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In this tutorial, you will learn about regular expressions (RegEx), and use Python's `re` module to work with RegEx (with the help of examples).

A **Regular Expression** (RegEx) is a sequence of characters that defines a search pattern. For example,

```
^a...s$
```

The above code defines a RegEx pattern. The pattern is: **any five letter string starting with `a` and ending with `s`**.

A pattern defined using RegEx can be used to match against a string.

Expression	String	Matched?
<code>^a...s\$</code>	<code>abs</code>	No match
	<code>alias</code>	Match
	<code>abyss</code>	Match
	<code>Alias</code>	No match
	<code>An abacus</code>	No match

Python has a module named `re` to work with RegEx. Here's an example:



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```
if result:
    print("Search successful.")
else:
    print("Search unsuccessful.")
```

Here, we used `re.match()` function to search `pattern` within the `test_string`. The method returns a match object if the search is successful. If not, it returns `None`.

There are other several functions defined in the `re` module to work with RegEx. Before we explore that, let's learn about regular expressions themselves.

If you already know the basics of RegEx, jump to [Python RegEx](#).

## Specify Pattern Using RegEx

To specify regular expressions, metacharacters are used. In the above example, `^` and `$` are metacharacters.

## MetaCharacters

Metacharacters are characters that are interpreted in a special way by a RegEx engine. Here's a list of metacharacters:

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



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[abc]	a	1 match
	ac	2 matches
	Hey Jude	No match
	abc de ca	5 matches

Here, [abc] will match if the string you are trying to match contains any of the a, b or c.

You can also specify a range of characters using - inside square brackets.

- [a-e] is the same as [abcde].
- [1-4] is the same as [1234].
- [0-39] is the same as [01239].

You can complement (invert) the character set by using caret ^ symbol at the start of a square-bracket.

- [^abc] means any character except a or b or c.
- [^0-9] means any non-digit character.

## . - Period

A period matches any single character (except newline '\n').

Expression

String

Matched?



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acde

2 matches (contains 4 characters)

## ^ - **Caret**

The caret symbol 

^

 is used to check if a string **starts with** a certain character.

Expression	String	Matched?
<p>^a</p>	<p>a</p>	1 match
	<p>abc</p>	1 match
	<p>bac</p>	No match
<p>^ab</p>	<p>abc</p>	1 match
	<p>acb</p>	No match (starts with <p>a</p> but not followed by <p>b</p> )

## \$ - **Dollar**

The dollar symbol 

\$

 is used to check if a string **ends with** a certain character.

Expression	String	Matched?
<p>a\$</p>	<p>a</p>	1 match
	<p>formula</p>	1 match



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ma*n	mn	1 match
	man	1 match
	maaan	1 match
	main	No match (a is not followed by n)
	woman	1 match

#### + - Plus

The plus symbol **+** matches **one or more occurrences** of the pattern left to it.

Expression	String	Matched?
ma+n	mn	No match (no a character)
	man	1 match
	maaan	1 match
	main	No match (a is not followed by n)
	woman	1 match

#### ? - Question Mark



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<code>ma?n</code>	<code>maan</code>	No match (more than one <code>a</code> character)
	<code>main</code>	No match (a is not followed by n)
	<code>woman</code>	1 match

### `{}` - Braces

Consider this code: `{n,m}`. This means at least `n`, and at most `m` repetitions of the pattern left to it.

Expression	String	Matched?
<code>a{2,3}</code>	<code>abc dat</code>	No match
	<code>abc daat</code>	1 match (at <code>daat</code> )
	<code>aabc daaat</code>	2 matches (at <code>aabc</code> and <code>daaat</code> )
	<code>aabc daaaat</code>	2 matches (at <code>aabc</code> and <code>daaaat</code> )

Let's try one more example. This RegEx `[0-9]{2, 4}` matches at least 2 digits but not more than 4 digits

Expression	String	Matched?
<code>[0-9]{2,4}</code>	<code>ab123csde</code>	1 match (match at <code>ab123csde</code> )
	<code>12 and 345673</code>	3 matches ( <code>12</code> , <code>3456</code> , <code>73</code> )



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Expression	String	Matched?
a b	cde	No match
	ade	1 match (match at <u>a</u> de)
	acdbea	3 matches (at <u>a</u> <u>c</u> <u>d</u> <u>b</u> <u>e</u> <u>a</u> )

Here, a|b match any string that contains either a or b

### () - Group

Parentheses () is used to group sub-patterns. For example, (a|b|c)xz match any string that matches either a or b or c followed by xz

Expression	String	Matched?
(a b c)xz	ab xz	No match
	abxz	1 match (match at <u>a</u> <u>b</u> <u>x</u> <u>z</u> )
	axz cabxz	2 matches (at <u>a</u> <u>x</u> <u>z</u> <u>b</u> <u>c</u> <u>a</u> <u>b</u> <u>x</u> <u>z</u> )

### \ - Backslash

Backslash \ is used to escape various characters including all metacharacters. For example,



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## Special Sequences

Special sequences make commonly used patterns easier to write. Here's a list of special sequences:

`\A` - Matches if the specified characters are at the start of a string.

Expression	String	Matched?
<code>\Athe</code>	the sun	Match
	In the sun	No match

`\b` - Matches if the specified characters are at the beginning or end of a word.

Expression	String	Matched?
<code>\bfoo</code>	football	Match
	a football	Match
	afootball	No match
<code>foo\b</code>	the foo	Match
	the afoo test	Match
	the afootest	No match



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beginning or end of a word.





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	afootball	Match
	the foo	No match
foo\B	the afoo test	No match
	the afootest	Match

`\d` - Matches any decimal digit. Equivalent to `[0-9]`

Expression	String	Matched?
<code>\d</code>	12abc3	3 matches (at <code>12abc3</code> )
	Python	No match

`\D` - Matches any non-decimal digit. Equivalent to `[^0-9]`

Expression	String	Matched?
<code>\D</code>	1ab34"50	3 matches (at <code>1ab34"50</code> )
	1345	No match

`\s` - Matches where a string contains any whitespace character. Equivalent to



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`\S` - Matches where a string contains any non-whitespace character.

Equivalent to `[^\t\n\r\f\v]`.

Expression	String	Matched?
<code>\S</code>	a b	2 matches (at <code>a</code> <code>b</code> )
		No match

`\w` - Matches any alphanumeric character (digits and alphabets). Equivalent to `[a-zA-Z0-9_]`. By the way, underscore `_` is also considered an alphanumeric character.

Expression	String	Matched?
<code>\w</code>	12&" : ; c	3 matches (at <code>1</code> <code>2</code> <code>c</code> )
	% "> !	No match

`\W` - Matches any non-alphanumeric character. Equivalent to `[^a-zA-Z0-9_]`

Expression	String	Matched?
	1a2%c	1 match (at <code>1a2%c</code> )



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	I like Python	1 match
Python\Z	I like Python Programming	No match
	Python is fun.	No match

**Tip:** To build and test regular expressions, you can use RegEx tester tools such as [regex101](https://regex101.com/) (<https://regex101.com/>). This tool not only helps you in creating regular expressions, but it also helps you learn it.

Now you understand the basics of RegEx, let's discuss how to use RegEx in your Python code.

## Python RegEx

Python has a module named `re` to work with regular expressions. To use it, we need to import the module.

```
import re
```

The module defines several functions and constants to work with RegEx.

## re.findall()



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```
string = 'hello 12 hi 89. Howdy 34'
pattern = '\d+'

result = re.findall(pattern, string)
print(result)

# Output: ['12', '89', '34']
```

If the pattern is not found, `re.findall()` returns an empty list.

## re.split()

The `re.split()` method splits the string where there is a match and returns a list of strings where the splits have occurred.

### Example 2: re.split()

```
import re

string = 'Twelve:12 Eighty nine:89.'
pattern = '\d+'

result = re.split(pattern, string)
print(result)

# Output: ['Twelve:', ' Eighty nine:', '.']
```

If the pattern is not found, `re.split()` returns a list containing the original



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```
string = 'Twelve:12 Eighty nine:89 Nine:9.'
pattern = '\d+'

# maxsplit = 1
# split only at the first occurrence
result = re.split(pattern, string, 1)
print(result)

# Output: ['Twelve:', ' Eighty nine:89 Nine:9.']
```

By the way, the default value of `maxsplit` is 0; meaning all possible splits.

## re.sub()

The syntax of `re.sub()` is:

```
re.sub(pattern, replace, string)
```

The method returns a string where matched occurrences are replaced with the content of `replace` variable.

### Example 3: re.sub()



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```
de 23 \n f45 6'

# matches all whitespace characters
pattern = '\s+'

# empty string
replace = ''

new_string = re.sub(pattern, replace, string)
print(new_string)

# Output: abc12de23f456
```

If the pattern is not found, `re.sub()` returns the original string.

You can pass `count` as a fourth parameter to the `re.sub()` method. If omitted, it results to 0. This will replace all occurrences.

```
import re

# multiline string
string = 'abc 12\nde 23 \n f45 6'

# matches all whitespace characters
pattern = '\s+'
replace = ''

new_string = re.sub(r'\s+', replace, string, 1)
print(new_string)

# Output:
# abc12de 23
# f45 6
```



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## Example 4: re.subn()

```
# Program to remove all whitespaces
import re

# multiline string
string = 'abc 12\
de 23 \n f45 6'

# matches all whitespace characters
pattern = '\s+'

# empty string
replace = ''

new_string = re.subn(pattern, replace, string)
print(new_string)

# Output: ('abc12de23f456', 4)
```

## re.search()

The `re.search()` method takes two arguments: a pattern and a string. The method looks for the first location where the RegEx pattern produces a match with the string.

If the search is successful, `re.search()` returns a match object; if not, it returns `None`.





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```
# check if 'Python' is at the beginning
match = re.search('\APython', string)

if match:
    print("pattern found inside the string")
else:
    print("pattern not found")

# Output: pattern found inside the string
```

Here, `match` contains a match object.

## Match object

You can get methods and attributes of a match object using [dir\(\)](#) ([/python-programming/methods/built-in/dir](#)) function.

Some of the commonly used methods and attributes of match objects are:

### `match.group()`

The `group()` method returns the part of the string where there is a match.

### Example 6: Match object



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```
pattern = '(\d{3}) (\d{2})'

# match variable contains a Match object.
match = re.search(pattern, string)

if match:
    print(match.group())
else:
    print("pattern not found")

# Output: 801 35
```

Here, `match` variable contains a match object.

Our pattern `(\d{3}) (\d{2})` has two subgroups `(\d{3})` and `(\d{2})`. You can get the part of the string of these parenthesized subgroups. Here's how:

```
>>> match.group(1)
'801'

>>> match.group(2)
'35'
>>> match.group(1, 2)
('801', '35')

>>> match.groups()
('801', '35')
```

## **match.start(), match.end() and match.span()**

The `start()` function returns the index of the start of the matched substring. Similarly, `end()` returns the end index of the matched substring.



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The `span()` function returns a tuple containing start and end index of the matched part.

```
>>> match.span()  
(2, 8)
```

## match.re and match.string

The `re` attribute of a matched object returns a regular expression object. Similarly, `string` attribute returns the passed string.

```
>>> match.re  
re.compile('(\d{3}) (\d{2})')  
  
>>> match.string  
'39801 356, 2102 1111'
```

We have covered all commonly used methods defined in the `re` module. If you want to learn more, visit [Python 3 re module](https://docs.python.org/3/library/re.html) (<https://docs.python.org/3/library/re.html>).

## Using r prefix before RegEx

When `r` or `R` prefix is used before a regular expression, it means raw string.



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## Example 7: Raw string using r prefix

```
import re

string = '\n and \r are escape sequences.'

result = re.findall(r'[\n\r]', string)
print(result)

# Output: ['\n', '\r']
```

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