# HowTo re

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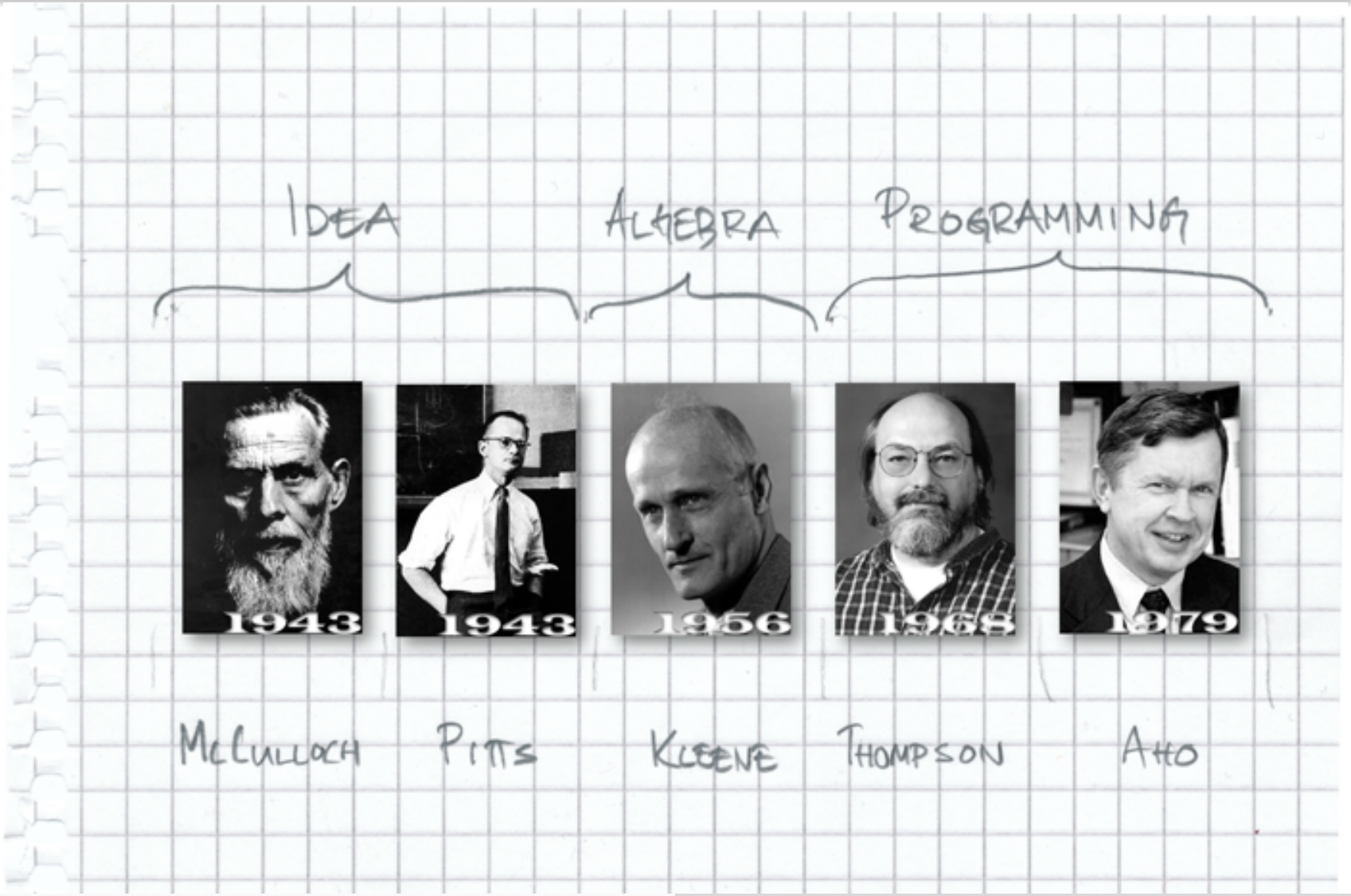
IDEA
ALGEBRA
PROGRAMMING
1943
1943
1956
1968
1979
McCULLOCH
PITTS
KLEENE
THOMPSON
AHO

Delivering Quality since December 31, 1997

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Release of Python 1.5

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- Deprecated old module ‘regex‘, based on Perl-style patterns.

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- Deprecated old module ‘regex‘, based on Perl-style patterns.
- ‘regex‘ finally removed in Python 2.5 (September 19, 2006)

Answer for questions:

- "Does this string match the pattern?"
- "Is there a match for the pattern anywhere in this string?"

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- "Does this string match the pattern?"
- "Is there a match for the pattern anywhere in this string?"
- Replace part of it
- Split into pieces

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re language is relatively small and restricted

- not all possible string processing tasks can be done
- some of them can be done, but expression would be very complicated

```
(?:(?:\r\n)?[ \t])*(?:(?:(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t]
)+|\Z|(?=[\["()<>@,;:\\".\[\]]))|"(?:[^\"\r\\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:
\r\n)?[ \t])*)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(
?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|"(?:[^\"\r\\]|\\.|(?:(?:\r\n)?[
\t]))*"(?:(?:\r\n)?[ \t])*))*@(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\0
31]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\
](?:(?:\r\n)?[ \t])*)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+
(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:
(?:\r\n)?[ \t])*))*|(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z
|(?=[\["()<>@,;:\\".\[\]]))|"(?:[^\"\r\\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)
?[ \t])*)*\<(?:(?:\r\n)?[ \t])*(?:@(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\
r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[
 \t])*)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)
?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t]
)*))*(?:,@(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[
 \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*
)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t]
)+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*))*)
*:(?:(?:\r\n)?[ \t])*)?(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+
|\Z|(?=[\["()<>@,;:\\".\[\]]))|"(?:[^\"\r\\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r
\n)?[ \t])*)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:
```

```
\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|"(?:[^\"\r\\]|\\.|(?:(?:\r\n)?[ \t
]))*"(?:(?:\r\n)?[ \t])*))*@(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031
]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](
?:(?:\r\n)?[ \t])*)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?
:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?
:\r\n)?[ \t])*))*\<(?:(?:\r\n)?[ \t])*)|(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?
:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|"(?:[^\"\r\\]|\\.|(?:(?:\r\n)?
[ \t]))*"(?:(?:\r\n)?[ \t])*)*:(?:(?:\r\n)?[ \t])*(?:(?:(?:[^()<>@,;:\\".\[\]
\000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|"(?:[^\"\r\\]|
\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>
@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|"
(?:[^\"\r\\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*))*@(?:(?:\r\n)?[ \t]
)*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\
".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*)(?:\.(?:(?:\r\n)?[ \t])*(?
:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[
\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*))*|(?:[^()<>@,;:\\".\[\] \000-
\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|"(?:[^\"\r\\]|\\.|(
?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*)*\<(?:(?:\r\n)?[ \t])*(?:@(?:[^()<>@,;
:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([
^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\"
.\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\
```

```
]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*))*(?:,@(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\
[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\
r\\]|\\.)*\](?:(?:\r\n)?[ \t])*)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\]
\000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]
|\\.)*\](?:(?:\r\n)?[ \t])*))*)*:(?:(?:\r\n)?[ \t])*)?(?:[^()<>@,;:\\".\[\] \0
00-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|"(?:[^\"\r\\]|\\
.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,
;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|"(?
:[^\"\r\\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*))*@(?:(?:\r\n)?[ \t])*
(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".
\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*)(?:\.(?:(?:\r\n)?[ \t])*(?:[
^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]
]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*))*\>(?:(?:\r\n)?[ \t])*)(?:,\s*(
?:(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\
".\[\]]))|"(?:[^\"\r\\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*)(?:\.(?:(
?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[
\["()<>@,;:\\".\[\]]))|"(?:[^\"\r\\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t
])*))*@(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t
])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*)(?
:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|
\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*))*|(?:
```

```
[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\
]]))|"(?:[^\"\r\\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*)*\<(?:(?:\r\n)
?[ \t])*(?:@(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["
()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*)(?:\.(?:(?:\r\n)
?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>
@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*))*(?:,@(?:(?:\r\n)?[
 \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,
;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*)(?:\.(?:(?:\r\n)?[ \t]
)*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\
".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*))*)*:(?:(?:\r\n)?[ \t])*)?
(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".
\[\]]))|"(?:[^\"\r\\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*)(?:\.(?:(?:
\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\[
"()<>@,;:\\".\[\]]))|"(?:[^\"\r\\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])
*))*@(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])
+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*)(?:\
.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z
|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*))*\>(?:(
?:\r\n)?[ \t])*))*)?;\s*)
```

Perl regex to validate email addresses according to the RFC 822

http://ex-parrot.com/~pdw/Mail-RFC822-Address

. ^ $ * + ? { } [ ] \ | ( )

## [ ] - class

```
>>> import re
>>> re.findall("[def]", "abcdefghi")
['d', 'e', 'f']
>>> re.findall("[d-f]", "abcdefghi")
['d', 'e', 'f']
>>>
```

## [ ] - class

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['d', 'e', 'f']
>>> re.findall("[d-f]", "abcdefghi")
['d', 'e', 'f']
>>>
```

## Metacharacters are not active inside class

```
>>> re.findall("[d-f$]", "abcdefg$hi")
['d', 'e', 'f', '$']
```

## ^ - complementing set

```
>>> import re
>>> re.findall("[^5]", "abc 456 xyz")
['a', 'b', 'c', ' ', '4', '6', ' ', 'x', 'y', 'z']
>>>
```

. - dot. Matches anything except a newline character

```
>>> import re
>>> regex = re.compile(".")
>>> regex.findall("string")
['s', 't', 'r', 'i', 'n', 'g']
>>>
```

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>>> import re
>>> regex = re.compile(".")
>>> regex.findall("string")
['s', 't', 'r', 'i', 'n', 'g']
>>>
```

There is compilation flag, which changes default behavior.

`*` - star. Specifies that previous character can be matched zero or more times.

```
>>> re.findall("ca*t", "ct, cat, caat")
['ct', 'cat', 'caat']
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`+` - plus. Similar to `*`, but requires at least one occurence of character.

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`?` - question mark. Matches either once or zero times

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```

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```

`?` - question mark. Matches either once or zero times

```
>>> re.findall("ca?t", "ct, cat, caat")
['ct', 'cat']

>>> re.findall("home-?brew", "homebrew, home-brew")
['homebrew', 'home-brew']
```

`{m,n}` - `m` and `n` are decimal numbers. There must be at least m repetitions, and at most n.

```
>>> re.findall("a/{1,2}b", "ab, a/b, a//b, a///b")
['a/b', 'a//b']
```

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```
>>> re.findall("a/{1,2}b", "ab, a/b, a//b, a///b")
['a/b', 'a//b']
```

`m` and `n` can be ommited. When m ommited, there is zero, when n ommited, upper bound infinity (more precisely, 2 billions)

```
{0,}  ==  "*"
{1,}  ==  "+"
{,1}  ==  {0,1}  ==  "?"
```

`*`, `+`, `?` and `{m,n}` are greedy. Will try to repeat it as many times as possible (re engine can match only 2 billion characters (2GB) – C `int` limitation).

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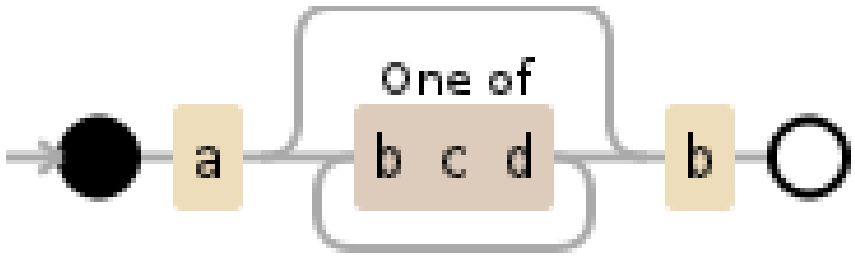
`a[bcd]*b` - matches `a`, zero or more letters from `bcd`, and ends with `b`




src: `https://www.debuggex.com/r/NT7_HIVhxI_h64zk`

```
re.match("a[bcd]*b", "abcbd")
```

- matches `a`

```
re.match("a[bcd]*b", "abcbd")
```

- matches `a`
- matches `abcbd` to the end of the string

```
re.match("a[bcd]*b", "abcbd")
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- matches `a`
- matches `abcbd` to the end of the string
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```
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```

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- fails, because current position is the end of the string, so cannot match `b`
- matches `abcb` - one less character

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- matches `abcb` - one less character
- fails, because current position is `d`, so cannot match `b`

```
re.match("a[bcd]*b", "abcbd")
```

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- matches `abc`, so `[bcd]*` matches only `bc`

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re.match("a[bcd]*b", "abcbd")
```

- matches `a`
- matches `abcbd` to the end of the string
- fails, because current position is the end of the string, so cannot match `b`
- matches `abcb` - one less character
- fails, because current position is `d`, so cannot match `b`
- matches `abc`, so `[bcd]*` matches only `bc`
- `abcb`, tries last character `b`, and it's on current position
- success

```
>>> re.findall('a[bcd]*b', 'abcbd')
['abcb']
```

`*?`, `+?`, `??`, `{m,n}?` are non-greedy. Will try to match as few characters as possible.

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```
>>> import re
>>> text =
     ↪  "<html><head><title>Title</title></head></html>"
```

`*?, +?, ??, {m,n}?` are non-greedy. Will try to match as few characters as possible.

```
>>> import re
>>> text =
    ↪  "<html><head><title>Title</title></head></html>"

>>> greedy_regex = re.compile("<.*>")
>>> greedy_regex.findall(text)
['<html><head><title>Title</title></head></html>']
```

`*?`, `+?`, `??`, `{m,n}?` are non-greedy. Will try to match as few characters as possible.

```
>>> import re
>>> text =
    ↪  "<html><head><title>Title</title></head></html>"

>>> greedy_regex = re.compile("<.*>")
>>> greedy_regex.findall(text)
['<html><head><title>Title</title></head></html>']

>>> non_greedy_regex = re.compile("<.*?>")
>>> non_greedy_regex.findall(text)
['<html>', '<head>', '<title>', '</title>', '</head>',
    ↪  '</html>']
>>>
```

\ - backslash (escape metacharacters)

For matching [ or \ you can use \[ or \\

```
>>> re.findall("\[\]", "Find brackets []")
['[]']
```

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For matching [ or \ you can use \[ or \\

```
>>> re.findall("\[\]", "Find brackets []")
['[]']
```

Some of special sequences beginning with \ express predefined sets of characters: set of digits, letters, everything but whitespace

- `\d` - any decimal digit, equivalent of `[0-9]`
- `\D` - everything but decimal digit, equivalent of `[^0-9]`

```
>>> re.findall("\d", "abc789xyz")
['7', '8', '9']
>>> re.findall("[0-9]", "abc789xyz")
['7', '8', '9']
```

- `\d` - any decimal digit, equivalent of `[0-9]`
- `\D` - everything but decimal digit, equivalent of `[^0-9]`

```
>>> re.findall("\d", "abc789xyz")
['7', '8', '9']
>>> re.findall("[0-9]", "abc789xyz")
['7', '8', '9']

>>> re.findall("\D", "abc789xyz")
['a', 'b', 'c', 'x', 'y', 'z']
>>> re.findall("[^0-9]", "abc789xyz")
['a', 'b', 'c', 'x', 'y', 'z']
```

- `\w` - any alphanumeric: `[a-zA-Z0-9_]`
- `\W` - any non-alphanumeric: `[^a-zA-Z0-9_]`

```
>>> re.findall('\w+', 'abc 789 xyz')
['abc', '789', 'xyz']
>>> re.findall('[a-zA-Z0-9_]+', 'abc 789 xyz')
['abc', '789', 'xyz']
```

- \w - any alphanumeric: [a-zA-Z0-9_]
- \W - any non-alphanumeric: [^a-zA-Z0-9_]

```
>>> re.findall('\w+', 'abc 789 xyz')
['abc', '789', 'xyz']
>>> re.findall('[a-zA-Z0-9_]+', 'abc 789 xyz')
['abc', '789', 'xyz']

>>> re.findall('\W+', 'abc 789 xyz')
[' ', ' ']
>>> re.findall('[^a-zA-Z0-9_]+', 'abc 789 xyz')
[' ', ' ']
```

- `\s` - any whitespace character: `[ \t\n\r\f\v]` (space, tab (ASCII 0x09), newline (0x0A), return (0x0D), form feed - page break(0x0C), vertical tab (0x0B))
- `\S` - any non-whitespace character: `[^ \t\n\r\f\v]`

- `\s` - any whitespace character: `[ \t\n\r\f\v]` (space, tab (ASCII 0x09), newline (0x0A), return (0x0D), form feed - page break(0x0C), vertical tab (0x0B))
- `\S` - any non-whitespace character: `[^ \t\n\r\f\v]`
- NOTE! Remember that Windows text files use `\r\n` to terminate lines, while UNIX text files use `\n`.

```
>>> text = "line,\nwith \ttab,\vvertical,\rreturn and
    ↪  \nnewlines."
>>> print(text)
line,
with    tab,
return and  vertical,
newlines.
```

```
>>> text = "line,\nwith \ttab,\vvertical,\rreturn and
    ↪  \nnewlines."
>>> print(text)
line,
with    tab,
return and  vertical,
newlines.

>>> re.findall("\s+", text)
['\n', ' \t', '\x0b', '\r', ' ', ' \n']
```

```
>>> text = "line,\nwith \ttab,\vvertical,\rreturn and
    ↪  \nnewlines."
>>> print(text)
line,
with    tab,
return and  vertical,
newlines.

>>> re.findall("\s+", text)
['\n', ' \t', '\x0b', '\r', ' ', ' \n']

>>> re.findall("\S+", text)
['line,', 'with', 'tab,', 'vertical,', 'return', 'and',
    ↪  'newlines.']
```

- re is handled as string

- re is handled as string
- one of `re` metacharacters is `\`

- re is handled as string
- one of `re` metacharacters is `\`
- backslash for escaping in `re` conflicts with the same purpose in Python

| Characters | Stage |
|---|---|
| `\section` | Text string to be matched |
| `\\section` | Escaped backslash for `re.compile()` |
| `"\\\\section"` | Escaped backslashes for a string literal |

| Characters | Stage |
|---|---|
| `\section` | Text string to be matched |
| `\\section` | Escaped backslash for `re.compile()` |
| `"\\\\section"` | Escaped backslashes for a string literal |

re string needs to be written as `"\\\\"` because regular expression must be `\\` and each must be escaped `\\` inside a regular Python string literal.

| Characters | Stage |
|---|---|
| `\section` | Text string to be matched |
| `\\section` | Escaped backslash for `re.compile()` |
| `"\\\\section"` | Escaped backslashes for a string literal |

re string needs to be written as `"\\\\"` because regular expression must be `\\` and each must be escaped `\\` inside a regular Python string literal.

Solution - raw string

| Regular string | Raw string |
|---|---|
| `"ab*"` | `r"ab*"` |
| `"\\\\section"` | `r"\\section"` |
| `"\\w+\\s+"` | `r"\w+\s+"` |

```
>>> latex = """
... \begin{document}
... \section{History}
... \subsection{Origins}
... \begin{frame}
... Content
... \end{frame}
... \end{document}
... """
```

```
>>> latex = """
... \begin{document}
... \section{History}
... \subsection{Origins}
... \begin{frame}
... Content
... \end{frame}
... \end{document}
... """

>>> latex
'\n\x08egin{document}\n\\section{History}\n\\subsection{Origin
```

```
>>> latex = """
... \begin{document}
... \section{History}
... \subsection{Origins}
... \begin{frame}
... Content
... \end{frame}
... \end{document}
... """

>>> latex
'\n\x08egin{document}\n\\section{History}\n\\subsection{Origin

>>> print(re.findall(r"\\section{.*}", latex))
['\\section{History}']
>>> print(re.findall(r"\\section{.*}", latex)[0])
\section{History}
```

```
>>> import re
>>> regex = re.compile('[a-zA-Z0-9]+')
>>> regex
re.compile('[a-zA-Z0-9]+')
>>> regex.findall('Search test 01')
['Search', 'test', '01']
```

```
>>> import re
>>> regex = re.compile('[a-zA-Z0-9]+')
>>> regex
re.compile('[a-zA-Z0-9]+')
>>> regex.findall('Search test 01')
['Search', 'test', '01']

>>> import re
>>> regex = re.compile('[a-zA-Z0-9]+')
>>> regex
re.compile('[a-zA-Z0-9]+')
>>> re.findall(regex, 'Search test 02')
['Search', 'test', '02']
```

```
>>> import re
>>> regex = re.compile('[a-zA-Z0-9]+')
>>> regex
re.compile('[a-zA-Z0-9]+')
>>> regex.findall('Search test 01')
['Search', 'test', '01']

>>> import re
>>> regex = re.compile('[a-zA-Z0-9]+')
>>> regex
re.compile('[a-zA-Z0-9]+')
>>> re.findall(regex, 'Search test 02')
['Search', 'test', '02']

>>> import re
>>> re.findall('[a-zA-Z0-9]+', 'Search test 03')
['Search', 'test', '03']
```

## re.DEBUG

```
>>> import re
>>> regex = re.compile('[a-z]', re.DEBUG)
in
  range (97, 122)
>>>
```

`re.ASCII, re.A`

`\xa0` - non-breaking space

```
>>> import re
>>> regex = re.compile("\s+")
>>> regex.findall("\xa0 ha")
['\xa0 ']
```

## `re.ASCII, re.A`

`\xa0` - non-breaking space

```
>>> import re
>>> regex = re.compile("\s+")
>>> regex.findall("\xa0 ha")
['\xa0 ']

>>> ascii_regex = re.compile("\s+", re.ASCII)
>>> ascii_regex.findall("\xa0 ha")
[' ']
>>>
```

## re.IGNORECASE, re.I

```
>>> import re
>>> text = "CamelCase CAPITAL and lower WoRd"
>>> regex = re.compile("[a-z]+")
>>> regex.findall(text)
['amel', 'ase', 'and', 'lower', 'o', 'd']
```

## re.IGNORECASE, re.I

```
>>> import re
>>> text = "CamelCase CAPITAL and lower WoRd"
>>> regex = re.compile("[a-z]+")
>>> regex.findall(text)
['amel', 'ase', 'and', 'lower', 'o', 'd']

>>> ignorecase_regex = re.compile("[a-z]+", re.I)
>>> ignorecase_regex.findall(text)
['CamelCase', 'CAPITAL', 'and', 'lower', 'WoRd']
>>>
```

## re.MULTILINE, re.M

```
>>> import re
>>> text = """From the beginning,
... in the middle,
... and at the end."""
```

## re.MULTILINE, re.M

```
>>> import re
>>> text = """From the beginning,
... in the middle,
... and at the end."""

>>> regex = re.compile("^[a-zA-Z]+")
>>> regex.findall(text)
['From']
```

## re.MULTILINE, re.M

```
>>> import re
>>> text = """From the beginning,
... in the middle,
... and at the end."""

>>> regex = re.compile("^[a-zA-Z]+")
>>> regex.findall(text)
['From']

>>> multiline_regex = re.compile("^[a-zA-Z]+", re.M)
>>> multiline_regex.findall(text)
['From', 'in', 'and']
>>>
```

## re.DOTALL, re.S

```
>>> import re
>>> text = """From the beginning,
... in the middle,
... and at the end."""
```

## re.DOTALL, re.S

```
>>> import re
>>> text = """From the beginning,
... in the middle,
... and at the end."""

>>> regex = re.compile(".+")
>>> regex.findall(text)
['From the beginning,', 'in the middle,', 'and at the
    ↪  end.']
```

## re.DOTALL, re.S

```
>>> import re
>>> text = """From the beginning,
... in the middle,
... and at the end."""

>>> regex = re.compile(".+")
>>> regex.findall(text)
['From the beginning,', 'in the middle,', 'and at the
    ↪  end.']

>>> dotall_regex = re.compile(".+", re.S)
>>> dotall_regex.findall(text)
['From the beginning,\nin the middle,\nand at the end.']
>>>
```

## re.VERBOSE, re.X

```
>>> import re
>>> numbers = "127.2, 15.30, 73"
>>> regex = re.compile(r"\d+\.?\d*")
>>> regex.findall(numbers)
['127.2', '15.30', '73']
```

## re.VERBOSE, re.X

```
>>> import re
>>> numbers = "127.2, 15.30, 73"
>>> regex = re.compile(r"\d+\.?\d*")
>>> regex.findall(numbers)
['127.2', '15.30', '73']

>>> verbose_regex = re.compile(r"""
        \d +  # the integral part
        \. ?  # the decimal point
        \d *  # some fractional digits""", re.X)
>>> verbose_regex.findall(numbers)
['127.2', '15.30', '73']
>>>
```

`re.LOCALE, re.L`

Make `\w`, `\W`, `\b`, and `\B`, dependent on the current locale instead of the Unicode database.

*Do not use.*

*Deprecated in Python 3.5, will be removed in version 3.6*

| - "or" operator

```
>>> re.findall("No|Yes", "Yes and No")
['Yes', 'No']
```

## | - "or" operator

```
>>> re.findall("No|Yes", "Yes and No")
['Yes', 'No']

>>> re.findall("Yes|No", "Yes|No")
['Yes', 'No']
>>> re.findall("Yes\|No", "Yes|No")
['Yes|No']
>>>
```

## ^, \A - beginning of lines

```
>>> text = """Your own personal Jesus
... Someone to hear your prayers
... Someone who cares
... Your own personal Jesus
... Someone to hear your prayers
... Someone who's there"""
```

## ^, \A - beginning of lines

```
>>> text = """Your own personal Jesus
... Someone to hear your prayers
... Someone who cares
... Your own personal Jesus
... Someone to hear your prayers
... Someone who's there"""

>>> re.findall("^Your", text)
['Your']
>>> re.findall("\AYour", text)
['Your']
```

## ^, \A - beginning of lines

```
>>> text = """Your own personal Jesus
... Someone to hear your prayers
... Someone who cares
... Your own personal Jesus
... Someone to hear your prayers
... Someone who's there"""

>>> re.findall("^Your", text)
['Your']
>>> re.findall("\AYour", text)
['Your']

>>> re.findall("^Your", text, re.M)
['Your', 'Your']
>>> re.findall("\AYour", text, re.M)
['Your']
```

## `$`, `\Z` - end of lines

```
>>> text = """Your own personal Jesus
... Someone to hear your prayers
... Someone who cares
... Your own personal Jesus"""
```

## `$`, `\Z` - end of lines

```
>>> text = """Your own personal Jesus
... Someone to hear your prayers
... Someone who cares
... Your own personal Jesus"""

>>> re.findall("Jesus$", text)
['Jesus']
>>> re.findall("Jesus\Z", text)
['Jesus']
```

## `$`, `\Z` - end of lines

```
>>> text = """Your own personal Jesus
... Someone to hear your prayers
... Someone who cares
... Your own personal Jesus"""

>>> re.findall("Jesus$", text)
['Jesus']
>>> re.findall("Jesus\Z", text)
['Jesus']

>>> re.findall("Jesus$", text, re.M)
['Jesus', 'Jesus']
>>> re.findall("Jesus\Z", text, re.M)
['Jesus']
```

## \b, \B - word boundaries

```
>>> text = "People in class heard that Pluto should be
    ↪  reclassified, because it is no longer a planet."
```

## \b, \B - word boundaries

```
>>> text = "People in class heard that Pluto should be
    ↪  reclassified, because it is no longer a planet."

>>> re.sub("class", "room", text)
'People in room heard that Pluto should be reroomified,
    ↪  because it is no longer a planet.'
```

## \b, \B - word boundaries

```
>>> text = "People in class heard that Pluto should be
    ↪  reclassified, because it is no longer a planet."

>>> re.sub("class", "room", text)
'People in room heard that Pluto should be reroomified,
    ↪  because it is no longer a planet.'

>>> re.sub(r"\bclass\b", "room", text)
'People in room heard that Pluto should be
    ↪  reclassified, because it is no longer a planet.'
```

## \b, \B - word boundaries

```
>>> text = "People in class heard that Pluto should be
    ↪  reclassified, because it is no longer a planet."

>>> re.sub("class", "room", text)
'People in room heard that Pluto should be reroomified,
    ↪  because it is no longer a planet.'

>>> re.sub(r"\bclass\b", "room", text)
'People in room heard that Pluto should be
    ↪  reclassified, because it is no longer a planet.'

>>> re.sub(r"\Bclass\B", "qual", text)
'People in class heard that Pluto should be
    ↪  requalified, because it is no longer a planet.'
```

## match() vs. search()

```
>>> text = 'Your own personal Jesus Someone to hear
    ↪  your prayers Someone who cares Your own
    ↪  personal Jesus'
```

## match() vs. search()

```
>>> text = 'Your own personal Jesus Someone to hear
    ↪  your prayers Someone who cares Your own
    ↪  personal Jesus'

>>> re.search("Your", text)
<_sre.SRE_Match object; span=(0, 4), match='Your'>
```

## match() vs. search()

```
>>> text = 'Your own personal Jesus Someone to hear
    ↪  your prayers Someone who cares Your own
    ↪  personal Jesus'

>>> re.search("Your", text)
<_sre.SRE_Match object; span=(0, 4), match='Your'>

>>> re.match("Your", text)
<_sre.SRE_Match object; span=(0, 4), match='Your'>
```

## match() vs. search()

```
>>> text = 'Your own personal Jesus Someone to hear
    ↪  your prayers Someone who cares Your own
    ↪  personal Jesus'

>>> re.search("Your", text)
<_sre.SRE_Match object; span=(0, 4), match='Your'>

>>> re.match("Your", text)
<_sre.SRE_Match object; span=(0, 4), match='Your'>

>>> re.search("Jesus", text)
<_sre.SRE_Match object; span=(18, 23), match='Jesus'>
```

## match() vs. search()

```
>>> text = 'Your own personal Jesus Someone to hear
    ↪  your prayers Someone who cares Your own
    ↪  personal Jesus'

>>> re.search("Your", text)
<_sre.SRE_Match object; span=(0, 4), match='Your'>

>>> re.match("Your", text)
<_sre.SRE_Match object; span=(0, 4), match='Your'>

>>> re.search("Jesus", text)
<_sre.SRE_Match object; span=(18, 23), match='Jesus'>

>>> re.match("Jesus", text)
>>>
```

## `findall()` vs. `finditer()`

```
>>> text = 'Your own personal Jesus Someone to hear
    ↪  your prayers Someone who cares Your own
    ↪  personal Jesus'
```

## findall() vs. finditer()

```
>>> text = 'Your own personal Jesus Someone to hear
    ↪  your prayers Someone who cares Your own
    ↪  personal Jesus'

>>> output_findall = re.findall("Someone", text)
>>> output_finditer = re.finditer("Someone", text)
```

## findall() vs. finditer()

```
>>> text = 'Your own personal Jesus Someone to hear
    ↪  your prayers Someone who cares Your own
    ↪  personal Jesus'

>>> output_findall = re.findall("Someone", text)
>>> output_finditer = re.finditer("Someone", text)

>>> type(output_findall)
<class 'list'>
>>> type(output_finditer)
<class 'callable_iterator'>
```

```
>>> output_findall
['Someone', 'Someone']
>>> output_finditer
<callable_iterator object at 0x7f69ffd267b8>
```

```
>>> output_findall
['Someone', 'Someone']
>>> output_finditer
<callable_iterator object at 0x7f69ffd267b8>

>>> list(output_finditer)
[<_sre.SRE_Match object; span=(24, 31),
    ↪  match='Someone'>, <_sre.SRE_Match object;
    ↪  span=(53, 60), match='Someone'>]
>>>
```

```
>>> matched = re.match("\d{0,2}-\d{0,3}", "88-299")
>>> matched
<_sre.SRE_Match object; span=(0, 6), match='88-299'>
>>> if matched:
...     # do something
...     pass
...
```

```
>>> matched = re.match("\d{0,2}-\d{0,3}", "88-299")
>>> matched
<_sre.SRE_Match object; span=(0, 6), match='88-299'>
>>> if matched:
...     # do something
...     pass
...

>>> non_matched = re.match("(\d?)-(\d{0,3})", "88-299")
>>> non_matched
>>> non_matched == None
True
>>>
```

## start() and end()

```
>>> text = "Soft Kitty, warm Kitty"
>>> matched = re.search("Kitty", text)
>>> matched.start()
5
>>> matched.end()
10
```

## match.re and match.string

```
>>> matched = re.match(r"(\w+)@(\w+\.\w+)",
    ↪  "login@server.com")
```

## match.re and match.string

```
>>> matched = re.match(r"(\w+)@(\w+\.\w+)",
    ↪  "login@server.com")

>>> matched.re
re.compile('(\\w+)@(\\w+\\.\\w+)')
>>> matched.string
'login@server.com'
>>>
```

## Split

```
>>> text = "Oh, what a day. What a lovely day!"
>>> re.split("\W+", text)
['Oh', 'what', 'a', 'day', 'What', 'a', 'lovely',
    ↪  'day', '']
```

## Split

```
>>> text = "Oh, what a day. What a lovely day!"
>>> re.split("\W+", text)
['Oh', 'what', 'a', 'day', 'What', 'a', 'lovely',
    ↪  'day', '']

>>> re.split("(\W+)", text)
['Oh', ', ', 'what', ' ', 'a', ' ', 'day', '. ',
    ↪  'What', ' ', 'a', ' ', 'lovely', ' ', 'day',
    ↪  '!', '']
>>>
```

## Search and replace - `sub()` and `subn()`

`sub()` *is deprecated since Python 3.5 and will be removed in 3.6*

```
>>> pattern = r"\bBar\b"
>>> replacement = "Baz"
>>> string = "Foo Bar"
```

## Search and replace - `sub()` and `subn()`

`sub()` *is deprecated since Python 3.5 and will be removed in 3.6*

```
>>> pattern = r"\bBar\b"
>>> replacement = "Baz"
>>> string = "Foo Bar"

>>> new_string, number_of_subs_made = re.subn(pattern,
    ↪  replacement, string)
>>> new_string, number_of_subs_made
('Foo Baz', 1)
>>>
```

```
>>> date = "15 October 2015"
>>> matched = re.match("(\d+) (\w+) (\d{4})", date)
>>> matched.groups()
('15', 'October', '2015')
>>> matched.group(1)
'15'
>>> matched.group(2)
'October'
>>> matched.group(3)
'2015'
>>>
```

## Named groups

```
>>> date = "15 October 2015"
>>> matched = re.match("(?P<day>\d+) (?P<month>\w+)
    ↪  (?P<year>\d{4})", date)
>>> matched.groups()
('15', 'October', '2015')
>>> matched.group('day')
'15'
>>> matched.group('month')
'October'
>>> matched.group('year')
'2015'
>>>
```

```
>>> m = re.search(r'(?P<quote>")(.*)(?P=quote)', 'This
    ↪  is "quote"')
>>> m
<_sre.SRE_Match object; span=(8, 15), match='"quote"'>
>>> m.groups()
('"', 'quote')
```

## Positive and negative lookahead assertions

```
>>> singer = "Michael Jackson"
>>> player = "Michael Jordan"
>>> player_pattern = "Michael (?=Jordan)"
>>> non_player_pattern = "Michael (?!Jordan)"
```

## Positive and negative lookahead assertions

```
>>> singer = "Michael Jackson"
>>> player = "Michael Jordan"
>>> player_pattern = "Michael (?=Jordan)"
>>> non_player_pattern = "Michael (?!Jordan)"

>>> re.match(player_pattern, player)
<_sre.SRE_Match object; span=(0, 8), match='Michael '>
>>> re.match(non_player_pattern, singer)
<_sre.SRE_Match object; span=(0, 8), match='Michael '>
```

## Positive and negative lookahead assertions

```
>>> singer = "Michael Jackson"
>>> player = "Michael Jordan"
>>> player_pattern = "Michael (?=Jordan)"
>>> non_player_pattern = "Michael (?!Jordan)"

>>> re.match(player_pattern, player)
<_sre.SRE_Match object; span=(0, 8), match='Michael '>
>>> re.match(non_player_pattern, singer)
<_sre.SRE_Match object; span=(0, 8), match='Michael '>

>>> re.match(player_pattern, singer)
>>> re.match(non_player_pattern, player)
>>>
```

## Positive and negative lookbehind assertions

```
>>> string = """
... def function():
...     return function()
"""
>>> re.search("(?<=def )function", string)
<_sre.SRE_Match object; span=(4, 12), match='function'>
>>> re.search("(?<!def )function", string)
<_sre.SRE_Match object; span=(27, 35), match='function'>
>>>
```

Language feature comparison (part 1)

| | "+" quantifier | Negated character classes | Non-greedy quantifiers[Note 1] | Shy groups[Note 2] | Recursion | Look-ahead | Look-behind | Backreferences[Note 3] | >9 indexable captures |
|---|---|---|---|---|---|---|---|---|---|
| Boost.Regex | Yes | Yes | Yes | Yes | Yes[Note 4] | Yes | Yes | Yes | Yes |
| Boost.Xpressive | Yes | Yes | Yes | Yes | Yes[Note 5] | Yes | Yes | Yes | Yes |
| CL-PPCRE | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes |
| EmEditor | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | No |
| FREJ | No[Note 6] | No | Some[Note 6] | Yes | No | No | No | Yes | Yes |
| GLib/GRegex | Yes | ? | Yes | ? | No | ? | ? | ? | ? |
| GNU grep | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | ? |
| Haskell | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes |
| ICU Regex | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes |
| Java | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes |
| JavaScript (ECMAScript) | Yes | Yes | Yes | Yes | No | Yes | No | Yes | Yes |
| JGsoft | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes |
| Lua | Yes | Yes | Yes | No | No | No | No | Yes | No |
| .NET | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes |
| OCaml | Yes | Yes | No | No | No | No | No | Yes | No |
| OmniOutliner 3.6.2 | Yes | Yes | Yes | No | No | No | No | ? | ? |
| PCRE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Perl | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| PHP | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Python | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes |
| Qt/QRegExp | Yes | Yes | Yes | Yes | No | Yes | No | Yes | Yes |
| R[Note 7] | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes |
| RE2 | Yes | Yes | Yes | Yes | No | No | No | No | Yes |
| Ruby | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| TRE | Yes | Yes | Yes | Yes | No | No | No | Yes | No |
| Vim 7.4b.000 (2013-07-28) [±] | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | No |
| RGX | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes |
| Tcl | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes |
| TRegExpr | Yes | ? | Yes | ? | ? | ? | ? | ? | ? |
| XRegExp | Yes | Yes | Yes | Yes | No | Yes | No | Yes | Yes |

**Language feature comparison (part 2)**

| | Directives[Note 1] | Conditionals | Atomic groups[Note 2] | Named capture[Note 3] | Comments | Embedded code | Unicode property support [1] | Balancing groups[Note 4] | Variable-length look-behinds[Note 5] |
|---|---|---|---|---|---|---|---|---|---|
| Boost.Regex | Yes | Yes | Yes | Yes | Yes | No | Some[Note 6] | No | No |
| Boost.Xpressive | Yes | No | Yes | Yes | Yes | No | No | No | No |
| CL-PPCRE | Yes | Yes | Yes | Yes | Yes | Yes | Some[Note 6] | No | No |
| EmEditor | Yes | Yes | ? | ? | Yes | No | ? | No | No |
| FREJ | No | No | Yes | Yes | Yes | No | ? | No | No |
| GLib/GRegex | Yes | Yes | Yes | Yes | Yes | No | Some[Note 6] | No | No |
| GNU grep | Yes | Yes | ? | Yes | Yes | No | No | No | No |
| Haskell | ? | ? | ? | ? | ? | No | No | No | No |
| ICU Regex | Yes | No | Yes | No | Yes | No | Yes | No | No |
| Java | Yes | No | Yes | Yes[Note 7] | Yes | No | Some[Note 6] | No | No |
| JavaScript (ECMAScript) | No | No | No | No | No | No | No | No | No |
| JGsoft | Yes | Yes | Yes | Yes | Yes | No | Some[Note 6] | No | Yes |
| Lua | No | No | No | No | No | No | No | No | No |
| .NET | Yes | Yes | Yes | Yes | Yes | No | Some[Note 6] | Yes | Yes |
| OCaml | No | No | No | No | No | No | No | No | No |
| OmniOutliner 3.6.2 | ? | ? | ? | ? | No | No | ? | No | No |
| PCRE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | No |
| Perl | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | No |
| PHP | Yes | Yes | Yes | Yes | Yes | No | No | No | No |
| Python | Yes | Yes | No | Yes | Yes | No | No | No | No |
| Qt/QRegExp | No | No | No | No | No | No | No | No | No |
| RE2 | Yes | No | ? | Yes | No | No | Some[Note 6] | No | No |
| Ruby | Yes | No | Yes | Yes | Yes | Yes | Some[Note 6] | No | No |
| Tcl | Yes | No | Yes | No | Yes | No | Yes | No | No |
| TRE | Yes | No | No | No | Yes | No | ? | No | No |
| Vim | Yes | No | Yes | No | No | No | No | No | Yes |
| RGX | Yes | Yes | Yes | Yes | Yes | No | Yes | No | No |
| XRegExp | Leading only | No | No | Yes | Yes | No | Yes | No | No |

- Regular Expression HOWTO: `https://docs.python.org/2/howto/regex.html`
- Python Docs: Library re: `https://docs.python.org/2/library/re.html`
- Google for Education. Python Regular Expressions: `https://developers.google.com/edu/python/regular-expressions?hl=en`
- Regex Debugger: `https://regex101.com/`
- Debuggex: `https://www.debuggex.com/`
- Core Python Applications programming: Regular expressions: `http://www.informit.com/articles/article.aspx?p=1707750&seqNum=2`
- Brief history by Staffan Noteberg: `http://blog.staffannoteberg.com/`