Python regular expression cheatsheet and examples

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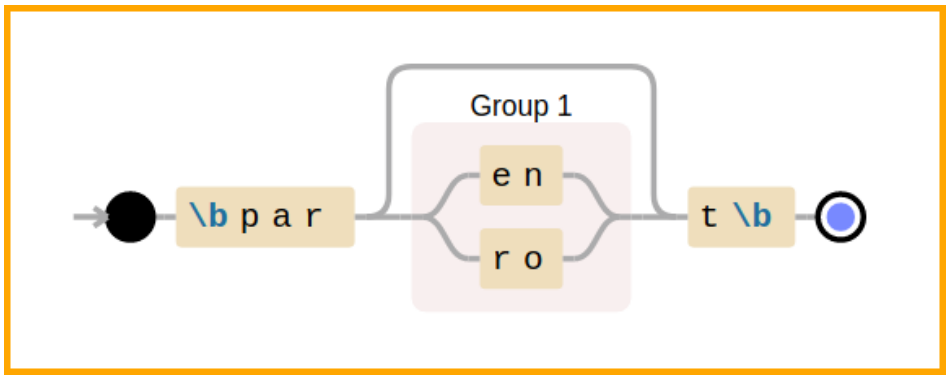
This blog post gives an overview and examples of regular expression syntax as implemented by the `re` built-in module (Python 3.13+). Assume ASCII character set unless otherwise specified. This post is an excerpt from my Understanding Python re(gex)? book.



Visualization created using debuggex *for the pattern* `r'\bpar(en|ro)?t\b'`

From docs.python: re:

> A regular expression (or RE) specifies a set of strings that matches it; the functions in this module let you check if a particular string matches a given regular expression

Elements that define a regular expression 🔗

Anchors	Description
`\A`	restricts the match to the start of string
`\Z`	restricts the match to the end of string
`^`	restricts the match to the start of line
`$`	restricts the match to the end of line

Anchors	Description
`\n`	newline character is used as the line separator
`re.MULTILINE` or `re.M`	flag to treat input as multiline string
`\b`	restricts the match to the start/end of words
	word characters: alphabets, digits, underscore
`\B`	matches wherever `\b` doesn't match

`^`, `$` and `\` are metacharacters in the above table, as these characters have special meaning. Prefix a `\` character to remove the special meaning and match such characters literally. For example, `\^` will match a `^` character instead of acting as an anchor.

Feature	Description
`|`	multiple RE combined as conditional OR
	each alternative can have independent anchors
`(pat)`	group patterns, also a capturing group
	`a(b|c)d` is same as `abd|acd`
`(?:pat)`	non-capturing group
`(?P<name>pat)`	named capture group
`.`	Match any character except the newline character `\n`
`[]`	Character class, matches one character among many

Greedy Quantifiers	Description
`*`	Match zero or more times
`+`	Match one or more times
`?`	Match zero or one times
`{m,n}`	Match `m` to `n` times (inclusive)
`{m,}`	Match at least `m` times
`{,n}`	Match up to `n` times (including `0` times)
`{n}`	Match exactly `n` times
`pat1.*pat2`	any number of characters between `pat1` and `pat2`

Greedy Quantifiers	Description
`pat1.*pat2|pat2.*pat1`	match both `pat1` and `pat2` in any order

Greedy here means that the above quantifiers will match as much as possible that'll also honor the overall RE. Appending a `?` to greedy quantifiers makes them **non-greedy**, i.e. match as *minimally* as possible. Appending a `+` to greedy quantifiers makes them **possessive**, which prevents backtracking. You can also use `(?>pat)` **atomic grouping** to safeguard from backtracking. Quantifiers can be applied to literal characters, groups, backreferences and character classes.

Character class	Description
`[aeiou]`	Match any vowel
`[^aeiou]`	`^` inverts selection, so this matches any consonant
`[a-f]`	`-` defines a range, so this matches any of abcdef characters
`\d`	Match a digit, same as `[0-9]`
`\D`	Match non-digits, same as `[^0-9]` or `[^\d]`
`\w`	Match word characters, same as `[a-zA-Z0-9_]`
`\W`	Match non-word characters, same as `[^a-zA-Z0-9_]` or `[^\w]`
`\s`	Match whitespace characters, same as `[\ \t\n\r\f\v]`
`\S`	Match non-whitespace characters, same as `[^\ \t\n\r\f\v]` or `[^\s]`

Lookarounds	Description
lookarounds	custom assertions, zero-width like anchors
`(?!pat)`	negative lookahead assertion
`(?<!pat)`	negative lookbehind assertion
`(?=pat)`	positive lookahead assertion
`(?<=pat)`	positive lookbehind assertion
`(?!pat1)(?=pat2)`	multiple assertions can be specified in any order
	as they mark a matching location without consuming characters
`((?!pat).)*`	Negate a grouping, similar to negated character class

Flags	Description
`re.IGNORECASE` or `re.I`	flag to ignore case
`re.DOTALL` or `re.S`	allow `.` metacharacter to match newline characters
`flags=re.S|re.I`	multiple flags can be combined using `|` operator
`re.MULTILINE` or `re.M`	allow `^` and `$` anchors to match line wise
`re.VERBOSE` or `re.X`	allows to use literal whitespaces for aligning purposes
	and to add comments after the `#` character
	escape spaces and `#` if needed as part of actual RE
`re.ASCII` or `re.A`	match only ASCII characters for `\b`, `\w`, `\d`, `\s`
	and their opposites, applicable only for Unicode patterns
`re.LOCALE` or `re.L`	use locale settings for byte patterns and 8-bit locales
`(?#comment)`	another way to add comments (not a flag)
`(?flags:pat)`	inline flags only for this `pat`, overrides `flags` argument
	flags is `i` for `re.I`, `s` for `re.S`, etc, except `L` for `re.L`
`(?-flags:pat)`	negate flags only for this `pat`
`(?flags-flags:pat)`	apply and negate particular flags only for this `pat`
`(?flags)`	apply flags for whole RE, can be used only at start of RE
	anchors if any, should be specified after `(?flags)`

Matched portion	Description
`re.Match` object	details like matched portions, location, etc
`m[0]` or `m.group(0)`	entire matched portion of `re.Match` object `m`
`m[n]` or `m.group(n)`	matched portion of the *n*th capture group
`m.groups()`	tuple of all the capture groups' matched portions
`m.span()`	start and end+1 index of the entire matched portion
	pass a number to get span of that particular capture group
	can also use `m.start()` and `m.end()`
`\N`	backreference, gives matched portion of the *N*th capture group

Matched portion	Description
	applies to both search and replacement sections
	possible values: `\1`, `\2` up to `\99` provided no more digits
`\g<N>`	backreference, gives matched portion of the Nth capture group
	possible values: `\g<0>`, `\g<1>`, etc (not limited to 99)
	`\g<0>` refers to the entire matched portion
`(?P<name>pat)`	named capture group
	refer as `'name'` in `re.Match` object
	refer as `(?P=name)` in search section
	refer as `\g<name>` in replacement section
`groupdict`	method applied on a `re.Match` object
	gives named capture group portions as a `dict`

ℹ️ `\0` and `\100` onwards are considered as octal values, hence cannot be used as backreferences.

re module functions 🔗

Function	Description
`re.search`	Check if given pattern is present anywhere in input string
	Output is a `re.Match` object, usable in conditional expressions
	r-strings preferred to define RE
	Use byte pattern for byte input
	Python also maintains a small cache of recent RE
`re.fullmatch`	ensures pattern matches the entire input string
`re.compile`	Compile a pattern for reuse, outputs `re.Pattern` object
`re.sub`	search and replace
`re.sub(r'pat', f, s)`	function `f` with `re.Match` object as the argument
`re.escape`	automatically escape all metacharacters
`re.split`	split a string based on RE

Function	Description
	text matched by the groups will be part of the output
	portion matched by pattern outside group won't be in output
`re.findall`	returns all the matches as a list
	if 1 capture group is used, only its matches are returned
	1+, each element will be tuple of capture groups
	portion matched by pattern outside group won't be in output
`re.finditer`	iterator with `re.Match` object for each match
`re.subn`	gives tuple of modified string and number of substitutions

The function definitions are given below:

```
re.search(pattern, string, flags=0)
re.fullmatch(pattern, string, flags=0)
re.compile(pattern, flags=0)
re.sub(pattern, repl, string, count=0, flags=0)
re.escape(pattern)
re.split(pattern, string, maxsplit=0, flags=0)
re.findall(pattern, string, flags=0)
re.finditer(pattern, string, flags=0)
re.subn(pattern, repl, string, count=0, flags=0)
```

Regular expression examples 🔗

As a good practice, always use **raw strings** to construct RE, unless other formats are required. This will avoid conflict between special meaning of the backslash character in RE and string literals.

> ℹ️ I wrote an interactive TUI app to help you experiment with the examples presented below. See PyRegexPlayground repo for installation instructions and usage guide. See PyRegexExercises repo for a TUI app with 100+ Python regex exercises.

- examples for `re.search()`

```
>>> sentence = 'This is a sample string'

# need to load the re module before use
>>> import re
# check if 'sentence' contains the pattern described by RE argument
```

```
>>> bool(re.search(r'is', sentence))
True

# ignore case while searching for a match
>>> bool(re.search(r'this', sentence, flags=re.I))
True

# example for a pattern not found in the input string
>>> bool(re.search(r'xyz', sentence))
False

# re.search output can be directly used in conditional expressions
>>> if re.search(r'ring', sentence):
...     print('mission success')
...
mission success

# use raw byte strings for patterns if input is of byte data type
>>> bool(re.search(rb'is', b'This is a sample string'))
True
```

- string and line anchors

```
# match the start of the input string
>>> bool(re.search(r'\Ahi', 'hi hello\ntop spot'))
True

# match the start of a line
>>> bool(re.search(r'^top', 'hi hello\ntop spot', flags=re.M))
True

# match the end of strings
>>> words = ['surrender', 'up', 'newer', 'do', 'era', 'eel', 'pest']
>>> [w for w in words if re.search(r'er\Z', w)]
['surrender', 'newer']

# check if there's a whole line 'par'
>>> bool(re.search(r'^par$', 'spare\npar\ndare', flags=re.M))
True
```

- examples for `re.findall()`

```
# match 'par' with optional 's' at start and optional 'e' at end
>>> re.findall(r'\bs?pare?\b', 'par spar apparent spare part pare')
['par', 'spar', 'spare', 'pare']

# numbers >= 100 with optional leading zeros
# you'd need r'\b0*[1-9]\d{2,}\b' if possessive quantifiers isn't used
>>> re.findall(r'\b0*+\d{3,}\b', '0501 035 154 12 26 98234')
['0501', '154', '98234']

# if multiple capturing groups are used, each element of output
```

```
# will be a tuple of strings of all the capture groups
>>> re.findall(r'([^/]+)/([^/,]+),?', '2020/04,1986/Mar')
[('2020', '04'), ('1986', 'Mar')]

# normal capture group will hinder ability to get the whole match
# non-capturing group to the rescue
>>> re.findall(r'\b\w*(?:st|in)\b', 'cost akin more east run')
['cost', 'akin', 'east']

# useful for debugging purposes as well
>>> re.findall(r':.*?:', 'green:3.14:teal::brown:oh!:blue')
[':3.14:', '::', ':oh!:']
```

- examples for `re.split()`

```
# split based on one or more digit characters
>>> re.split(r'\d+', 'Sample123string42with777numbers')
['Sample', 'string', 'with', 'numbers']

# split based on digit or whitespace characters
>>> re.split(r'[\d\s]+', '**1\f2\n3star\t7 77\r**')
['**', 'star', '**']

# to include the matching delimiter strings as well in the output
>>> re.split(r'(\d+)', 'Sample123string42with777numbers')
['Sample', '123', 'string', '42', 'with', '777', 'numbers']

# multiple capture groups example
# note that the portion matched by b+ isn't present in the output
>>> re.split(r'(a+)b+(c+)', '3.14aabccc42')
['3.14', 'aa', 'ccc', '42']

# use non-capturing group if capturing is not needed
>>> re.split(r'hand(?:y|ful)', '123handed42handy777handful500')
['123handed42', '777', '500']
```

- backreferencing within the search pattern

```
>>> words = ['effort', 'flee', 'facade', 'oddball', 'rat', 'tool']

# whole words that have at least one consecutive repeated character
>>> [w for w in words if re.search(r'\b\w*(\w)\1\w*\b', w)]
['effort', 'flee', 'oddball', 'tool']
```

- working with matched portions

```
# re.Match object
>>> re.search(r'so+n', 'too soon a song snatch')
<re.Match object; span=(4, 8), match='soon'>

# retrieving the entire matched portion, note the use of [0]
```

```
>>> motivation = 'Doing is often better than thinking of doing.'
>>> re.search(r'of.*ink', motivation)[0]
'often better than think'

# capture group example
>>> purchase = 'coffee:100g tea:250g sugar:75g chocolate:50g'
>>> m = re.search(r':(.*?)g.*?:(.*?)g.*?chocolate:(.*?)g', purchase)
# to get the matched portion of the second capture group
>>> m[2]
'250'

# to get a tuple of all the capture groups
>>> m.groups()
('100', '250', '50')
```

- examples for `re.finditer()`

```
# numbers < 350
>>> m_iter = re.finditer(r'\d+', '45 349 651 593 4 204 350')
>>> [m[0] for m in m_iter if int(m[0]) < 350]
['45', '349', '4', '204']

# start and end+1 index of each matching portion
>>> m_iter = re.finditer(r'so+n', 'song too soon snatch')
>>> for m in m_iter:
...     print(m.span())
...
(0, 3)
(9, 13)
```

- examples for `re.sub()`

```
# add something to the start of every line
>>> ip_lines = "catapults\nconcatenate\ncat"
>>> print(re.sub(r'^', '* ', ip_lines, flags=re.M))
* catapults
* concatenate
* cat

# replace 'par' only at the start of a word
>>> re.sub(r'\bpar', 'X', 'par spar apparent spare part')
'X spar apparent spare Xt'

# same as: r'part|parrot|parent'
>>> re.sub(r'par(en|ro)?t', 'X', 'par part parrot parent')
'par X X X'

# remove first two columns where : is delimiter
>>> re.sub(r'\A([^:]+:){2}', '', 'apple:123:banana:cherry')
'banana:cherry'
```

- backreferencing in the replacement section

```
# remove any number of consecutive duplicate words separated by space
# use \W+ instead of space to cover cases like 'a;a<-;a'
>>> re.sub(r'\b(\w+)( \1)+\b', r'\1', 'aa a a a 42 f_1 f_1 f_13.14')
'aa a 42 f_1 f_13.14'

# add something around the matched strings
>>> re.sub(r'\d+', r'(\g<0>0)', '52 apples and 31 mangoes')
'(520) apples and (310) mangoes'

# swap words that are separated by a comma
>>> re.sub(r'(\w+),(\w+)', r'\2,\1', 'good,bad 42,24')
'bad,good 24,42'

# example with both capturing and non-capturing groups
>>> re.sub(r'(\d+)(?:abc)+(\d+)', r'\2:\1', '1000abcabc42 12abcd21')
'42:1000 12abcd21'
```

- using functions in the replacement section of `re.sub()`

```
>>> from math import factorial
>>> numbers = '1 2 3 4 5'
>>> def fact_num(n):
...     return str(factorial(int(n[0])))
...
>>> re.sub(r'\d+', fact_num, numbers)
'1 2 6 24 120'

# using lambda
>>> re.sub(r'\d+', lambda m: str(factorial(int(m[0]))), numbers)
'1 2 6 24 120'
```

- examples for lookarounds

```
# change 'cat' only if it is not followed by a digit character
# note that the end of string satisfies the given assertion
# 'catcat' has two matches as the assertion doesn't consume characters
>>> re.sub(r'cat(?!\d)', 'dog', 'hey cats! cat42 cat_5 catcat')
'hey dogs! cat42 dog_5 dogdog'

# change whole word only if it is not preceded by : or -
>>> re.sub(r'(?<![:-])\b\w+', 'X', ':cart <apple -rest ;tea')
':cart <X -rest ;X'

# extract digits only if it is preceded by - and followed by ; or :
>>> re.findall(r'(?<=-)\d+(?=[:;])', '42 apple-5, fig3; x-83, y-20: f12')
['20']

# words containing 'b' and 'e' and 't' in any order
>>> words = ['sequoia', 'questionable', 'exhibit', 'equation']
```

```
>>> [w for w in words if re.search(r'(?=.*b)(?=.*e).*t', w)]
['questionable', 'exhibit']

# match if 'do' is not there between 'at' and 'par'
>>> bool(re.search(r'at((?!do).)*par', 'fox,cat,dog,parrot'))
False
# match if 'go' is not there between 'at' and 'par'
>>> bool(re.search(r'at((?!go).)*par', 'fox,cat,dog,parrot'))
True
```

- examples for `re.compile()`

Regular expressions can be compiled using the `re.compile()` function, which gives back a `re.Pattern` object. The top level `re` module functions are all available as methods for this object. Compiling a regular expression helps if the RE has to be used in multiple places or called upon multiple times inside a loop (speed benefit). By default, Python maintains a small list of recently used RE, so the speed benefit doesn't apply for trivial use cases.

```
>>> pet = re.compile(r'dog')
>>> type(pet)
<class 're.Pattern'>
>>> bool(pet.search('They bought a dog'))
True
>>> bool(pet.search('A cat crossed their path'))
False

>>> pat = re.compile(r'\([^)]*\)')
>>> pat.sub('', 'a+b(addition) - foo() + c%d(#modulo)')
'a+b - foo + c%d'
>>> pat.sub('', 'Hi there(greeting). Nice day(a(b)')
'Hi there. Nice day'
```

Understanding Python re(gex)? book 🔗

Visit my GitHub repo Understanding Python re(gex)? for details about the book I wrote on Python regular expressions. The book uses plenty of examples to explain the concepts from the basics and introduces more advanced concepts step-by-step. The book also covers the third-party regex module. The cheatsheet and examples presented in this post are based on the contents of this book.