Regular Expressions

Chapter 11

Python for Informatics: Exploring Information
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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.

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Regular expression – Wikipedia, the free encyclopedia

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Regular expression

From Wikipedia, the free encyclopedia

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, a program that either serves as a parser generator or examines text and identifies parts that match the provided specification.

The following examples illustrate a few specifications that could be expressed in a regular expression:

- The sequence of characters "car" appearing consecutively in any context, such as in "car", "cartoon", or "bicarbonate"
- The sequence of characters "car" occurring in that order with other characters between them, such as in "Icelander" or "chandler"

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

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

The Regular Expression Module

- Before you can use regular expressions in your program, you must import the library using "import re"
- You can use re.search() to see if a string matches a regular expression, similar to using the find() method for strings
- You can use re.findall() 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
```

Using re.search() like startswith()

```
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
```

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

Wild-Card Characters

- The dot character matches any character
- 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
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X-Sieve: CMU Sieve 2.3
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X-DSPAM-Confidence: 0.8475
X-Content-Type-Message-Body: text/plain
```

Match the start of the line

Many times

```
^X.*:
```

Match any character

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
```

Match the start of the line

Many times

```
^X.*:
```

Match any character

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
```

Match the start of the line

One or more times

```
^X-\S+:
```

Match any non-whitespace character

Matching and Extracting Data

- The 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:' ?

One or more characters

^F.+:

First character in the match is an F

Last character in the match is a :

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:']
```

One or more characters but not greedy

^F.+?:

First character in the match is an F

Last character in the match is a :

Fine-Tuning String Extraction

- You can refine the match for re.findall() and separately determine which portion of the match is to be extracted by using parentheses

```
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']
```

\S+@\S+

At least one non-whitespace character

Fine-Tuning String Extraction

- Parentheses 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+)
```

21 31

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

```
>>> 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
uct.ac.za
```

Extracting a host name - using find and string slicing

The Double Split Pattern

- 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 at sign

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']
```

```
'@([^ ]*)'
```

Match non-blank character

Match many of them

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']
```

'@([^]*)'

Extract the non-blank characters

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 at sign

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)
```

```
X-DSPAM-Confidence: 0.8475
```

python ds.py
Maximum: 0.9907

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']
```

At least one or more

\$[0-9.]+

A real dollar sign

A digit or period

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