REGULAR EXPRESSIONS

David Kauchak
NLP – Fall 2020

Regular expressions

Regular expressions are a very powerful tool to do string matching and processing

Allows you to do things like:

- Tell me if a string starts with a lowercase letter, then is followed by 2 numbers and ends with "ing" or "ion"
- Replace all occurrences of one or more spaces with a single space
- Split up a string based on whitespace or periods or commas or …
- Give me all parts of the string where a digit is proceeded by a letter and then the '#' sign

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.
PERL!
TAP TAP

http://xkcd.com/208/

Regular expressions: literals

We can put any string in a regular expression

- /test/
  - matches any string that has "test" in it
- /this class/
  - matches any string that has "this class" in it
- /Test/
  - case sensitive: matches any string that has "Test" in it

Regular expressions: character classes

A set of characters to match:

- put in brackets: []
- [abc] matches a single character a or b or c

What would the following match?

/[Tt]est/ any string with "Test" or "test" in it

Regular expressions: character classes

A set of characters to match:

- put in brackets: []
- [abc] matches a single character a or b or c

Can use - to represent ranges

- [a-z] is equivalent to
- [A-D] is equivalent to
- [0-9] is equivalent to

Regular expressions: character classes

A set of characters to match:

- put in brackets: []
- [abc] matches a single character a or b or c

Can use - to represent ranges

- [a-z] is equivalent to [abcdefghijklmnopqrstuvwxyz]
- [A-D] is equivalent to [ABCD]
- [0-9] is equivalent to [0123456789]

Regular expressions: character classes

For example:

/[0-9][0-9][0-9][0-9]/

matches any four digits, e.g. a year

Can also specify a set NOT to match:

^ means all characters EXCEPT those specified

- [^a] all characters except 'a'
- [^0-9] all characters except numbers
- [^A-Z] ???

Regular expressions: character classes

For example:

/[0-9][0-9][0-9][0-9]/

matches any four digits, e.g. a year

Can also specify a set NOT to match:

^ means all characters EXCEPT those specified

- [^a] all characters except ‘a’
- [^0-9] all characters except numbers
- [^A-Z] not an upper case letter (be careful, this will match **any** character that’s not uppercase, not just letters

Regular expressions: character classes

Meta-characters (not always available)

- \w - word character (a-zA-Z_0-9)
- \W - non word-character (i.e. everything else)
- \d - digit (0-9)
- \s - whitespace character (space, tab, endline, …)
- \S - non-whitespace
- \b matches a word boundary (whitespace, beginning or end of line)
- . matches any character

What would the following match?

/19\d\d/

- would match any 4 digits starting with 19

/\s\s/

- matches anything with two adjacent whitespace characters (spaces, tabs, etc)

/\s[aeiou]..\s/

- any three letter word that starts with a vowel

Regular expressions: repetition

* matches zero or more of the preceding character

/ba*d/

matches any string with:

- bd
- bad
- baad
- baaad

/A.*A/

matches any string starts and ends with A

+ matches **one** or more of the preceding character

/ba+d/

matches any string with

- bad
- baad
- baaad
- baaaad

Regular expressions: repetition

? zero or 1 occurrence of the preceding

/fights?/

matches any string with "fight" or "fights" in it

{n,m} matches n to m inclusive

/ba{3,4}d/

matches any string with

- baaad
- baaaad

Regular expressions: beginning and end

^ marks the beginning of the line
$ marks the end of the line

/test/ test can occur anywhere

/^test/ must start with test

/test$/ must end with test

/^test$/ ???

Regular expressions: beginning and end

^ marks the beginning of the line
$ marks the end of the line

/test/ test can occur anywhere

/^test/ must start with test

/test$/ must end with test

/^test$/ must be exactly test

Regular expressions: repetition revisited

What if we wanted to match:

This is very interesting

This is very very interesting

This is very very very interesting

Would /This is very+ interesting/ work?

- No… + only corresponds to the 'y'
- /This is (very)+interesting/

Repetition operators only apply to a single character.
Use parentheses to group a string of characters.

Regular expressions: disjunction

| has the lowest precedence and can be used

/cats|dogs/

matches:

- cats
- dogs

does NOT match:

- catsogs

Regular expressions: disjunction

We want to match:

I like cats

I like dogs

Does /^I like cats|dogs$/ work?

No! Matches:

- I like cats
- dogs

Solution?

Regular expressions: disjunction

We want to match:

I like cats

I like dogs

/^I like (cats|dogs)$/

matches:

- I like cats
- I like dogs

Some examples

All strings that start with a capital letter

IP addresses

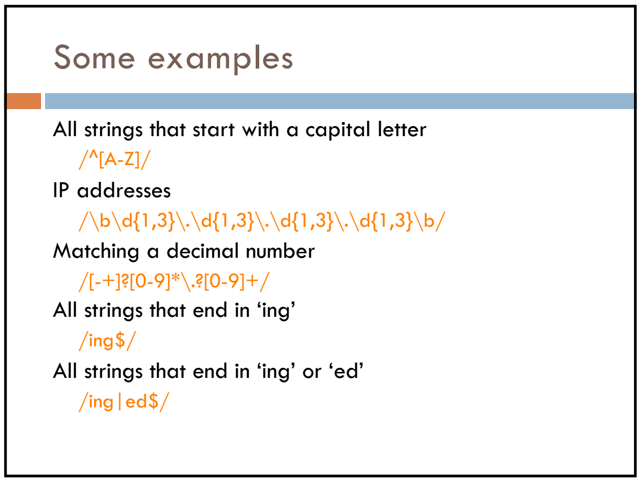
- 255.255.122.122

Matching a decimal number

All strings that end in ‘ing’

All strings that end in ‘ing’ or ‘ed’

All strings that begin and end with the same character



Some examples

All strings that start with a capital letter

/^[A-Z]/

IP addresses

/\b\d{1,3}\.\d{1,3}\.\d{1,3}\.\d{1,3}\b/

Matching a decimal number

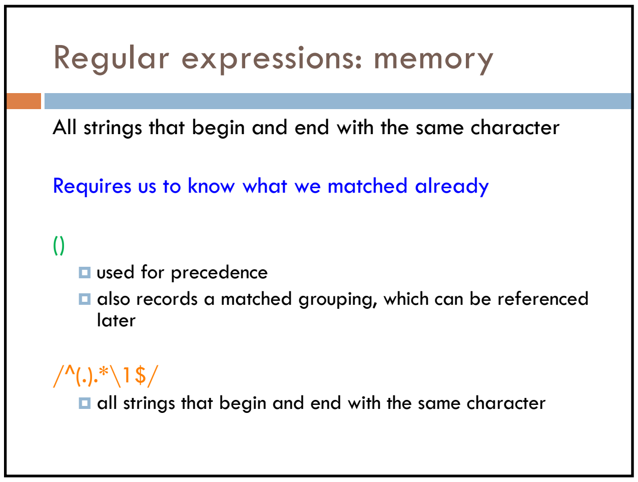
/[-+]?[0-9]*\.?[0-9]+/

All strings that end in 'ing'

/ing$/

All strings that end in 'ing' or 'ed'

/ing|ed$/



Regular expressions: memory

All strings that begin and end with the same character

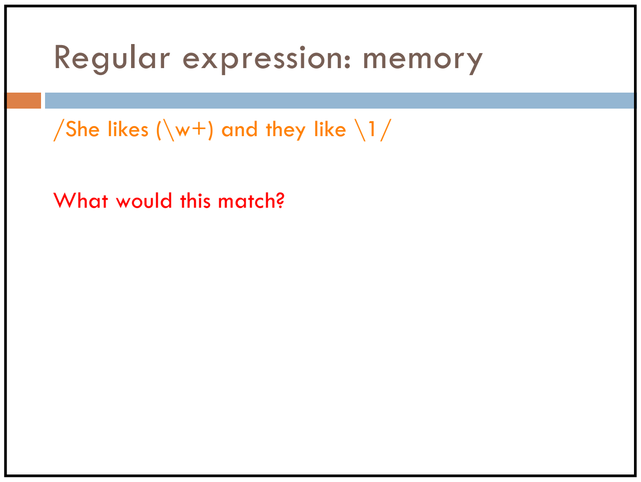
Requires us to know what we matched already

()

- used for precedence
- also records a matched grouping, which can be referenced later

/^(.).*\1$/

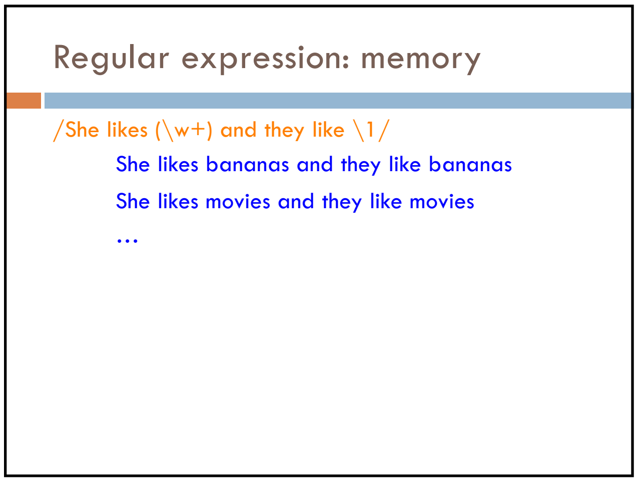
- all strings that begin and end with the same character



Regular expression: memory

/She likes (\w+) and they like \1/

What would this match?



Regular expression: memory

/She likes (\w+) and they like \1/

She likes bananas and they like bananas

She likes movies and they like movies

…

Regular expression: memory

/She likes (\w+) and they like \1/

We can use multiple matches

/She likes (\w+) and (\w+) and they also like \1 and \2/

Regular expressions: substitution

Most languages also allow for substitution

s/banana/apple/

substitute first occurrence banana for apple

s/banana/apple/g

substitute all occurrences (globally)

s/^(.*)$/\1 \1/

???

s/\s+/ /g

???

Regular expressions: substitution

Most languages also allow for substitution

s/banana/apple/

substitute first occurrence banana for apple

s/banana/apple/g

substitute all occurrences (globally)

s/^(.*)$/\1 \1/

duplicate the string, separated by a space

s/\s+/ /g

substitute multiple spaces to a space

Regular expressions by language

Java: as part of the String class

```
String s = "this is a test"
s.matches("test")
s.matches(".*test.*")
s.matches("this\\sis .* test")
s.split("\\s+")
s.replaceAll("\\s+", " ");
```

Be careful, matches must match the whole string (i.e. an implicit ^ and $)

Regular expressions by language

Java: java.util.regex

Full regular expression capabilities

Matcher class: create a matcher and then can use it

```
String s = "this is a test"
Pattern pattern = Pattern.compile("is\\s+")
Matcher matcher = pattern.matcher(s)
```

- matcher.matches()
- matcher.find()
- matcher.replaceAll("blah")
- matcher.group()

Regular expressions by language

Python:

```
import re

s = "this is a test"
p = re.compile("test")
p.match(s)

p = re.compile(".*test.*")
re.split('\s+', s)
re.sub('\s+', ' ', s)
```

Regular expressions by language

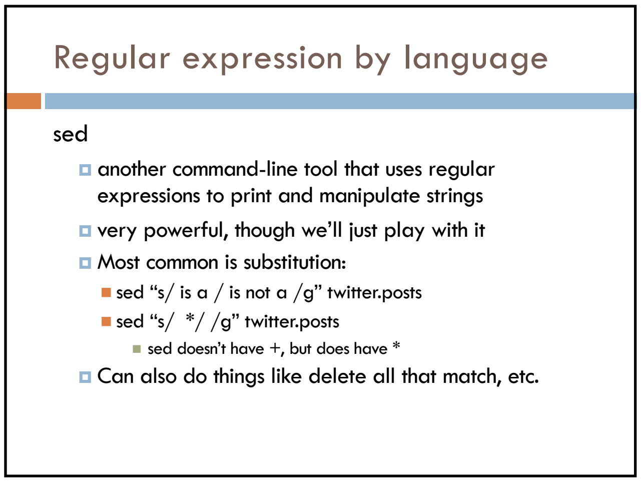
perl:

```
$s = "this is a test"
$s =~ /test/
$s =~ /^test$/
$s =~ /this\sis .* test/
split /\s+/, $s
$s =~ s/\s+/ /g
```

Regular expression by language

grep

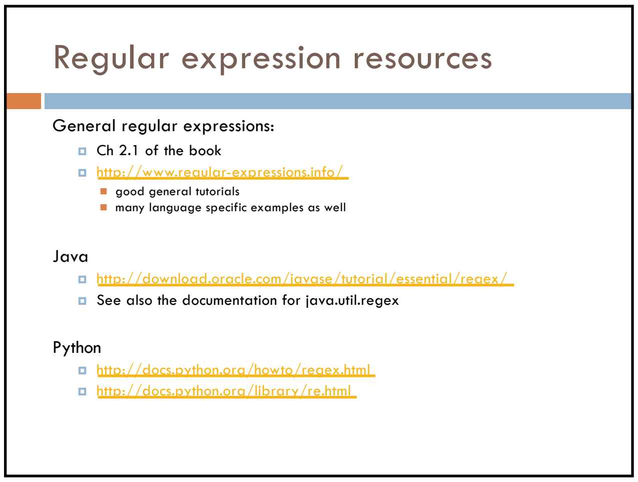
- command-line tool for regular expressions (general regular expression print/parser)
- returns all lines that match a regular expression
- grep "@" twitter.posts
- grep "http:" twiter.posts
- can't used metacharacters (\d, \w), use [] instead
- Often want to use "grep –E" (for extended syntax)



Regular expression by language

sed

- another command-line tool that uses regular expressions to print and manipulate strings
- very powerful, though we'll just play with it
- Most common is substitution:
  - sed "s/ is a / is not a /g" twitter.posts
  - sed "s/ */ /g" twitter.posts
    - sed doesn't have +, but does have *
- Can also do things like delete all that match, etc.



Regular expression resources

General regular expressions:

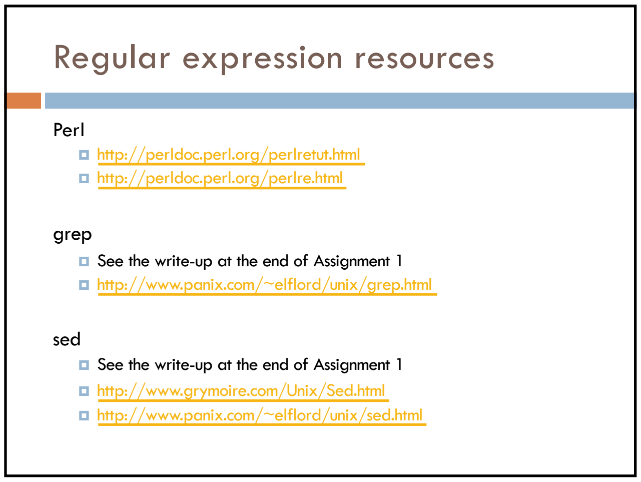
- Ch 2.1 of the book
- http://www.regular-expressions.info/
  - good general tutorials
  - many language specific examples as well

Java

- http://download.oracle.com/javase/tutorial/essential/regex/
- See also the documentation for java.util.regex

Python

- http://docs.python.org/howto/regex.html
- http://docs.python.org/library/re.html



Regular expression resources

Perl

- http://perldoc.perl.org/perlretut.html
- http://perldoc.perl.org/perlre.html

grep

- See the write-up at the end of Assignment 1
- http://www.panix.com/~elflord/unix/grep.html

sed

- See the write-up at the end of Assignment 1
- http://www.grymoire.com/Unix/Sed.html
- http://www.panix.com/~elflord/unix/sed.html