Python (part 3)
String manipulation and Regular expression

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The need to process string data in data science

- In data science, we often encounter strings and need to do string processing operations, especially in preprocessing step
- Example: normalize strings, find and extract substrings containing important info
- With simple string operations: use methods of string in Python
- With complex string operations: …

Example

- Convert text into a standard format

	County	State	Voted
0	De Witt County	IL	97.8
1	Lac qui Parle County	MN	98.8
2	Lewis and Clark County	MT	95.2
3	St John the Baptist Parish	LA	52.6

	County	State	Population
0	DeWitt	IL	16,798
1	Lac Qui Parle	MN	8,067
2	Lewis & Clark	MT	55,716
3	St. John the Baptist	LA	43,044

Example

- Extract a piece of text to create a feature

169.237.46.168 - -

[26/Jan/2004:10:47:58 -0800]"GET /stat141/Winter04 HTTP/1.1" 301 328

"http://anson.ucdavis.edu/courses"

"Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; .NET CLR 1.1.4322)"

Example

- Transform text into features

unclean **or** degraded floors walls **or** ceilings

inadequate **and** inaccessible handwashing facilities

inadequately cleaned **or** sanitized food contact surfaces

wiping cloths **not** clean **or** properly stored **or** inadequate sanitizer

foods **not** protected **from contamination**

unclean nonfood contact surfaces

unclean **or** unsanitary food contact surfaces

unclean hands **or** improper use of gloves

inadequate washing facilities **or** equipment

These new features can be used **in** an analysis of food safety scores.

Example

- Text analysis
  - Do different political parties focus on different topics or use different language in their speeches?

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State of the Union Address

George Washington

January 8, 1790

Fellow-Citizens of the Senate and House of Representatives:

I embrace with great satisfaction the opportunity which now presents itself of congratulating you on the present favorable prospects of our public …

Basic String Manipulation

Basic String Manipulation

- Transform upper case characters to lower case (or vice versa).
- Replace a substring with another or delete a substring.
- Split a string into pieces at a particular character.
- Slice a string at specified locations.

Basic String Manipulation

	County	State	Voted
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- Capitalization: qui vs Qui
- Omission of words: County and Parish are absent from right table
- Different abbreviation conventions: & vs and
- Different punctuation conventions: St. vs St
- Use of whitespace: DeWitt vs De Witt

Basic String Manipulation

```
def clean_county(county):
    return (
        county.lower()
        .replace("county", "")
        .replace("parish", "")
        .replace("&", "and")
        .replace(".", "")
        .replace(" ", "")
    )
```

Basic String Manipulation

- Complete list methods

Method	Description
str.lower()	Returns a copy of a string with all letters converted to lowercase
str.replace(a, b)	Replaces all instances of the substring a in str with the substring b
str.strip()	Removes leading and trailing whitespace from str
str.split(a)	Returns substrings of str split at a substring a
str[x:y]	Slices str, returning indices x (inclusive) to y (not inclusive)

Splitting Strings to Extract Pieces of Text

- How to get Date from this string information

169.237.46.168 - - [26/Jan/2004:10:47:58 -0800]"GET /stat141/Winter04 HTTP/1.1"
301 328 "http://anson.ucdavis.edu/courses""Mozilla/4.0 (compatible; MSIE 6.0;
Windows NT 5.0; .NET CLR 1.1.4322)"

Splitting Strings to Extract Pieces of Text

- How to get Date from this string information

```
log_entry.split('[')

log_entry.split('[')[1].split(':')[0]

(log_entry.split('[')[1]
 .split(':')[0]
 .split('/'))
```

Regular expression

Regular expression

- Example about a quite complex string operation
- Find and extract phone number (according to US phone number format: **3 numbers, then -, then 3 numbers, then -, then 4 numbers**) from a string (e.g., “My phone is 123-456-7890”)
- Use string methods in Python: how many lines of code?
- Use Regex: one line of code :-)

Regular expression - Regex

- Allow to do **complex** string operations via **string patterns**
- A string pattern is written according to **Regex syntax**
- E.g., pattern of US phone number (3 numbers, then -, then 3 numbers, then -, then 4 numbers): **\d{3}-\d{3}-\d{4}**
- Regex is supported in most programming languages, most editors, and some Linux commands (e.g. find, grep)

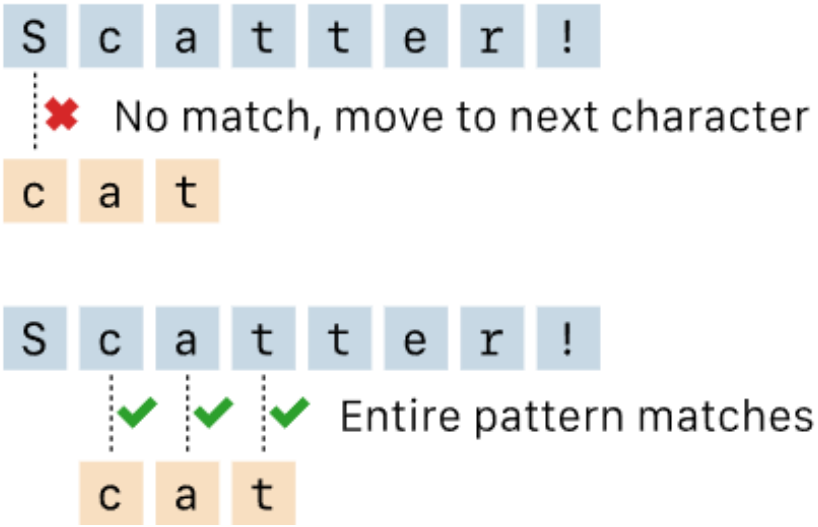
The plan

- First, learn about Regex syntax for writing patterns
- Then, learn about string functions in Python which use patterns written in Regex syntax

Regex — syntax

Literal

- A character is called a literal if this character means itself
- Demo …
- Find the pattern "*cat*" in the string "*scatter!*"



Character set

Syntax	Meaning (note: “the set of ...” means “a char in this set ...”)
[]	A set of chars; e.g. [1a.] is the set of chars 1, a, .
[start-end]	The set of all chars from start to end; e.g. [0-5] is the set of all chars from 0 to 5, [a-z] is the set of all chars from a to z
[^]	A negated set; e.g. [^12] is the set of all chars except 1, 2
.	The set of all chars except newline
\w & \W	The set of word chars (a-z, A-Z, 0-9, _) & the negated set
\d & \D	The set of digit chars & the negated set
\s & \S	The set of whitespace chars (space, tab, newline) & the negated set

Quantifier

Syntax	Meaning
{m}	The char right before repeats m times
{m,n}	The char right before repeats m-n times
{m,}	The char right before repeats ≥ m times
{,n}	The char right before repeats ≤ n times
*****	Is the shorthand of {0,}
+	Is the shorthand of {1,}
?	Is the shorthand of {0,1}

Quantifier

- The **greedy** property of quantifier: quantifier will get the longest result
- Demo

Quantifier

- Quantifier only has effect on one char right before it
- To make quantifier having effect on more than one char right before it, we can use () to group chars
- Demo …

Anchor

Syntax	Meaning
^	The location of the pattern after is the start of string
$	The location of the pattern before is the end of string
\b	The location of the pattern after is the start of a word
\B	The location of the pattern after is not the start of a word

- Demo

Or

Syntax: |

Meaning: or pattern before |, or pattern after |

- Normally, pattern before | is all before | in Regex expression, and pattern after | is all after |
- We can use group if we just want a part before | and a part after |:

(the part before | the part after)

Demo …

Regex — in Python

Use Regex in Python

```
import re # Built-in lib
```

- Here we just talk about some common used functions of this lib
- When needed, you can search document

Regex function

- re.search(…)
- re.finditer(…)
- re.findall(…)
- re.sub(…)
- re.split(…)
- Use flag

Reference

- https://docs.python.org/3/library/re.html
- The “Principles and Techniques of Data Science” book, chapter 13 - Working with Text. URL: https://www.textbook.ds100.org/ch/13/text_strings.html