Regular Expressions

Chapter 11
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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.

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

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

http://en.wikipedia.org/wiki/Regular_expression
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"
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
Whenever I learn a new skill I concoct elaborate fantasy scenarios where it lets me save the day.

Oh no! The killer must have followed her on vacation!

But to find them we'd have to search through 200 MB of emails looking for something formatted like an address!

It's hopeless!

Everybody stand back.

I know regular expressions.
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()`

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

```python
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()`

```python
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

```python
hand = open('mbox-short.txt')
for line in hand:
    line = line.rstrip()
    if line.startswith('From:') :
        print line
```
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
- If you add the *asterisk* character, the character is "any number of times"

**X-Sieve:** CMU Sieve 2.3
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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

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\textbf{X-Sieve: CMU Sieve 2.3}
\textbf{X-DSPAM-Result: Innocent}
\textbf{X-Plane is behind schedule: two weeks}

\texttt{^X-\S+:}

- Match the start of the line
- Match any non-whitespace character
- One or more times
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()`

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

`[0-9]` matches any digit

One or more digits
Matching and Extracting Data

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

```python
>>> 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

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

Why not 'From:'?

- **First character in the match is an F**
- **Last character in the match is a :**
- One or more characters
Non-Greedy Matching

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

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

- First character in the match is an F
- Last character in the match is a :
- One or more characters but not greedily
Fine Tuning String Extraction

• You can 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

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

\S+@\S+  
At least one non-whitespace character
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

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

```python
>>> y = re.findall(r'^From \((\S+@\S+)\)', x)
>>> print y
['stephen.marquard@uct.ac.za']
```
Extracting a host name - using find and string slicing.
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
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

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

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

stephen.marquard@uct.ac.za
['stephen.marquard', 'uct.ac.za']
'uct.ac.za'
```
The Regex Version

```
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
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 .*@([\^ ]*)'
Even Cooler Regex Version

Import re

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

Y = re.findall('^From .*@([^ ]*)', line)

Print y['uct.ac.za']

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

Skip a bunch of characters, looking for an at-sign
Even Cooler Regex Version

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

```
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
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 .*@([\^ \]*)'
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)
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[aeiou] Matches a single character in the listed **set**

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(  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 '\'

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

A real dollar sign
A digit or period
At least one or more
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