Lecture 18

Regular expressions

Regular Expression E-mail Matching Example

```
/[\w._%+-]+@[\w.-]+\.[a-zA-Z]{2,4}/
```

Regular Expressions (RE, regex)

- Notation for describing simple string patterns
- Very useful for text processing:
  - Finding/extracting patterns in the text
  - Manipulating strings
  - Checking string correctness

Search in a log file for a data or/and time?

```
Catalogue listing of /Users/hoakley/Documents/0newDownloads/logstuff/0logarchive/dest/Full1.logarchive :
Persist/0000000000000268.tracev3  2017-09-03 14:43:19  2017-09-04 09:50:22  10477040 bytes, period 1147.0 min
Persist/0000000000000269.tracev3  2017-09-04 09:52:11  2017-09-04 20:42:44  10483320 bytes, period 650.5 min
Persist/000000000000026a.tracev3  2017-09-04 20:42:58  2017-09-05 13:31:30  10478896 bytes, period 1008.5 min
Persist/000000000000026b.tracev3  2017-09-05 13:31:30  2017-09-05 22:06:04  10480248 bytes, period 514.6 min
Persist/000000000000026c.tracev3  2017-09-05 22:06:04  2017-09-06 16:17:08  10473488 bytes, period 1091.1 min
Persist/000000000000026d.tracev3  2017-09-06 16:21:19  2017-09-07 08:58:59  10473696 bytes, period 997.7 min
Persist/000000000000026e.tracev3  2017-09-07 08:58:59  2017-09-07 17:59:08  10483432 bytes, period 540.1 min
Persist/000000000000026f.tracev3  2017-09-07 18:00:46  2017-09-08 09:49:59  10482224 bytes, period 949.2 min
Persist/0000000000000270.tracev3  2017-09-08 09:50:00  2017-09-08 22:03:47  10482224 bytes, period 733.8 min
Persist/0000000000000271.tracev3  2017-09-08 22:03:48  2017-09-09 17:48:56  10483488 bytes, period 1185.1 min
Persist/0000000000000272.tracev3  2017-09-09 17:49:13  2017-09-10 10:23:52  10472576 bytes, period 994.6 min
Persist/0000000000000273.tracev3  2017-09-10 10:24:16  2017-09-11 05:35:53  10482240 bytes, period 1151.6 min
Persist/0000000000000274.tracev3  2017-09-11 05:35:53  2017-09-11 20:39:47  10486576 bytes, period 903.9 min
Persist/0000000000000275.tracev3  2017-09-11 20:39:52  2017-09-12 15:20:50  10477104 bytes, period 1121.0 min
Persist/0000000000000276.tracev3  2017-09-12 15:20:50  2017-09-13 07:11:04  10475936 bytes, period 950.2 min
Persist/0000000000000277.tracev3  2017-09-13 07:11:29  2017-09-13 19:32:24  10483424 bytes, period 740.9 min
Persist/0000000000000278.tracev3  2017-09-13 19:32:27  2017-09-14 14:36:05  10482800 bytes, period 1143.6 min
Persist/0000000000000279.tracev3  2017-09-14 14:36:06  2017-09-15 05:22:03  10481936 bytes, period 886.0 min
Persist/000000000000027a.tracev3  2017-09-15 05:22:03  2017-09-15 17:59:43  10476536 bytes, period 757.7 min
Persist/000000000000027b.tracev3  2017-09-15 17:59:48  2017-09-16 06:23:12  10485344 bytes, period 743.4 min
Persist/000000000000027c.tracev3  2017-09-16 06:23:14  2017-09-16 22:16:08  10481768 bytes, period 952.9 min
Persist/000000000000027d.tracev3  2017-09-16 22:16:09  2017-09-17 07:38:38  1542408 bytes, period 562.5 min
```

Fast Verification of

- Address
- Email address
- Time
- Passwords
- Names
- Credit Card numbers
- ….

Regular expressions can be used anywhere!!

- Python
- SQL
- Java (and many many other programming languages)
- Text Editors (Atom, Notepad ++, etc)
- IDEs (Eclipse, IntelliJ, etc)
- Tableau
- ...

Example. What would you do?

```
# Find all numbers in the given text

line = "2 plus 2 is 4 and not 567".
```

Example. Solution Without RE

```
# Find all numbers in the given text

line = "2 plus 2 is 4 and not 567".
```

```
>>> line = "2 plus 2 is 4 and not 567"
>>> [int(s) for s in line.split() if s.isdigit()]
[2, 2, 4, 567]
```

Example

```
import re

line = "2 plus 2 is 4 and not 567"

matched = re.findall('[0-9]+', line)

print(matched)
```

Example. What is the problem?

```
import re

line = "2 plus 2 is 4 and not 567"

matched = re.findall('[0-9]+', line)

print(matched)
```

```
['2', '2', '4', '567']
```

Example. Fix

```
import re

line = "2 plus 2 is 4 and not 567"

matched = re.findall('[0-9]+', line)

int_list = [int(s) for s in matched]

print(int_list)
```

```
[2, 2, 4, 567]
```

Example. Issue? Sometimes..

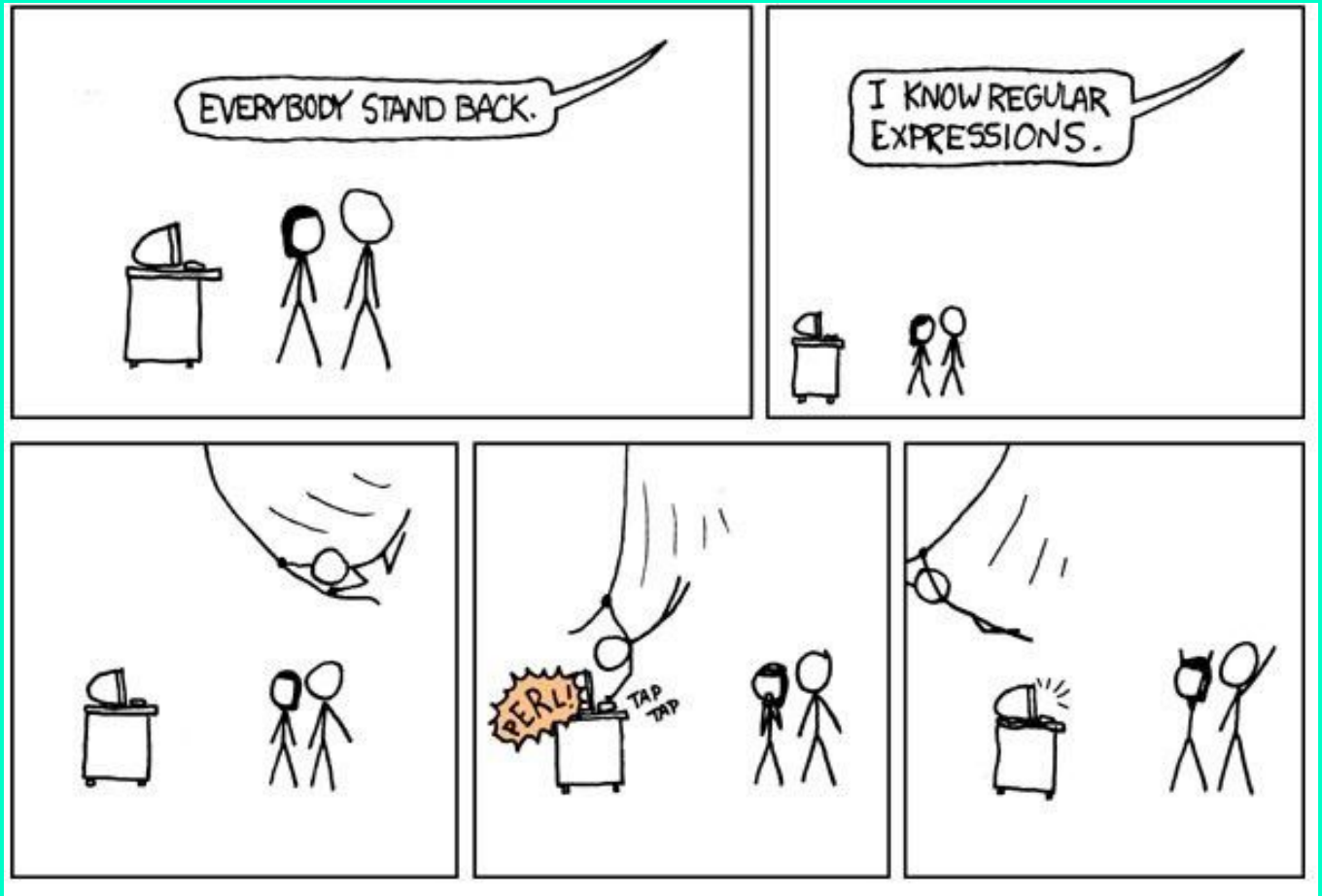
```
import re

line = "Aqua34, 2 plus 2 is 4 and not 567"

matched = re.findall('[0-9]+', line)

int_list = [int(s) for s in matched]

print(int_list)
```

```
[34, 2, 2, 4, 567]
```

Example. Issue? Fix.

```
import re

line = "Aqua34, 2 plus 2 is 4 and not 567"

matched = re.findall(r'\b[0-9]+\b', line)

int_list = [int(s) for s in matched]

print(int_list)
```

```
[2, 2, 4, 567]
```


EVERYBODY STAND BACK.
I KNOW REGULAR EXPRESSIONS.
PERL!
TAP TAP

Regular Expression (RE, regex)

- Special text string for describing a search pattern
  - Mini language
- When apply a RE to a text, usually we get a class of strings (matches)
- Work over some alphabet
  - Letters (small case, upper case, both, numbers, all characters etc)
- String:
  - Can be empty (ε - epsilon)
  - Any sequence of characters over alphabet of length 1 or more

Building Blocks, Identifiers

- \d : any digit
- \D : anything but a number
- \s : space [\t\n\r\f\v]
  - \f page break; \v vertical tab character
- \S : anything but a space
- \t : tab
- \n : new line
- \w : word character: a-z, A-Z, 0-9, including the _
- \W : anything but a character
- . (period) **wildcard**. matches *any* symbol (except new line)
- \b : word boundary
- \. : A period

Building Blocks. Modifiers

- { } : {2, 5}. \d{2,5} Looking for 2-5 digits in a row
- + : match 1 or more.
- ? : match 0 or 1.
- * : match 0 or more.
- $: match the end of the string
- ^ : match the beginning of the string
- | : either/or \d{2, 5} | \d{5, 8}
- [ ] : Used to construct character classes (range)
  - [A - Z], [A-Za-z]
- {n} : Expected “n” amount
- ^ : Negating character class

Examples. demo

```
re.findall(pattern, string)
```

- Extract names
- Extract ages
- Put them in the dictionary

Re.search (Demo)

- Search in the text for the *first* occurence. Return None if nothing is found. Returns the found object otherwise.

Match words with particular pattern

input_string = “Marina, Katya, Irina, Maria, Olga, Bogdan”.

What these words have in common, except the one?

Match words with particular pattern

```
input_string = “Marina, Katya, Irina, Maria, Olga, Bogdan”.
```

What these words have in common, except the one?

All of them but the last one, ends with an ‘a’.

How to find them? (demo)

^ symbol (caret)

[5]: find only 5

[^5]: find anything but a 5

[^a-t]: all letters but not in a range a-t

A few key operations for []

- [ACE]
  - any of the symbols A, C, or E
- [A-E]
  - any of the symbols A, B, C, D, or E
- [A-E_]
  - any of A-E, or the underscore _
- [^A-E_]
  - any character not in the previous class (^ negates a class)
- [-A-Z]
  - any of A-Z, or the hyphen
- Using parentheses to change precedence:
  - ABC? matches AB or ABC
  - A(BC)? matches A or ABC

Practice 1

- How many numbers do I have in my text?
  - Using regex, not your eyes :)

```
input = "One, 2, three, 3, 4, 5. Time 4you 2go home. Joke,
in 50 minutes."
```

Practice 1. Solution

```
input = "One, 2, three, 3, 4, 5. Time 4you 2go home. Joke,
in 50 minutes."
```

```
all_matches = re.findall(r'\b\d+\b', input)
print(all_matches)

print(len(all_matches))
```

Practice 1. Solution

```
input = "One, 2, three, 3, 4, 5. Time 4you 2go home. Joke,
in 50 minutes."
```

```
all_matches = re.findall(r'\b\d+\b', input)   # \b[0-9]+\b ok too
print(all_matches)

print(len(all_matches))
```

Practice 2, then demo

```
input = "1, 12, 123, 12345, 123456, 1234567, 12345678"

all_matches = re.findall(r'\d{3}', input)

print(len(all_matches))
```

A: 1

B: 5

C: 7

D: 8

E: Have no idea

Practice 2.2 Greedy matching

```
input = "1, 12, 123, 12345, 123456, 1234567, 12345678"

all_matches = re.findall(r'\d{3,5}', input)

print(len(all_matches))
```

A: 1

B: 5

C: 7

D: 8

E: None of the above

Practice 3

Use regular expression to match a 10-digit phone number with dashes and parentheses:

```
(847)812-4567   : valid

(312)345-7512   : valid

(345)5435674    : invalid

234-534-6434    : invalid
```

Practice 3.solution

```
(847)812-4567    : valid

(312)345-7512    : valid

(345)5435674     : invalid

234-534-6434     : invalid
```

```
input = "(847)812-4567, (312)345-7512, (345)5435674, 234-534-6434"

all_matches = re.findall(r'\(\d{3}\)\d{3}\-\d{4}', input)
```

Practice 4. What to Change?

Now using '?' make a dash optional in your phone number RE.

(847)812-4567 : valid

(312)345-7512 : valid

(345)5435674 : ~~invalid~~ valid

234-534-6434 : invalid

```
all_matches = re.findall(r'\(\d{3}\)\d{3}\-\d{4}', input)
```

Practice 4. Solution

Now using ‘?’ make a dash optional in your phone number RE.

(847)812-4567 : valid

(312)345-7512 : valid

(345)5435674 : ~~invalid~~ valid

234-534-6434 : invalid

```
all_matches = re.findall(r'\(\d{3}\)\d{3}\-?\d{4}', input)
```

Wildcards

. (dot): A dot . is a replacement for **any** character (if used outside [ ])

.* : which allows 0 or more repetitions of any character. This is often used to match *any* text

Practice 5.

| : (Pipe, Alternation, OR)

It alternates two or more valid patterns where at least one of those patterns must match in that position.

Practice 5.

| : (Pipe, Alternation, OR)

It alternates two or more valid patterns where at least one of those patterns must match in that position.

Write RE to capture 5-digit U.S. ZIP codes that end in "22" or "30" .

Then write code that checks if a given zip is correct (search)

Practice 5. solution.

Write RE to capture 5-digit U.S. ZIP codes that end in "22" or "30,"

```
input_zip = "12311, 2222, 53430, 92122, 92130, 34530, 30322, 435322, 43225"

zip_splitted = input_zip.split(',')

for  z in zip_splitted:
     if re.search(r'\b[0-9]{3}(22|30)\b', z):
          print(z + " is correct")
     else:
          print(z + " is not correct")
```

Practice 6. Valid name

Check that a given name (Last and First) has a proper format:

Langlois, Marina: OK

Langlois Marina: OK

Langlois Marina: NOT OK

LangloisMarina: NOT OK

Practice 6. Valid name

Check that a given name (Last and First) has a proper format:

Langlois, Marina: OK

Langlois Marina: OK

Langlois Marina: NOT OK

LangloisMarina: NOT OK

```
name = "Langlois, Marina"

if re.search(r'\w+,? \w+', name):

    print(name + " is correct")

else:

    print(name + " is not correct")
```

Regular Expression E-mail Matching Example

```
/[\w._%+-]+@[\w.-]+\.[a-zA-Z]{2,4}/
```

Regular Expression E-mail Matching Example

Regular expression boundary

Match anything contained within brackets

Match as many times as possible

Match the @ symbol

Match upper and lower case A through Z

/[\w._%+-]+@[\w.-]+\.[a-zA-Z]{2,4}/

Match a single period

Match ., _, %, +, and - if found

Match at least two times but no more than four times

Match any character A-Z upper or lower case and any number 0 to 9

ComputerHope.com

Search and Group

- re.search(). This method either returns None if the pattern doesn't match, or a re.MatchObject with additional information about which part of the string the match was found.
- Note that this method stops after the first match, so this is best suited for testing a regular expression more than extracting data.

https://regexone.com/references/python

Search and Group

```
import re
regex = r"([a-zA-Z]+) (\d+)"
match = re.search(regex, "June 24")
if match:
    # If we want, we can use the
    # MatchObject's start() and end()
    # methods to retrieve where the
    # pattern matches in the input string
```

Search and Group

```
import re
regex = r"([a-zA-Z]+) (\d+)"
match = re.search(regex, "June 24")
if match:
    # If we want, we can use the
    # MatchObject's start() and end()
    # methods to retrieve where the
    # pattern matches in the input string

    print("Match at index %s, %s" % (match.start(), match.end()))
```

Search and Group

```
import re
regex = r"([a-zA-Z]+) (\d+)"
match = re.search(regex, "June 24")
if match:
    # If we want, we can use the
    # MatchObject's start() and end()
    # methods to retrieve where the
    # pattern matches in the input string

    print("Match at index %s, %s" % (match.start(), match.end()))
    Match at index 0, 7      ← output

    # This will print [0, 7), since it matches at the beginning and end of
    # the string
```

Search and Group

```
import re
regex = r"([a-zA-Z]+) (\d+)"
match = re.search(regex, "June 24")
if match:
    # Or we can use a group() method to get all the matches and captured groups.
```

Search and Group

```
import re
regex = r"([a-zA-Z]+) (\d+)"
match = re.search(regex, "June 24")
if match:
    # Or we can use a group() method to get all the matches and captured groups.
    # The groups contain the matched values.  In particular:
    #    match.group(0) always returns the fully matched string
    #    match.group(1), match.group(2), ... will return the capture
    #            groups in order from left to right in the input string
    #    match.group() is equivalent to match.group(0)
```

Search and Group

```
import re
regex = r"([a-zA-Z]+) (\d+)"
match = re.search(regex, "June 24")
if match:
    # Or we can use a group() method to get all the matches and captured groups.
    # The groups contain the matched values.  In particular:
    #    match.group(0) always returns the fully matched string

    print(match.group(0))
    June 24    <- output
```

Search and Group

```
import re
regex = r"([a-zA-Z]+) (\d+)"
match = re.search(regex, "June 24")
if match:
    # Or we can use a group() method to get all the matches and captured groups.
    # The groups contain the matched values.  In particular:
    #    match.group(0) always returns the fully matched string

    print(match.group(0))
    June 24   <- output
    #    match.group(1), match.group(2), ... will return the capture
    #            groups in order from left to right in the input string
```

Search and Group

```
import re
regex = r"([a-zA-Z]+) (\d+)"
match = re.search(regex, "June 24")
if match:
    # Or we can use a group() method to get all the matches and captured groups.
    # The groups contain the matched values.  In particular:
    #    match.group(0) always returns the fully matched string

    print(match.group(0))
    June 24   <- output
    #    match.group(1), match.group(2), ... will return the capture
    #            groups in order from left to right in the input string

    print("Month: %s" % (match.group(1)))     Month: June <- output
    print("Day: %s" % (match.group(2)))       Day: 24
```

Search and Group

```
import re
regex = r"([a-zA-Z]+) (\d+)"
match = re.search(regex, "June 24")
if match:
    # Or we can use a group() method to get all the matches and captured groups.
    # The groups contain the matched values.  In particular:
    #    match.group(0) always returns the fully matched string

    print(match.group(0))
    June 24   <- output
    #    match.group(1), match.group(2), ... will return the capture
    #            groups in order from left to right in the input string

    print("Month: %s" % (match.group(1)))     Month: June <- output
    print("Day: %s" % (match.group(2)))       Day: 24
else:
    print("The regex pattern does not match. :(")
```

Search vs match

`search` ⇒ find something anywhere in the string and return a match object.

`match` ⇒ find something at the *beginning* of the string and return a match object.

```
a = "123abc"

t = re.search("[a-z]+", a)

if t:
    print(t.group())
else:
    print("no match")
```

```
abc
```

Search vs match

`search` ⇒ find something anywhere in the string and return a match object.

`match` ⇒ find something at the *beginning* of the string and return a match object.

```
a = "123abc"

t = re.search("[a-z]+", a)

if t:
    print(t.group())
else:
    print("no match")
```

```
abc
```

```
a = "123abc"

t = re.match("[a-z]+", a)

if t:
    print(t.group())
else:
    print("no match")
```

```
no match
```

PRACTICE

- Write a Python program to separate and print the numbers of a given string.

Practice (Demo)

- Write a Python program to separate and print the numbers of a given string.

```
import re
# Sample string.
text = "Ten 10, Twenty 20, Thirty 30"
result = re.split("\D+", text)
# Print results.
for element in result:
    print(element)
```

Word boundary

- Matches the empty string, but only at the beginning or end of a word
- There are a few rules for "\b".

- We know that \w matches any alphanumeric character; this is equivalent to the class [a-zA-Z0-9_].
- Also \W is the opposite of \w

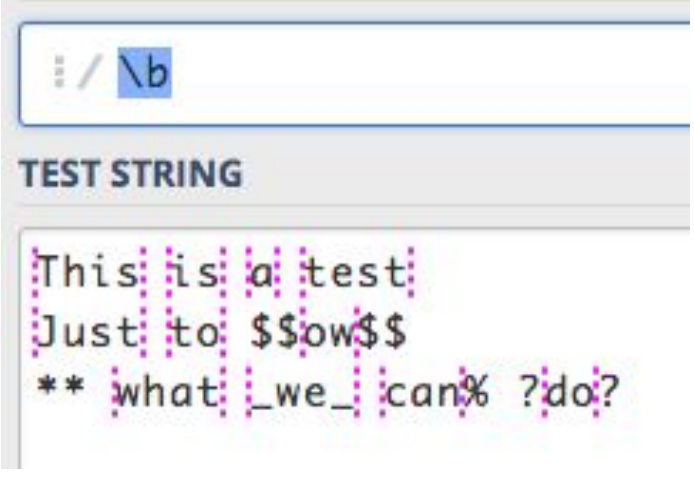
Rules:

- \b is defined as the **boundary** between a \w and a \W character (or vice versa) between \w and the beginning/end of the string

Word boundary

Rules:

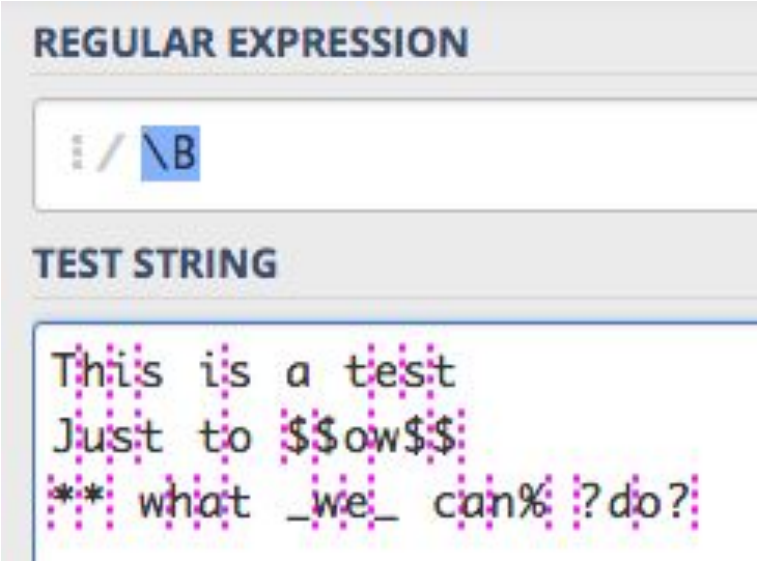
- \b is defined as the **boundary** between a \w and a \W character (or vice versa) between \w and the beginning/end of the string
- Example:




```
input text = "This is a test
              Just to $$ow$$
               ** what _we_ can% ?do?"
```

Word boundary "\B": Opposite to \b (little b)

- Matches the empty string, but only when it is not at the beginning or end of a word



How to fix?

input_string = “Marina, Katya, Irina, Maria, Olga, Bogdan”.

Output: ['Marina', 'Katya', 'Irina', 'Maria', 'Olga']

```
all_matches2 = re.findall(r'[A-Z][a-z]*a\b', input_line)
print(all_matches2)
```