	Alphanumeric (depends on LOCALE flag)
<code>\W</code>	Non-alphanumeric
<code>\Z</code>	End of string

**Regex flags**

<code>I</code> or <code>IGNORECASE &lt;=&gt; (?i)</code>	Case insensitive matching
<code>L</code> or <code>LOCALE &lt;=&gt; (?L)</code>	<code>\w</code> , <code>\W</code> , <code>\b</code> , <code>\B</code> depend on current locale
<code>M</code> or <code>MULTILINE &lt;=&gt; (?m)</code>	Match every new line, not only start/end of string

<code>S</code> or <code>DOTALL &lt;=&gt; (?s)</code>	'.' matches ALL chars, including newline
<code>U</code> or <code>UNICODE &lt;=&gt; (?u)</code>	<code>\w</code> , <code>\W</code> , <code>\b</code> , and <code>\B</code> dependent on Unicode database
<code>X</code> or <code>VERBOSE &lt;=&gt; (?x)</code>	Ignores whitespace outside character sets

**Regex functions**

<code>compile(pattern[, flags=0])</code>	Compiles Regular Expression Object
<code>escape(string)</code>	Escape non-alphanumerics
<code>match(pattern, string[, flags])</code>	Match from start
<code>search(pattern, string[, flags])</code>	Match anywhere
<code>split(pattern, string[, maxsplit=0])</code>	Splits by pattern, keeping splitter if grouped

<code>findall(pattern, string)</code>	Non-overlapping matches as list of groups or tuples (>1)
<code>finditer(pattern, string[, flags])</code>	Iterator over non-overlapping matches
<code>sub(pattern, repl, string[, count=0])</code>	Replace count first leftmost non-overlapping; If repl is function, called with a MatchObj
<code>subn(pattern, repl, string[, count=0])</code>	Like sub(), but returns (newString, numberOfSubsMade)

**Regex objects**

<code>flags</code>	Flags
<code>groupindex</code>	{group name: group number}
<code>pattern</code>	Pattern
<code>match(string[, pos][, endpos])</code>	Match from start of target[pos:endpos]
<code>search(string[, pos][, endpos])</code>	Match anywhere in target[pos:endpos]

<code>split(string[, maxsplit=0])</code>	See split() function
<code>findall(string[, pos[, endpos]])</code>	See findall() function
<code>finditer(string[, pos[, endpos]])</code>	See finditer() function
<code>sub(repl, string[, count=0])</code>	See sub() function
<code>subn(repl, string[, count=0])</code>	See subn() function

**Regex match objects**

<code>pos</code>	pos passed to search or match
<code>endpos</code>	endpos passed to search or match

<code>re</code>	RE object
-----------------	-----------

<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 &lt;= gi &lt;= 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>	<code>span(group)</code>	<code>(start(group), end(group));</code> (None, None) if group didn't contribute
<code>start(group)</code> <code>, end(group)</code>	Indices of start & end of group match (None if group exists but didn't contribute)	<code>string</code>	String passed to <code>match()</code> or <code>search()</code>

## Number / Math

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

## Functions

<code>pow(&lt;num&gt;, &lt;num&gt;)</code> <code>&lt;num&gt; ** &lt;num&gt;</code>	Power
<code>abs(&lt;num&gt;)</code>	Absolute
<code>round(&lt;num&gt;[, ±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
```

## 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> <code>s = 1, 'a', 3.0</code>	Create tuple
<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.

<code>s = [1, 'a', 3.0]</code> <code>s = list(range(3))</code>	Create list	<code>s.extend(it)</code> <code>s[len(s):len(s)] = it</code>	Add elements from iterable to end
<code>s[i] = x</code>	Replace item index i with x	<code>s.insert(i, x)</code> <code>s[i:i] = [x]</code>	Insert item at index i
<code>s[&lt;slice&gt;] = it</code>	Replace slice with iterable	<code>s.remove(x)</code> <code>del s[s.index(x)]</code>	Remove item
<code>del s[&lt;slice&gt;]</code> <code>s[&lt;slice&gt;] = []</code>	Delete slice	<code>y = s.pop([i])</code>	Remove and return last item, or indexed item
<code>s.append(x)</code> <code>s += x</code> <code>s[len(s):len(s)] = [x]</code>	Add element to end		



<code>s.reverse()</code>	Reverse in place
<code>s.sort(cmp=func, key=getter, reverse=False)</code>	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.

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

### Set

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

<code>set(iterable=None)</code> {1, 2, 3}	New set from iterable, or empty	<code>v in s</code> <code>v not in s</code>	Test membership
<code>frozenset(iterable=None)</code>	But {} creates an empty dictionary (sad!)	<code>s1.issubset(s2)</code>	True if <code>s1</code> is subset of <code>s2</code>
<code>len(s)</code>	Cardinality		

<code>s1.issuperset(s2)</code>	True if s1 is superset of s2	<code>s1.intersection(s2[, s3...])</code>	New set of shared elements
<code>s.add(v)</code>	Add element	<code>s1 &amp; s2</code>	
<code>s.remove(v)</code>	Remove element (KeyError if not found)	<code>s1.union(s2[, s3...])</code>	New set of all elements
<code>s.discard(v)</code>	Remove element if present	<code>s1   s2</code>	
<code>s.pop()</code>	Remove and return arbitrary element (KeyError if empty)	<code>s1.difference(s2[, s3...])</code>	New set of elements unique to s1
<code>s.clear()</code>	Remove all elements	<code>s1 - s2</code>	
		<code>s1.symmetric_difference(s2)</code>	New set of unshared elements
		<code>s1 ^ s2</code>	
		<code>s.copy()</code>	Shallow copy
		<code>s.update(it1[, it2...])</code>	Add all values from iterables

## Bytes

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

<code>b'&lt;str&gt;'</code>	Create from ASCII characters and <code>\x00-\xff</code>	<code>&lt;bytes&gt; = &lt;bytes&gt;[&lt;slice&gt;]</code>	Return <i>bytes</i> even if only one element
<code>bytes(&lt;ints&gt;)</code>	Create from int sequence	<code>list(&lt;bytes&gt;)</code>	Return ints in range 0 to 255
<code>bytes(&lt;str&gt;, 'utf-8')</code>	Create from string	<code>&lt;bytes_sep&gt;.join(&lt;byte_objs&gt;)</code>	Join <i>byte_objs</i> sequence with <i>bytes_sep</i> separator
<code>&lt;str&gt;.encode('utf-8')</code>		<code>str(&lt;bytes&gt;, 'utf-8')</code>	Convert bytes to string
<code>&lt;int&gt;.to_bytes(1, length, order, signed=False)</code>	Create from int (order='big' 'little')	<code>&lt;bytes&gt;.decode('utf-8')</code>	
<code>bytes.fromhex('&lt;hex&gt;')</code>	Create from hex pairs (can be separated by whitespace)	<code>int.from_bytes(b'bytes', order, signed=False)</code>	Return int from bytes (order='big' 'little')
<code>&lt;int&gt; = &lt;bytes&gt;[&lt;index&gt;]</code>	Return int in range 0 to 255	<code>&lt;bytes&gt;.hex(sep='', 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)
```

## Built-in functions

<code>abs()</code>	Absolute value of number	<code>any()</code>	True if any element of iterable is true (any([]) == False)
<code>aiter()</code>	Asynchronous iterator for an asynchronous iterable	<code>ascii()</code>	A string with a printable representation of an object
<code>all()</code>	True if all elements of iterable are true (all([]) == True)		

<code>bin()</code>	Convert integer number to binary string	<code>id()</code>	Return unique integer identifier of object
<code>bool()</code>	Boolean value	<code>__import__()</code>	Invoked by the import statement
<code>breakpoint()</code>	Drop into debugger at call site	<code>input(prompt='')</code>	Read string from stdin, with optional prompt
<code>bytearray()</code>	New array of bytes	<code>int()</code>	Create integer from number or string
<code>bytes()</code>	New bytes object	<code>isinstance()</code>	True if object is instance of given class
<code>callable()</code>	True if the argument is callable	<code>issubclass()</code>	True if class is subclass of given class
<code>chr()</code>	One character string for unicode ordinal i ( $0 \leq i \leq 0x10ffff$ )	<code>iter()</code>	Iterator for object
<code>classmethod()</code>	Transform method into class method	<code>len()</code>	Length of object
<code>compile()</code>	Compile source into code or AST object	<code>list()</code>	Create list
<code>complex()</code>	Complex number with the value $\text{real} + \text{imag} * 1j$	<code>locals()</code>	Dictionary of current local symbol table
<code>delattr()</code>	Delete the named attribute, if object allows	<code>map()</code>	Apply function to every item of iterable
<code>dict()</code>	Create new dictionary	<code>max()</code>	Largest item in an iterable
<code>dir()</code>	List of names in the local scope	<code>memoryview()</code>	Access internal object data via buffer protocol
<code>divmod()</code>	Pair of numbers (quotient, remainder)	<code>min()</code>	Smallest item in an iterable
<code>enumerate()</code>	Enumerate object as (n, item) pairs	<code>next()</code>	Next item from iterator
<code>eval()</code>	Execute expression	<code>object()</code>	New featureless object
<code>exec()</code>	Execute Python code	<code>oct()</code>	Convert integer to octal string
<code>filter()</code>	Make iterator from an iterable, return True	<code>open()</code>	Open file object
<code>float()</code>	Floating point number from number or string	<code>ord()</code>	Integer representing Unicode code point of character
<code>format()</code>	Formatted representation	<code>pow()</code>	Return base to the power exp.
<code>frozenset()</code>	New frozenset object	<code>print()</code>	Print object to text stream file
<code>getattr()</code>	Get value of named attribute of object	<code>property()</code>	Property decorator
<code>globals()</code>	Dictionary of current module namespace	<code>range()</code>	Generate integer sequence
<code>hasattr()</code>	True if object has named attribute	<code>repr()</code>	String representation of object for debugging
<code>hash()</code>	Hash value of object	<code>reversed()</code>	Reverse iterator
<code>help()</code>	Built-in help system	<code>round()</code>	Number rounded to ndigits precision after decimal point
<code>hex()</code>	Convert integer to lowercase hexadecimal string		

<code>set()</code>	New set object	<code>sum()</code>	Sums items of iterable
<code>setattr()</code>	Set object attribute value by name	<code>super()</code>	Proxy object that delegates method calls to parent or sibling
<code>slice()</code>	Slice object representing a set of indices	<code>tuple()</code>	Create a tuple
<code>sorted()</code>	New sorted list from the items in iterable	<code>type()</code>	Type of an object
<code>staticmethod()</code>	Transform method into static method	<code>vars()</code>	dict attribute for any other object with a dict attribute
<code>str()</code>	String description of object	<code>zip()</code>	Iterate over multiple iterables in parallel

## Time

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

### Time formatting

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

```
$ 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
```