pandas.DataFrame

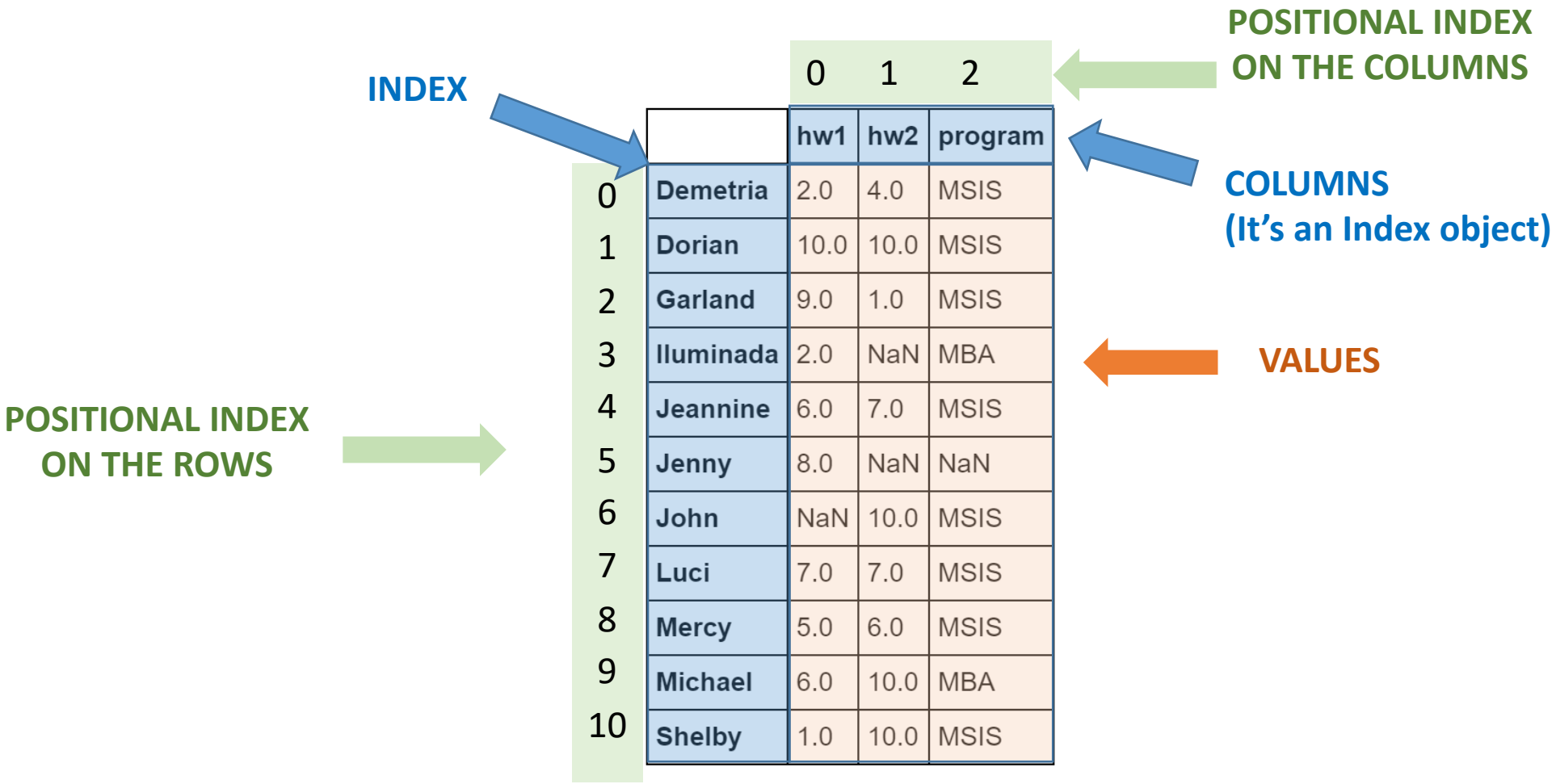
module 4

Announcements

- Codecademy due 5/1
- Form groups of 3 for project:
  - Detect interesting and somewhat unexpected finding in a real-world data set of your choice – more details later

DataFrame

DataFrame = Table



Index, columns, values

Return the index (as an index object), the columns (as index object) and the values (as 2-dimensional ndarray)

Example:

```
df.index
```

```
Index([u'Demetria', u'Dorian', u'Garland', u'Iluminada', u'Jeannine', u'Jenny',
       u'John', u'Luci', u'Mercy', u'Michael', u'Shelby'],
      dtype='object')
```

```
df.columns
```

```
Index([u'hw1', u'hw2', u'program'], dtype='object')
```

```
df.values
```

```
array([[2.0, 4.0, 'MSIS'],
       [10.0, 10.0, 'MSIS'],
       [9.0, 1.0, 'MSIS'],
       [2.0, nan, 'MBA'],
       [6.0, 7.0, 'MSIS'],
       [8.0, nan, nan],
       [nan, 10.0, 'MSIS'],
       [7.0, 7.0, 'MSIS'],
       [5.0, 6.0, 'MSIS'],
       [6.0, 10.0, 'MBA'],
       [1.0, 10.0, 'MSIS']], dtype=object)
```

POSITIONAL INDEX ON THE COLUMNS

INDEX

POS. INDEX ON ROWS

COLUMNS

VALUES

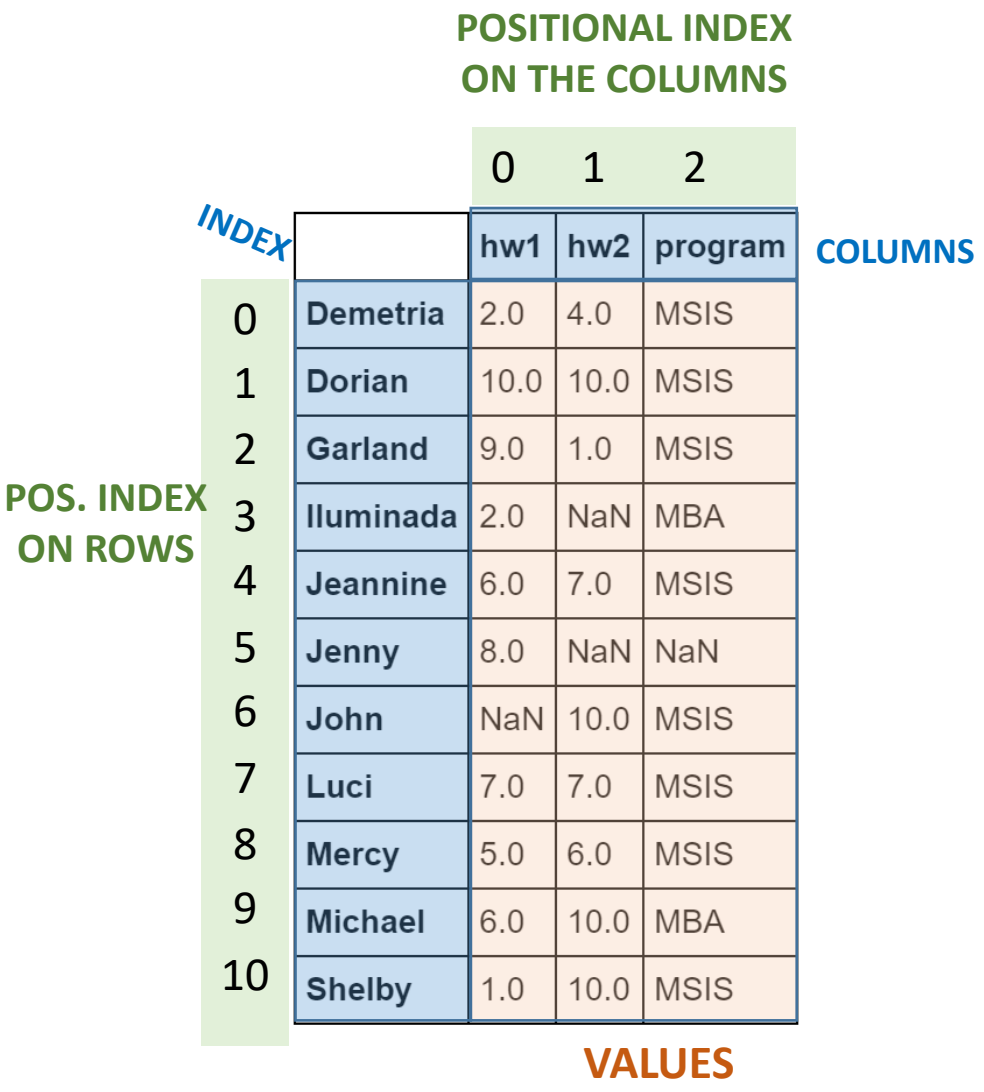
		0	1	2
		hw1	hw2	program
0	Demetria	2.0	4.0	MSIS
1	Dorian	10.0	10.0	MSIS
2	Garland	9.0	1.0	MSIS
3	Iluminada	2.0	NaN	MBA
4	Jeannine	6.0	7.0	MSIS
5	Jenny	8.0	NaN	NaN
6	John	NaN	10.0	MSIS
7	Luci	7.0	7.0	MSIS
8	Mercy	5.0	6.0	MSIS
9	Michael	6.0	10.0	MBA
10	Shelby	1.0	10.0	MSIS

df.iloc[x,y]

Access using the **positional index**..

•**x** is the information needed to select the rows: positional index or range of integers

•**y (optional)** is the information needed to select the columns: positional index or range of integers



df.iloc[x,y] – one row

```
df.iloc[2,:]
```

```
df.iloc[2]
```

RESULT:

```
hw1              9
hw2              1
program       MSIS
Name: Garland, dtype: object
```

A Series!

POSITIONAL INDEX ON THE COLUMNS

INDEX		0 hw1	1 hw2	2 program
0	Demetria	2.0	4.0	MSIS
1	Dorian	10.0	10.0	MSIS
2	Garland	9.0	1.0	MSIS
3	Iluminada	2.0	NaN	MBA
4	Jeannine	6.0	7.0	MSIS
5	Jenny	8.0	NaN	NaN
6	John	NaN	10.0	MSIS
7	Luci	7.0	7.0	MSIS
8	Mercy	5.0	6.0	MSIS
9	Michael	6.0	10.0	MBA
10	Shelby	1.0	10.0	MSIS

POS. INDEX ON ROWS

COLUMNS

df.iloc[x,y] – one column

```
df.iloc[:,1]
```

RESULT:

```
Demetria      4.0
Dorian       10.0
Garland       1.0
Iluminada     NaN
Jeannine      7.0
Jenny         NaN
John         10.0
Luci          7.0
Mercy         6.0
Michael      10.0
Shelby       10.0
Name: hw2, dtype: float64
```

POSITIONAL INDEX ON THE COLUMNS

		0	1	2
INDEX		hw1	hw2	program
0	Demetria	2.0	4.0	MSIS
1	Dorian	10.0	10.0	MSIS
2	Garland	9.0	1.0	MSIS
3	Iluminada	2.0	NaN	MBA
4	Jeannine	6.0	7.0	MSIS
5	Jenny	8.0	NaN	NaN
6	John	NaN	10.0	MSIS
7	Luci	7.0	7.0	MSIS
8	Mercy	5.0	6.0	MSIS
9	Michael	6.0	10.0	MBA
10	Shelby	1.0	10.0	MSIS

POS. INDEX ON ROWS

COLUMNS

df.iloc[x,y] – one specific value

```
df.iloc[2,1]
```

```
1.0
```

POSITIONAL INDEX ON THE COLUMNS

INDEX		hw1	hw2	program
		0	1	2
0	Demetria	2.0	4.0	MSIS
1	Dorian	10.0	10.0	MSIS
2	Garland	9.0	1.0	MSIS
3	Iluminada	2.0	NaN	MBA
4	Jeannine	6.0	7.0	MSIS
5	Jenny	8.0	NaN	NaN
6	John	NaN	10.0	MSIS
7	Luci	7.0	7.0	MSIS
8	Mercy	5.0	6.0	MSIS
9	Michael	6.0	10.0	MBA
10	Shelby	1.0	10.0	MSIS

POS. INDEX ON ROWS

COLUMNS

df.iloc[x,y] – a subset of rows/columns

```
df.iloc[:5,-2:]
```

	hw2	program
Demetria	4.0	MSIS
Dorian	10.0	MSIS
Garland	1.0	MSIS
Iluminada	NaN	MBA
Jeannine	7.0	MSIS

POSITIONAL INDEX ON THE COLUMNS

		0	1	2
INDEX		hw1	hw2	program
0	Demetria	2.0	4.0	MSIS
1	Dorian	10.0	10.0	MSIS
2	Garland	9.0	1.0	MSIS
3	Iluminada	2.0	NaN	MBA
4	Jeannine	6.0	7.0	MSIS
5	Jenny	8.0	NaN	NaN
6	John	NaN	10.0	MSIS
7	Luci	7.0	7.0	MSIS
8	Mercy	5.0	6.0	MSIS
9	Michael	6.0	10.0	MBA
10	Shelby	1.0	10.0	MSIS

POS. INDEX ON ROWS

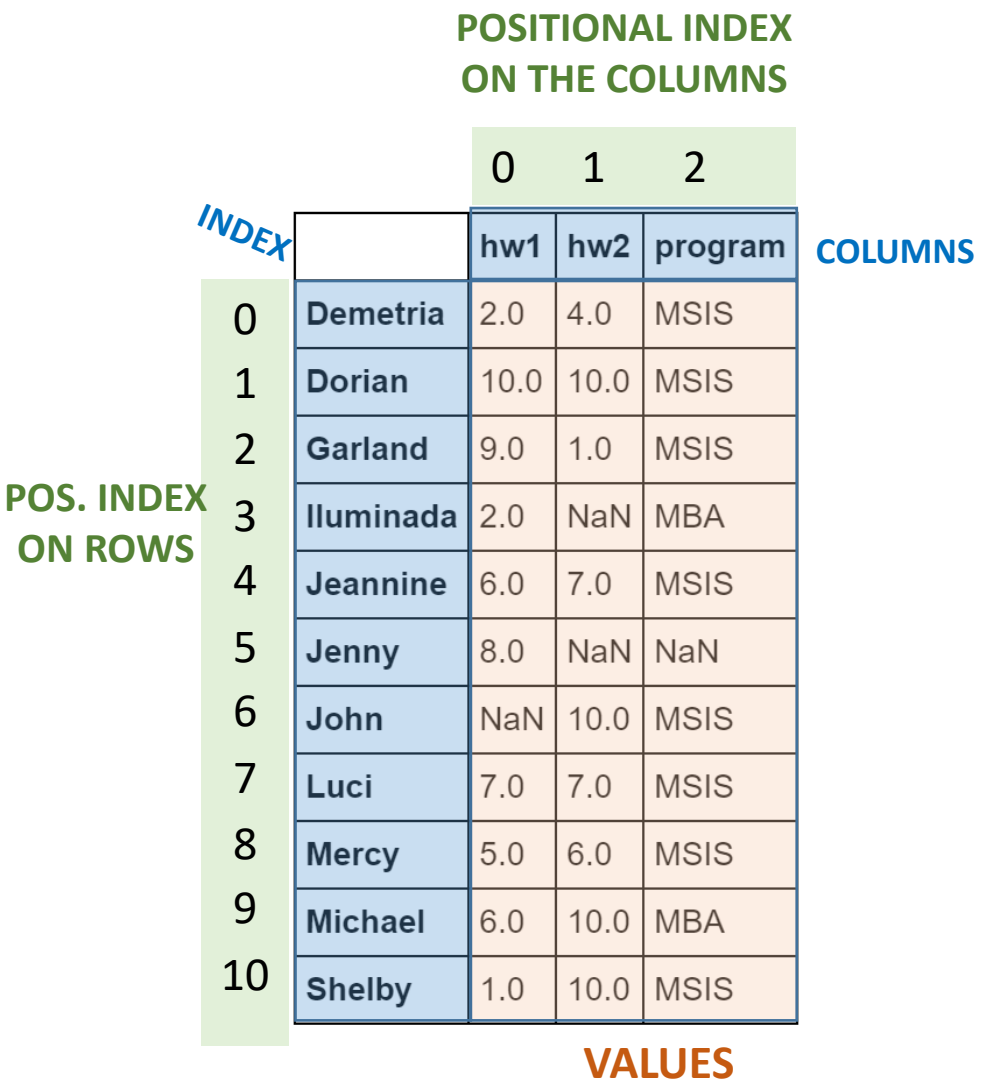
COLUMNS

df.loc[x,y]

Access using the **index labels**.

•**x** s the information needed to select the rows: label index, range of index labels, or **boolean masks**

•**y (optional)** is the information needed to select the columns: label index, range of index labels, or **boolean masks**



df.loc[x,y] – one specific value

```
df.loc['Garland','hw2']
```

```
1.0
```

POSITIONAL INDEX ON THE COLUMNS

		0	1	2
INDEX		hw1	hw2	program
0	Demetria	2.0	4.0	MSIS
1	Dorian	10.0	10.0	MSIS
2	Garland	9.0	1.0	MSIS
3	Iluminada	2.0	NaN	MBA
4	Jeannine	6.0	7.0	MSIS
5	Jenny	8.0	NaN	NaN
6	John	NaN	10.0	MSIS
7	Luci	7.0	7.0	MSIS
8	Mercy	5.0	6.0	MSIS
9	Michael	6.0	10.0	MBA
10	Shelby	1.0	10.0	MSIS

POS. INDEX ON ROWS

COLUMNS

df.loc[x,y] – one row

```
df.loc['Garland',:]
```

```
df.loc['Garland']
```

RESULT:

```
hw1              9
hw2              1
program       MSIS
Name: Garland, dtype: object
```

A Series!

POSITIONAL INDEX ON THE COLUMNS

INDEX		0 hw1	1 hw2	2 program
0	Demetria	2.0	4.0	MSIS
1	Dorian	10.0	10.0	MSIS
2	Garland	9.0	1.0	MSIS
3	Iluminada	2.0	NaN	MBA
4	Jeannine	6.0	7.0	MSIS
5	Jenny	8.0	NaN	NaN
6	John	NaN	10.0	MSIS
7	Luci	7.0	7.0	MSIS
8	Mercy	5.0	6.0	MSIS
9	Michael	6.0	10.0	MBA
10	Shelby	1.0	10.0	MSIS

POS. INDEX ON ROWS

COLUMNS

df.loc[x,y] – one column

```
df.loc[:,'hw1']
```

```
df['hw1']
```

```
df.hw1
```

RESULT:

```
Name
Demetria       2.0
Dorian        10.0
Garland        9.0
Iluminada      2.0
Jeannine       6.0
Jenny          8.0
John           NaN
Luci           7.0
Mercy          5.0
Michael        6.0
Shelby         1.0
Name: hw1, dtype: float64
```

POSITIONAL INDEX ON THE COLUMNS

POS. INDEX ON ROWS

INDEX		0 hw1	1 hw2	2 program
0	Demetria	2.0	4.0	MSIS
1	Dorian	10.0	10.0	MSIS
2	Garland	9.0	1.0	MSIS
3	Iluminada	2.0	NaN	MBA
4	Jeannine	6.0	7.0	MSIS
5	Jenny	8.0	NaN	NaN
6	John	NaN	10.0	MSIS
7	Luci	7.0	7.0	MSIS
8	Mercy	5.0	6.0	MSIS
9	Michael	6.0	10.0	MBA
10	Shelby	1.0	10.0	MSIS

COLUMNS

df.loc[x,y] – using Boolean masks

Select those students whose name starts with 'J'

```
mask = (df.index >= 'J') & (df.index < 'K')
df.loc[mask,:]
```

	hw1	hw2	program
Name			
Jeannine	6.0	7.0	MSIS
Jenny	8.0	NaN	NaN
John	NaN	10.0	MSIS

POSITIONAL INDEX ON THE COLUMNS

		0	1	2
INDEX		hw1	hw2	program
0	Demetria	2.0	4.0	MSIS
1	Dorian	10.0	10.0	MSIS
2	Garland	9.0	1.0	MSIS
3	Iluminada	2.0	NaN	MBA
4	Jeannine	6.0	7.0	MSIS
5	Jenny	8.0	NaN	NaN
6	John	NaN	10.0	MSIS
7	Luci	7.0	7.0	MSIS
8	Mercy	5.0	6.0	MSIS
9	Michael	6.0	10.0	MBA
10	Shelby	1.0	10.0	MSIS

POS. INDEX ON ROWS

COLUMNS

Problems

1. Retrieve Shelby's hw1 grade
2. Retrieve Shelby's information
3. Who obtained the highest grade in hw2? Note that there are ties
4. Find those students who obtained the same score in hw1 and in hw2.
5. Find the average hw1 score of those students who got a hw2 score greater than 5.

sort_values

Sort the rows based on the value of a column

```
df.sort_values(by='hw1',ascending=False)
```

	hw1	hw2	program
Dorian	10.0	10.0	MSIS
Garland	9.0	1.0	MSIS
Jenny	8.0	NaN	NaN
Luci	7.0	7.0	MSIS
Jeannine	6.0	7.0	MSIS
Michael	6.0	10.0	MBA
Mercy	5.0	6.0	MSIS
Demetria	2.0	4.0	MSIS
Iluminada	2.0	NaN	MBA
Shelby	1.0	10.0	MSIS
John	NaN	10.0	MSIS

```
df.sort_values(by=['hw1','hw2'],ascending=[False, True])
```

	hw1	hw2	program
Dorian	10.0	10.0	MSIS
Garland	9.0	1.0	MSIS
Jenny	8.0	NaN	NaN
Luci	7.0	7.0	MSIS
Jeannine	6.0	7.0	MSIS
Michael	6.0	10.0	MBA
Mercy	5.0	6.0	MSIS
Demetria	2.0	4.0	MSIS
Iluminada	2.0	NaN	MBA
Shelby	1.0	10.0	MSIS
John	NaN	10.0	MSIS

POS. INDEX ON ROWS

POSITIONAL INDEX ON THE COLUMNS

	0	1	2
INDEX		hw1	hw2	program
0	**Demetria**	2.0	4.0	MSIS
1	**Dorian**	10.0	10.0	MSIS
2	**Garland**	9.0	1.0	MSIS
3	**Iluminada**	2.0	NaN	MBA
4	**Jeannine**	6.0	7.0	MSIS
5	**Jenny**	8.0	NaN	NaN
6	**John**	NaN	10.0	MSIS
7	**Luci**	7.0	7.0	MSIS
8	**Mercy**	5.0	6.0	MSIS
9	**Michael**	6.0	10.0	MBA
10	**Shelby**	1.0	10.0	MSIS

COLUMNS

sort_index

Sort by the index labels

```
df.sort_index()
```

	hw1	hw2	program
Demetria	2.0	4.0	MSIS
Dorian	10.0	10.0	MSIS
Garland	9.0	1.0	MSIS
Iluminada	2.0	NaN	MBA
Jeannine	6.0	7.0	MSIS
Jenny	8.0	NaN	NaN
John	NaN	10.0	MSIS
Luci	7.0	7.0	MSIS
Mercy	5.0	6.0	MSIS
Michael	6.0	10.0	MBA
Shelby	1.0	10.0	MSIS

POSITIONAL INDEX ON THE COLUMNS

		0	1	2	
INDEX		hw1	hw2	program	COLUMNS
0	Demetria	2.0	4.0	MSIS	
1	Dorian	10.0	10.0	MSIS	
2	Garland	9.0	1.0	MSIS	
3	Iluminada	2.0	NaN	MBA	
4	Jeannine	6.0	7.0	MSIS	
5	Jenny	8.0	NaN	NaN	
6	John	NaN	10.0	MSIS	
7	Luci	7.0	7.0	MSIS	
8	Mercy	5.0	6.0	MSIS	
9	Michael	6.0	10.0	MBA	
10	Shelby	1.0	10.0	MSIS	

POS. INDEX ON ROWS

head and tail

Return the first or last rows

```
df.head(4)
```

	hw1	hw2	program
Demetria	2.0	4.0	MSIS
Dorian	10.0	10.0	MSIS
Garland	9.0	1.0	MSIS
Iluminada	2.0	NaN	MBA

```
df.tail(3)
```

	hw1	hw2	program
Mercy	5.0	6.0	MSIS
Michael	6.0	10.0	MBA
Shelby	1.0	10.0	MSIS

POSITIONAL INDEX ON THE COLUMNS

		0	1	2	
INDEX		hw1	hw2	program	COLUMNS
0	**Demetria**	2.0	4.0	MSIS	
1	**Dorian**	10.0	10.0	MSIS	
2	**Garland**	9.0	1.0	MSIS	
3	**Iluminada**	2.0	NaN	MBA	
4	**Jeannine**	6.0	7.0	MSIS	
5	**Jenny**	8.0	NaN	NaN	
6	**John**	NaN	10.0	MSIS	
7	**Luci**	7.0	7.0	MSIS	
8	**Mercy**	5.0	6.0	MSIS	
9	**Michael**	6.0	10.0	MBA	
10	**Shelby**	1.0	10.0	MSIS	

POS. INDEX ON ROWS

Problems

1. Sort the MSIS students by hw2 descending.
2. Show **only** the field *hw1* of the four students with the largest hw2 grade (do not use nlargest on the dataframe... it has bugs)

mean, max, min, etc

Aggregate functions will be broadcasted to all columns (axis = 0, default) or rows

```
df.mean()
```

```
hw1    5.600000
hw2    7.222222
dtype: float64
```

```
df.mean(axis=1)
```

```
Demetria      3.0
Dorian       10.0
Garland       5.0
Iluminada     2.0
Jeannine      6.5
Jenny         8.0
John         10.0
Luci          7.0
Mercy         5.5
Michael       8.0
Shelby        5.5
dtype: float64
```

POSITIONAL INDEX ON THE COLUMNS

INDEX		hw1	hw2	program
		0	1	2
0	Demetria	2.0	4.0	MSIS
1	Dorian	10.0	10.0	MSIS
2	Garland	9.0	1.0	MSIS
3	Iluminada	2.0	NaN	MBA
4	Jeannine	6.0	7.0	MSIS
5	Jenny	8.0	NaN	NaN
6	John	NaN	10.0	MSIS
7	Luci	7.0	7.0	MSIS
8	Mercy	5.0	6.0	MSIS
9	Michael	6.0	10.0	MBA
10	Shelby	1.0	10.0	MSIS

COLUMNS

POS. INDEX ON ROWS

Problems

1. Compute the spread (i.e., highest minus lowest hw grade) of each student. Consider only the students who submitted both homeworks
2. Who has the largest spread?

Adding rows

A new student has joined. His name is Oliver and he is the MSIS program; his hw1 is missing and his hw2 score is 8.

```
df2 = df.copy()
```

```
import numpy as np
df2.loc['Oliver'] = [np.nan,8,'MSIS']
df2
```

POSITIONAL INDEX ON THE COLUMNS

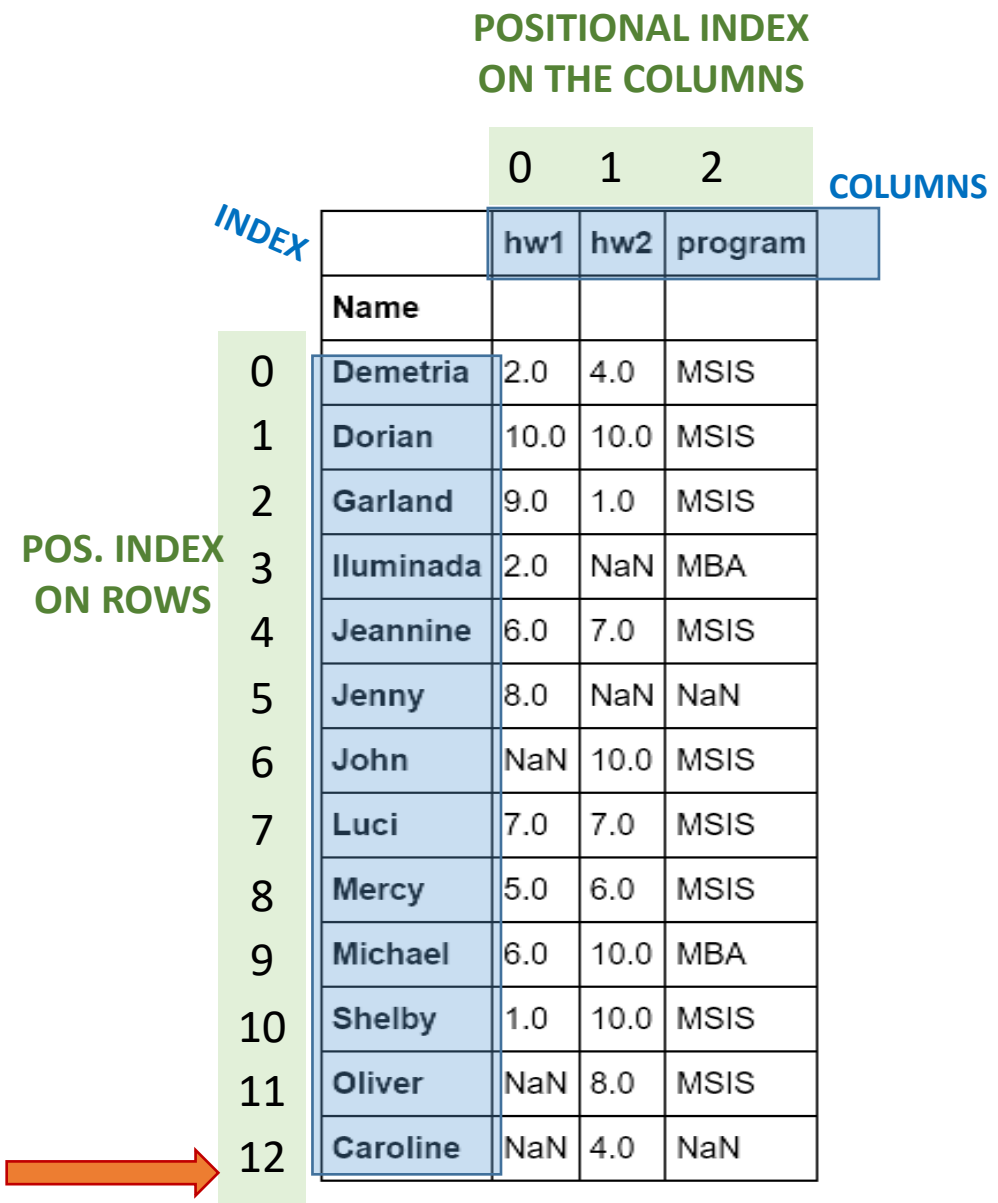
	0	1	2
INDEX		hw1	hw2	program
	Name			
POS. INDEX ON ROWS 0	Demetria	2.0	4.0	MSIS
1	Dorian	10.0	10.0	MSIS
2	Garland	9.0	1.0	MSIS
3	Iluminada	2.0	NaN	MBA
4	Jeannine	6.0	7.0	MSIS
5	Jenny	8.0	NaN	NaN
6	John	NaN	10.0	MSIS
7	Luci	7.0	7.0	MSIS
8	Mercy	5.0	6.0	MSIS
9	Michael	6.0	10.0	MBA
10	Shelby	1.0	10.0	MSIS
11	Oliver	NaN	8.0	MSIS

COLUMNS

Adding rows

A new student has joined. Her name is Caroline and she got 4 in hw2. She is not in any program yet.

```
df2.loc['Caroline','hw2'] = 4
df2
```



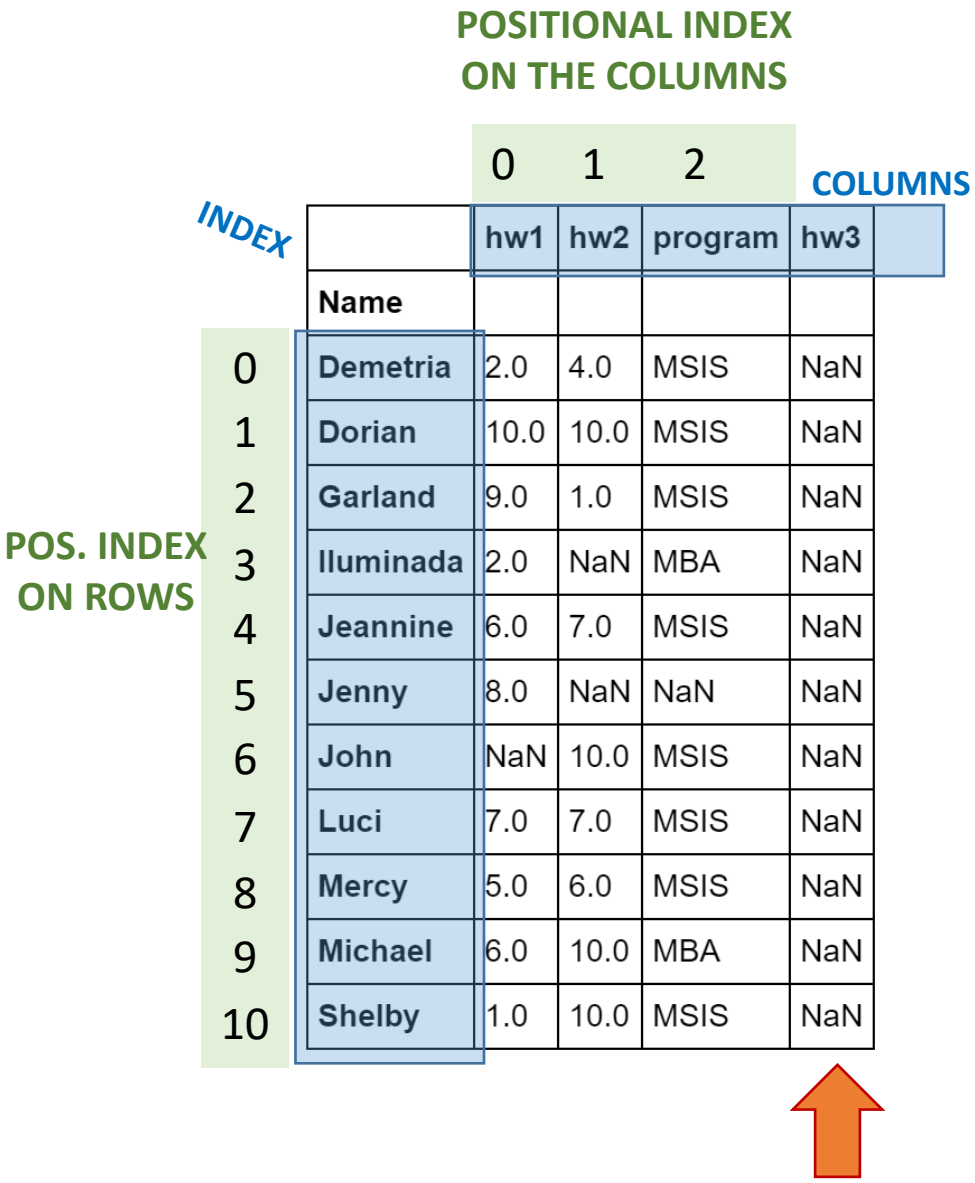
	hw1	hw2	program
Name			
0 Demetria	2.0	4.0	MSIS
1 Dorian	10.0	10.0	MSIS
2 Garland	9.0	1.0	MSIS
3 Iluminada	2.0	NaN	MBA
4 Jeannine	6.0	7.0	MSIS
5 Jenny	8.0	NaN	NaN
6 John	NaN	10.0	MSIS
7 Luci	7.0	7.0	MSIS
8 Mercy	5.0	6.0	MSIS
9 Michael	6.0	10.0	MBA
10 Shelby	1.0	10.0	MSIS
11 Oliver	NaN	8.0	MSIS
12 Caroline	NaN	4.0	NaN

Adding columns

Add an "empty" column hw3

```
df2 = df.copy()
```

```
df2['hw3'] = np.nan
df2
```



Adding calculated columns

Let's add a column with the final grade. It is computed as 0.2*hw1 + 0.8*hw2.

```
df2 = df.copy()
```

```
df2['finalGrade'] = 0.2 * df2['hw1'] + 0.8 * df2['hw2']
df2
```

POSITIONAL INDEX ON THE COLUMNS

COLUMNS

INDEX

POS. INDEX ON ROWS

		0	1	2	
		hw1	hw2	program	finalGrade
	Name				
0	Demetria	2.0	4.0	MSIS	3.6
1	Dorian	10.0	10.0	MSIS	10.0
2	Garland	9.0	1.0	MSIS	2.6
3	Iluminada	2.0	NaN	MBA	NaN
4	Jeannine	6.0	7.0	MSIS	6.8
5	Jenny	8.0	NaN	NaN	NaN
6	John	NaN	10.0	MSIS	NaN
7	Luci	7.0	7.0	MSIS	7.0
8	Mercy	5.0	6.0	MSIS	5.8
9	Michael	6.0	10.0	MBA	9.2
10	Shelby	1.0	10.0	MSIS	8.2