

Regular Expressions

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

Example

Give you a string → "From: test@ntut.edu.tw to Kevin"

How to identify the e-mail ?

Regular Expression Quick Guide

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


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', 'r')
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 = "X-Sieve: CMU Sieve 2.3"
print(re.findall("^X.*:", x))
```

```
→ ['X-Sieve:']
```

Match the start of the
line

Many
times

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

Match any character

X . * :



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

- `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('[AEIOUM]+', x)
>>> print(y)
['M']
```


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 :']
```

One or more
characters

[^]F . + :

First character in
the match is an F

Last character in the
match is a :

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:']
```

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+`

↑ ↑

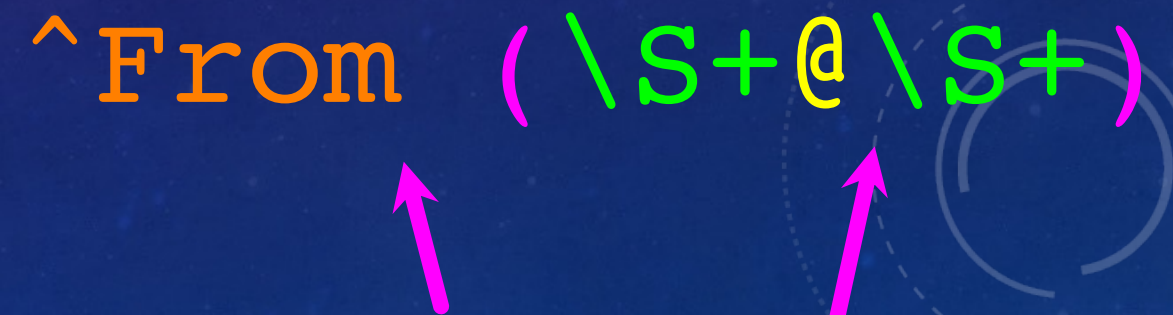
At least one
non-whitespace
character

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']
```

The diagram shows the regex pattern `^From (\S+@\S+)` in orange and green text. Two pink arrows point to the opening parenthesis `(` and the closing parenthesis `)`, indicating that these characters are not part of the extracted string match.

Summary: Use re.findall to perform extraction

```
x = "From: test@ntut.edu.tw to Kevin"  
ret = re.findall("^F.+?: (\S+@\S+)", x)  
print(ret)
```

```
['test@ntut.edu.tw']
```

```
x = "From: Bill to Kevin"  
ret = re.findall("^F.+?: (\S+@\S+)", x)  
print(ret)
```

Another way: Use re.search to perform extraction

```
import re

x = "From: test@ntut.edu.tw to QQQQ"
ret = re.search("^F.+:", x)
if ret:
    print(x[ret.end():])

x = x[ret.end():]
ret = re.search("\S+@\S+", x)
print(ret.group())
```

```
ryanpan@RyanPanPC $ python3 test.py
test@ntut.edu.tw to QQQQ
test@ntut.edu.tw
```


STRING PARSING EXAMPLES...

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

X-DSPAM-Confidence: 0.8475

```
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))
```


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

I will give you a LOG.txt like this

=== LOG.txt ===

Hella buys Computer for \$734
Alice buys Computer for \$548
[VIP] Peter buys Computer for \$666
[VIP] Peter buys Book for \$973
Alice buys Paper for \$545
Alice buys Notebook for \$501
Bob buys Paper for \$182
[VIP] Sue buys Notebook for \$396
[VIP] Sue buys Notebook for \$4
Bob buys Book for \$850
Bob buys Book for \$691

Please analyze to a file like this

=== Analysis_result.txt ===

[VIP]
Peter buys Computer: 666, Book: 973
Sue buys NoteBook: 400

[Member]
Hella buys Computer: 734
Alice buys Computer: 548, Paper 545, Notebook: 501
Bob buys Paper: 182, Book 1541

Total Computer sales: 1948
Total NoteBook sales: 901
Total Paper sales: 627
Total Book sales: 2514