REGULAR EXPRESSIONS

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NLP – Fall 2024

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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

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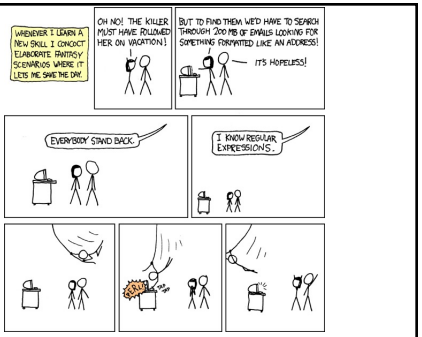

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Regular expressions: literals

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

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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

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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

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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]

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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] ???

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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

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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

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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

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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

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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

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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$/ ???

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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

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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.

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Regular expressions: disjunction

| has the lowest precedence and can be used

/cats|dogs/

matches:
- cats
- dogs

does NOT match:
- catsogs

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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?

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Regular expressions: disjunction

We want to match:

I like cats

I like dogs

/^I like (cats|dogs)$/

matches:
- I like cats
- I like dogs

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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

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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$/

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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

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Regular expression: memory

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

What would this match?

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Regular expression: memory

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

She likes bananas and they like bananas

She likes movies and they like movies

…

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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/

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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

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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 $)

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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()

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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)
```

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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 use metacharacters (\d, \w), use [] instead
- Often want to use "grep –E" (for extended syntax)

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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.

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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

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Regular expression resources

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

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