ECE 20875

Python for Data Science

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(Adapted from material developed by Profs. Milind Kulkarni, Stanley Chan, Chris Brinton, David Inouye)

regular expressions

basic text processing

- Python lets you do a lot of simple text processing with strings:

```
s = “hello world”
s.count(“l”)          #returns 3
s.endswith(“rld”)     #returns True
“ell” in s            #returns True
s.find(“ell”)         #returns 1
s.replace(“o”, “0”) #returns “hell0 w0rld”
s.split(“ “)          #returns [“hello”, ‘world”]
“XX“.join([“hello”, “world”]) #returns “helloXXworld”
```

See https://docs.python.org/3/library/stdtypes.html#string-methods for more

- But what if we want to do fancier processing? More complicated substitutions or searches?

regular expressions

- Powerful tool to find/replace/count/capture patterns in strings: **regular expressions (regex)**

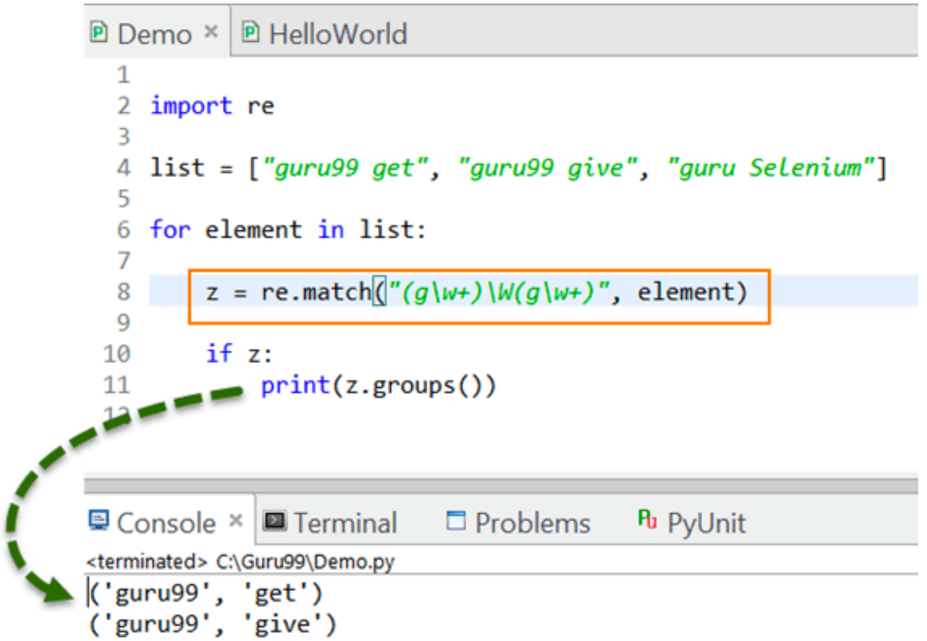
- Can do very sophisticated text manipulation and text extraction

```
import re
s = "hello cool world see”
#find all double letters that are one character from the end of a word
p = re.compile(r'((.)\2)(?=.\b)')
#replace those double letters with their capital version
s1 = p.sub(lambda match : match.group(1).upper(), s)
print(s1) #prints ‘heLLo cOOl world see’
```

- Useful for data problems that require extracting data from a corpus

regular expressions (regex)

- A means for defining **regular languages**
  - A **language** is a set (possibly infinite) of strings
  - A **string** is a sequence of characters drawn from an **alphabet**
  - A **regular language** is one class of languages: those defined by regular expressions (ECE 369 and 468 go into more details, including what other kinds of languages there are)
- Use: Find whether a string (or a substring) *matches* a regex (more formally, whether a substring is in the language)



regular expressions

- A single string is a regular expression: “ece 20875”, “data science”
  - Note: the *empty string* is also a valid regular expression
- All other regular expressions can be built up from three operations:
  1. Concatenating two regular expressions: “ece 20875 data science”
  2. A choice between two regular expressions: “(ece 20875) | (data science)”
  3. Repeating a regular expression 0 or more times “(ece)*”

building regular expressions

- A regular expression in Python is *compiled*:

```
import re
p = re.compile(“ece (264|20875|368)”)
```

- This creates special code for matching a regular expression (ECE 369/468 discusses the machinery behind this)

- Can then look for the regular expression in other strings:

```
p.match(“ece 264”)          #returns a match object
p.match(“hello ece 20875”) #returns None
p.search(“hello ece 368”)  #returns a match object
```

- `match` checks only at the beginning of the string, while `search` looks throughout, and both only return the first occurrence

inspecting a match object

- We want to see what the match is, so we can set it to a variable:
  `x = p.search("hello ece 368")`

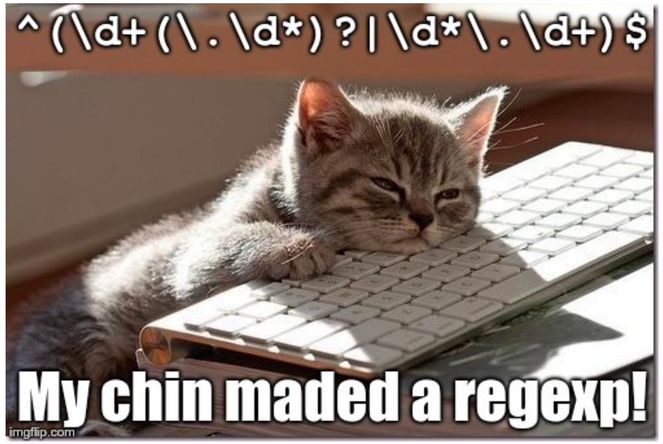
- If we print x, we will see the match **object** (more on objects later)
```
print(x)    # Returns <re.Match object; span=(6, 13)
                  #              match='ece 368'>
```

- To see the actual match string, we use `group()`:
```
x.group()  # Returns "ece 368"
```

- To see the index of the match, we use `span()`:
```
x.span()  # Returns (6,13)
```

extra syntax for regex

- `.` #wildcard, matches any character (except newline)
- `^abc` #matches ‘abc’ only at the start of the string
- `abc$` #matches ‘abc’ only at the end of the string
- `a?` #matches 0 or one ‘a’
- `a*` #matches *zero* or more ‘a’s
- `a+` #matches *one* or more ‘a’s
- `[abc]` #character class, matches ‘a’ or ‘b’ or ‘c’
- `[^abc]` #matches any character *except* ‘a’ or ‘b’ or ‘c’
- `[a-z]` #character class, matches any letter between ‘a’ and ‘z’



extra syntax for regex

- \s #matches whitespace
- \S #matches non-whitespace
- \d #matches digit
- \D #matches non-digit
- \w #matches any word character, which is alphanumeric and the underscore (equivalent to [a-zA-Z0-9_])
- \W #matches any non-word character

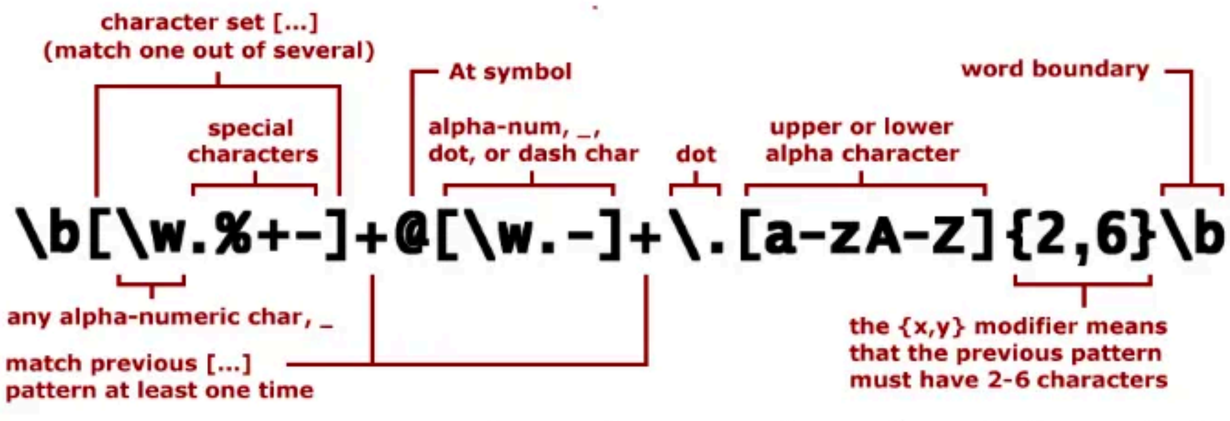
```
s = “hello 12 hi 89. Howdy 34”
p = re.compile(“\d+”)

result = p.findall(s)
print(result)

#Output: ['12', '89', '34']
```

lookahead characters

- `\b` : matches the empty string at the beginning or end of a word
- `\B` : matches the empty string *not* at the beginning or end of a word

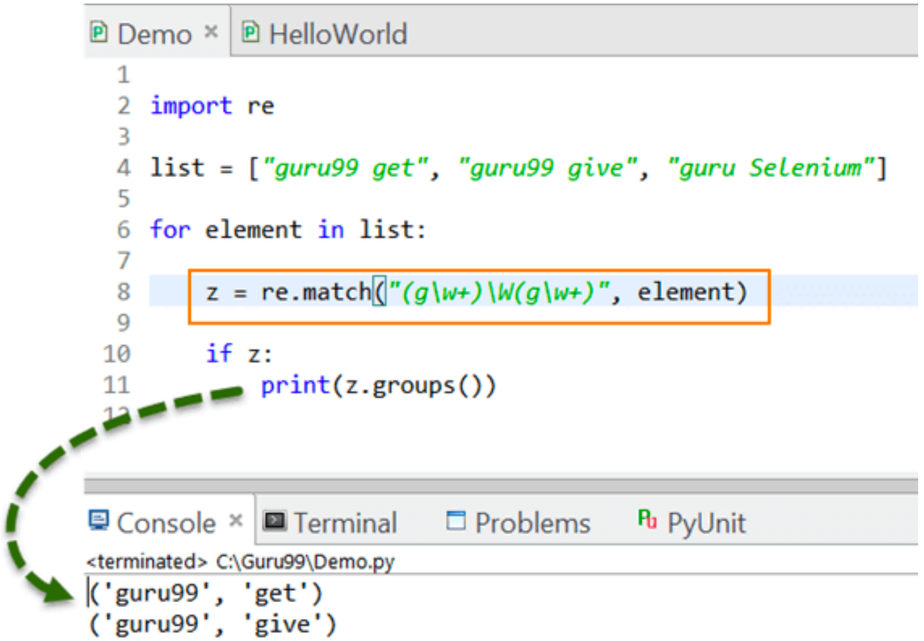


- `(?=abc)` : matches if “abc” is what comes next
- `(?!abc)` : matches if “abc” is *not* what comes next
- These are **zero-width assertions**: They don’t cause the engine to advance through the string, and they are not part of the resulting match

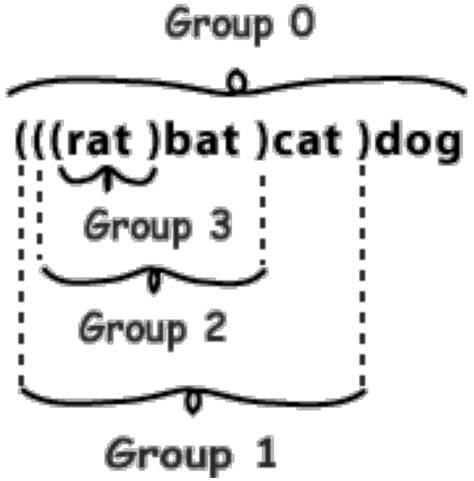
Other regex examples: https://www.pythonsheets.com/notes/python-rexp.html

groups

- Can use parentheses to capture **groups**
  - Groups together characters (like in math): (abc)* means repeat abc, but abc* means repeat c
- Groups are **captured** by regular expressions
  - `match.group(k)` returns the contents of the kth group in the matched text
  - Group 0 is always the whole matched regex
  - `match.groups()` returns all subgroups in a list



groups



- Groups can be nested — count based on number of left parentheses
- Groups can be named: `re.compile("(?P<foo>abc)")`
- Can refer to groups within a regular expression (or a substitution):
  - `\k` refers to the content of the kth group
  - `(?P=foo)` refers to the content of the group named `foo`

```
x = "dog = (?P<pet>\w+), cat
= (?P=pet)"

y = "random_text  dog =
sammy, cat = sammy"

z = re.compile(x).search(y)

print(z.group("pet"))

#prints sammy
```

substitution

- There is also a replacement command `sub()`
  - `p.sub(a,b)` rewrites `b` with any match to `p` replaced by `a`
- For example, we can generate the following regex, with groups:
  - `p = re.compile(r'hello (\w*)') #match "hello …"`
  - Note that prefixing a string with `r' makes it a raw string **literal** that tells Python not to process it (useful when trying to match characters like "\n")
- We can write the following replacements, using the groups if we want:
  - `p.sub(r'goodbye \1', 'well hello ece') #returns 'well goodbye ece'`
  - `p.sub(r'\1 goodbye \1', 'well hello X') #return 'well X goodbye X'`