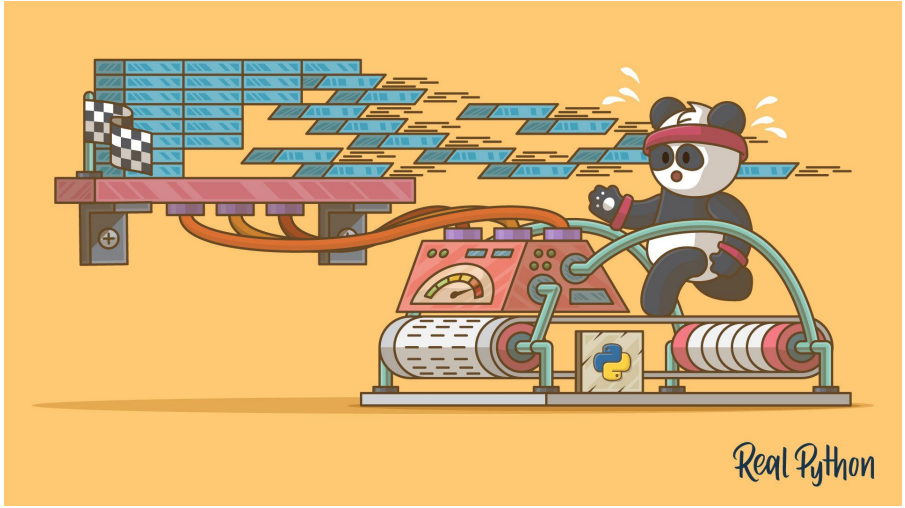
Data Science (COSE471) Spring 2021

Pandas Part 2



Dept. of Computer Science and Engineering

Korea University

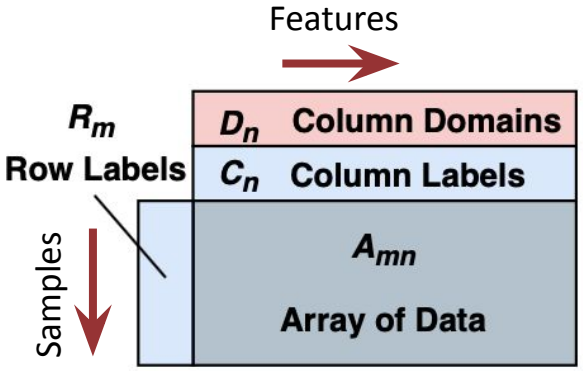
Quick review from last lecture

Announcements

- Homework #1 is due on March 26 (Fri) 11:59pm
- Quiz #1 and #2 graded, and solution was posted in GradeScope.
- Office hour sign-up sheet is posted in Blackboard

The world, a statistician's view

A (statistical) population from which we draw **samples**.
Each sample has certain **features**.



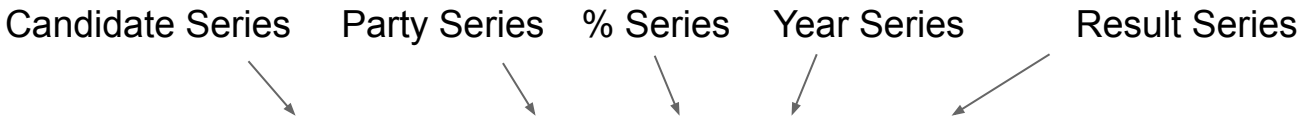
	Candidate	Party	%	Year	Result
0	Obama	Democratic	52.9	2008	win
1	McCain	Republican	45.7	2008	loss
2	Obama	Democratic	51.1	2012	win
3	Romney	Republican	47.2	2012	loss
4	Clinton	Democratic	48.2	2016	loss
5	Trump	Republican	46.1	2016	win

A generic DataFrame
(from https://arxiv.org/abs/2001.00888)

Relationship Between Data Frames, Series, and Indices

We can think of a Data Frame as a collection of Series that all share the same Index.

- Candidate, Party, %, Year, and Result Series all share an index from 0 to 5.



	Candidate	Party	%	Year	Result
0	Obama	Democratic	52.9	2008	win
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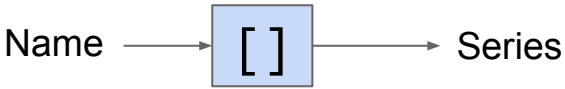
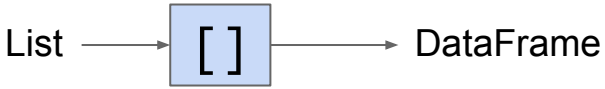
3	Romney	Republican	47.2	2012	loss
4	Clinton	Democratic	48.2	2016	loss
5	Trump	Republican	46.1	2016	win

DataFrame access: [], loc, iloc

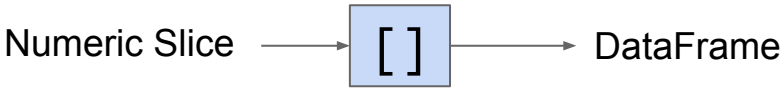
- Strings, integers - row/column labels
- Lists - similar, but always return dataframes
- Slices of labels: **end-point inclusive**!
- Boolean arrays: “mask” selection.



Single Column Selection



Multiple Column Selection



(Multiple) Row Selection

`iloc`: integer/positional

- Always 0-based, for rows and columns.
- Slices as usual, end-point exclusive.
- Use carefully (error prone).

`head, size, shape, and describe`

- Handy utilities to summarize a DF.

This Lecture: New Syntax / Concept Summary

- Operations on String series
  - e.g. babynames[“Name”].str.startswith()
- Creating and dropping columns.
  - Creating temporary columns is often convenient for sorting.
- Passing an index as an argument to loc.
  - Useful as an alternate way to sort a dataframe.
- Groupby: Output of .groupby(“Name”) is a DataFrameGroupBy object. Condense back into a DataFrame or Series with:
  - groupby.agg
  - groupby.size
  - groupby.filter
  - and more...
- Pivot tables: An alternate way to group by exactly two columns.
- Merge: A method to join two dataframes

Structure For Today

Today we'll introduce additional syntax by trying to solve various practical problems on our baby names dataset.

- Goal 1: Find the most popular name in California in 2018.
- Goal 2: Find all names that start with J.
- Goal 3: Sort names by length.
- Goal 4: Find the name whose popularity has changed the most.
- Goal 5: Count the number of female and male babies born in each year.

We will also play around with our election dataset.

You'll get a chance to practice this syntax in homework #2.

str

Manipulating String Data

Goal 1: Find all rows where the Name starts with J.

Manipulating String Data

Suppose we want to find all rows where the Name starts with J.

Approach 1:

- Create a list of booleans where ith entry is True if ith name starts with J.
- Pass this list to [] or loc[].

	State	Sex	Year	Name	Count
221131	CA	F	2018	Emma	2722
378377	CA	M	2018	Noah	2555
221132	CA	F	2018	Mia	2484
221133	CA	F	2018	Olivia	2456
378378	CA	M	2018	Liam	2405

Manipulating String Data

Suppose we want to find all rows where the Name starts with J.

Approach 1:

- Create a list of booleans where ith entry is True if ith name starts with J.
- Pass this list to [] or loc[].

Goal: Fill the list comprehension ??? so that it returns the desired list.

```
starts_with_j = [???]
babynames[starts_with_j].sample(5)
```

```
[x * 2 for x in [3, 4, 5]]
[6, 8, 10]
```

기존의 리스트에 기반한 리스트를 만들기 위해
일부 프로그래밍 언어에서 사용 가능한 문법적 구조조

Example list comprehension

	State	Sex	Year	Name	Count
22345	CA	F	1945	Jannie	8
170806	CA	F	2005	Jolina	9
354075	CA	M	2009	Jaylan	8
124886	CA	F	1993	Joseph	26
357780	CA	M	2010	Jess	5

Manipulating String Data

Suppose we want to find all rows where the Name starts with J.

startswith은 Pandas 문법이 아닌 Python 문법이다.

Approach 1:

- Create a list of booleans where ith entry is True if ith name starts with J.
- Pass this list to [] or loc[].

Goal: Write a list comprehension that returns the desired list.

```
starts_with_j = [x.startswith('J') for x in babynames["Name"]]
babynames[starts_with_j].sample(5)
```

	State	Sex	Year	Name	Count
22345	CA	F	1945	Jannie	8
170806	CA	F	2005	Jolina	9
354075	CA	M	2009	Jaylan	8
124886	CA	F	1993	Joseph	26
357780	CA	M	2010	Jess	5

A More Advanced Approach

Approach 1: Use a list comprehensions.

```
j_names = babynames[ [x.startswith('J') for x in babynames["Name"]] ]
```

Approach 2: Use a `str method` from the `Series` class (more on this shortly).

pandas.str.startswith 문법도 존재함

```
j_names = babynames[babynames["Name"].str.startswith('J')]
```

Question: What's better about this second approach?

- **More readable!** Others can understand your code. ← the main great thing
- First one is likely to be less efficient.

Idiomatic Code

Approach 1: Use a list comprehensions.

```
j_names = babynames[ [x.startswith('J') for x in babynames["Name"]] ]
```

Approach 2: Use a `str` method from the `Series` class (more on this shortly).

```
j_names = babynames[babynames["Name"].str.startswith('J')]
```

Terminology note: We say that approach #1 is not **idiomatic**.

- Idiom: “the language peculiar to a people or to a district, community, or class.”
- In other words, people from the broader pandas community won’t like reading your code if it looks like approach 1.

pandas를 사용해 데이터를 가공하고 있다면,
판다스 내부에서 제공하는 메소드를 좀 더 활용하는 것이 좋다.

Str Methods

The `str` methods from the `Series` class have pretty intuitive behavior.

- Won't define formally. Full list at bottom of [this link].

Example: `str.startswith`

```
babynames[babynames["Name"].str.startswith('J')].sample(5)
```

	State	Sex	Year	Name	Count
32151	CA	F	1953	Jewel	11
316051	CA	M	1995	Jarrett	32
344242	CA	M	2006	Josemanuel	26
343769	CA	M	2006	Junior	96
172550	CA	F	2006	Jazmin	582

Str Methods

The `str` methods from the `Series` class have pretty intuitive behavior.

- Won't define formally. Full list at bottom of [this link].

Example: `str.contains`

```
babynames[babynames["Name"].str.contains('ad')].sample(5)
```

	State	Sex	Year	Name	Count
221233	CA	F	2018	Madelyn	336
221518	CA	F	2018	Guadalupe	98
290499	CA	M	1984	Bradford	32
152534	CA	F	2000	Khadija	5
132159	CA	F	1995	Soledad	31

Str Methods

The `str` methods from the `Series` class have pretty intuitive behavior.

- Won't define formally. Full list at bottom of [this link].

Example: `str.split` 파이썬 문법과 활용하는 방법 동일하다.

```
babynames["Name"].str.split('a').to_frame().head(5)
```

	Name
0	[M, ry]
1	[Helen]
2	[Dorothy]
3	[M, rg, ret]
4	[Fr, nces]

Challenge

Write a line of code that creates a list (or Series or array) of all names that end with “ert”.

- Your list should have only one instance of each name!

```
babynames[babynames["Name"].str.startswith('J')].sample(5)
```

	State	Sex	Year	Name	Count
32151	CA	F	1953	Jewel	11
316051	CA	M	1995	Jarrett	32
344242	CA	M	2006	Josemanuel	26
343769	CA	M	2006	Junior	96
172550	CA	F	2006	Jazmin	582

Challenge

Write a line of code that creates a list (or Series or array) of all names that end with “ert”.

- Your list should have only one instance of each name!

str.endswith 메소드 활용 방법도 매우 유익하다.

```
babynames[babynames["Name"].str.endswith("ert")]["Name"].unique()
```

Adding, Modifying, and Removing Columns

Sorting By Length

Goal 3: Sort our baby names by length.

The `sort_values` function does not provide the ability to pass a custom comparison function.

Lots of weird ways to do this:

```
babynames.iloc[[i for i, m in sorted(enumerate(babynames['Name']), key=lambda x: -len(x[1]))]].head(5)
```

Let's see two different ways of doing this that are much nicer.

- Approach 1: Creating a temporary column, then sort on it.
- Approach 2: Creating a sorted index and using loc.

Approach 1: Create a Temporary Column

Intuition: Create a column equal to the length. Sort by that column.

	State	Sex	Year	Name	Count	name_lengths
312731	CA	M	1993	Ryanchristopher	5	15
322558	CA	M	1997	Franciscojavier	5	15
297806	CA	M	1987	Franciscojavier	5	15
307174	CA	M	1991	Franciscojavier	6	15
302145	CA	M	1989	Franciscojavier	6	15

Syntax for Column Addition

Adding a column is easy:

```
#create a new series of only the lengths
babyname_lengths = babynames["Name"].str.len()

#add that series to the dataframe as a column
babynames["name_lengths"] = babyname_lengths
```

Can also do both steps on one line of code

	State	Sex	Year	Name	Count	name_lengths
0	CA	F	1910	Mary	295	4
1	CA	F	1910	Helen	239	5
2	CA	F	1910	Dorothy	220	7
3	CA	F	1910	Margaret	163	8
4	CA	F	1910	Frances	134	7

Syntax for Dropping a Column (or Row)

After sorting, we can drop the temporary column.

- The Drop method assumes you're dropping a row by default. Use axis = 1 to drop a column instead.

axis = 0는 가로 축으로 값을 수정하는 매개변수임

```
babynames = babynames.drop("name_lengths", axis = 1)
```

	State	Sex	Year	Name	Count	name_lengths
312731	CA	M	1993	Ryanchristopher	5	15
322558	CA	M	1997	Franciscojavier	5	15
297806	CA	M	1987	Franciscojavier	5	15
307174	CA	M	1991	Franciscojavier	6	15
302145	CA	M	1989	Franciscojavier	6	15

	State	Sex	Year	Name	Count
312731	CA	M	1993	Ryanchristopher	5
322558	CA	M	1997	Franciscojavier	5
297806	CA	M	1987	Franciscojavier	5
307174	CA	M	1991	Franciscojavier	6
302145	CA	M	1989	Franciscojavier	6

Sorting by Arbitrary Functions

Suppose we want to sort by the number of occurrences of “dr” + number of occurrences of “ea”.

- Use the Series `.map` method.

```
def dr_ea_count(string):
    return string.count('dr') + string.count('ea')

babynames["dr_ea_count"] = babynames["Name"].map(dr_ea_count)
babynames = babynames.sort_values(by = "dr_ea_count", ascending=False)
```

	State	Sex	Year	Name	Count	dr_ea_count
108712	CA	F	1988	Deandrea	5	3
293396	CA	M	1985	Deandrea	6	3
101958	CA	F	1986	Deandrea	6	3
115935	CA	F	1990	Deandrea	5	3
131003	CA	F	1994	Leandrea	5	3

A Little More .loc

Sorting By Length

Goal 3: Sort our baby names by length.

The `sort_values` function does not provide the ability to pass a custom comparison function.

Let's see two different ways of doing this that are much nicer.

- Approach 1: Creating a temporary column, then sort on it.
- **Approach 2: Creating a sorted index and using loc.**

Approach 2: Create a Sorted Index and Pass to .loc

Another approach is to take advantage of another feature of .loc.

- `df.loc[idx]` returns the DataFrame in the same order as the given index.
- Only works if the index exactly matches the DataFrame.

Let's see this approach in action.

Approach 2: Create a Sorted Index and Pass to .loc

Step 1: Create Series of only the lengths of the names.

- This Series will have the same index as the original DataFrame.

```
name_lengths = babynames["Name"].str.len()
name_lengths.head(5)
```

	State	Sex	Year	Name	Count
340748	CA	M	2005	Pedro	442
294382	CA	M	1986	Royce	32
241809	CA	M	1943	Les	7
52043	CA	F	1965	Cristine	18
308476	CA	M	1992	Reyes	24

babynames

```
340748    5
294382    5
241809    3
52043     8
308476    5
Name: Name, dtype: int64
```

name_lengths

Approach 2: Create a Sorted Index and Pass to .loc

Step 2: Sort the series of only name lengths.

- This Series will have an index which is reordered relative to the original dataframe.

```
name_lengths_sorted_by_length = name_lengths.sort_values()
name_lengths_sorted_by_length.head(5)
```

```
340748    5
294382    5
241809    3
52043     8
308476    5
Name: Name, dtype: int64
```

name_lengths

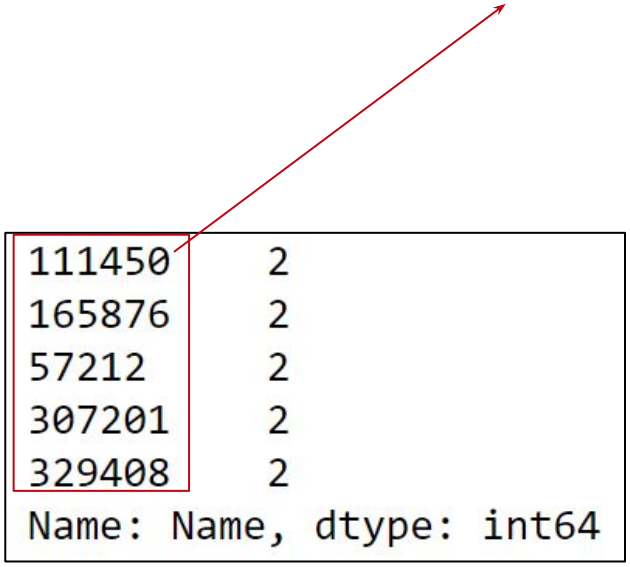
```
111450    2
165876    2
57212     2
307201    2
329408    2
Name: Name, dtype: int64
```

name_lengths_sorted_by_length

Approach 2: Create a Sorted Index and Pass to .loc

Step 3: Pass the sorted index as an argument of .loc to the original dataframe.

```
index_sorted_by_length = name_lengths_sorted_by_length.index
babynames.loc[index_sorted_by_length].head(5)
```



```
111450    2
165876    2
57212     2
307201    2
329408    2
Name: Name, dtype: int64
```

name_lengths_sorted_by_length

	State	Sex	Year	Name	Count
111450	CA	F	1989	Vy	8
165876	CA	F	2004	An	17
57212	CA	F	1968	Jo	80
307201	CA	M	1991	Jc	6
329408	CA	M	2000	Al	7

babynames.loc[index_sorted_by_length]

groupby.agg

Sorting By Length

Goal 4: Find the names that have changed the most in popularity.

Let's start by defining what we mean by changed popularity.

- In lecture, let's stay simple and use the AMMD (absolute max/min difference): max(count) - min(count).

Note: This is not a common term. I just made it up.

Example for "Jennifer":

- In 1954, there were only 5.
- In 1972, we hit peak Jennifer. 6,066 Jennifers were born.
- AMMD is 6,066 - 5 = 6,061.

Example: Computing the AMMD for a Given Name

```
def ammd(series):
    return max(series) - min(series)
```

```
jennifer_counts = babynames.query("Name == 'Jennifer'")["Count"]
```

```
88492     5812
123809    3003
20807       80
19084       22
42180      868
Name: Count, dtype: int64
```

```
ammd(jennifer_counts)
```

```
6061
```

Approach 1: Getting AMMD for Every Name

Approach 1: Hack something together using our existing Python knowledge.

```
#build dictionary where entry i is the ammd for the given name
#e.g. ammd["jennifer"] should be 6061
ammd_of_babyname_counts = {}
for name in ??:
    counts_of_current_name = babynames[??]["Count"]
    ammd_of_babyname_counts[name] = ammd(counts_of_current_name)

#convert to series
ammd_of_babyname_counts = pd.Series(ammd_of_babyname_counts)
```

Challenge: Try to fill in the code above.

Approach 1: Getting AMMD for Every Name

Approach 1: Hack something together using our existing Python knowledge.

```
#build dictionary where entry i is the ammd for the given name
#e.g. ammd["jennifer"] should be 6061
ammd_of_babyname_counts = {}
for name in sorted(babynames["Name"].unique()):
    counts_of_current_name = babynames[babynames["Name"] == name]["Count"]
    ammd_of_babyname_counts[name] = ammd(counts_of_current_name)

#convert to series
ammd_of_babyname_counts = pd.Series(ammd_of_babyname_counts)
ammd_of_babyname_counts.head(5)
```

The code above is extremely slow, and also way more complicated than the better approach coming next.

Approach 2: Using Groupby and Agg

The code below is the more idiomatic way of computing what we want.

- Much simpler, much faster, much more versatile.

Approach 1

```
#build dictionary where entry i is the ammd for the given name
#e.g. ammd["jennifer"] should be 6061
ammd_of_babyname_counts = {}
for name in babynames["Name"].unique()[0:5]:
    counts_of_current_name = babynames[babynames["Name"] == name]["Count"]
    ammd_of_babyname_counts[name] = ammd(counts_of_current_name)

#convert to series
ammd_of_babyname_counts = pd.Series(ammd_of_babyname_counts)
```

```
Aadan        2
Aaden      138
Aadhav       2
Aadhira      4
Aadhya      45
dtype: int64
```

Approach 2

```
babynames.groupby("Name").agg(ammd)
```

Name	Year	Count
Aadan	6	2
Aaden	11	138
Aadhav	3	2
Aadhira	1	4
Aadhya	11	45

Check Your groupBy Understanding

Approach 2 generated two columns, Year and Count.

What do you think the Year column represents?

A. The number of years a name appeared.
B. The difference between the earliest and latest year a name appeared.
C. It has no meaning because our code was only designed to work with counts.
D. Not sure.

Approach 2

```
babynames.groupby("Name").agg(ammd)
```

Name	Year	Count
Aadan	6	2
Aaden	11	138
Aadhav	3	2
Aadhira	1	4
Aadhya	11	45

Attendance Question:

Approach 2 generated two columns, Year and Count.

What do you think the Year column represents?

A. The number of years a name appeared.

B. The difference between the earliest and latest year a name appeared.

C. It has no meaning because our code was only designed to work with counts.

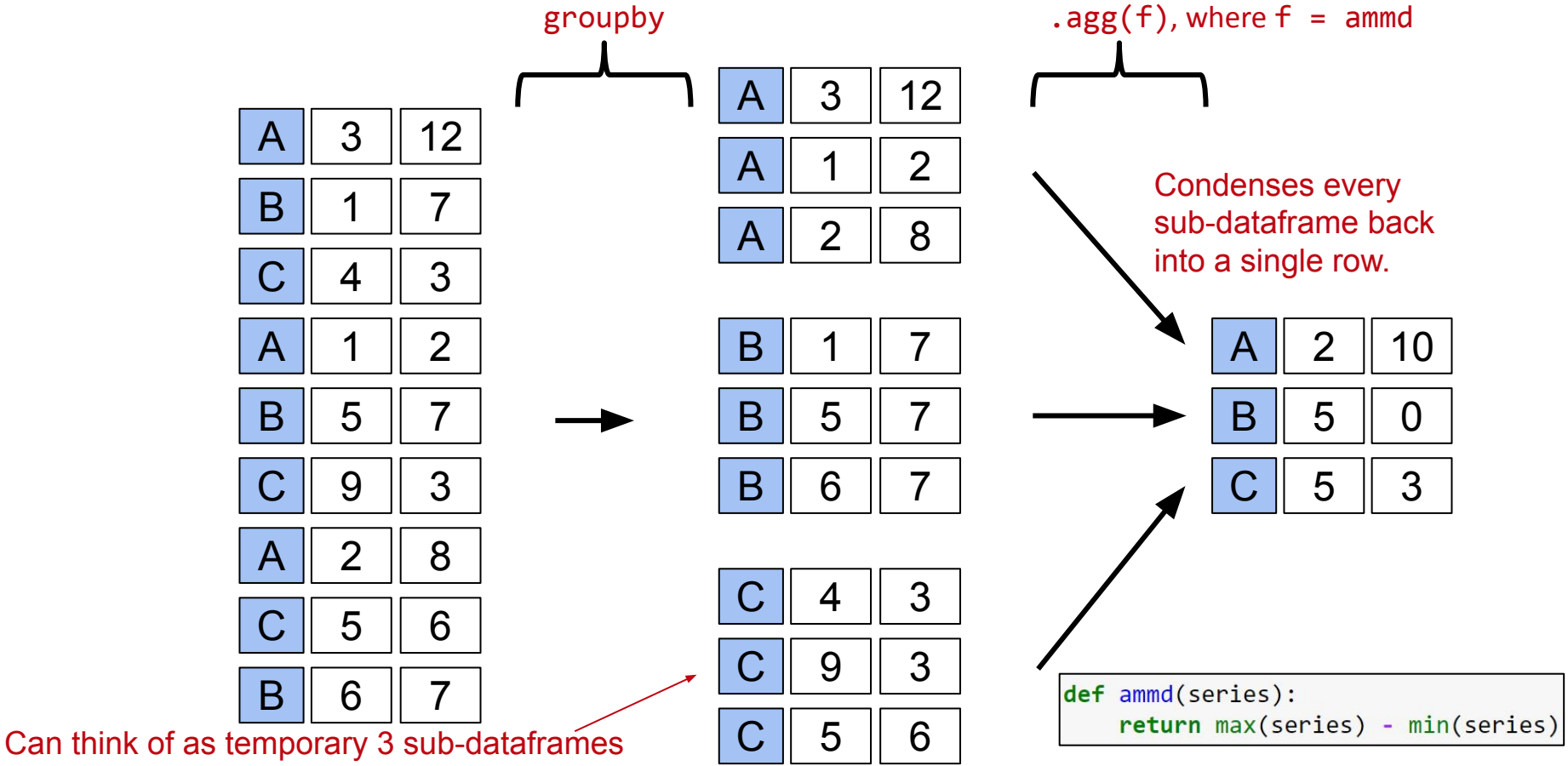
D. Not sure.

Approach 2

```
babynames.groupby("Name").agg(ammd)
```

Name	Year	Count
Aadan	6	2
Aaden	11	138
Aadhav	3	2
Aadhira	1	4
Aadhya	11	45

DataFrame groupby.agg Visually

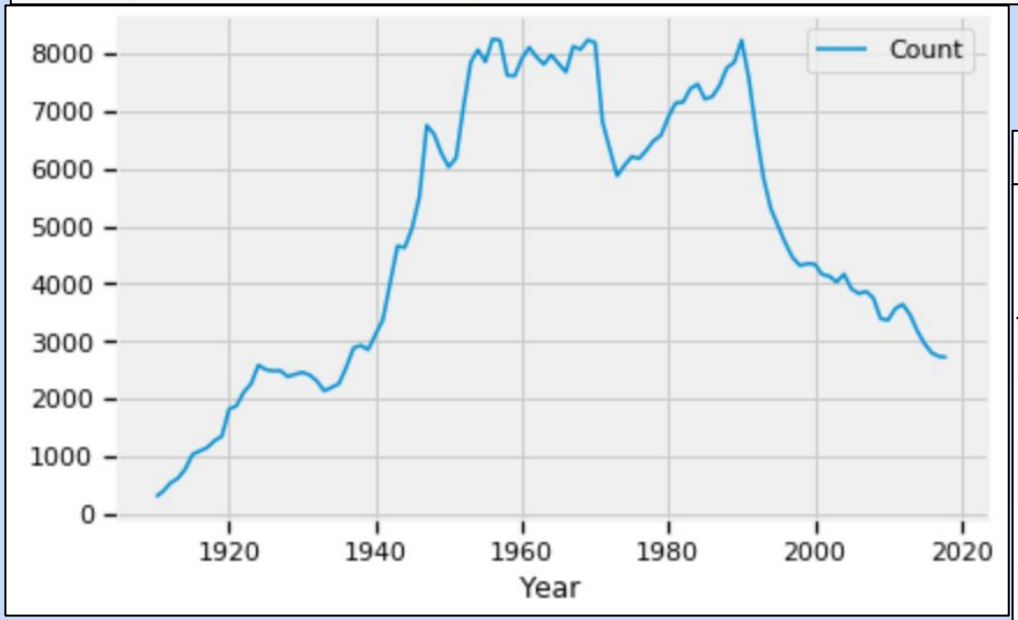


Some `groupby.agg` puzzles

groupby Puzzle #1

Below, we show the result of the given code. What does it mean?

```
babynames.groupby("Year").agg(ammd).plot()
```



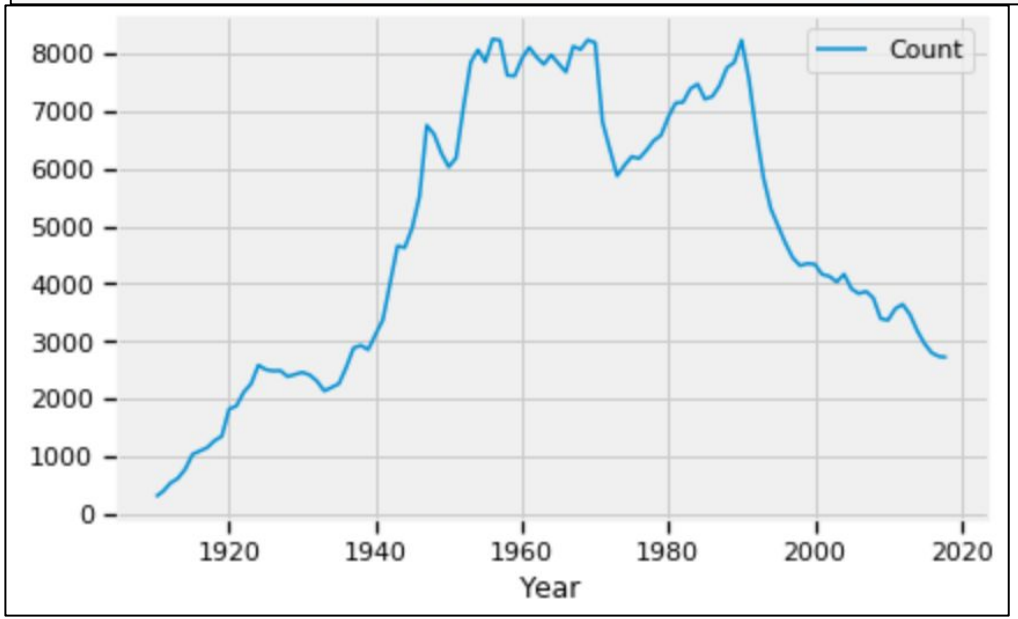

```
babynames.groupby("Year").agg(ammd).head(5)
```

Year	Count
1910	290
1911	385
1912	529
1913	609
1914	768

groupby Puzzle #1

Below, we show the result of the given code. What does it mean?

```
babynames.groupby("Year").agg(ammd).plot()
```



Your answer:

groupby Puzzle #2

Be careful when using groupby. Consider the results on our elections table:

```
elections.groupby("Party").agg(max)
```

Party	Year	Candidate	Popular vote	Result	%
American	1976	Thomas J. Anderson	873053	loss	21.554001
American Independent	1976	Lester Maddox	9901118	loss	13.571218
Anti-Masonic	1832	William Wirt	100715	loss	7.821583
Anti-Monopoly	1884	Benjamin Butler	134294	loss	1.335838
Citizens	1980	Barry Commoner	233052	loss	0.270182
Communist	1932	William Z. Foster	103307	loss	0.261069
Constitution	2016	Michael Peroutka	203091	loss	0.152398
Constitutional Union	1860	John Bell	590901	loss	12.639283
Democratic	2016	Woodrow Wilson	69498516	win	61.344703

groupby Puzzle #2

Why does the table seem to claim that Woodrow Wilson won the presidency in 2016?

```
elections.groupby("Party").agg(max)
```

Party	Year	Candidate	Popular vote	Result	%
American	1976	Thomas J. Anderson	873053	loss	21.554001
American Independent	1976	Lester Maddox	9901118	loss	13.571218
Anti-Masonic	1832	William Wirt	100715	loss	7.821583
Anti-Monopoly	1884	Benjamin Butler	134294	loss	1.335838
Citizens	1980	Barry Commoner	233052	loss	0.270182
Communist	1932	William Z. Foster	103307	loss	0.261069
Constitution	2016	Michael Peroutka	203091	loss	0.152398
Constitutional Union	1860	John Bell	590901	loss	12.639283
Democratic	2016	Woodrow Wilson	69498516	win	61.344703

groupby Puzzle #2

Why does the table seem to claim that Woodrow Wilson won the presidency in 2016?

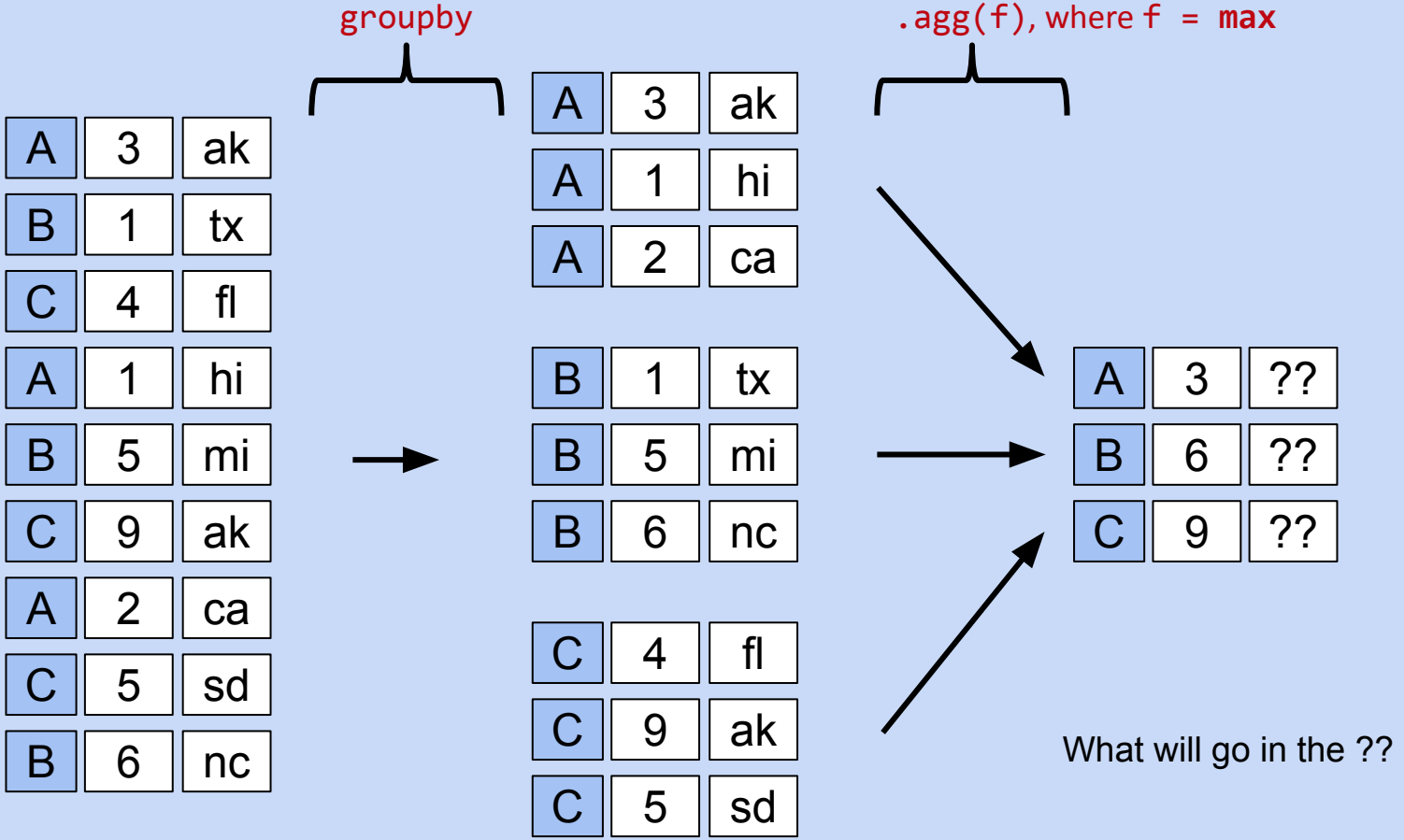
Every column is calculated independently! Among Democrats:

- Last year they ran: 2016
- Alphabetically latest candidate name: Woodrow Wilson
- Highest % of vote: 61.34

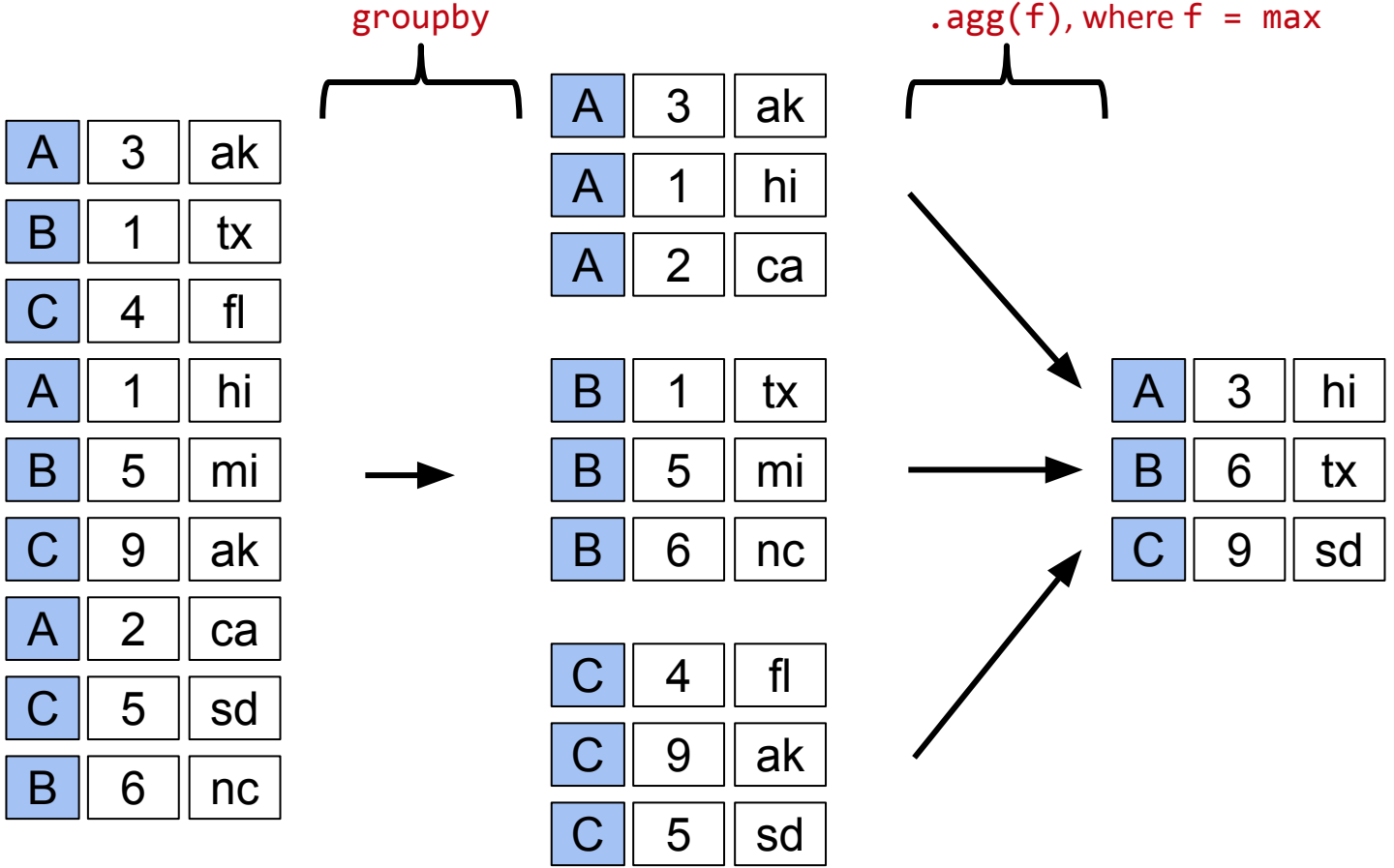
```
elections.groupby("Party").agg(max)
```

Party	Year	Candidate	Popular vote	Result	%
American	1976	Thomas J. Anderson	873053	loss	21.554001
American Independent	1976	Lester Maddox	9901118	loss	13.571218
Anti-Masonic	1832	William Wirt	100715	loss	7.821583
Anti-Monopoly	1884	Benjamin Butler	134294	loss	1.335838
Citizens	1980	Barry Commoner	233052	loss	0.270182
Communist	1932	William Z. Foster	103307	loss	0.261069
Constitution	2016	Michael Peroutka	203091	loss	0.152398
Constitutional Union	1860	John Bell	590901	loss	12.639283
Democratic	2016	Woodrow Wilson	69498516	win	61.344703

groupby Puzzle #3



groupby Puzzle #3



Puzzle #4

Very hard puzzle: Try to write code that returns the table below.

- Each row shows the best result (in %) by each party.
  - For example: Best Democratic result ever was Johnson's 1964 win.

Party	Year	Candidate	Popular vote	Result	%
American	1856	Millard Fillmore	873053	loss	21.554001
American Independent	1968	George Wallace	9901118	loss	13.571218
Anti-Masonic	1832	William Wirt	100715	loss	7.821583
Anti-Monopoly	1884	Benjamin Butler	134294	loss	1.335838
Citizens	1980	Barry Commoner	233052	loss	0.270182
Communist	1932	William Z. Foster	103307	loss	0.261069
Constitution	2008	Chuck Baldwin	199750	loss	0.152398
Constitutional Union	1860	John Bell	590901	loss	12.639283
Democratic	1964	Lyndon Johnson	43127041	win	61.344703

Puzzle #4

Very hard puzzle: Try to write code that returns the table below.

- Hint, first do: `elections_sorted_by_percent = elections.sort_values("%", ascending=False)`
- Each row shows the best result (in %) by each party.

Party	Year	Candidate	Popular vote	Result	%
American	1856	Millard Fillmore	873053	loss	21.554001
American Independent	1968	George Wallace	9901118	loss	13.571218
Anti-Masonic	1832	William Wirt	100715	loss	7.821583
Anti-Monopoly	1884	Benjamin Butler	134294	loss	1.335838
Citizens	1980	Barry Commoner	233052	loss	0.270182
Communist	1932	William Z. Foster	103307	loss	0.261069
Constitution	2008	Chuck Baldwin	199750	loss	0.152398
Constitutional Union	1860	John Bell	590901	loss	12.639283
Democratic	1964	Lyndon Johnson	43127041	win	61.344703

Puzzle #4

Very hard puzzle: Try to write code that returns the table below.

- First sort the DataFrame so that rows are in ascending order of %.

```
elections_sorted_by_percent = elections.sort_values("%", ascending=False)
```

- Then group by Party and take the 0th member of each series.

```
elections_sorted_by_percent.groupby("Party").agg(lambda x : x.iloc[0])
```

Party	Year	Candidate	Popular vote	Result	%
American	1856	Millard Fillmore	873053	loss	21.554001
American Independent	1968	George Wallace	9901118	loss	13.571218
Anti-Masonic	1832	William Wirt	100715	loss	7.821583
Anti-Monopoly	1884	Benjamin Butler	134294	loss	1.335838
Citizens	1980	Barry Commoner	233052	loss	0.270182
Communist	1932	William Z. Foster	103307	loss	0.261069
Constitution	2008	Chuck Baldwin	199750	loss	0.152398
Constitutional Union	1860	John Bell	590901	loss	12.639283
Democratic	1964	Lyndon Johnson	43127041	win	61.344703

Quick Note

If this type of programming seems scary, don’t worry, you’ll get used to it.

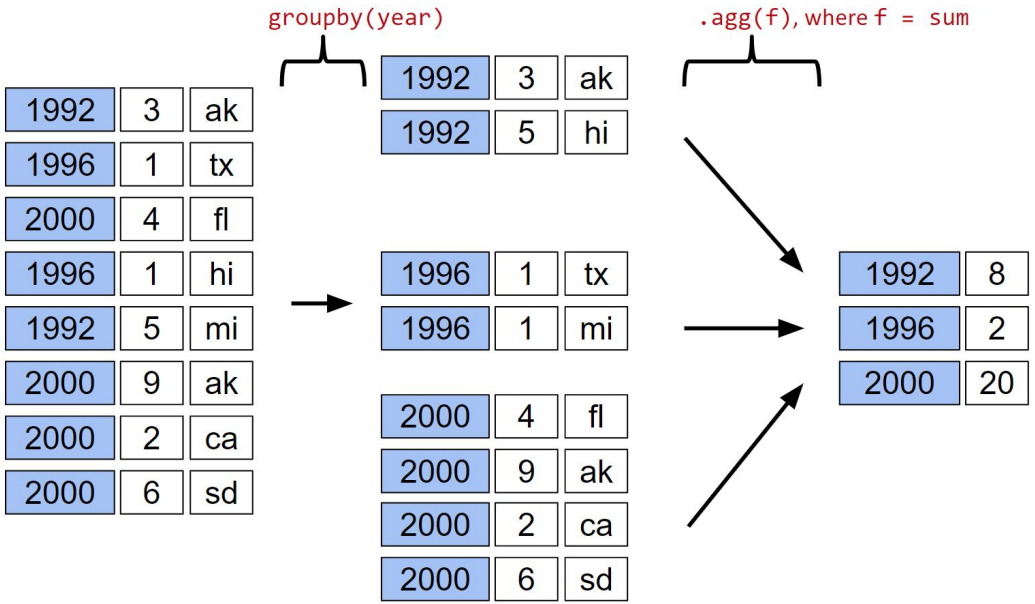
- Very different than the procedural style that you may be used to in Java, Matlab, Python, etc.
- Has a more declarative/SQL like feel.

Other groupby Features

Revisiting groupby.agg

So far, we've seen that df.groupby("year").agg(sum):

- Organizes all rows with the same year into a subframe for that year.
- Creates a new dataframe with one row representing each subframe year.
  - All rows in each subframe are combined using the sum function.



Raw groupby Objects

The result of a groupby operation applied to a DataFrame is a DataFrameGroupBy object.

- It is not a DataFrame!

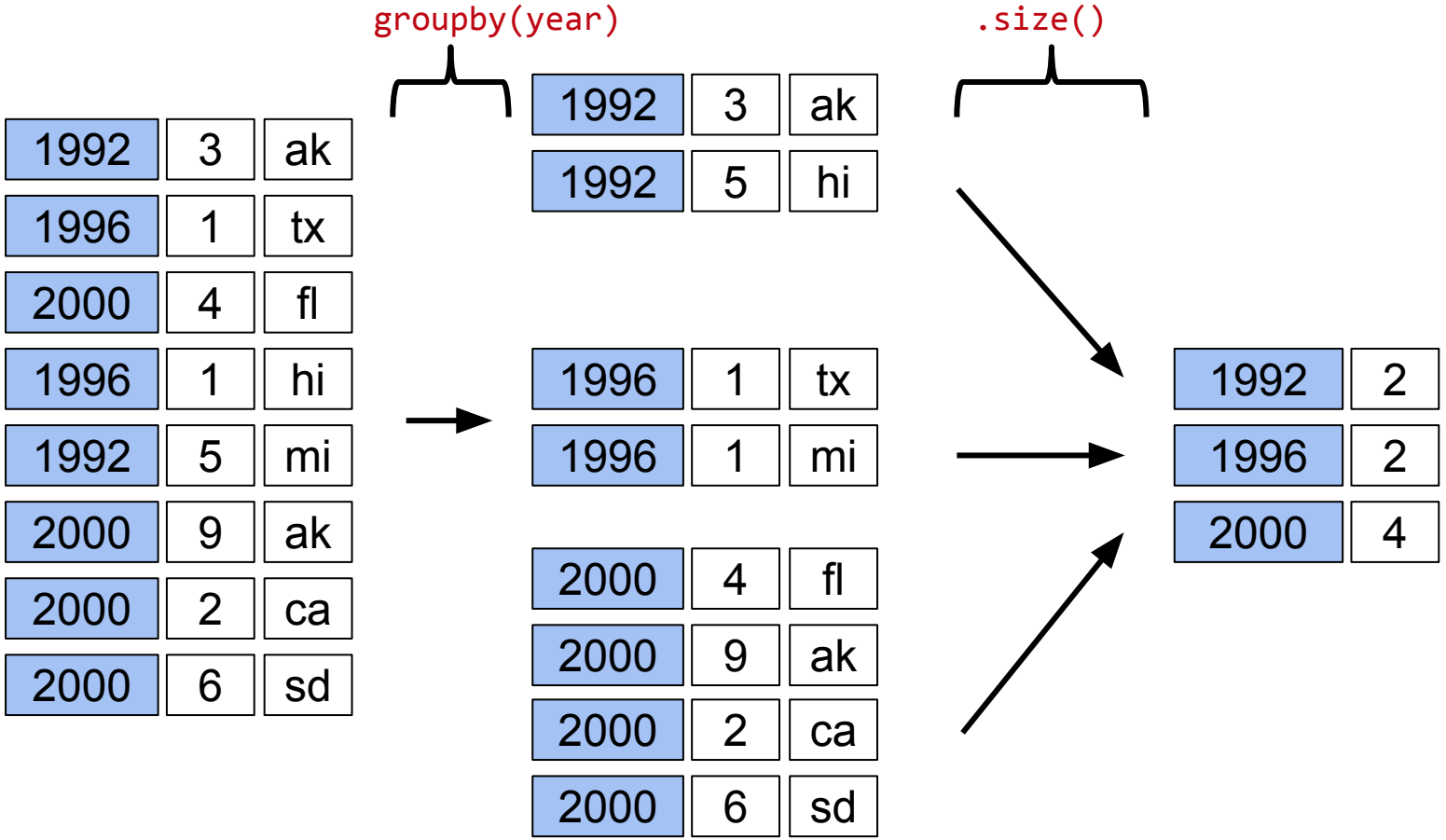
```
grouped_by_year = elections_sorted_by_percent.query("Year > 1950").groupby("Year")
type(grouped_by_year)
```

```
pandas.core.groupby.DataFrameGroupBy
```

Given a DataFrameGroupBy object, can use various functions to generate DataFrames (or Series). Agg is only one choice:

- agg: Creates a new DataFrame with one aggregated row per subframe.
- size: Creates a new Series with the size of each subframe.
- filter: Creates a copy of the original DataFrame, but keeping only rows from subframes that obey the provided condition.

groupby.size()

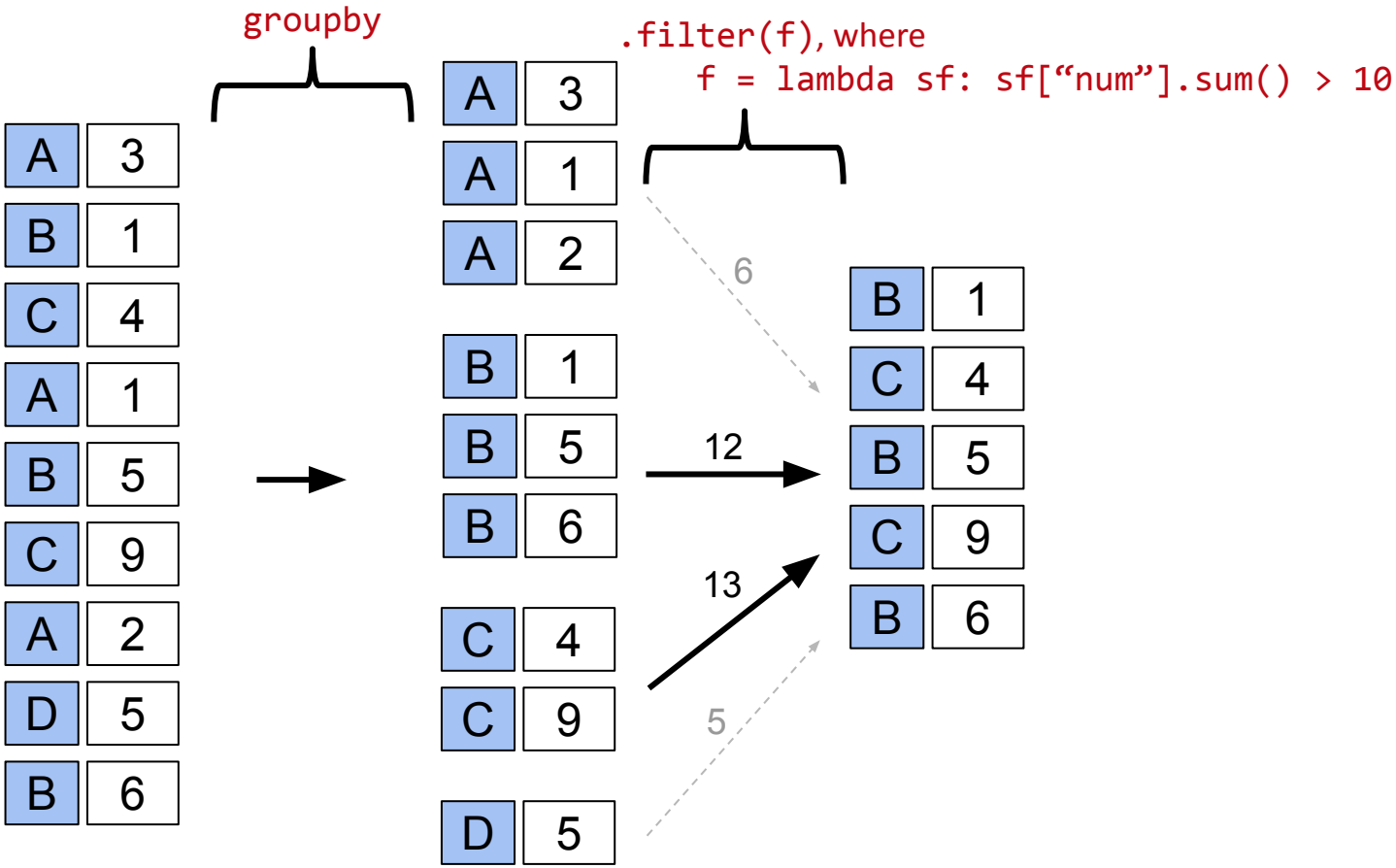


Filtering by Group

Another common use for groups is to filter data.

- `groupby.filter` takes an argument `f`.
- `f` is a function that:
  - Takes a DataFrame as input.
  - Returns either true or false.
- For each group g, f is applied to the subframe comprised of the rows from the original dataframe corresponding to that group.

groupby.filter



groupby.sum(), groupby.mean(), groupby.max(), etc…

For common operations, rather than saying e.g. groupby.agg(sum), we can instead do groupby.sum():

```
elections.groupby("Year").agg(sum).head()
```

```
elections.groupby("Year").sum().head()
```

```
elections.groupby("Year").agg(max).head()
```

```
elections.groupby("Year").max().head()
```