

Programming Principles in Python (CSCI 503/490)

Data

Dr. David Koop

Data Frame

```
df = pd.read_csv('penguins_lter.csv')
```

	studyName	Sample Number	Species	Region	Island	Stage	Individual ID	Clutch Completion	Date Egg	Culmen Length (mm)
0	PAL0708	1	Adelie Penguin (Pygoscelis adeliae)	Anvers	Torgersen	Adult, 1 Egg Stage	N1A1	Yes	11/11/07	39.1
1	PAL0708	2	Adelie Penguin (Pygoscelis adeliae)	Anvers	Torgersen	Adult, 1 Egg Stage	N1A2	Yes	11/11/07	39.5
2	PAL0708	3	Adelie Penguin (Pygoscelis adeliae)	Anvers	Torgersen	Adult, 1 Egg Stage	N2A1	Yes	11/16/07	40.3
3	PAL0708	4	Adelie Penguin (Pygoscelis adeliae)	Anvers	Torgersen	Adult, 1 Egg Stage	N2A2	Yes	11/16/07	NaN
4	PAL0708	5	Adelie Penguin (Pygoscelis adeliae)	Anvers	Torgersen	Adult, 1 Egg Stage	N3A1	Yes	11/16/07	36.7
...	...	...	...	...	...	...	...	...	...	...
339	PAL0910	120	Gentoo penguin (Pygoscelis papua)	Anvers	Biscoe	Adult, 1 Egg Stage	N38A2	No	12/1/09	NaN
340	PAL0910	121	Gentoo penguin (Pygoscelis papua)	Anvers	Biscoe	Adult, 1 Egg Stage	N39A1	Yes	11/22/09	46.8
341	PAL0910	122	Gentoo penguin (Pygoscelis papua)	Anvers	Biscoe	Adult, 1 Egg Stage	N39A2	Yes	11/22/09	50.4
342	PAL0910	123	Gentoo penguin (Pygoscelis papua)	Anvers	Biscoe	Adult, 1 Egg Stage	N43A1	Yes	11/22/09	45.2
343	PAL0910	124	Gentoo penguin (Pygoscelis papua)	Anvers	Biscoe	Adult, 1 Egg Stage	N43A2	Yes	11/22/09	49.9

344 rows x 17 columns



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344 rows x 17 columns

Column: df['Island']



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Row: df.loc[2]

Index

344 rows x 17 columns

Column: df['Island']

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```
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Row: df.loc[2]

Index

Cell: df.loc[341, 'Species']

344 rows x 17 columns

Column: df['Island']

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```

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Row: df.loc[2]

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Missing Data

Cell: df.loc[341, 'Species']

Column: df['Island']

344 rows x 17 columns

Filtering

```
df[df['Culmen Length (mm)'] > 40]
```

	studyName	Sample Number	Species	Region	Island	Stage	Individual ID	Clutch Completion	Date Egg	Culmen Length (mm)
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Reading and Writing Data

- Reading:
 - `df = pd.read_csv(fname)`
- Writing
 - `df.to_csv(fname)`
- Many options also possible on both
 - `sep`: the separator (defaults to comma)
 - `skiprows`: when reading, number of list of lines to skip
 - `index`: set to `None` when writing if unimportant
- Also methods for other formats (json, parquet, sql)
- Methods are `read_*` and `to_*`

Writing CSV data with pandas

- Basic: `df.to_csv(<fname>)`
- Change delimiter with `sep` kwarg:
 - `df.to_csv('example.dsv', sep='|')`
- Change missing value representation
 - `df.to_csv('example.dsv', na_rep='NULL')`
- Don't write row or column labels:
 - `df.to_csv('example.csv', index=False, header=False)`
- Series may also be written to csv

Derived Data

- Create new columns from existing columns
 - `r["PctFail"] = r['Fail'] / r['Total']`
- Note that operations are computed in a vectorized manner
- Similarities to functional paradigm (map/filter):
 - specify the operation once
 - no loops
 - interpreted as an operation on the entire column

Avoid inplace

PDEP-8: In-place methods in pandas

Proposal (still being discussed!):

- The `inplace` parameter will be deprecated and removed from any method that can never be done inplace
- The `inplace` parameter is kept only in a few methods such as `fillna()`

For example, replace

```
df.reset_index(inplace=True)
```

with

```
df = df.reset_index()
```

Full proposal: <https://github.com/pandas-dev/pandas/pull/51466>

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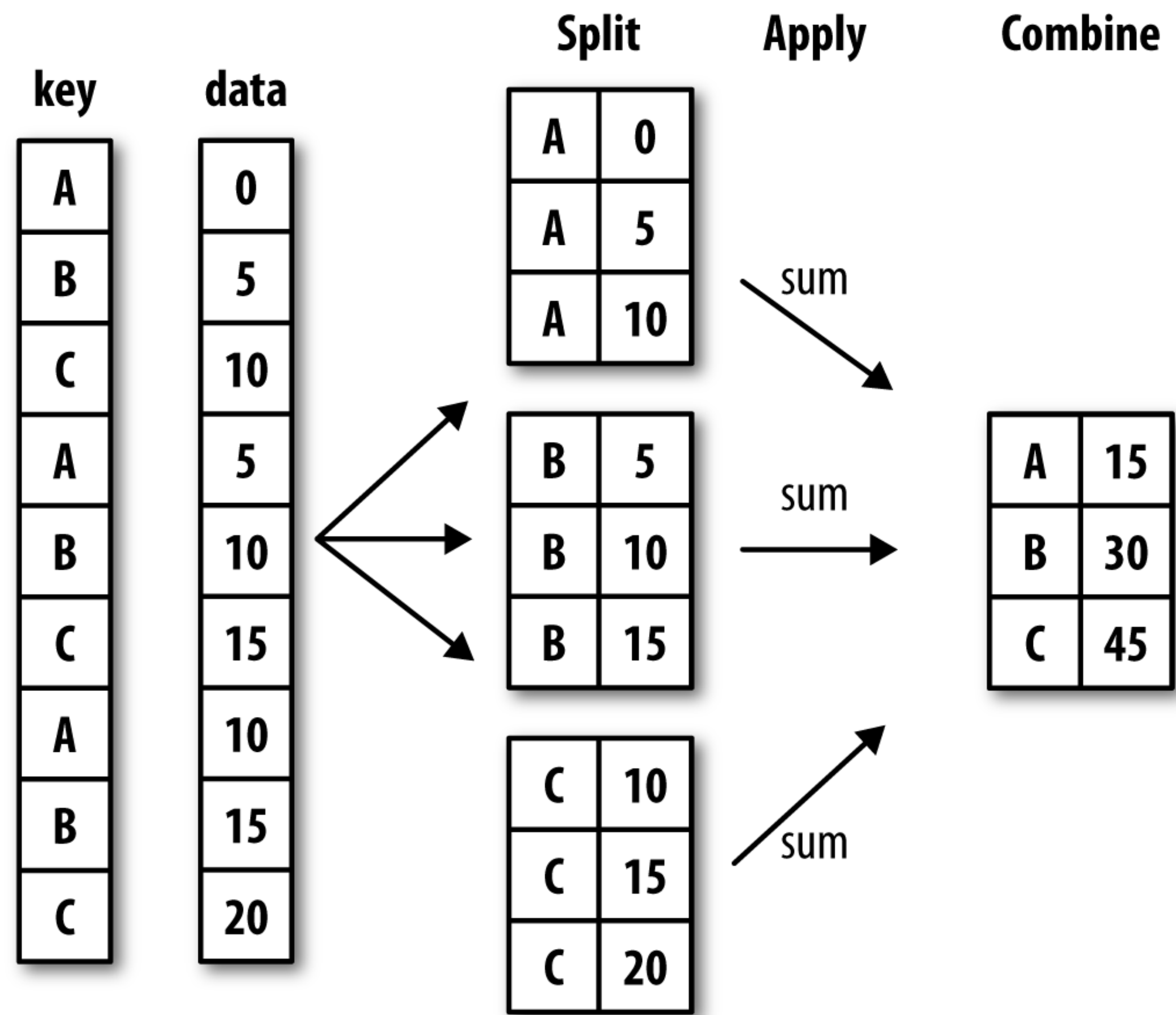
[J. Van den Bossche, 2023]

Split-Apply-Combine

- `df.groupby('Island')[['Culmen Length (mm)', 'Culmen Depth (mm)']].mean()`
- `df.groupby('Island').agg({'Culmen Length (mm)': 'mean', 'Culmen Depth (mm)': 'mean'})`
- `df.groupby('Island').agg(cul_length=('Culmen Length (mm)', 'mean'), cul_depth=('Culmen Depth (mm)', 'mean'))`

	cul_length	cul_depth
Island		
Biscoe	45.257485	15.874850
Dream	44.167742	18.344355
Torgersen	38.950980	18.429412

Split-Apply-Combine



[W. McKinney, Python for Data Analysis]

Different Data Layouts

	treatmenta	treatmentb
John Smith	—	2
Jane Doe	16	11
Mary Johnson	3	1

Initial Data

name	trt	result
John Smith	a	—
Jane Doe	a	16
Mary Johnson	a	3
John Smith	b	2
Jane Doe	b	11
Mary Johnson	b	1

Tidy Data

	John Smith	Jane Doe	Mary Johnson
treatmenta	—	16	3
treatmentb	2	11	1

Transpose

[H. Wickham, 2014]

Solution: Melting + Pivot

id	date	element	value
MX17004	2010-01-30	tmax	27.8
MX17004	2010-01-30	tmin	14.5
MX17004	2010-02-02	tmax	27.3
MX17004	2010-02-02	tmin	14.4
MX17004	2010-02-03	tmax	24.1
MX17004	2010-02-03	tmin	14.4
MX17004	2010-02-11	tmax	29.7
MX17004	2010-02-11	tmin	13.4
MX17004	2010-02-23	tmax	29.9
MX17004	2010-02-23	tmin	10.7

(a) Molten data

id	date	tmax	tmin
MX17004	2010-01-30	27.8	14.5
MX17004	2010-02-02	27.3	14.4
MX17004	2010-02-03	24.1	14.4
MX17004	2010-02-11	29.7	13.4
MX17004	2010-02-23	29.9	10.7
MX17004	2010-03-05	32.1	14.2
MX17004	2010-03-10	34.5	16.8
MX17004	2010-03-16	31.1	17.6
MX17004	2010-04-27	36.3	16.7
MX17004	2010-05-27	33.2	18.2

(b) Tidy data

[H. Wickham, 2014]

Assignment 7

- Musical Artists Datasets
- Downloading and uncompressing files
- Finding files using OS libraries
- Load per-artist numpy arrays, each saved in the .npy format
- Store per-month dataframes, each in a csv file
- Issue with r.e.m..npy

Food Inspections Example

String Methods

- Can do many of the same methods used for single strings on entire columns
- Requires `.str` prefix before calling the method
 - `violations.value.str.strip().str.split(' - Comments:')`
- Also helps when extracting from a list
 - `comments.str[1]`

String Methods

Argument	Description
<code>count</code>	Return the number of non-overlapping occurrences of substring in the string.
<code>endswith</code>	Returns <code>True</code> if string ends with suffix.
<code>startswith</code>	Returns <code>True</code> if string starts with prefix.
<code>join</code>	Use string as delimiter for concatenating a sequence of other strings.
<code>index</code>	Return position of first character in substring if found in the string; raises <code>ValueError</code> if not found.
<code>find</code>	Return position of first character of <i>first</i> occurrence of substring in the string; like <code>index</code> , but returns <code>-1</code> if not found.
<code>rfind</code>	Return position of first character of <i>last</i> occurrence of substring in the string; returns <code>-1</code> if not found.
<code>replace</code>	Replace occurrences of string with another string.
<code>strip</code> , <code>rstrip</code> , <code>lstrip</code>	Trim whitespace, including newlines; equivalent to <code>x.strip()</code> (and <code>rstrip</code> , <code>lstrip</code> , respectively) for each element.
<code>split</code>	Break string into list of substrings using passed delimiter.
<code>lower</code>	Convert alphabet characters to lowercase.
<code>upper</code>	Convert alphabet characters to uppercase.
<code>casefold</code>	Convert characters to lowercase, and convert any region-specific variable character combinations to a common comparable form.
<code>ljust</code> , <code>rjust</code>	Left justify or right justify, respectively; pad opposite side of string with spaces (or some other fill character) to return a string with a minimum width.

[W. McKinney, Python for Data Analysis]

Support for Datetime

- Python has datetime library to support dates and times
- pandas has a Timestamp data type that functions somewhat similarly
- Pandas can convert timestamps
 - `pd.to_datetime`: versatile, can often guess format
- Like string methods, also a `.dt` accessor for datetime methods/properties
- With a timestamp, filtering based on datetimes becomes easier
 - `df[df['Inspection Date'] > '2021']`

Method chaining in pandas

- Tom Augspurger's [post](#)
- [Effective Pandas](#) book by Matt Harrison
- Functions written for chaining, and pipe allows custom functions
- ```
def read(fp):
 df = (pd.read_csv(fp)
 .rename(columns=str.lower)
 .drop('unnamed: 36', axis=1)
 .pipe(extract_city_name)
 .pipe(time_to_datetime, ['dep_time', 'arr_time',
 'crs_arr_time', 'crs_dep_time'])
 .assign(fl_date=lambda x: pd.to_datetime(x['fl_date']),
 dest=lambda x: pd.Categorical(x['dest']),
 origin=lambda x: pd.Categorical(x['origin']),
 tail_num=lambda x: pd.Categorical(x['tail_num']),
 unique_carrier=lambda x: pd.Categorical(x['unique_carrier']),
 cancellation_code=lambda x: pd.Categorical(x['cancellation_code'])))
 return df
```



# Example: Inspect Intermediate Results

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- ```
def csnap(df, fn=lambda x: x.shape, msg=None):  
    """ Custom Help function to print things in method chaining.  
        Returns back the df to further use in chaining.  
    """  
    if msg:  
        print(msg)  
    display(fn(df))  
    return df
```
- ```
wine.pipe(csnap) # display data frame
 .rename(columns={"color_intensity": "ci"})
 .assign(color_filter=lambda x: np.where(x.hue > 1, 1, 0))
 .pipe(csnap) # display data frame
...
```