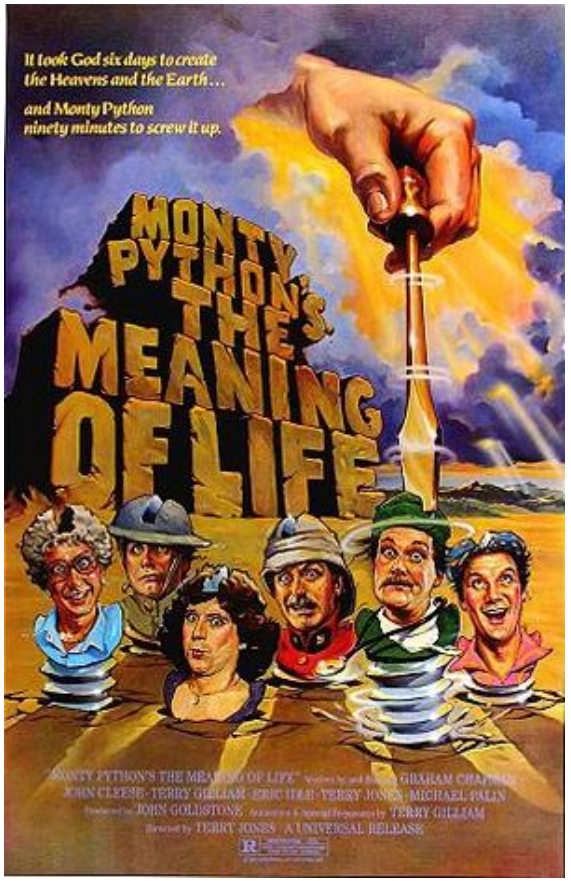
Regular Expressions

- Introduction
- Understanding RegEx
- Wildcards
- Matching
- Escape Character



Regular Expressions

In computing, a regular expression, also referred to as "regex" or "regexp" provides a concise and flexible means for matching strings of text, such as particular characters, words, or patterns of characters. A regular expression is written in a formal language that can be interpreted by a regular expression processor.

http://en.wikipedia.org/wiki/Regular_expression

Regular Expressions

Really clever "wild card" expressions for matching and parsing strings.

http://docs.python.org/library/re.html

Really smart "Find" or "Search"

Understanding Regular Expressions

- Very powerful and quite cryptic
- Fun once you understand them
- Regular expressions are a language unto themselves
- A language of "marker characters" - programming with characters
- It is kind of an "old school" language - compact

http://xkcd.com/208/

Regular Expression Quick Guide

`^`	Matches the beginning of a line
`$`	Matches the end of the line
`.`	Matches any one character
`\s`	Matches whitespace
`\S`	Matches any non-whitespace character
`*`	Repeats a character zero or more times
`*?`	Repeats a character zero or more times (non-greedy)
`+`	Repeats a character one or more times
`+?`	Repeats a character one or more times (non-greedy)
`[aeiou]`	Matches a single character in the listed set
`[^XYZ]`	Matches a single character not in the listed set
`[a-z0-9]`	The set of characters can include a range
`(`	Indicates where string extraction is to start
`)`	Indicates where string extraction is to end

The Regular Expression Module

- Before you can use regular expressions in your program, you must import the library using "`import re`"
- Use `re.search()` to see if a string matches a regular expression, similar to using the `find()` method for strings
- Use `re.findall()` to extract portions of a string that match your regular expression similar to a combination of `find()` and slicing: `var[5:10]`

Using `re.search()` like `find()`

```
hand = open('mbox-short.txt')
for line in hand:
    line = line.rstrip()
    if line.find('From:') >= 0:
        print (line)
```

```
import re

hand = open('mbox-short.txt')
for line in hand:
    line = line.rstrip()
    if re.search('From:', line):
        print (line)
```

Doesn’t show real power.

Using `re.search()` like `startswith()`

^ used to match “the beginning” of the line

```
hand = open('mbox-short.txt')
for line in hand:
    line = line.rstrip()
    if line.startswith('From:'):
        print (line)
```

```
import re

hand = open('mbox-short.txt')
for line in hand:
    line = line.rstrip()
    if re.search('^From:', line):
        print (line)
```

Fine-tune what is matched by adding special characters to the string

Wild-Card Characters

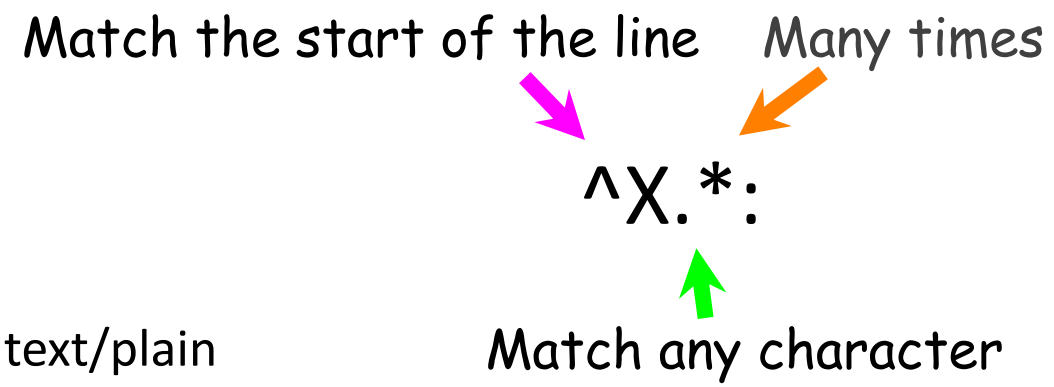
- The dot character matches any character
  - Example: `'F..m:'` matches `'From:'`, `'Fxxm:'`, `'F12m:'` and `'F!@m:'`
- If you add the asterisk character, the character is "any number of times"

X-Sieve: CMU Sieve 2.3
X-DSPAM-Result: Innocent
X-DSPAM-Confidence: 0.8475
X-Content-Type-Message-Body: text/plain

^X.*:

Wild-Card Characters

- The dot character matches any character
  - Example: `'F..m:'` matches `'From:'`, `'Fxxm:'`, `'F12m:'` and `'F!@m:'`
- If you add the asterisk character, the character is "any number of times"

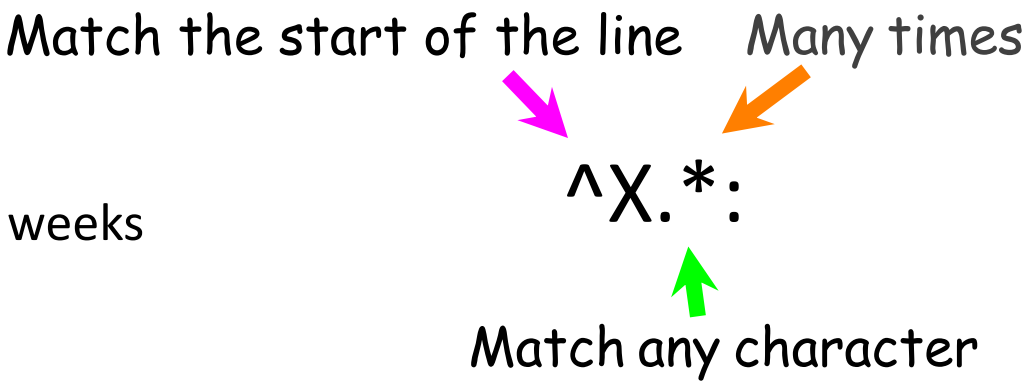


X-Sieve: CMU Sieve 2.3
X-DSPAM-Result: Innocent
X-DSPAM-Confidence: 0.8475
X-Content-Type-Message-Body: text/plain

Fine-Tuning Your Match

- Depending on how "clean" your data is and the purpose of your application, you may want to narrow your match down a bit

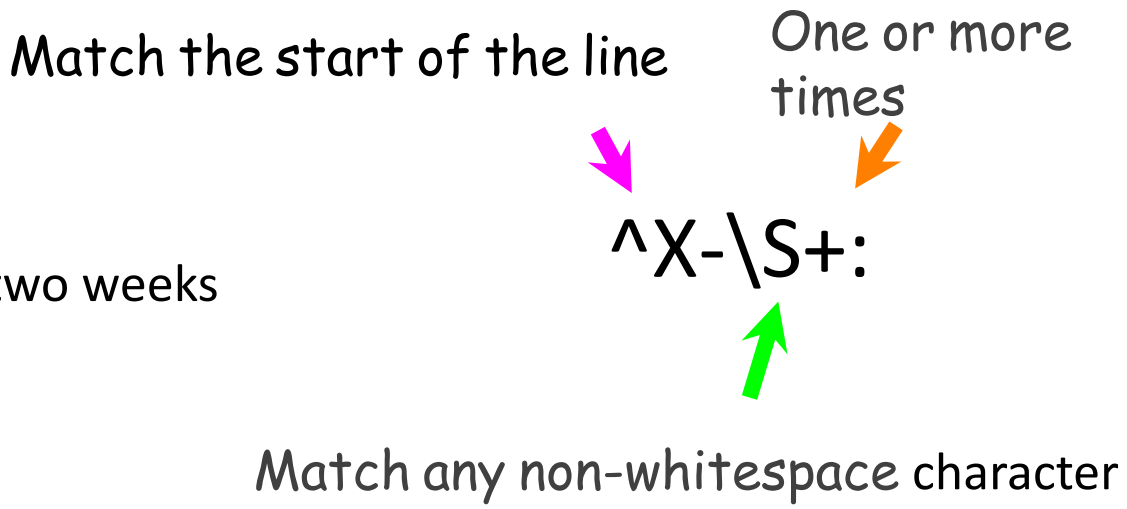
X-Sieve: CMU Sieve 2.3
X-DSPAM-Result: Innocent
X-Plane is behind schedule: two weeks



Fine-Tuning Your Match

- Depending on how "clean" your data is and the purpose of your application, you may want to narrow your match down a bit

X-Sieve: CMU Sieve 2.3
X-DSPAM-Result: Innocent
X-Plane is behind schedule: two weeks



Matching and Extracting Data

- `re.search()` returns a `True/False` depending on whether the string matches the regular expression
- If we actually want the matching strings to be extracted, we use `re.findall()`

[0-9]+

One or more digits

```
>>> import re
>>> x = 'My 2 favorite numbers are 19 and 42'
>>> y = re.findall('[0-9]+',x)
>>> print (y)
['2', '19', '42']
```

Matching and Extracting Data

- When we use `re.findall()` it returns a list of zero or more sub-strings that match the regular expression

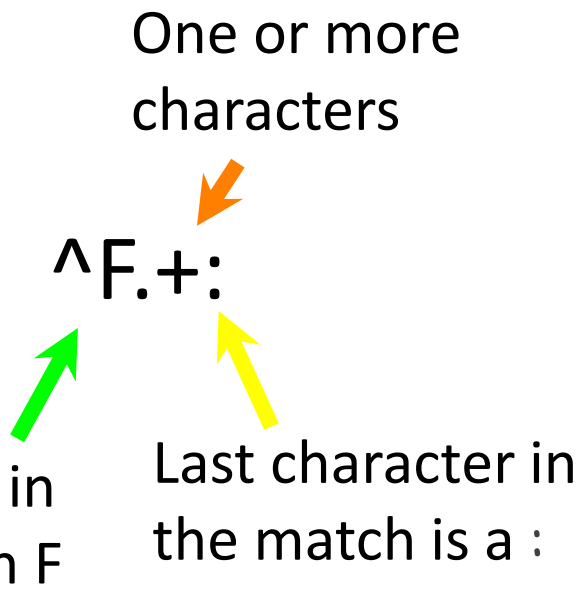
```
>>> import re
>>> x = 'My 2 favorite numbers are 19 and 42'
>>> y = re.findall('[0-9]+',x)
>>> print (y)
['2', '19', '42']
>>> y = re.findall('[AEIOU]+',x)
>>> print (y)
[]
```

Warning: Greedy Matching

- The repeat characters (* and +) push outward in both directions (greedy) to match the largest possible string

```
>>> import re
>>> x = 'From: Using the : character'
>>> y = re.findall('^F.+:', x)
>>> print (y)
['From: Using the :']
```

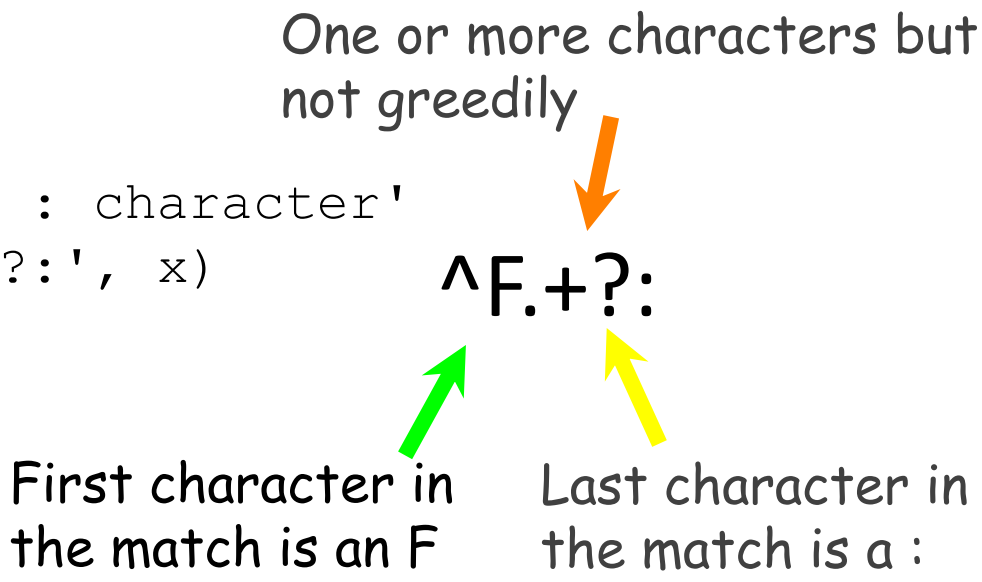
Why not 'From:'?



Non-Greedy Matching

- Not all regular expression repeat codes are greedy!
- If you add a `?` character, the `+` and `*` chill out a bit...

```
>>> import re
>>> x = 'From: Using the : character'
>>> y = re.findall('^F.+?:', x)
>>> print (y)
['From:']
```

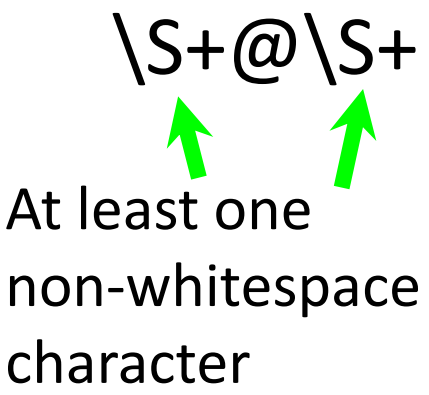


Fine Tuning String Extraction

- Refine the match for `re.findall()` and separately determine which portion of the match that is to be extracted using parenthesis

From stephen.marquard@uct.ac.za Sat Jan 5 09:14:16 2008

```
>>> y = re.findall('\S+@\S+',x)
>>> print (y)
['stephen.marquard@uct.ac.za']
>>> y = re.findall('^From.*? (\S+@\S+)',x)
>>> print (y)
['stephen.marquard@uct.ac.za']
```



Fine Tuning String Extraction

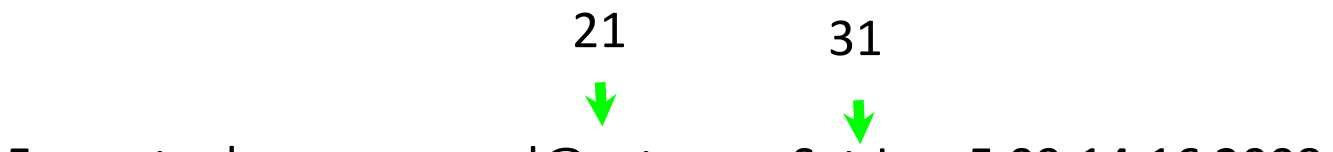
- Parenthesis are not part of the match - but they tell where to start and stop what string to extract

From stephen.marquard@uct.ac.za Sat Jan 5 09:14:16 2008

```
>>> y = re.findall('\S+@\S+',x)
>>> print (y)
['stephen.marquard@uct.ac.za']
>>> y = re.findall('^From (\S+@\S+)',x)
>>> print (y)
['stephen.marquard@uct.ac.za']
```

^From (\S+@\S+)

Extracting a host name - using `find` and `string` slicing.




```
>>>data = 'From stephen.marquard@uct.ac.za Sat Jan  5 09:14:16 2008'
>>>atpos = data.find('@')
>>>print (atpos)
21
>>>sppos = data.find(' ',atpos)
>>>print (sppos)
31
>>>host = data[atpos+1 : sppos]
>>>print(host)
```

The Double Split Version

- Sometimes we split a line one way and then grab one of the pieces of the line and split that piece again

From stephen.marquard@uct.ac.za Sat Jan 5 09:14:16 2008

```
words = line.split()
email = words[1]
pieces = email.split('@')
print (pieces[1])
```

stephen.marquard@uct.ac.za

['stephen.marquard', 'uct.ac.za']

'uct.ac.za'

The Regex Version

From stephen.marquard@uct.ac.za Sat Jan 5 09:14:16 2008

```
import re
lin = 'From stephen.marquard@uct.ac.za Sat Jan  5
09:14:16 2008'
y = re.findall('@([^ ]*)',lin)
print (y)
['uct.ac.za']
```

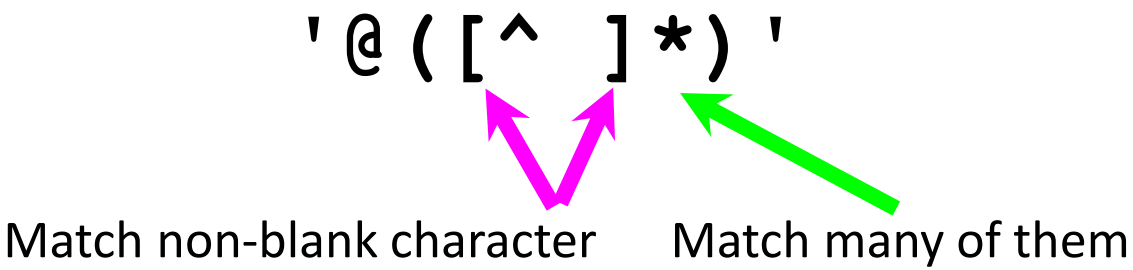
'@([^]*)'

Look through the string until you find an @

The Regex Version

From stephen.marquard@uct.ac.za Sat Jan 5 09:14:16 2008

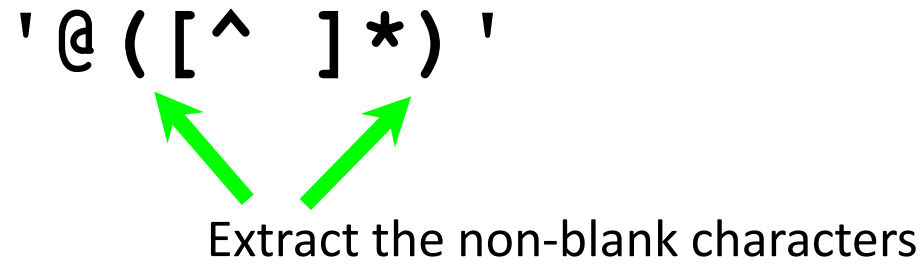
```
import re
lin = 'From stephen.marquard@uct.ac.za Sat Jan  5 09:14:16 2008'
y = re.findall('@([^ ]*)',lin)
print (y)
['uct.ac.za']
```



The Regex Version

From stephen.marquard@uct.ac.za Sat Jan 5 09:14:16 2008

```
import re
lin = 'From stephen.marquard@uct.ac.za Sat Jan  5 09:14:16 2008'
y = re.findall('@([^ ]*)',lin)
print (y)
['uct.ac.za']
```

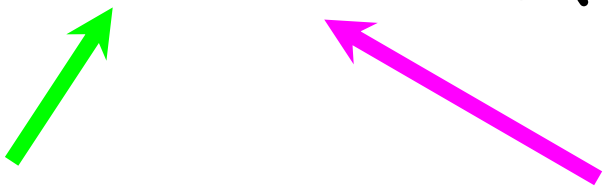


Even Cooler Regex Version

From stephen.marquard@uct.ac.za Sat Jan 5 09:14:16 2008

```
import re
lin = 'From stephen.marquard@uct.ac.za Sat Jan  5 09:14:16 2008'
y = re.findall('^From .*@([^ ]*)',lin)
print (y)
['uct.ac.za']
```

'^From .*@([^]*)'



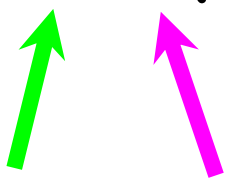
Starting at the beginning of the line, look for the string 'From '

Even Cooler Regex Version

From stephen.marquard@uct.ac.za Sat Jan 5 09:14:16 2008

```
import re
lin = 'From stephen.marquard@uct.ac.za Sat Jan  5 09:14:16 2008'
y = re.findall('^From .*@([^ ]*)',lin)
print (y)
['uct.ac.za']
```

'^From .*@([^]*)'



Skip a bunch of characters, looking for an @

Even Cooler Regex Version

From stephen.marquard@uct.ac.za Sat Jan 5 09:14:16 2008

```
import re
lin = 'From stephen.marquard@uct.ac.za Sat Jan  5 09:14:16 2008'
y = re.findall('^From .*@([^ ]*)',lin)
print (y)
['uct.ac.za']
```

'^From .*@([^]*)'

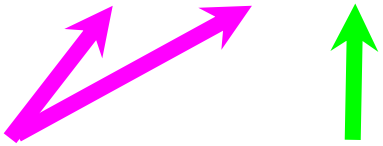
Start 'extracting'

Even Cooler Regex Version

From stephen.marquard@uct.ac.za Sat Jan 5 09:14:16 2008

```
import re
lin = 'From stephen.marquard@uct.ac.za Sat Jan  5 09:14:16 2008'
y = re.findall('^From .*@([^ ]*)',lin)
print y['uct.ac.za']
```

'^From .*@([^]*)'



Match non-blank character Match many of them

Even Cooler Regex Version

From stephen.marquard@uct.ac.za Sat Jan 5 09:14:16 2008

```
import re
lin = 'From stephen.marquard@uct.ac.za Sat Jan  5 09:14:16 2008'
y = re.findall('^From .*@([^ ]*)',lin)
print (y)
['uct.ac.za']
```

'^From .*@([^]*)'

Stop 'extracting'

Spam Confidence

```
import re
hand = open('mbox-short.txt')
numlist = list()
for line in hand:
    line = line.rstrip()
    stuff = re.findall('^X-DSPAM-Confidence: ([0-9.]+)', line)
    if len(stuff) != 1:  continue
    num = float(stuff[0])
    numlist.append(num)
print ('Maximum:', max(numlist))
```

```
python ds.py
Maximum: 0.9907
```

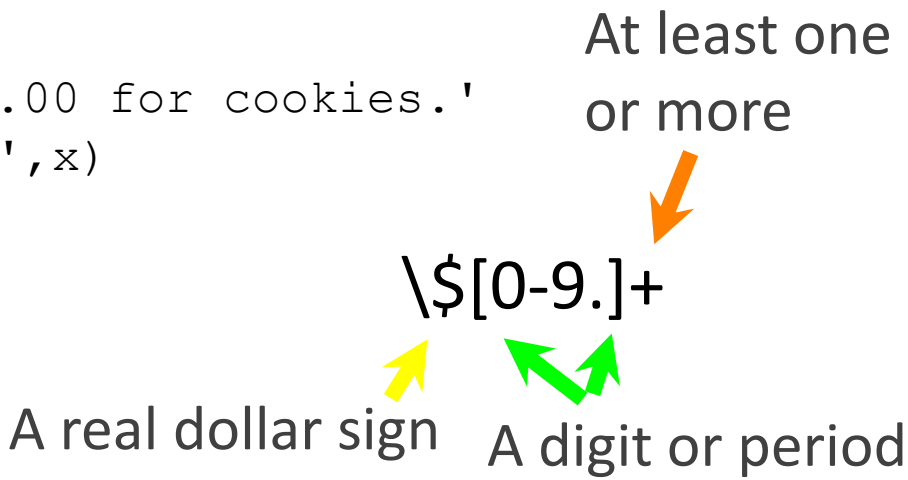
Regular Expression Quick Guide

`^`	Matches the beginning of a line
`$`	Matches the end of the line
`.`	Matches any character
`\s`	Matches whitespace
`\S`	Matches any non-whitespace character
`*`	Repeats a character zero or more times
`*?`	Repeats a character zero or more times (non-greedy)
`+`	Repeats a character one or more times
`+?`	Repeats a character one or more times (non-greedy)
`[aeiou]`	Matches a single character in the listed set
`[^XYZ]`	Matches a single character not in the listed set
`[a-z0-9]`	The set of characters can include a range
`(`	Indicates where string extraction is to start
`)`	Indicates where string extraction is to end

Escape Character

- If you want a special regular expression character to just behave normally (most of the time) you prefix it with '\'

```
>>> import re
>>> x = 'We just received $10.00 for cookies.'
>>> y = re.findall('\$[0-9.]+',x)
>>> print y
['$10.00']
```



Summary

- Regular expressions are a cryptic but powerful language for matching strings and extracting elements from those strings
- Regular expressions have special characters that indicate intent