

Filtering joins

JOINING DATA WITH PANDAS



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Mutating versus filtering joins

Mutating joins:

- Combines data from two tables based on matching observations in both tables

Filtering joins:

- Filter observations from table based on whether or not they match an observation in another table

What is a semi-join?

Left Table			Right Table		Result Table			
A	B	C	C	D	=	A	B	C
A2	B2	C2	C1	D1	=	A2	B2	C2
A3	B3	C3	C2	D2		A4	B4	C4
A4	B4	C4	C4	D4				
			C5	D5				

Semi-joins

- Returns the intersection, similar to an inner join
- Returns only columns from the left table and ***not*** the right
- No duplicates

Musical dataset



¹ Photo by Vlad Bagacian from Pexels

Example datasets

```
   gid  name
0  1    Rock
1  2    Jazz
2  3    Metal
3  4  Alternative ...
4  5  Rock And Roll
```

```
   tid  name          aid  mtid  gid  composer          u_price
0  1    For Those Ab...  1     1     1  Angus Young,...  0.99
1  2    Balls to the...  2     2     1    nan           0.99
2  3    Fast As a Shark  3     2     1  F. Baltes, S...  0.99
3  4    Restless and...  3     2     1  F. Baltes, R...  0.99
4  5    Princess of ...  3     2     1  Deaffy & R.A...  0.99
```

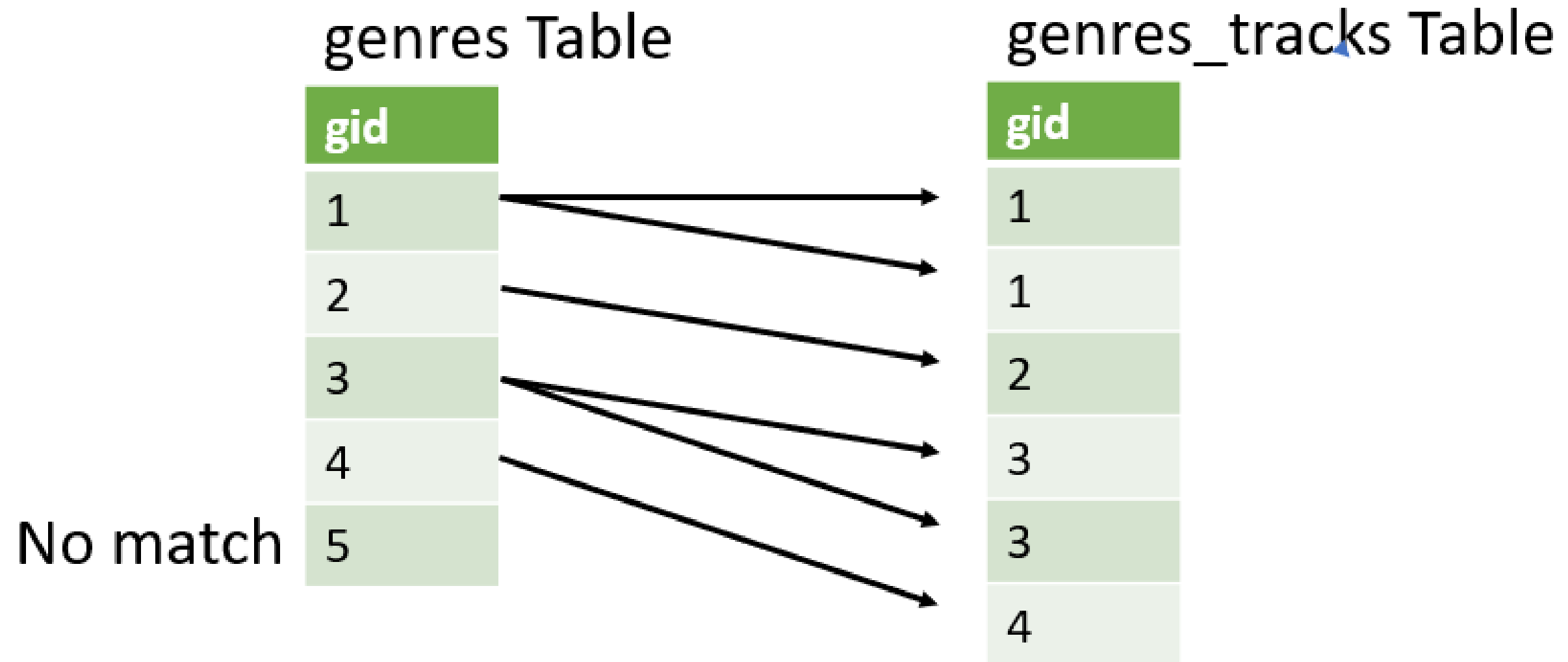
Step 1 - semi-join

```
genres_tracks = genres.merge(top_tracks, on='gid')  
print(genres_tracks.head())
```

	gid	name_x	tid	name_y	aid	mtid	composer	u_price
0	1	Rock	2260	Don't Stop M...	185	1	Mercury, Fre...	0.99
1	1	Rock	2933	Mysterious Ways	232	1	U2	0.99
2	1	Rock	2618	Speed Of Light	212	1	Billy Duffy/...	0.99
3	1	Rock	2998	When Love Co...	237	1	Bono/Clayton...	0.99
4	1	Rock	685	Who'll Stop ...	54	1	J. C. Fogerty	0.99

Step 2 - semi-join

```
genres['gid'].isin(genres_tracks['gid'])
```



Step 2 - semi-join

```
genres['gid'].isin(genres_tracks['gid'])
```

```
0    True
1    True
2    True
3    True
4   False
Name: gid, dtype: bool
```


Step 3 - semi-join

```
genres_tracks = genres.merge(top_tracks, on='gid')  
top_genres = genres[genres['gid'].isin(genres_tracks['gid'])]  
print(top_genres.head())
```

```
   gid  name  
0  1    Rock  
1  2    Jazz  
2  3    Metal  
3  4  Alternative & Punk  
4  6    Blues
```

What is an anti-join?

Left Table

A	B	C
A2	B2	C2
A3	B3	C3
A4	B4	C4

Right Table

C	D
C1	D1
C2	D2
C4	D4
C5	D5

=

Result Table

A	B	C
A3	B3	C3

Anti-join:

- Returns the left table, excluding the intersection
- Returns only columns from the left table and ***not*** the right

Step 1 - anti-join

```
genres_tracks = genres.merge(top_tracks, on='gid', how='left', indicator=True)
print(genres_tracks.head())
```

	gid	name_x		tid	name_y	aid	mtid	composer	u_price	_merge
0	1	Rock		2260.0	Don't Stop M...	185.0	1.0	Mercury, Fre...	0.99	both
1	1	Rock		2933.0	Mysterious Ways	232.0	1.0	U2	0.99	both
2	1	Rock		2618.0	Speed Of Light	212.0	1.0	Billy Duffy/...	0.99	both
3	1	Rock		2998.0	When Love Co...	237.0	1.0	Bono/Clayton...	0.99	both
4	5	Rock And Roll		NaN	NaN	NaN	NaN	NaN	NaN	left_only

Step 2 - anti-join

```
gid_list = genres_tracks.loc[genres_tracks['_merge'] == 'left_only', 'gid']  
print(gid_list.head())
```

```
23      5  
34      9  
36     11  
37     12  
38     13  
Name: gid, dtype: int64
```

Step 3 - anti-join

```
genres_tracks = genres.merge(top_tracks, on='gid', how='left', indicator=True)
gid_list = genres_tracks.loc[genres_tracks['_merge'] == 'left_only', 'gid']
non_top_genres = genres[genres['gid'].isin(gid_list)]
print(non_top_genres.head())
```

```
   gid  name
0  5    Rock And Roll
1  9     Pop
2  11  Bossa Nova
3  12  Easy Listening
4  13  Heavy Metal
```

Let's practice!
JOINING DATA WITH PANDAS

Concatenate DataFrames together vertically

JOINING DATA WITH PANDAS



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Concatenate two tables vertically

A	B	C
A1	B1	C1
A2	B2	C2
A3	B3	C3



A	B	C
A4	B4	C4
A5	B5	C5
A6	B6	C6

- Pandas `.concat()` method can concatenate both vertical and horizontal.
 - `axis=0` , vertical

Basic concatenation

- 3 different tables
- Same column names
- Table variable names:
 - `inv_jan` (*top*)
 - `inv_feb` (*middle*)
 - `inv_mar` (*bottom*)

	iid	cid	invoice_date	total
0	1	2	2009-01-01	1.98
1	2	4	2009-01-02	3.96
2	3	8	2009-01-03	5.94

	iid	cid	invoice_date	total
0	7	38	2009-02-01	1.98
1	8	40	2009-02-01	1.98
2	9	42	2009-02-02	3.96

	iid	cid	invoice_date	total
0	14	17	2009-03-04	1.98
1	15	19	2009-03-04	1.98
2	16	21	2009-03-05	3.96

Basic concatenation

```
pd.concat([inv_jan, inv_feb, inv_mar])
```

	iid	cid	invoice_date	total
0	1	2	2009-01-01	1.98
1	2	4	2009-01-02	3.96
2	3	8	2009-01-03	5.94
0	7	38	2009-02-01	1.98
1	8	40	2009-02-01	1.98
2	9	42	2009-02-02	3.96
0	14	17	2009-03-04	1.98
1	15	19	2009-03-04	1.98
2	16	21	2009-03-05	3.96

Ignoring the index

```
pd.concat([inv_jan, inv_feb, inv_mar],  
          ignore_index=True)
```

	iid	cid	invoice_date	total
0	1	2	2009-01-01	1.98
1	2	4	2009-01-02	3.96
2	3	8	2009-01-03	5.94
3	7	38	2009-02-01	1.98
4	8	40	2009-02-01	1.98
5	9	42	2009-02-02	3.96
6	14	17	2009-03-04	1.98
7	15	19	2009-03-04	1.98
8	16	21	2009-03-05	3.96

Setting labels to original tables

```
pd.concat([inv_jan, inv_feb, inv_mar],  
          ignore_index=False,  
          keys=['jan', 'feb', 'mar'])
```

		iid	cid	invoice_date	total
jan	0	1	2	2009-01-01	1.98
	1	2	4	2009-01-02	3.96
	2	3	8	2009-01-03	5.94
feb	0	7	38	2009-02-01	1.98
	1	8	40	2009-02-01	1.98
	2	9	42	2009-02-02	3.96
mar	0	14	17	2009-03-04	1.98
	1	15	19	2009-03-04	1.98
	2	16	21	2009-03-05	3.96

Concatenate tables with different column names

Table: `inv_jan`

	iid	cid	invoice_date	total
0	1	2	2009-01-01	1.98
1	2	4	2009-01-02	3.96
2	3	8	2009-01-03	5.94

Table: `inv_feb`

	iid	cid	invoice_date	total	bill_ctry
0	7	38	2009-02-01	1.98	Germany
1	8	40	2009-02-01	1.98	France
2	9	42	2009-02-02	3.96	France

Concatenate tables with different column names

```
pd.concat([inv_jan, inv_feb],  
          sort=True)
```

	bill_ctry	cid	iid	invoice_date	total
0	NaN	2	1	2009-01-01	1.98
1	NaN	4	2	2009-01-02	3.96
2	NaN	8	3	2009-01-03	5.94
0	Germany	38	7	2009-02-01	1.98
1	France	40	8	2009-02-01	1.98
2	France	42	9	2009-02-02	3.96

Concatenate tables with different column names

```
pd.concat([inv_jan, inv_feb],  
          join='inner')
```

iid	cid	invoice_date	total
1	2	2009-01-01	1.98
2	4	2009-01-02	3.96
3	8	2009-01-03	5.94
7	38	2009-02-01	1.98
8	40	2009-02-01	1.98
9	42	2009-02-02	3.96

Using append method

`.append()`

- Simplified version of the `.concat()` method
- Supports: `ignore_index`, and `sort`
- Does Not Support: `keys` and `join`
 - Always `join = outer`

Append these tables

	iid	cid	invoice_date	total
0	1	2	2009-01-01	1.98
1	2	4	2009-01-02	3.96
2	3	8	2009-01-03	5.94

	iid	cid	invoice_date	total	bill_ctry
0	7	38	2009-02-01	1.98	Germany
1	8	40	2009-02-01	1.98	France
2	9	42	2009-02-02	3.96	France

	iid	cid	invoice_date	total
0	14	17	2009-03-04	1.98
1	15	19	2009-03-04	1.98
2	16	21	2009-03-05	3.96

Append the tables

```
inv_jan.append([inv_feb, inv_mar],  
               ignore_index=True,  
               sort=True)
```

	bill_ctry	cid	iid	invoice_date	total
0	NaN	2	1	2009-01-01	1.98
1	NaN	4	2	2009-01-02	3.96
2	NaN	8	3	2009-01-03	5.94
3	Germany	38	7	2009-02-01	1.98
4	France	40	8	2009-02-01	1.98
5	France	42	9	2009-02-02	3.96
6	NaN	17	14	2009-03-04	1.98
7	NaN	19	15	2009-03-04	1.98
8	NaN	21	16	2009-03-05	3.96

Let's practice!

JOINING DATA WITH PANDAS

Verifying integrity

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Let's check our data

Possible merging issue:

A	B	C		C	D
A1	B1	C1	↔	C1	D1
A2	B2	C2		C1	D2
A3	B3	C3		C1	D3
				C2	D4

- Unintentional one-to-many relationship
- Unintentional many-to-many relationship

Possible concatenating issue:

A	B	C
A1	B1	C1
A2	B2	C2
A3	B3	C3

↕

A	B	C
A3 (duplicate)	B3 (duplicate)	C3 (duplicate)
A4	B4	C4
A5	B5	C5

- Duplicate records possibly unintentionally introduced

Validating merges

`.merge(validate=None)` :

- Checks if merge is of specified type
- `'one_to_one'`
- `'one_to_many'`
- `'many_to_one'`
- `'many_to_many'`

Merge dataset for example

Table Name: tracks

	tid	name	aid	mtid	gid	u_price
0	2	Balls to the...	2	2	1	0.99
1	3	Fast As a Shark	3	2	1	0.99
2	4	Restless and...	3	2	1	0.99

Table Name: specs

	tid	milliseconds	bytes
0	2	342562	5510424
1	3	230619	3990994
2	2	252051	4331779

Merge validate: one_to_one

```
tracks.merge(specs, on='tid',  
             validate='one_to_one')
```

```
Traceback (most recent call last):  
MergeError: Merge keys are not unique in right dataset; not a one-to-one merge
```


Merge validate: one_to_many

```
albums.merge(tracks, on='aid',  
             validate='one_to_many')
```

	aid	title	artid	tid	name	mtid	gid	u_price
0	2	Balls to the...	2	2	Balls to the...	2	1	0.99
1	3	Restless and...	2	3	Fast As a Shark	2	1	0.99
2	3	Restless and...	2	4	Restless and...	2	1	0.99

Verifying concatenations

`.concat(verify_integrity=False)` :

- Check whether the new concatenated index contains duplicates
- Default value is `False`

Dataset for .concat() example

Table Name: `inv_feb`

	<code>cid</code>	<code>invoice_date</code>	<code>total</code>
<code>iid</code>			
7	38	2009-02-01	1.98
8	40	2009-02-01	1.98
9	42	2009-02-02	3.96

Table Name: `inv_mar`

	<code>cid</code>	<code>invoice_date</code>	<code>total</code>
<code>iid</code>			
9	17	2009-03-04	1.98
15	19	2009-03-04	1.98
16	21	2009-03-05	3.96

Verifying concatenation: example

```
pd.concat([inv_feb, inv_mar],  
          verify_integrity=True)
```

```
Traceback (most recent call last):  
ValueError: Indexes have overlapping  
values: Int64Index([9], dtype='int64',  
name='iid')
```

```
pd.concat([inv_feb, inv_mar],  
          verify_integrity=False)
```

	cid	invoice_date	total
iid			
7	38	2009-02-01	1.98
8	40	2009-02-01	1.98
9	42	2009-02-02	3.96
9	17	2009-03-04	1.98
15	19	2009-03-04	1.98
16	21	2009-03-05	3.96

Why verify integrity and what to do

Why:

- Real world data is often ***NOT*** clean

What to do:

- Fix incorrect data
- Drop duplicate rows

Let's practice!
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