DataFrames, Indexing, Filtering, Selecting

UBCO Master of Data Science – DATA 542

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Lecture 1 - review

Data wrangling importance

Python dynamic data type vs static data types in languages like C

Overhead of python data types

More efficient data types in Python packages: NumPy and Pandas

NumPy ndarrays

NumPy array creation:

- From python lists and arrays
- From scratch with functions: zeros, ones, full, arrange, linspace, random, eye, empty
- Define data types and array dimensions and size in the functions
- Computations on arrays

Lecture 2 learning outcomes

A the end of this lecture you should be able to:

- Understand the DataFrames and Series objects
- Perform functions on DataFrames and Series to index and select data
- Perform functions on DataFrames and Series to sub-set data (slicing)

Why Pandas?

NumPy data structure (ndarray) is good for computations with:

- Numerical values
- Clean data
- No-missing values

NumPy limitations:

- Categorical data
- Work with labels (attach labels to data)
- Work with missing values
- Heterogeneous data
- Operations that do not map on each element (e.g. grouping, pivot)

Pandas

Built on NumPy

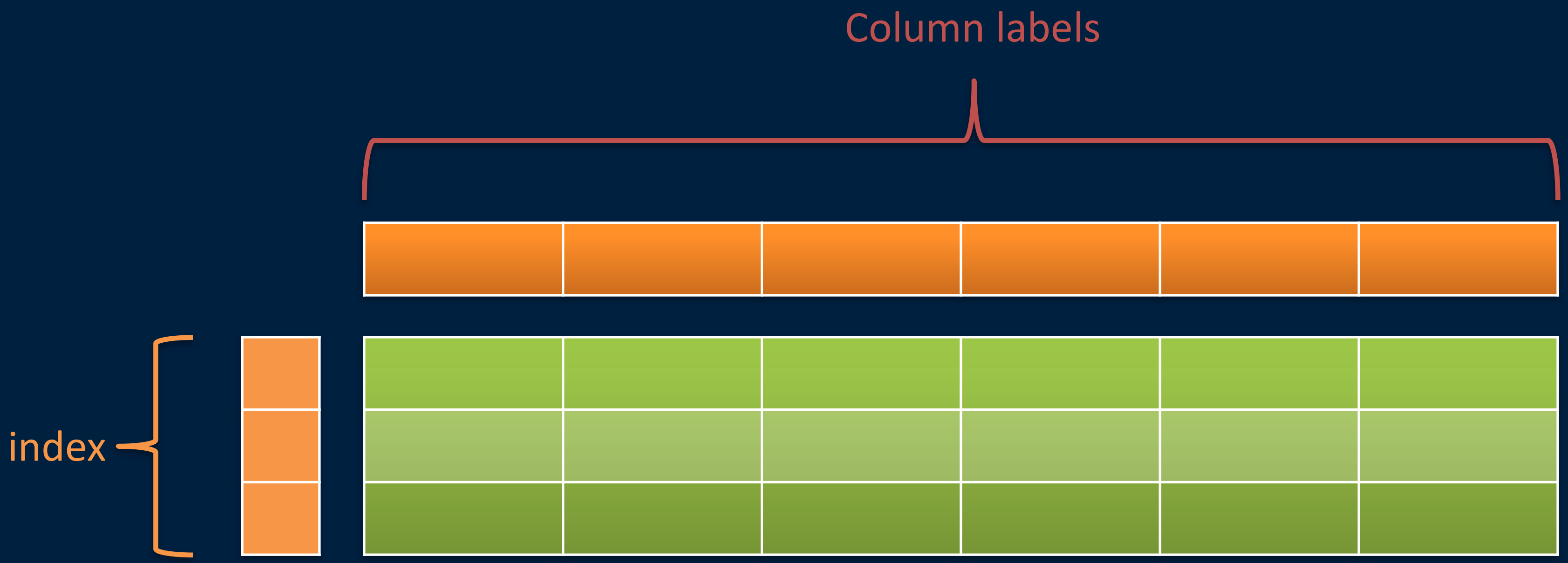
Data structures:

- Series
- DataFrames

Rectangular grids with labels for rows and columns instead of integer indices

Powerful operations on data

DataFrames



Pandas vs NumPy

Pandas vs NumPy

Pandas installation

Refer to Pandas website for installation and documents.

- http://pandas.pydata.org

Install NumPy first

Run

```
conda install pandas
```

Or

```
python3 -m pip install --upgrade pandas
```

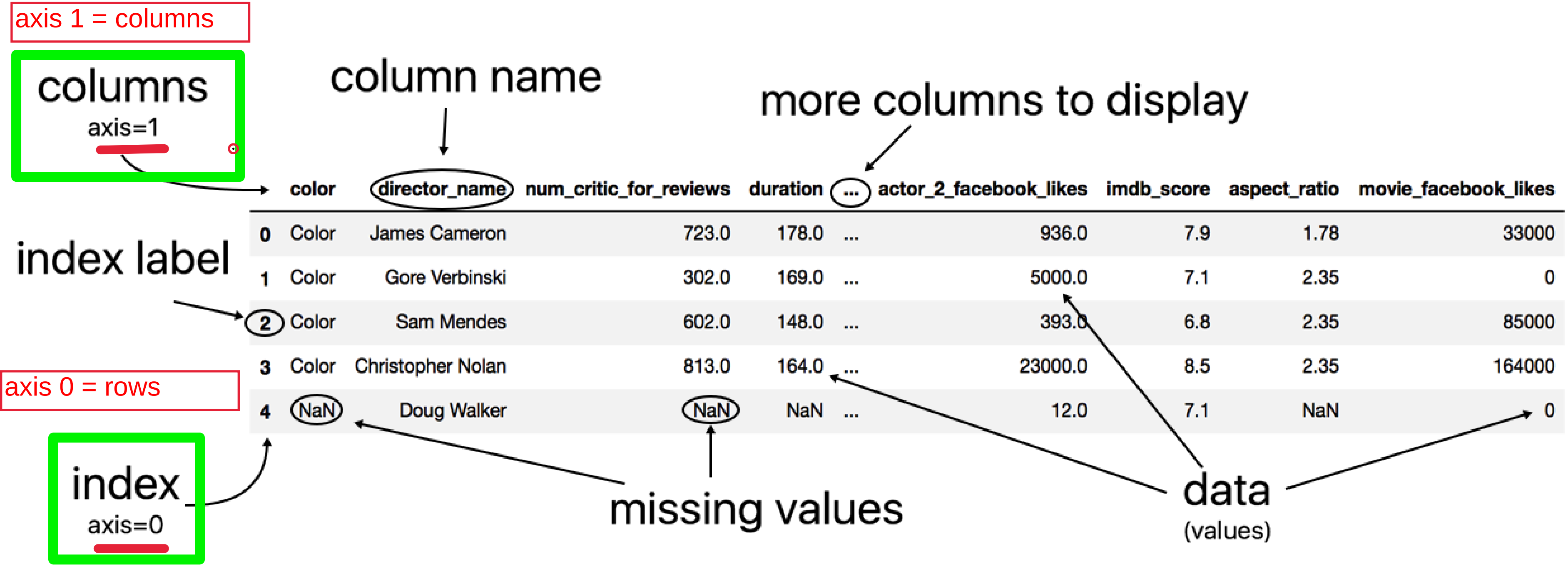
Import Pandas

```
import pandas as pd
```

Access built-in documentation

```
pd.<TAB>
pd.?
```

Anatomy of a DataFrame and a Series



	color	director_name	num_critic_for_reviews	duration	...	actor_2_facebook_likes	imdb_score	aspect_ratio	movie_facebook_likes
0	Color	James Cameron	723.0	178.0	...	936.0	7.9	1.78	33000
1	Color	Gore Verbinski	302.0	169.0	...	5000.0	7.1	2.35	0
2	Color	Sam Mendes	602.0	148.0	...	393.0	6.8	2.35	85000
3	Color	Christopher Nolan	813.0	164.0	...	23000.0	8.5	2.35	164000
4	NaN	Doug Walker	NaN	NaN	...	12.0	7.1	NaN	0

Source: https://medium.com/dunder-data/selecting-subsets-of-data-in-pandas-6fcd0170be9c

Pandas Series

One-dimensional array of indexed data. More general and flexible than NumPy array.

It can be created from a list or array.

```
data = pd.Series([25.,50.,75.,100])
data
```

Output:

```
0 25.0
1 50.0
2 75.0
3 100.0
4 dtype: float64
```

Attributes:

- values
- index

Pandas Series cont.

Numpy Array defines integer index *implicitly*

Pandas Series defines index ***explicitly*** that is associated with the values

```
data = pd.Series( [25.,50.,75.,100]   values
                  ,
            index=['a','b','c',’d’]   index
                 )
```

```
data[ ‘b’ ]
Output: 50.0
```

Pandas Series as dictionaries

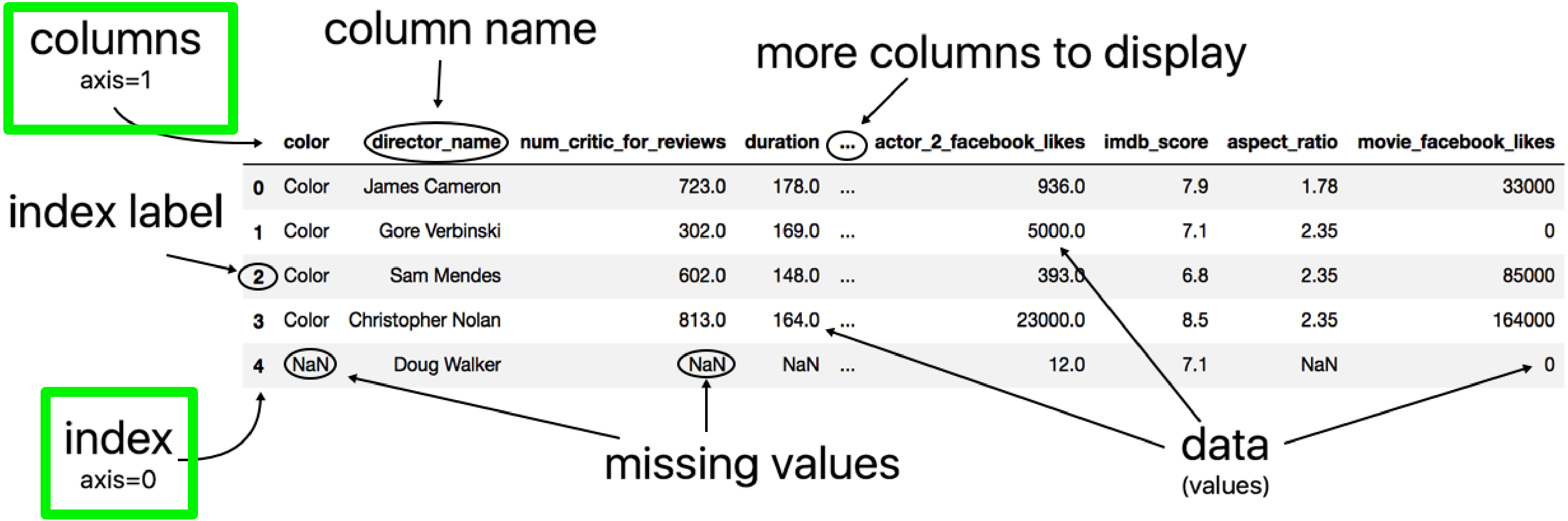
Specialized form of dictionary, more efficient than python dictionary

```
population_dict = {'California': 38332521,
                   'Texas': 26448193,
                   'New York': 19651127,
                   'Florida': 19552860}
population = pd.Series( population_dict )
population['California’]
Output: 38332521
```

Try it

Pass a dictionary

Anatomy of a DataFrame and a Series



	color	director_name	num_critic_for_reviews	duration	...	actor_2_facebook_likes	imdb_score	aspect_ratio	movie_facebook_likes
0	Color	James Cameron	723.0	178.0	...	936.0	7.9	1.78	33000
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4	NaN	Doug Walker	NaN	NaN	...	12.0	7.1	NaN	0

Source: https://medium.com/dunder-data/selecting-subsets-of-data-in-pandas-6fcd0170be9c

Pandas DataFrames (1 of 3)

Data structures as aligned Pandas Series: they share same indices

```
population = pd.Series({'California': 38332521,
                        'Florida': 19552860,
                        'Illinois':12882135,
                        'New York': 19651127,
                        'Texas': 26448193})
```

California	38332521
Florida	19552860
Illinois	12882135
New York	19651127
Texas	26448193

Pandas DataFrames (2 of 3)

```
area = pd.Series({'California': 423967,
                  'Texas': 695662,
                  'New York': 141297,
                  'Florida': 170312,
                  'Illinois': 149995})
```

California	423967
Texas	695662
New York	141297
Florida	170312
Illinois	149995

Pandas DataFrames (3 of 3)

```
states = pd.DataFrame({'population_':
population,'area_': area})
```

	population_	area_
California	38332521	423967
Texas	26448193	695662
New York	19651127	141297
Florida	19552860	170312
Illinois	12882135	149995

Try IT

Create a dataframe called States

1- Using Series:

```
states = pd.DataFrame({'population_':
population,'area_': area})
```

2- Reading from a CSV (next slide)

DataFrames from csv files

```
df = pd.read_csv("US-population-areas.csv",
index_col = 0)
```

Pass the first column as the labels (row index)

Index Labels you want to work with

	population	area
California	38332521	423967
Texas	26448193	695662
New York	19651127	141297
Florida	19552860	170312
Illinois	12882135	149995

Indexing and Slicing

Why indexing/sub setting

Data values from one row

	department	age	height	food	color
Jane	biology	32	160	steak	blue
Sara	chemistry	40	158	lamb	red
Nicole	biology	35	170	apple	orange
Kaden	computer	50	180	cheese	yellow
Jeff	statistics	35	175	steak	blue
Reza	chemistry	45	165	lamb	red
John	statistics	45	162	apple	orange
Ramon	computer	40	175	cheese	yellow
Bryce	engineering	28	180	steak	blue

Why indexing/sub setting: Slicing rows

Data values for everyone who is in biology

	department	age	height	food	color
Jane	biology	32	160	steak	blue
Sara	chemistry	40	158	lamb	red
Nicole	biology	35	170	apple	orange
Kaden	computer	50	180	cheese	yellow
Jeff	statistics	35	175	steak	blue
Reza	chemistry	45	165	lamb	red
John	statistics	45	162	apple	orange
Ramon	computer	40	175	cheese	yellow
Bryce	engineering	28	180	steak	blue

Why indexing/sub setting: Indexing columns

Data values for one or multiple columns. For example department and/or color for all samples

	department	age	height	food	color
Jane	biology	32	160	steak	blue
Sara	chemistry	40	158	lamb	red
Nicole	biology	35	170	apple	orange
Kaden	computer	50	180	cheese	yellow
Jeff	statistics	35	175	steak	blue
Reza	chemistry	45	165	lamb	red
John	statistics	45	162	apple	orange
Ramon	computer	40	175	cheese	yellow
Bryce	engineering	28	180	steak	blue

Why indexing/sub setting: selected rows and columns

Data values for selected rows and columns. For example: everyone is chemistry and his favorite color

	department	age	height	food	color
Jane	biology	32	160	steak	blue
Sara	chemistry	40	158	lamb	red
Nicole	biology	35	170	apple	orange
Kaden	computer	50	180	cheese	yellow
Jeff	statistics	35	175	steak	blue
Reza	chemistry	45	165	lamb	red
John	statistics	45	162	apple	orange
Ramon	computer	40	175	cheese	yellow
Bryce	engineering	28	180	steak	blue

Why indexing/sub setting: Filtering columns based on a condition

Data values for everyone who is shorter than 160

	department	age	height	food	color
Jane	biology	32	160	steak	blue
Sara	chemistry	40	158	lamb	red
Nicole	biology	35	170	apple	orange
Kaden	computer	50	180	cheese	yellow
Jeff	statistics	35	175	steak	blue
Reza	chemistry	45	165	lamb	red
John	statistics	45	162	apple	orange
Ramon	computer	40	175	cheese	yellow
Bryce	engineering	28	180	steak	blue

Slicing Series

Slicing with array-style operations

```
population_dict = {'California': 38332521, 'Texas': 26448193,
                   'New York': 19651127, 'Florida': 19552860}
population = pd.Series( population_dict )
```

```
population['California': 'New York']
```

Inclusive

```
Output:
          California 38332521
          Texas 26448193
          New York 19651127
          dtype: int64
```

Pandas DataFrames

DataFrames as specialized dictionaries

Dictionary: Maps Key to Value

DataFrame: Maps Column name to Series

Column Name

```
States['area']
```

Output:

```
California 423967
Texas      695662
New York   141297
Florida    170312
Illinois   149995
Name: area, dtype: int64
```

Try IT

1- Slice series

2- Slice Dataframe

Use the previous 2 slides

Indexing/sub-setting operations syntax

[ ]

loc [starting row label : inclusive ending row label ,
starting column label : inclusive ending column label]

iloc [starting row number : exclusive ending row number ,
starting column number : exclusive ending column number]

df[]

df.loc[ ]

df.iloc[ ]

Indexers: loc

Use indexing attributes

`loc`: allows indexing and slicing that always references the **explicit** index: LOCATION (Labels)

```
data.loc[1]
Output: 'a'
data.loc[1:3]
Output:
1 a
3 b
```

```
data = pd.Series(['a', 'b', 'c'], index=[1, 3, 5])
```

1	a
3	b
5	c

Indexers: iloc

`iloc`: allows indexing and slicing that always references the **implicit** index: integer indexing

```
data.iloc[1]
```

Output: 'b'

```
data.iloc[1:3]
```

Output:

```
3 b
5 c
```

```
data = pd.Series(['a', 'b', 'c'], index=[1, 3, 5])
```

1	a
3	b
5	c

Indexing/sub-setting operations

[ ]

loc [starting row : **inclusive** ending row , starting column : **inclusive** ending column]

If did not mention, means start from the first one until the ending row/column

iloc [starting row : **exclusive** ending row , starting column : **exclusive** ending column]

If did not mention, means start from the starting row/column until the end
THE SAME APPLIES FOR ENDING IN THE LOC OPERATION

Data selection in DataFrames

Dictionary-style:

```
data['area']
```

Column name

Attribute-style:

```
data.area
```

Column name

	population	area
California	38332521	423967
Texas	26448193	695662
New York	19651127	141297
Florida	19552860	170312
Illinois	12882135	149995

Data selection in DataFrames cont.

Attribute-style does not work for:

- Column name is not string
- Column name conflicts with DataFrame functions (such as `pop()`)

```
data.area is data['area’] output: True
data.pop is data[‘pop’] output: False
```

Do NOT use attribute style for assignment in DataFrames

`pop(item)`: returns an item from DataFrame

Data selection in DataFrames cont.

```
data['density'] =
data['population']/data['area']
```

	population	area	density
California	38332521	423967	90.413926
Texas	26448193	695662	38.018740
New York	19651127	141297	139.076746
Florida	19552860	170312	114.806121
Illinois	12882135	149995	85.883763

More Examples

Indexers: loc

Use indexing attributes

`loc`: allows indexing and slicing that always references the **explicit** index: LOCATION (Labels)

```
data.loc[1]
Output: 'a'
data.loc[1:3]
Output:
1  a
3  b
```

1 and 3 is referencing the labels here

```
data = pd.Series(['a', 'b', 'c'], index=[1, 3, 5])
```

1	a
3	b
5	c

Indexers: iloc

`iloc`: allows indexing and slicing that always references the **implicit** index: integer indexing

```
data.iloc[1]
```

Output: 'b'

```
data.iloc[1:3]
```

Output:

3 b

5 c

1 and 3 is referencing the index, ie. b is at index 1 (think in terms of list [a,b,c])

```
data = pd.Series(['a', 'b', 'c'],
index=[1, 3, 5])
```

1	a
3	b
5	c

Data selection in DataFrames

Dictionary-style:

```
data['area']
```

Column name

Attribute-style:

```
data.area
```

Column name

	population	area
California	38332521	423967
Texas	26448193	695662
New York	19651127	141297
Florida	19552860	170312
Illinois	12882135	149995

Data selection in DataFrames cont.

Attribute-style does not work for:

- Column name is not string

- Column name conflicts with DataFrame functions (such as `pop()`)

```
data.area is data['area’] output: True
data.pop is data[‘pop’] output: False
```

Do NOT use attribute style for assignment in DataFrames

`pop(item)`: returns an item from DataFrame

Data selection in DataFrames cont.

```
data['density'] =
data['population']/data['area']
```

	population	area	density
California	38332521	423967	90.413926
Texas	26448193	695662	38.018740
New York	19651127	141297	139.076746
Florida	19552860	170312	114.806121
Illinois	12882135	149995	85.883763

Data selection in DataFrames cont.

Array-style:

```
data.values
```

```
array([[3.83325210e+07, 4.23967000e+05, 9.04139261e+01],
       [2.64481930e+07, 6.95662000e+05, 3.80187404e+01],
       [1.96511270e+07, 1.41297000e+05, 1.39076746e+02],
       [1.95528600e+07, 1.70312000e+05, 1.14806121e+02],
       [1.28821350e+07, 1.49995000e+05, 8.58837628e+01]])
```

```
data.values[0]
```

```
array([3.83325210e+07, 4.23967000e+05, 9.04139261e+01])
```

Data selection in DataFrames cont.

Array-style:

```
data.T      #Transpose
```

	California	Texas	New York	Florida	Illinois
population	3.833252e+07	2.644819e+07	1.965113e+07	1.955286e+07	1.288214e+07
area	4.239670e+05	6.956620e+05	1.412970e+05	1.703120e+05	1.499950e+05
density	9.041393e+01	3.801874e+01	1.390767e+02	1.148061e+02	8.588376e+01

Data selection in DataFrames cont.

iloc and loc:

```
data.iloc[:4, :2]
```

	population	area
California	38332521	423967
Texas	26448193	695662
New York	19651127	141297
Florida	19552860	170312

```
Data.loc['California':'New York', 'area':]
```

	area	density
California	423967	90.413926
Texas	695662	38.018740
New York	141297	139.076746

Data selection in DataFrames cont.

Combining NumPy-style data access patterns with indexers in DataFrames:

```
# combine masking and fancy indexing
data.loc[ data.density > 100, ['population', 'area’] ]
```

Discuss the output

	population	area	density
California	38332521	423967	90.413926
Texas	26448193	695662	38.018740
New York	19651127	141297	139.076746
Florida	19552860	170312	114.806121
Illinois	12882135	149995	85.883763

Data selection in DataFrames cont.

Combining NumPy-style data access patterns with indexers in DataFrames:

```
data.iloc[0,2]=90
```

	population	area	density
California	38332521	423967	90.000000
Texas	26448193	695662	38.018740
New York	19651127	141297	139.076746
Florida	19552860	170312	114.806121
Illinois	12882135	149995	85.883763

DataFrame Slicing: sub- setting rows

```
data[1:3]
```

	population	area	density
Texas	26448193	695662	38.018740
New York	19651127	141297	139.076746

```
data['Texas': 'Florida’]
```

	population	area	density
Texas	26448193	695662	38.018740
New York	19651127	141297	139.076746
Florida	19552860	170312	114.806121

DataFrame Slicing: sub- setting rows through masking

Masking is a row-wise operation:

```
data[(80 <data.density) & (data.density < 115)]
```

	population	area	density
California	38332521	423967	90.000000
Florida	19552860	170312	114.806121
Illinois	12882135	149995	85.883763

In Practice
More on Series and Dataframes

Pandas Series cont.

Attributes:

- values
- index

Values are NumPy arrays.

```
data.values
Output: array([ 25., 50., 75., 100.])
```

Pandas Series cont.

index is an array-like object of type pd.Index.

See index:

```
data.index
```

```
Output: RangeIndex(start=0, stop=4, step=1)
```

Or access by [] :

```
Data[1:3]
```

```
Output:
            1  50.0
            2  75.0
            dtype: float64
```

Pandas Series cont.

Numpy Array defines integer index *implicitly*

Pandas Series defines index ***explicitly*** that is associated with the values

```
data = pd.Series( [25.,50.,75.,100]   values
                  ,
            index=['a','b','c',’d’]   index
                 )
```

```
data[ ‘b’ ]
Output: 50.0
```

Pandas Series cont.

```
data = pd.Series([25.,50.,75.,100],
                 index=['a', 'b','c','d’])


data = pd.Series([25.,50.,75.,100],
                 index=[7,2,3,6])


data = pd.Series([25.,50.,75.,100],
                 index=[‘a’,5,’b’,7])
```

Not desirable for operation : when slicing

Pandas Series as dictionaries

Specialized form of dictionary, more efficient than python dictionary

```
population_dict = {'California': 38332521,
                   'Texas': 26448193,
                   'New York': 19651127,
                   'Florida': 19552860}
population = pd.Series( population_dict )
population['California’]
Output: 38332521
```

Try it

Pass a dictionary

Pandas Series as dictionaries cont.

Slicing with array-style operations

```
population_dict = {'California': 38332521, 'Texas': 26448193,
                   'New York': 19651127, 'Florida': 19552860}
population = pd.Series( population_dict )
```

```
population['California': 'New York']
```

Inclusive

```
Output:
            California 38332521
            Texas 26448193
            New York 19651127
            dtype: int64
```

Constructing Series objects

```
pd.Series(data, index=index)
```

optional

Data can be:

1- List or NumPy array

```
pd.Series([2, 4, 6])
```

2- Scalar

```
pd.Series(5, index=[100, 200, 300])
```

3- dictionary

```
pd.Series({2:'a', 1:'b', 3:'c’})
```

Constructing Series objects cont.

4- explicitly set index to have a different result

```
pd.Series({2:'a', 1:'b', 3:'c'}, index=[3, 2])
```

Desired indices
(Explicitly identified keys)

```
Output:
            3  c
            2  a
            dtype: object
```

Question

Question 1: What is the result of executing this code:

```
my_list = [2, 3, '2', 5,'me']
index = ['i', 'j', 'k', 2, 3]
data = pd.Series(my_list, index)
```

A) Value error

B) Type error

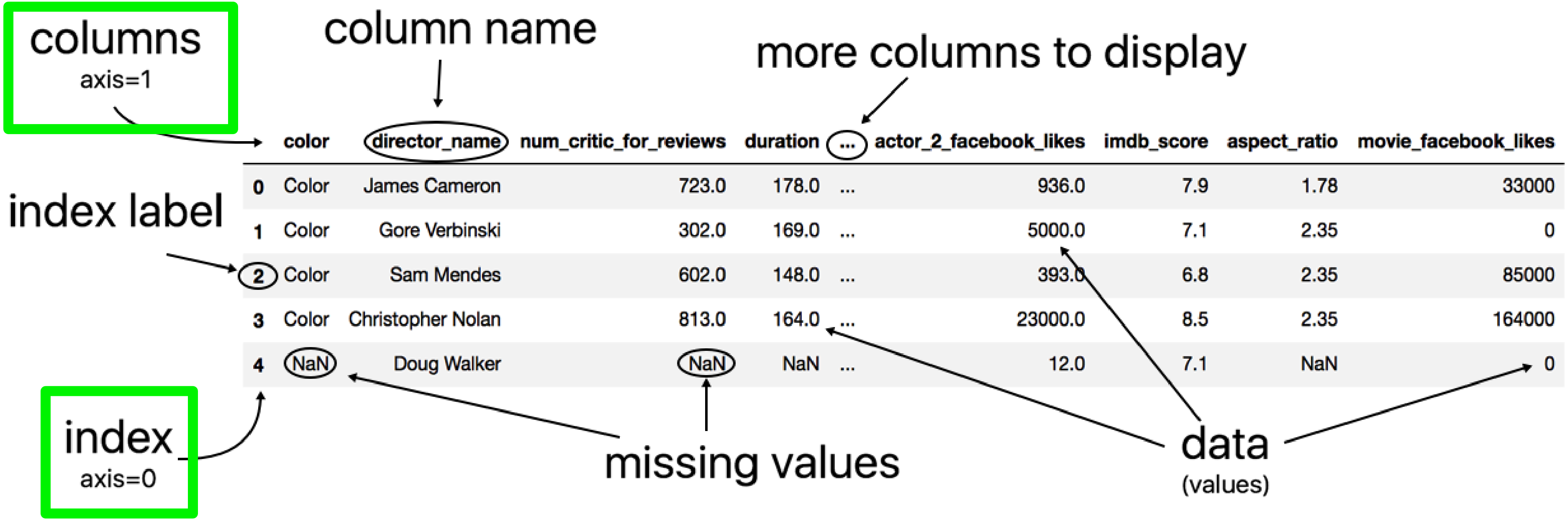
C)

```
i     2
j     3
k     2
2     5
3    me
```

D)

```
0     2
1     3
2     2
3     5
4    me
```

Anatomy of a DataFrame and a Series



	color	director_name	num_critic_for_reviews	duration	...	actor_2_facebook_likes	imdb_score	aspect_ratio	movie_facebook_likes
0	Color	James Cameron	723.0	178.0	...	936.0	7.9	1.78	33000
1	Color	Gore Verbinski	302.0	169.0	...	5000.0	7.1	2.35	0
2	Color	Sam Mendes	602.0	148.0	...	393.0	6.8	2.35	85000
3	Color	Christopher Nolan	813.0	164.0	...	23000.0	8.5	2.35	164000
4	NaN	Doug Walker	NaN	NaN	...	12.0	7.1	NaN	0

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Pandas DataFrames

Data structures as aligned Pandas Series: they share same indices

```
population = pd.Series({'California': 38332521,
                        'Florida': 19552860,
                        'Illinois':12882135,
                        'New York': 19651127,
                        'Texas': 26448193})
```

California	38332521
Florida	19552860
Illinois	12882135
New York	19651127
Texas	26448193

Pandas DataFrames cont.

```
area = pd.Series({'California': 423967,
                  'Texas': 695662,
                  'New York': 141297,
                  'Florida': 170312,
                  'Illinois': 149995})
```

California	423967
Texas	695662
New York	141297
Florida	170312
Illinois	149995

Pandas DataFrames cont.

```
states = pd.DataFrame({'population_':
population,'area_': area})
```

	population_	area_
California	38332521	423967
Texas	26448193	695662
New York	19651127	141297
Florida	19552860	170312
Illinois	12882135	149995

Pandas DataFrames cont.

Attributes: index , columns

Dot notation

```
states.index
```

```
Output:

Index(['California', 'Texas', 'New York',
'Florida', 'Illinois'], dtype='object’)
```

Dot notation

```
states.columns
```

```
Output:

Index(['population_', 'area_'], dtype='object')
```

Creating DataFrame objects

1- From an single Series

```
pd.DataFrame(population, columns=['population’])
```

Optional, if no column name is chosen
you will see integer index starting at 0

2- From a *list* of *dictionaries*

```
data = [{'a': i, 'b': 2 * i} for i in range(3)]
pd.DataFrame(data)
```

Question

Question 1: What is the result of the following code?

```
data = [{'a': i, 'b': 2 * i} for i in range(3)]
```

```
[{'a': 0, 'b': 0}, {'a': 1, 'b': 2}, {'a': 2, 'b': 4}]
```

Question 2: What is the result of the following code?

```
pd.DataFrame(data)
```

	a	b
0	0	0
1	1	2
2	2	4

Creating DataFrame objects cont.

3- From a **list of dictionaries**, with missing keys

Pandas will the missing values with **NAN**

```
pd.DataFrame([{'a': 1, 'b': 2},
              {'b': 3, 'c': 4}])
```

row

	a	b	c
0	1.0	2	NaN
1	NaN	3	4.0

Null values are filled with NAN

Creating DataFrame objects cont.

4- From a dictionary of Series objects

```
pd.DataFrame({'population': population,
              'area': area})
```

Creating DataFrame objects cont.

5- From a two-dimensional NumPy array

```
pd.DataFrame(np.random.rand(3, 2),
columns=['foo', 'bar'], index=['a', 'b', 'c’])
```

Optional, if column name and index is not defined, integer index will be used for each

	foo	bar
a	0.997026	0.985137
b	0.175123	0.834443
c	0.606030	0.725598

Creating DataFrame objects cont.

6-Reading from a file

```
df  = pd.read_csv("US-population-areas.csv")
```

File Path

	Unnamed: 0	population	area
0	California	38332521	423967
1	Texas	26448193	695662
2	New York	19651127	141297
3	Florida	19552860	170312
4	Illinois	12882135	149995

Creates integer indexes

DataFrames from csv files

```
df  = pd.read_csv("US-population-areas.csv",
index_col = 0)
```

Pass the first column as the labels (row index)

Index Labels you want to work with

	population	area
California	38332521	423967
Texas	26448193	695662
New York	19651127	141297
Florida	19552860	170312
Illinois	12882135	149995

Pandas DataFrames cont.

Attributes:

- values
- Index
- columns

```
index = df.index
columns = df.columns
values = df.values

type(index)
type(columns)
type(values)
```

Question

Question 1: What is the resulting dataframe?

```
pd.DataFrame([{'a': 1, 'b': 2},
              {'b': 3, 'c': 4}])
```

A

	a	b	c
0	1.0	2	NaN
1	NaN	3	4.0

B

	a	b	c
0	1.0	2.0	NaN
1	NaN	NaN	4.0

C

	a	b
0	1	2
1	4	3

Pandas DataFrames cont.

DataFrames as specialized dictionaries

Dictionary: Maps Key to Value

DataFrame: Maps Column name to Series

Column Name

```
States['area']
```

Output:

```
California  423967
Texas       695662
New York    141297
Florida     170312
Illinois    149995
Name: area, dtype: int64
```

Pandas index object

Like **immutable** arrays and ordered set in Python

Indexing, slicing, and NumPy array attributes

```
ind = pd.Index([2, 3, 5, 7, 11])
ind[1]
Output: 3
ind[::2]
Output: Int64Index([2, 5, 11], dtype='int64')
print(ind.size, ind.shape, ind.ndim, ind.dtype)
Output: 5 (5,) 1 int64
```

Pandas index object cont.

Unions, intersections, differences and other Set operations

```
indA = pd.Index([1, 3, 5, 7, 9])
indB = pd.Index([2, 3, 5, 7, 11])
indA & indB # intersection
indA.intersection(indB) ←——— Object methods
Output: Int64Index([3, 5, 7], dtype='int64')
indA | indB # union
indA ^ indB # symmetric difference
Output: Int64Index([1, 2, 9, 11],
dtype='int64')
```

Question

Question 1: Index object in Pandas is immutable. The following statement will give an error. True or False?

```
ind = pd.Index([2, 3, 5, 7, 11])
ind[2]=8
```

1) `True`
2) `False`

Try it:

Create a Series of three of your family members.

Create a Series of their favorite fruit.

Create a Series of their age.

Create a DataFrame for your family members from the above Series.

Select the first two members and their ages.

In Practice
More on Slicing and Indexing
Series and Dataframes

Series

Dictionary-like operations

```
data = pd.Series([0.25, 0.5, 0.75, 1.0],
index=['a', 'b', 'c', 'd’])
```

```
1- data['b’]
2- 'a' in data
3- data.keys()
4- list(data.items())
5- data['e'] = 1.25
   data
```

Discuss the output

Series cont.

NumPy arrays operations: *slicing*

```
data = pd.Series([0.25, 0.5, 0.75, 1.0],
index=['a', 'b', 'c', 'd'])
```

Discuss the output

```
data['a':'c'] # slicing by explicit index
```

Start **Inclusive End**

```
data[0:2] # slicing by implicit integer index
```

Exclusive End

Series cont.

Discuss the output

NumPy arrays operations: *masking*, and *fancy indexing*

```
data = pd.Series([0.25, 0.5, 0.75, 1.0, 1.25],
                 index=['a', 'b', 'c', 'd', 'e'])
```

Desired conditions **Combination operations**

```
data[(data > 0.3) & (data < 0.8)] # masking
```

```
b    0.50
c    0.75
dtype: float64
```

Series cont.

Discuss the output

NumPy arrays operations: *masking*, and *fancy indexing*

```
data = pd.Series([0.25, 0.5, 0.75, 1.0, 1.25],
                 index=['a', 'b', 'c', ‘d’, ‘e’])


data[['a', 'e']] # fancy indexing
```

List of desired indicies

```
a      0.25
e      1.25
dtype: float64
```

Source of CONFUSION with integer indexing

Try it yourself

```
data = pd.Series(['a', 'b', 'c'], index=[1, 3, 5])
# explicit index when indexing - Output: 'a'
data[1]
# implicit index when slicing  -
data[1:3]
Output:
3 b
5 c dtype: object
```

Indexers: loc

Use indexing attributes

`loc`: allows indexing and slicing that always references the **explicit** index: LOCATION (Labels)

```
data = pd.Series(['a', 'b', 'c'], index=[1, 3, 5])
```

```
1    a
3    b
5    c
```

```
data.loc[1]
```

Output: 'a'

```
data.loc[1:3]
```

Output:

```
1 a
3 b
```

Indexers: iloc

`iloc`: allows indexing and slicing that always references the **implicit** index: integer indexing

```
data.iloc[1]
```

Output: 'b'

```
data.iloc[1:3]
```

Output:

```
3 b
5 c
```

```
data = pd.Series(['a', 'b', 'c'], index=[1, 3, 5])
```

1	a
3	b
5	c

Data selection in DataFrames

Dictionary-style:

```
data['area']
```

Column name

Attribute-style:

```
data.area
```

Column name

	population	area
California	38332521	423967
Texas	26448193	695662
New York	19651127	141297
Florida	19552860	170312
Illinois	12882135	149995

Data selection in DataFrames cont.

Attribute-style does not work for:

- Column name is not string
- Column name conflicts with DataFrame functions (such as `pop()`)

```
data.area is data['area’] output: True
data.pop is data[‘pop’] output: False
```

Do NOT use attribute style for assignment in DataFrames

`pop(item)`: returns an item from DataFrame

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