

Explicit indexes

The dog dataset, revisited

```
print(dogs)
```

	name	breed	color	height_cm	weight_kg
0	Bella	Labrador	Brown	56	25
1	Charlie	Poodle	Black	43	23
2	Lucy	Chow Chow	Brown	46	22
3	Cooper	Schnauzer	Gray	49	17
4	Max	Labrador	Black	59	29
5	Stella	Chihuahua	Tan	18	2
6	Bernie	St. Bernard	White	77	74

.columns and .index

```
dogs.columns
```

```
Index(['name', 'breed', 'color', 'height_cm', 'weight_kg'], dtype='object')
```

```
dogs.index
```

```
RangeIndex(start=0, stop=7, step=1)
```

Setting a column as the index

```
dogs_ind = dogs.set_index("name")
```

Setting a column as the index

```
dogs_ind = dogs.set_index("name")  
print(dogs_ind)
```

	breed	color	height_cm	weight_kg
name				
Bella	Labrador	Brown	56	25
Charlie	Poodle	Black	43	23
Lucy	Chow Chow	Brown	46	22
Cooper	Schnauzer	Grey	49	17
Max	Labrador	Black	59	29
Stella	Chihuahua	Tan	18	2
Bernie	St. Bernard	White	77	74

Removing an index

```
dogs_ind.reset_index()
```

	name	breed	color	height_cm	weight_kg
0	Bella	Labrador	Brown	56	25
1	Charlie	Poodle	Black	43	23
2	Lucy	Chow Chow	Brown	46	22
3	Cooper	Schnauzer	Grey	49	17
4	Max	Labrador	Black	59	29
5	Stella	Chihuahua	Tan	18	2
6	Bernie	St. Bernard	White	77	74

Dropping an index

```
dogs_ind.reset_index(drop=True)
```

```
breed  color  height_cm  weight_kg
0    Labrador  Brown        56        25
1      Poodle  Black        43        23
2    Chow Chow  Brown        46        22
3   Schnauzer  Grey        49        17
4    Labrador  Black        59        29
5  Chihuahua    Tan        18         2
6  St. Bernard  White       77        74
```

Indexes make subsetting simpler

```
dogs[dogs["name"].isin(["Bella", "Stella"])]
```

```
   name      breed  color  height_cm  weight_kg
0  Bella    Labrador  Brown        56         25
5  Stella  Chihuahua    Tan        18          2
```

Indexes make subsetting simpler

```
dogs[dogs["name"].isin(["Bella", "Stella"])]
```

```
      name      breed  color  height_cm  weight_kg
0    Bella    Labrador  Brown        56         25
5   Stella  Chihuahua    Tan        18          2
```

```
dogs_ind.loc[['Bella', 'Stella']]
```

```
      breed  color  height_cm  weight_kg
name
Bella    Labrador  Brown        56         25
Stella  Chihuahua    Tan        18          2
```

Index values don't need to be unique

```
dogs_ind2 = dogs.set_index("breed")
print(dogs_ind2)
```

		name	color	height_cm	weight_kg
breed					
Labrador		Bella	Brown	56	25
Poodle		Charlie	Black	43	23
Chow Chow		Lucy	Brown	46	22
Schnauzer		Cooper	Grey	49	17
Labrador		Max	Black	59	29
Chihuahua		Stella	Tan	18	2
St. Bernard		Bernie	White	77	74

Subsetting on duplicated index values

```
dogs_ind2.loc[ "Labrador" ]
```

			name	color	height_cm	weight_kg
	breed					
	Labrador	Bella	Brown		56	25
	Labrador	Max	Black		59	29

Multi-level indexes a.k.a. hierarchical indexes

```
dogs_ind3 = dogs.set_index(["breed", "color"])
print(dogs_ind3)
```

			name	height_cm	weight_kg
breed	color				
Labrador	Brown	Bella		56	25
Poodle	Black	Charlie		43	23
Chow Chow	Brown	Lucy		46	22
Schnauzer	Grey	Cooper		49	17
Labrador	Black	Max		59	29
Chihuahua	Tan	Stella		18	2
St. Bernard	White	Bernie		77	74

Subset the outer level with a list

```
dogs_ind3.loc[["Labrador", "Chihuahua"]]
```

			name	height_cm	weight_kg
breed	color				
Labrador	Brown	Bella	56	25	
	Black	Max	59	29	
Chihuahua	Tan	Stella	18	2	

Subset inner levels with a list of tuples

```
dogs_ind3.loc[[("Labrador", "Brown"), ("Chihuahua", "Tan")]]
```

			name	height_cm	weight_kg
breed	color				
Labrador	Brown	Bella		56	25
Chihuahua	Tan	Stella		18	2

Sorting by index values

```
dogs_ind3.sort_index()
```

			name	height_cm	weight_kg
breed	color				
Chihuahua	Tan	Stella		18	2
Chow Chow	Brown	Lucy		46	22
Labrador	Black	Max		59	29
	Brown	Bella		56	25
Poodle	Black	Charlie		43	23
Schnauzer	Grey	Cooper		49	17
St. Bernard	White	Bernie		77	74

Controlling sort_index

```
dogs_ind3.sort_index(level=["color", "breed"], ascending=[True, False])
```

			name	height_cm	weight_kg
breed	color				
Poodle	Black	Charlie		43	23
Labrador	Black	Max		59	29
	Brown	Bella		56	25
Chow Chow	Brown	Lucy		46	22
Schanuzer	Grey	Cooper		49	17
Chihuahua	Tan	Stella		18	2
St. Bernard	White	Bernie		77	74

Now you have two problems

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- Indexes violate "tidy data" principles

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- Index values are just data
- Indexes violate "tidy data" principles
- You need to learn two syntaxes

Temperature dataset

	date	city	country	avg_temp_c
0	2000-01-01	Abidjan	Côte D'Ivoire	27.293
1	2000-02-01	Abidjan	Côte D'Ivoire	27.685
2	2000-03-01	Abidjan	Côte D'Ivoire	29.061
3	2000-04-01	Abidjan	Côte D'Ivoire	28.162
4	2000-05-01	Abidjan	Côte D'Ivoire	27.547

Let's practice!

Slicing and subsetting with .loc and .iloc

Slicing lists

```
breeds = [ "Labrador", "Poodle",
           "Chow Chow", "Schnauzer",
           "Labrador", "Chihuahua",
           "St. Bernard"]
```

```
[ 'Labrador',
  'Poodle',
  'Chow Chow',
  'Schnauzer',
  'Labrador',
  'Chihuahua',
  'St. Bernard']
```

Slicing lists

```
breeds = [ "Labrador", "Poodle",  
          "Chow Chow", "Schnauzer",  
          "Labrador", "Chihuahua",  
          "St. Bernard" ]
```

```
breeds[2:5]
```

```
[ 'Chow Chow', 'Schnauzer', 'Labrador' ]
```

```
[ 'Labrador',  
  'Poodle',  
  'Chow Chow',  
  'Schnauzer',  
  'Labrador',  
  'Chihuahua',  
  'St. Bernard' ]
```

Slicing lists

```
breeds = [ "Labrador", "Poodle",  
          "Chow Chow", "Schnauzer",  
          "Labrador", "Chihuahua",  
          "St. Bernard" ]
```

```
['Labrador',  
 'Poodle',  
 'Chow Chow',  
 'Schnauzer',  
 'Labrador',  
 'Chihuahua',  
 'St. Bernard']
```

```
breeds[2:5]
```

```
['Chow Chow', 'Schnauzer', 'Labrador']
```

```
breeds[:3]
```

```
['Labrador', 'Poodle', 'Chow Chow']
```

Slicing lists

```
breeds = ["Labrador", "Poodle",  
          "Chow Chow", "Schnauzer",  
          "Labrador", "Chihuahua",  
          "St. Bernard"]
```

```
['Labrador',  
 'Poodle',  
 'Chow Chow',  
 'Schnauzer',  
 'Labrador',  
 'Chihuahua',  
 'St. Bernard']
```

```
breeds[2:5]
```

```
['Chow Chow', 'Schnauzer', 'Labrador']
```

```
breeds[:3]
```

```
['Labrador', 'Poodle', 'Chow Chow']
```

```
breeds[:]
```

```
['Labrador', 'Poodle', 'Chow Chow', 'Schnauzer',  
 'Labrador', 'Chihuahua', 'St. Bernard']
```

Sort the index before you slice

```
dogs_srt = dogs.set_index(["breed", "color"]).sort_index()  
print(dogs_srt)
```

			name	height_cm	weight_kg
breed	color				
Chihuahua	Tan	Stella		18	2
Chow Chow	Brown	Lucy		46	22
Labrador	Black	Max		59	29
	Brown	Bella		56	25
Poodle	Black	Charlie		43	23
Schnauzer	Grey	Cooper		49	17
St. Bernard	White	Bernie		77	74

Slicing the outer index level

```
dogs_srt.loc["Chow Chow":"Poodle"]
```

			name	height_cm	weight_kg
breed	color				
Chow	Chow	Brown	Lucy	46	22
Labrador	Black		Max	59	29
	Brown		Bella	56	25
Poodle	Black	Charlie		43	23

The final value "Poodle" is included

Full dataset

			name	height_cm	weight_kg
breed	color				
Chihuahua	Tan		Stella	18	2
Chow Chow	Brown		Lucy	46	22
Labrador	Black		Max	59	29
	Brown		Bella	56	25
Poodle	Black	Charlie		43	23
Schnauzer	Grey		Cooper	49	17
St. Bernard	White		Bernie	77	74

Slicing the inner index levels badly

```
dogs_srt.loc["Tan":"Grey"]
```

Empty DataFrame

Columns: [name, height_cm, weight_kg]

Index: []

Full dataset

breed	color	name	height_cm	weight_kg
Chihuahua	Tan	Stella	18	2
Chow Chow	Brown	Lucy	46	22
Labrador	Black	Max	59	29
	Brown	Bella	56	25
Poodle	Black	Charlie	43	23
Schnauzer	Grey	Cooper	49	17
St. Bernard	White	Bernie	77	74

Slicing the inner index levels correctly

```
dogs_srt.loc[  
    ("Labrador", "Brown") : ("Schnauzer", "Grey")]
```

			name	height_cm	weight_kg
breed	color				
Labrador	Brown	Bella		56	25
Poodle	Black	Charlie		43	23
Schnauzer	Grey	Cooper		49	17

Full dataset

breed	color	name	height_cm	weight_kg
Chihuahua	Tan	Stella	18	2
Chow Chow	Brown	Lucy	46	22
Labrador	Black	Max	59	29
	Brown	Bella	56	25
Poodle	Black	Charlie	43	23
Schnauzer	Grey	Cooper	49	17
St. Bernard	White	Bernie	77	74

Slicing columns

```
dogs_srt.loc[:, "name": "height_cm"]
```

			name	height_cm
breed	color			
Chihuahua	Tan	Stella	18	
Chow Chow	Brown	Lucy	46	
Labrador	Black	Max	59	
	Brown	Bella	56	
Poodle	Black	Charlie	43	
Schnauzer	Grey	Cooper	49	
St. Bernard	White	Bernie	77	

Full dataset

breed	color	name	height_cm	weight_kg
Chihuahua	Tan	Stella	18	2
Chow Chow	Brown	Lucy	46	22
Labrador	Black	Max	59	29
	Brown	Bella	56	25
Poodle	Black	Charlie	43	23
Schnauzer	Grey	Cooper	49	17
St. Bernard	White	Bernie	77	74

Slice twice

```
dogs_srt.loc[  
    ("Labrador", "Brown"):( "Schnauzer", "Grey"),  
    "name": "height_cm"]
```

			name	height_cm
breed	color			
Labrador	Brown	Bella	56	
Poodle	Black	Charlie	43	
Schanuzer	Grey	Cooper	49	

Full dataset

			name	height_cm	weight_kg
breed	color				
Chihuahua	Tan	Stella	18	2	
Chow Chow	Brown	Lucy	46	22	
Labrador	Black	Max	59	29	
	Brown	Bella	56	25	
Poodle	Black	Charlie	43	23	
Schnauzer	Grey	Cooper	49	17	
St. Bernard	White	Bernie	77	74	

Dog days

```
dogs = dogs.set_index("date_of_birth").sort_index()  
print(dogs)
```

	name	breed	color	height_cm	weight_kg
date_of_birth					
2011-12-11	Cooper	Schanuzer	Grey	49	17
2013-07-01	Bella	Labrador	Brown	56	25
2014-08-25	Lucy	Chow Chow	Brown	46	22
2015-04-20	Stella	Chihuahua	Tan	18	2
2016-09-16	Charlie	Poodle	Black	43	23
2017-01-20	Max	Labrador	Black	59	29
2018-02-27	Bernie	St. Bernard	White	77	74

Slicing by dates

```
# Get dogs with date_of_birth between 2014-08-25 and 2016-09-16  
dogs.loc[ "2014-08-25": "2016-09-16" ]
```

	name	breed	color	height_cm	weight_kg
date_of_birth					
2014-08-25	Lucy	Chow Chow	Brown	46	22
2015-04-20	Stella	Chihuahua	Tan	18	2
2016-09-16	Charlie	Poodle	Black	43	23

Slicing by partial dates

```
# Get dogs with date_of_birth between 2014-01-01 and 2016-12-31  
dogs.loc[ "2014":"2016" ]
```

	name	breed	color	height_cm	weight_kg
date_of_birth					
2014-08-25	Lucy	Chow Chow	Brown	46	22
2015-04-20	Stella	Chihuahua	Tan	18	2
2016-09-16	Charlie	Poodle	Black	43	23

Subsetting by row/column number

```
print(dogs.iloc[2:5, 1:4])
```

```
breed  color  height_cm  
2  Chow    Chow   Brown        46  
3  Schnauzer  Grey   Black        49  
4  Labrador  Black   White       59
```

Full dataset

	name	breed	color	height_cm	weight_kg
0	Bella	Labrador	Brown	56	25
1	Charlie	Poodle	Black	43	23
2	Lucy	Chow Chow	Brown	46	22
3	Cooper	Schnauzer	Grey	49	17
4	Max	Labrador	Black	59	29
5	Stella	Chihuahua	Tan	18	2
6	Bernie	St. Bernard	White	77	74

Let's practice!

Working with pivot tables

A bigger dog dataset

```
print(dog_pack)
```

	breed	color	height_cm	weight_kg
0	Boxer	Brown	62.64	30.4
1	Poodle	Black	46.41	20.4
2	Beagle	Brown	36.39	12.4
3	Chihuahua	Tan	19.70	1.6
4	Labrador	Tan	54.44	36.1
..
87	Boxer	Gray	58.13	29.9
88	St. Bernard	White	70.13	69.4
89	Poodle	Gray	51.30	20.4
90	Beagle	White	38.81	8.8
91	Beagle	Black	33.40	13.5

Pivoting the dog pack

```
dogs_height_by_breed_vs_color = dog_pack.pivot_table(  
    "height_cm", index="breed", columns="color")  
print(dogs_height_by_breed_vs_color)
```

color	Black	Brown	Gray	Tan	White
breed					
Beagle	34.500000	36.4500	36.313333	35.740000	38.810000
Boxer	57.203333	62.6400	58.280000	62.310000	56.360000
Chihuahua	18.555000	NaN	21.660000	20.096667	17.933333
Chow Chow	51.262500	50.4800	NaN	53.497500	54.413333
Dachshund	21.186667	19.7250	NaN	19.375000	20.660000
Labrador	57.125000	NaN	NaN	55.190000	55.310000
Poodle	48.036000	57.1300	56.645000	NaN	44.740000
St. Bernard	63.920000	65.8825	67.640000	68.334000	67.495000

.loc[] + slicing is a power combo

```
dogs_height_by_breed_vs_color.loc["Chow Chow":"Poodle"]
```

color	Black	Brown	Gray	Tan	White
breed					
Chow Chow	51.262500	50.480	NaN	53.4975	54.413333
Dachshund	21.186667	19.725	NaN	19.3750	20.660000
Labrador	57.125000	NaN	NaN	55.1900	55.310000
Poodle	48.036000	57.130	56.645	NaN	44.740000

The axis argument

```
dogs_height_by_breed_vs_color.mean(axis="index")
```

```
color
Black    43.973563
Brown    48.717917
Gray     48.107667
Tan      44.934738
White    44.465208
dtype: float64
```

Calculating summary stats across columns

```
dogs_height_by_breed_vs_color.mean(axis="columns")
```

```
breed
Beagle      36.362667
Boxer       59.358667
Chihuahua   19.561250
Chow Chow    52.413333
Dachshund   20.236667
Labrador     55.875000
Poodle       51.637750
St. Bernard  66.654300
dtype: float64
```

Let's practice!