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LECTURE 6

Regex

Using string methods and regular expressions (regex) to work with textual data

Data 100, Summer 2025 @ UC Berkeley

Josh Grossman and Michael Xiao

📣 Announcements

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Homework 2A due tomorrow!

Lab 2B due Thursday, July 3rd!

Homework 2B due Monday, July 7th

Reminder to make sure your **DSP accommodations are submitted ASAP**

- **By Sunday, July 6th** at the latest
- Very important if you have exam accommodations

This Week

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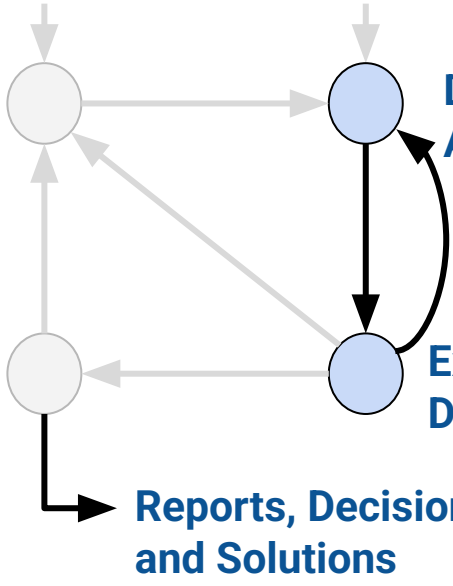

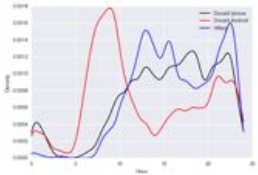

(Last Lecture)

Data Wrangling
Intro to EDA

(Today)

Working with Text Data
Regular Expressions

(Next)

Visualization
Code for plotting data

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Goals for this Lecture

Lecture 6, Data 100 Summer 2025

Common EDA task: clean text!

- Operate on text data using pandas **`str`** methods
- Apply **regex** to identify patterns in strings

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Why Work With Text?

Lecture 6, Data 100 Summer 2025

- **Standard Text Manipulation Tasks**
- `pandas str` methods
- Why regex?
- Regex basics
- Regex functions

Why Work With Text? Two Common Goals

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1. **Canonicalization**: Convert data into a standard form.

Ex Join tables with mismatched labels

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

	County	Population
0	DeWitt	16798
1	Lac Qui Parle	8067
2	Lewis & Clark	55716
3	St. John the Baptist	43044

	County	State	Population
0	dewitt	IL	16798
1	lacquiparle	MN	8067
2	lewisandclark	MT	55716
3	stjohnthebaptist	LS	43044

Regex Pipeline for Canonicalizing High School Names

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Two datasets needed to be merged based on HS name and location.

Problem: HS names not canonicalized.

For example: "The Bear Preparatory High School" and "Bear Prep"

Solution: Canonicalize with regex! →

```r
simplify_school_name <- function(school_name) {
  # Heuristics for making high school and college names simpler for matching

  school_name %>%
    str_to_lower %>%
    str_replace_all("\\bschool\\b", "") %>%
    str_replace_all("\\bhigh\\b", "") %>%

    # Often high schools can have same simple name as elementary
    # and middle schools, so keep the distinction for now so
    # the simple names are different
    # str_replace_all("\\belem(entary)?\\b", "") %>%

    # H S is an abbv. for high school
    str_replace_all("\\bh\\s?s\\b", "") %>%

    str_replace_all("\\bsenior|charter|college|international|intl\\b", "") %>%
    str_replace_all("\\bacad(emy)?\\b", "") %>%
    str_replace_all("\\btech(nical)?\\b", "") %>%
    str_replace_all("\\bprep(aratory)?\\b", "") %>%
    str_replace_all("\\b(the|of|and|for|at|\\@)\\b", "") %>%

    # st: (mary's) --> st marys
    str_replace_all("[\\'\\:\\)\\(]", "") %>%

    # st. john & mary-joseph --> st john mary joseph
    str_replace_all("[\\.\\-\\/\\&]", " ") %>%

    # removes duplicate whitespace and starting/ending whitespace
    str_squish
}
```

Research Paper: Tomkins et al. (2023)

Why Work With Text? Two Common Goals

1. **Canonicalization**: Convert data into a standard form.

Ex Join tables with mismatched labels

	County	State
0	De Witt County	IL
1	Lac qui Parle County	MN
2	Lewis and Clark County	MT
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	County	Population
0	DeWitt	16798
1	Lac Qui Parle	8067
2	Lewis & Clark	55716
3	St. John the Baptist	43044

join?

	County	Population	State
0	dewitt	16798	IL
1	lacquiparle	8067	MN
2	lewisandclark	55716	MT
3	stjohnthebaptist	43044	LS

2. **Extract** information.

Ex Extract dates and times from log files

```
169.237.46.168 - -
[26/Jan/2014:10:47:58 -0800] "GET
/stat141/Winter04/ HTTP/1.1" 200 2585
"http://anson.ucdavis.edu/courses/"
```

```
day, month, year = "26", "Jan", "2014"
hour, minute, seconds = "10", "47", "58"
```

Project with a Federal District Court

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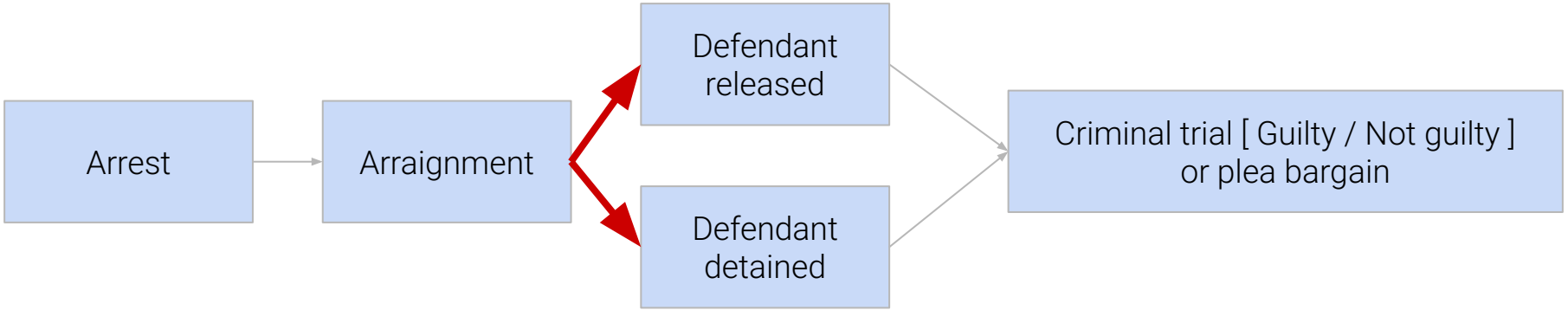
Motivating question: Can we make **pretrial detention** decisions more equitably?



Defendant Info in PDF Bail Reports

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District/Office	Charge(s) (Title, Section, and Description)
[redacted]	21 U.S.C. §841(a)(1),(b)(1)(C)
Judicial Officer The Honorable [redacted] U.S. Magistrate Judge	
Docket Number (Year – Sequence No. – Def. No.) 4:18-cr-00001-XX-1	

DEFENDANT

Name	DOB:	Employer/School	
[redacted]	7/11/1977	UNEMPLOYED	
Address [redacted]		Employer/School Address N/A	
Time At Address 7 Months/7 Years	Time in Community Life	Monthly Income $0	Time with Employer/School N/A

PREBAIL REPORT
(Prepared on December 12, 2018)

Defendant Info in PDF Bail Reports

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03/22/2008 [redacted]	1. No Arrest 2. **Possess Methaqualone**	03/15/2010**: Convicted of Count 2 (Felony);** Sentence: 5 Years Probation 03/12/2010: "Conviction Certified by [redacted] 03/26/2013: Sentence Modified: 5 Years Probation, 28 Days Jail
08/23/2008 [redacted]	**DUI Alcohol/Drugs**	04/22/2009: Subsequent Count of Drive: License Suspended/Etc: Specific Violation – Dismissed/Furtherance of Justice/Plea to Other Charge **Convicted (Misdemeanor);** Sentence: 3 Years Probation, 15 Days Jail

XXX County records provided by XXX reflect that the defendant has **14 Failures to Appear and two prior probation revocations in XXX County.**

Identify and Extract Data Using Patterns in Text

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```
03/22/2008
XXX County, XXX
1. No Arrest
2. Possess Methaqualone
03/15/2010: Convicted of Count 2
(Felony); Sentence: 5 Years
Probation
03/12/2010: "Conviction
Certified
by XXX, Court Clerk, XXX County"
03/26/2013: Sentence Modified: 5
Years Probation, 28 Days Jail
08/23/2008
...
```

```
XXX, XXX
DUI Alcohol/Drugs 04/22/2009:
Subsequent Count of
Drive: License Suspended/Etc:
Specific Violation -
Dismissed/Furtherance of
Justice/Plea to Other Charge
Convicted (Misdemeanor);
Sentence: 3 Years Probation, 15
Days Jail
...
XXX County records provided by
XXX reflect that the defendant
has 14 Failures to Appear
and two prior probation
revocations in XXX County.
...
```


For a more detailed description, see footnote 12 in onlinelibrary.wiley.com/doi/abs/10.1111/jels.12343

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`pandas str` Methods

Lecture 6, Data 100 Summer 2025

- Why work with text?
- **`pandas str` methods**
- Why regex?
- Regex basics
- Regex functions

From String to `str`

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In "base" Python, we have various string operations to work with text data.

Recall:

transformation	`s.lower()` `s.upper()`
split	`s.split(…)`
membership	`'ab' in s`

replacement/ deletion	`s.replace(…)`
substring	`s[1:4]`
length	`len(s)`

Problem: Python assumes we are working with **one string at a time**. Looping can be slow!

`str` Methods

Pandas `str` methods are **vectorized**. No looping; simultaneous computation!

`Series.str.<string_operation>()`

`.str` is a `pandas` accessor, just like `.dt` from the EDA lecture. Accessors provide a wide variety of domain-specific functions.

Apply the function *<string_operation>* to every string in the `Series` → Vectorized!

```
populations["County"]
```

```
0                  DeWitt
1           Lac Qui Parle
2           Lewis & Clark
3    St. John the Baptist
Name: County, dtype: object
```

```
populations["County"].str.lower()
```

```
0                  dewitt
1           lac qui parle
2           lewis & clark
3    st. john the baptist
Name: County, dtype: object
```

`.str` Methods

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Most base Python string operations have a **`pandas str`** equivalent

Operation	Python (single string)	pandas (Series of strings)
transformation	`s.lower()` `s.upper()`	`ser.str.lower()` `ser.str.upper()`
replacement/ deletion	`s.replace(…)`	`ser.str.replace(…)`
split	`s.split(…)`	`ser.str.split(…)`
substring	`s[1:4]`	`ser.str[1:4]`
membership	`'ab' in s`	`ser.str.contains(…)`
length	`len(s)`	`ser.str.len()`

Demo 1: Canonicalization

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

	County	Population
0	DeWitt	16798
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	County	State	Population
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2	lewisandclark	MT	55716
3	stjohnthebaptist	LS	43044

```
def canonicalize_county(county_series):
 return (county_series
                .str.lower()                  # lowercase
                .str.replace(' ', '')         # remove space
                .str.replace('&', 'and')      # replace &
                .str.replace('.', '')         # remove dot
                .str.replace('county', '')
                .str.replace('parish', '')
           )
```

Demo

lec06.ipynb

Demo

lec06.ipynb

Demo 2: Extracting Date Info (The Long Way)

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```
169.237.46.168 - -
[26/Jan/2014:10:47:58 -0800] "GET
/stat141/Winter04/ HTTP/1.1" 200 2585
"http://anson.ucdavis.edu/courses/"
```



```
day, month, year = "26", "Jan", "2014"
hour, minute, seconds = "10", "47", "58"
```

One possible solution:

```
pertinent = line.split("[")[1].split(']')[0]
day, month, rest         = pertinent.split('/')
year, hour, minute, rest2 = rest.split(':')
seconds, time_zone       = rest2.split(' ')
```

Note: While you should understand the code in this part of the demo, regex is a sleeker way to solve the problem above.

Why regex?

Lecture 6, Data 100 Summer 2025

- Why work with text?
- `pandas str` methods
- **Why regex?**
- Regex basics
- Regex functions

String Extraction: An Alternate Approach

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While we can sometimes "hack" together Code that uses **`replace/split`**…

```
pertinent = line.split("[")[1].split(']')[0]
day, month, rest = pertinent.split('/')
year, hour, minute, rest = rest.split(':')
seconds, time_zone = rest.split(' ')
```

It often won't work.

How would you extract **moon**-like patterns in this string?

```
"moon moo mooooooon mon moooon"
```

Circa 2013 meme, "Moon moon"

String Extraction: An Alternate Approach

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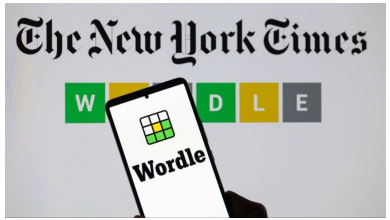
An alternate approach is to use a **regular expression**.

- Implementation provided in the Python **`re`** library and the pandas **`str`** accessor.
- We can simplify the code in the previous demo with regex:

```
import re
pattern = r'\[(\d+)\/(\w+)\/(\d+):(\d+):(\d+):(\d+) (.+)\]'
day, month, year, hour, minute, second, time_zone = re.findall(pattern, line)[0]
```

```
169.237.46.168 - -
[26/Jan/2014:10:47:58 -0800] "GET
/stat141/Winter04/ HTTP/1.1" 200 2585
"http://anson.ucdavis.edu/courses/"
```



Productive mindset to adopt: Think of regex problems like **word puzzles**!

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Regex Basics

Lecture 6, Data 100 Summer 2025

- Why work with text?
- `pandas str` methods
- Why regex?
- **Regex basics**
- Regex functions

Regular Expressions Specify Patterns in Strings

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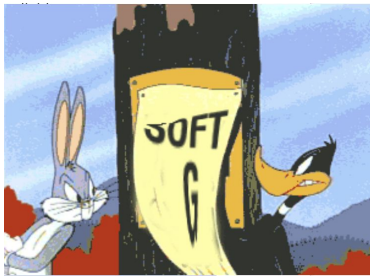
A regular expression ("regex") is a sequence of characters that specifies a search **pattern**.

Example: `[0-9]{3}-[0-9]{2}-[0-9]{4}`

3 of any digit, then a dash,
then 2 of any digit, then a dash,
then 4 of any digit.

The language of Social Security Numbers (e.g., 123-45-6789) is described by this regular expression.



"Regex" pronunciation? (as in Re**g**ular)
Check out English Stackexchange discussion

Goals for regex

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The goal of today is NOT to memorize the language of regular expressions!

Instead:

1. Understand what regex is capable of.
2. Parse and create regex, **with a reference table to help you**.

Resources for Practicing Regex

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Many resources to experiment with regexes (e.g., regex101.com, regexone.com, …)

For experimenting, we recommend regex101.com. We will use it during today's demos.

- **Important:** Choose the Python "flavor" in the left sidebar. We'll explain the **`r"`** soon!
- Note the reference table in the bottom right.

Regex Basics

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There are four basic operations in regex.

Concatenation – "look for consecutive characters"

`BAAB` matches `BAAB`

`|` – "or"

`BAB|BAAB` matches `BAB` *or* `BAAB`

`*` – "zero or more"

`AB*A` matches `AA`, `ABA`, `ABBA`, ...

`()` – "consider a group"

`(AB)*A` matches `A`, `ABA`, `ABABA`, ...
`A(A|B)AAB` matches `AAAAB` *or* `ABAAB`

*, `(` `)`, and `|` are called **metacharacters** – they represent an operation, rather than a literal text character

Summary So Far

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Operation	Order	Example	Matches	Doesn't match
concatenation (consecutive chars)	3	`AABAAB`	`AABAAB`	every other string
or, |	4	`AA|BAAB`	`AA` `BAAB`	every other string
***** (zero or more)	2	`AB*A`	`AA` `ABBBBBBA`	`AB` `ABABA`
group (parenthesis)	1	`A(A|B)AAB`	`AAAAB` `ABAAB`	every other string
		`(AB)*A`	`A` `ABABABABA`	`AA` `ABBA`

The regex order of operations. Grouping is evaluated first.

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Which pattern matches moon, moooon, etc? Your expression should match any EVEN number of “o”s, excluding zero (e.g., don’t match mn or mooon).

ⓘ Click **Present with Slido** or install our Chrome extension to activate this poll while presenting.

Try it yourself!

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regex101.com/r/8tkQ23/1

moo(oo)*n

Regex Expanded

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Six more regex operations.

newline

. – "look for *any* character other than \n"

`.U.U.U.` matches `CUMULUS, JUGULUM`

[] – "define a character class"

`[A-Za-z]` matches `A, a, B, b...`

+ – "one or more"

`AB+` matches `AB, ABB, ABBB, ...`

? – "zero or one" ("optional")

`AB?` matches `A, AB`

{x} – "repeat exactly x times"

`AB{2}` matches `ABB`

{x, y} – "repeat between x and y times"

`AB{0,2}` matches `A, AB, ABB`

Keep in mind: ***** = **{0,}**, **+** = **{1,}**, and **?** = **{0,1}** = **{,1}**

Character Classes

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[A-Z] – any uppercase letter between A and Z

[0-9] – any digit between 0 and 9

[A-Za-z0-9] – any letter, any digit

Regex built-in classes:

\w is equivalent to [A-Za-z0-9]

\d is equivalent to [0-9]

\s matches space, tab or newline

Use **^** to negate a class = match any character *other* than what follows

[^A-Z] – any character that is *not* an uppercase letter between A and Z

Capitalized shortcuts: **[^A-Za-z0-9] = [^\w] = `\W` [^\d] = `\D` [^\s]=`\S`**

Summary So Far

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Operation	Example	Matches	Doesn't match
any character (except newline)	`.U.U.U.`	`CUMULUS` `JUGULUM`	`SUCCUBUS` `TUMULTUOUS`
character class	`[A-Za-z][a-z]*`	`word` `Capitalized`	`camelCase` `4illegal`
repeated exactly a times: {a}	`j[aeiou]{3}hn`	`jaoehn` `jooohn`	`jhn` `jaeiouhn`
repeated from a to b times: {a,b}	`j[ou]{1,2}hn`	`john` `juohn`	`jhn` `jooohn`
at least one	`jo+hn`	`john` `jooooohn`	`jhn` `jjohn`

What pattern only matches lowercase alphabetic strings that have a repeated vowel (e.g., bazaar, beetroot, radii, oodles, vacuum)?

2-minute stretch!

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How Josh learned regex: regexcrossword.com

Email Address Regular Expression (probably a bad idea)

```
(?:(?:\r\n)?[ \t])*(?:(?:(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|"(?:[^\"\r\n\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|"(?:[^\"\r\n\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*)*\<(?:(?:\r\n)?[ \t])*(?:@(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*(?:,@(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*)*)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*)*:(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|"(?:[^\"\r\n\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*)?:(?:(?:\r\n)?[ \t])*)?(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|"(?:[^\"\r\n\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|"(?:[^\"\r\n\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*)*\<(?:(?:\r\n)?[ \t])*(?:@(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*(?:,@(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*)*:(?:(?:\r\n)?[ \t])*)?(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|"(?:[^\"\r\n\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|"(?:[^\"\r\n\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*)*\<(?:(?:\r\n)?[ \t])*(?:@(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*(?:,@(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*)*:(?:(?:\r\n)?[ \t])*)?(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|"(?:[^\"\r\n\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|"(?:[^\"\r\n\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*)*:(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|"(?:[^\"\r\n\]|\\.|(?:(?:\r\n)?[ \t]))*"(?:(?:\r\n)?[ \t])*)@(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*)(?:\.(?:(?:\r\n)?[ \t])*(?:[^()<>@,;:\\".\[\] \000-\031]+(?:(?:(?:\r\n)?[ \t])+|\Z|(?=[\["()<>@,;:\\".\[\]]))|\[([^\[\]\r\\]|\\.)*\](?:(?:\r\n)?[ \t])*)*)
```

source, StackOverflow discussion

Greediness

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Regex is **greedy** – it looks for the *longest possible* match in a string.

```
<div>.*</div>
```

regex101.com/r/HATiTH/1

"This is an ** example of greediness in ** regular expressions."

Greediness

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Regex is **greedy** – it looks for the *longest possible* match in a string.

```
<div>.*</div>
```

In English:

- "Look for the exact string "
- then, "grab every character except \n…"
- "… until the **FINAL** instance of the string "

"This is an ** **example of greediness in** ** regular expressions."

Greediness

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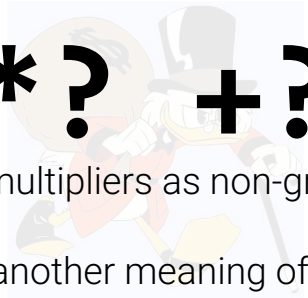
Regex is **greedy** – it looks for the *longest possible* match in a string.

```
<div>.*?</div>
```

In English:

- "Look for the exact string "
- then, "grab every character except \n…"
- "… until the **FIRST** instance of the string "



? tags multipliers as non-greedy. Docs.

This is another meaning of the **?** modifier!

"This is an ** **example of greediness ** **in regular expressions."

Regex *Even More* Expanded

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The last set!

**** – "read the next character literally"

`a\+b` matches `a+b`

^ – "match the beginning of a string"

`^abc` matches "`abc 123`", not "`123 abc`"

$ – "match the end of a string"

`abc$` matches "`123 abc`", not "`abc 123`"

Be careful: ^ has different behavior inside/outside of character classes!

[^abc] → Match any single character other than a, b, or c

Evan Misshula: Ex-presidents often end up rich. You **start** with **power ^** and **end** with **money $**

Summary So Far

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Operation	Example	Matches	Doesn't match
beginning of line	`^ark`	`ark two` `ark o ark`	`dark`
end of line	`ark$`	`dark` `ark o ark`	`ark two`
escape character	`cow\.com`	`cow.com`	`cowscom`

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Which of the following strings matches this regex expression?

^w+\.be?r(oco|ke)I+.*\.(edu|com)$

Which of the following strings matches this regex expression?
^w+\.be?r(oco|ke)l+.*\.(edu|com)$

- www.berkeley.edu
- https://www.berkeley.edu
- www.brocolli.com
- w.berocoley.edu
- www.berkeley.edu/brocolli

Operation	Order	Example	Matches	Doesn't match
concatenation (consecutive chars)	3	AABAAB	AABAAB	every other string
or, |	4	AA|BAAB	AA BAAB	every other string
* (zero or more)	2	AB*A	AA ABBBBBBA	AB ABABA
group (parenthesis)	1	A(A|B)AAB	AAAAB ABAAB	every other string
		(AB)*A	A ABABABABA	AA ABBA

Operation	Example	Matches	Doesn't match
any character (except newline)	.U.U.U.	CUMULUS JUGULUM	SUCCUBUS TUMULTUOUS
character class	[A-Za-z][a-z]*	word Capitalized	camelCase 4illegal
repeated exactly a times: {a}	j[aeiou]{3}hn	jaoehn jooohn	jhn jaeiouhn
repeated from a to b times: {a,b}	j[ou]{1,2}hn	john juohn	jhn jooohn
at least one	jo+hn	john jooooooohn	jhn jjohn

Operation	Example	Matches	Doesn't match
beginning of line	^ark	ark two ark o ark	dark
end of line	ark$	dark ark o ark	ark two
escape character	cow\.com	cow.com	cowscom

Additional Regex Functionality

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Regex101.com is great for learning basic regex *syntax*.

For full functionality of regex (matching, splitting, search and replace, group management, …), see **The Python Regex HOWTO**: docs.python.org/3/howto/regex.html.

Regex is also a sleek way to find+replace in your favorite text editor (even Google Slides!)

Regex Functions

Lecture 6, Data 100 Summer 2025

- Why work with text?
- `pandas str` methods
- Why regex?
- Regex basics
- **Regex functions**

Before We Begin: Raw Strings in Python

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When specifying a pattern, use **raw strings**.

```
pattern = r"[0-9]+"
```

Create by putting **r** before string delimiters:
(**r"..." r'...', r"""..."""**, **r'''...'''**)

Python **and** Regex each use backlash (\) as the **escape character.**

Standard string	Raw string	Matches
"ab*"	r"ab*"	a, ab, abb, …
"\\w+\\s+"	r"\w+\s+"	One or more of [A-Za-z0-9], then one or more spaces
"\\\\section"	r"\\section"	\section

For more information see "The Backslash Plague"

Why we need four backslashes \\\\ to match one backlash

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Suppose we want to match the **literal text '\n'** in a document (i.e, NOT a newline)

print('**\n**') prints a newline

print('**\\n**') prints '\n', which regex would then interpret as the literal character 'n'

print('**\\\n**') prints a literal \, followed by a newline

print('**\\\\n**') prints '\\n', which regex would interpret as the literal string '\n' → Done… 🥲

print(**r'\\n'**) prints '\\n', which regex would interpret as the literal string '\n' → Easier! 😎

Note: All of these examples are in the demo!

Extraction

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`re.findall(pattern, text)` docs

Return a **list** of all matches to `pattern`.

```
text = "My social security number is
123-45-6789 bro, or actually maybe it's
321-45-6789.";
pattern = r"[0-9]{3}-[0-9]{2}-[0-9]{4}"
re.findall(pattern, text)
```

```
['123-45-6789', '321-45-6789']
```

A **match** is a substring that matches the provided regex.

Extraction

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`re.findall(pattern, text)` docs

Return a **list** of all matches to `pattern`.

```
text = "My social security number is
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re.findall(pattern, text)
```

```
['123-45-6789', '321-45-6789']
```

A **match** is a substring that matches the provided regex.

`ser.str.findall(pattern)` docs

Returns a Series of lists

```
df["SSN"].str.findall(pattern)
```

	SSN
0	987-65-4321
1	forty
2	123-45-6789 bro or 321-45-6789
3	999-99-9999

```
0                  [987-65-4321]
1                             []
2   [123-45-6789, 321-45-6789]
3                  [999-99-9999]
Name: SSN, dtype: object
```

Extraction with Capture Groups

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Earlier we used parentheses to specify the **order of operations**.

( ) also specifies a **capture group**.

- Some **`re`** functions extract *only* the text matched by capture groups, if they are specified

```
text = """I will meet you at 08:30:00 pm tomorrow"""
pattern = ".*(\d\d):(\d\d):(\d\d).*"
matches = re.findall(pattern, text)
matches
```

```
[('08', '30', '00')]
```

The capture groups each capture two digits.

Extraction with Capture Groups

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`ser.str.extract(pattern)` docs

Returns a DataFrame of each capture group's **first** match in the string

```
pattern_cg = r"([0-9]{3})-([0-9]{2})-([0-9]{4})"
df["SSN"].str.extract(pattern_cg)
```

	SSN
0	987-65-4321
1	forty
2	123-45-6789 bro or 321-45-6789
3	999-99-9999

	0	1	2
0	987	65	4321
1	NaN	NaN	NaN
2	123	45	6789
3	999	99	9999

`ser.str.extractall(pattern)` docs

Returns a multi-indexed DataFrame of **all** matches for each capture group

```
df["SSN"].str.extractall(pattern_cg)
```

	SSN
0	987-65-4321
1	forty
2	123-45-6789 bro or 321-45-6789
3	999-99-9999

		0	1	2
match				
0	0	987	65	4321
2	0	123	45	6789
	1	321	45	6789
3	0	999	99	9999

Substitution

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`re.sub(pattern, repl, text)` docs

Returns text with all instances of `pattern` replaced by `repl`.

```
text = '<div><td valign="top">Moo</td></div>'
pattern = r"<[^>]+>"
re.sub(pattern, '', text)
```

Moo

How it works:

- **`pattern`** matches HTML tags
- Then, sub/replace HTML tags with **`repl=''`** (i.e., empty string)

Substitution

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`re.sub(pattern, repl, text)` docs

Returns text with all instances of `pattern` replaced by `repl`.

```
text = '<div><td valign="top">Moo</td></div>'
pattern = r"<[^>]+>"
re.sub(pattern, '', text)
```

```
Moo
```

How it works:

- **`pattern`** matches HTML tags
- Then, sub/replace HTML tags with **`repl=''`** (i.e., empty string)

`ser.str.replace(pattern, repl, regex=True )` docs

Returns Series with all instances of `pattern` in Series `ser` replaced by `repl`.

```
df["Html"].str.replace(pattern, '',
                       regex = True)
```

	Html
0	<td valign="top">Moo</td>
1	Link
2	Bold text

```
0          Moo
1         Link
2    Bold text
Name: Html, dtype: object
```

re.sub and ser.str.replace

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findall → list of matches

extract → DataFrame of matches

sub/replace → Convert matches

Demo

lec06.ipynb

String Function Summary

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Base Python	re	pandas str
`s.lower()` `s.upper()`		`ser.str.lower()` `ser.str.upper()`
`s.replace(…)`	`re.sub(…)`	`ser.str.replace(…)`
`s.split(…)`	`re.split(…)`	`ser.str.split(…)`
`s[1:4]`		`ser.str[1:4]`

	`re.findall(…)`	`ser.str.findall(…)`
		`ser.str.extractall(…)`
		`ser.str.extract(…)`

`'ab' in s`	`re.search(…)`	`ser.str.contains(…)`
`len(s)`		`ser.str.len()`
`s.strip()`		`ser.str.strip()`

Limitations of Regular Expressions

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Easier to write than to read.

Regular expressions sometimes jokingly referred to as a "**write only language**". A famous 1997 quote from Jamie Zawinski (co-creator of Firefox's predecessor)

> *Some people, when confronted with a problem, think "I know, I'll use regular expressions." Now they have two problems.*

Regular expressions are terrible at certain types of problems:

- For parsing a hierarchical structure, such as JSON, use the `json.load()` parser, not regex!
- Parsing real-world HTML/xml (lots of ...<tag>..</tag>..): use `html.parser`.
- Counting (same number of instances of a and b). (impossible)

LLMs are also great at regex tasks! But, sometimes unreliable + computationally expensive.

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LECTURE 6

Regex

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