

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

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

Right Table

C	D
C1	D1
C2	D2
C4	D4
C5	D5

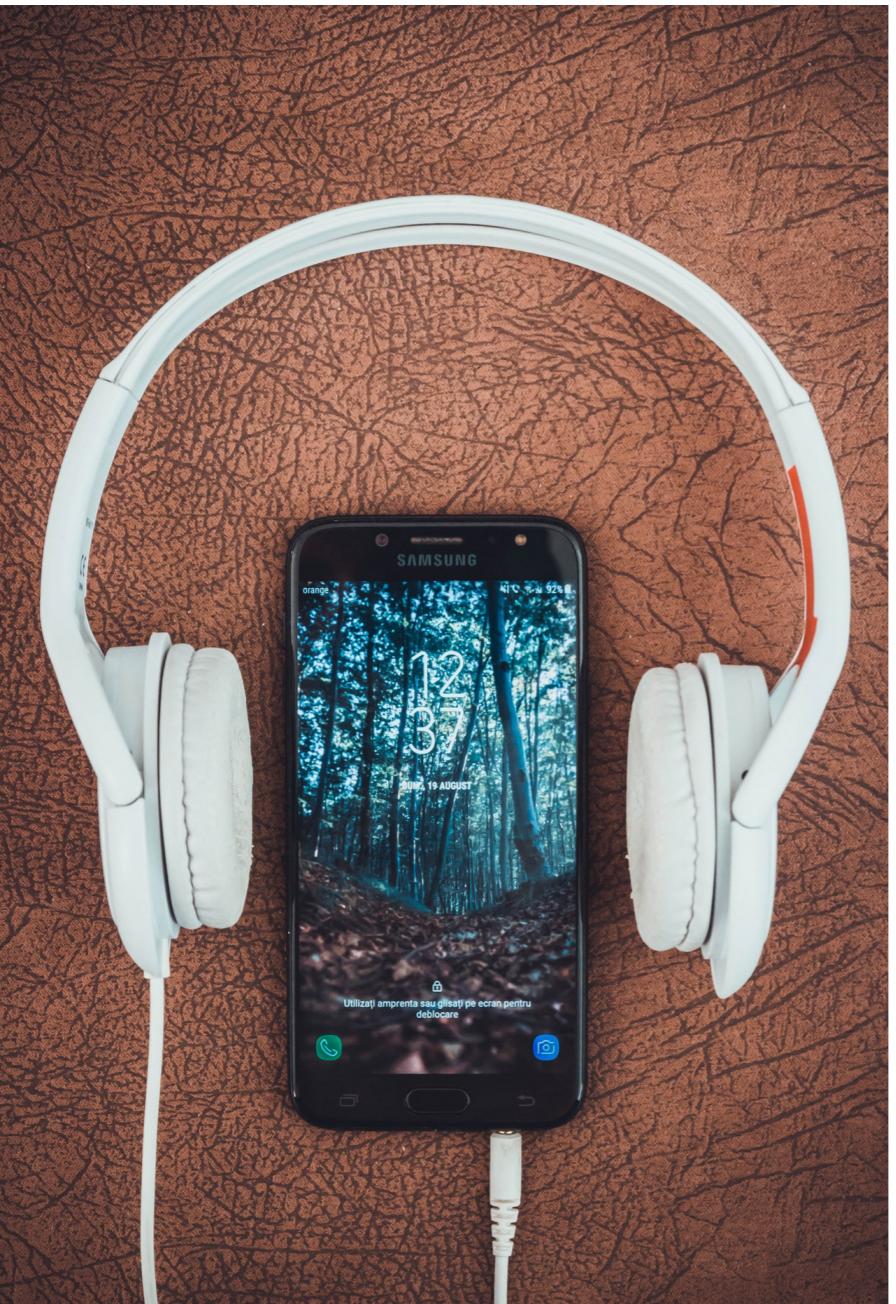
Result Table

A	B	C
A2	B2	C2
A4	B4	C4

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

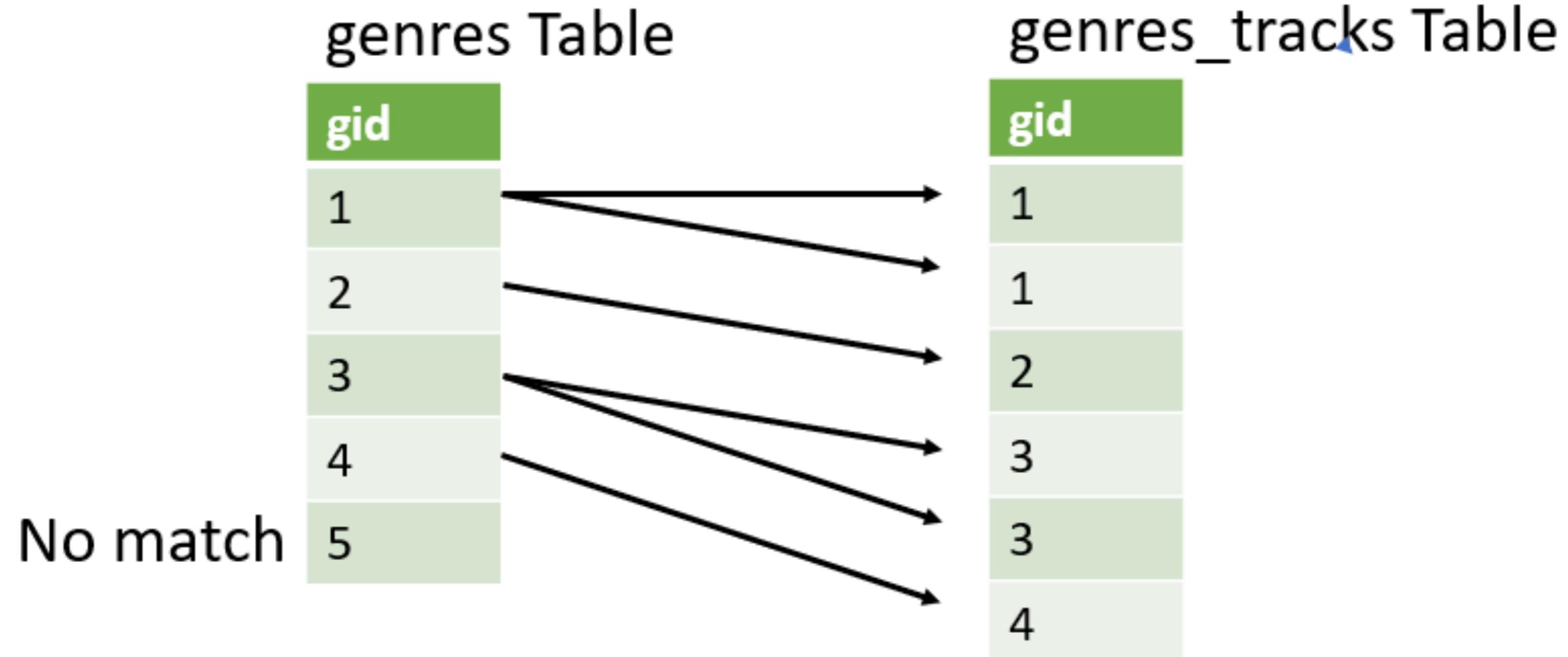
Step 1 - semi-join

```
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 Me Now	185.0	1.0	Mercury, Freddie	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/... (1)	0.99	both
3	1	Rock	2998.0	When Love Comes To Town	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 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	2009-01-01	1.98
	1	2	2009-01-02	3.96
	2	3	2009-01-03	5.94
feb	0	7	2009-02-01	1.98
	1	8	2009-02-01	1.98
	2	9	2009-02-02	3.96
mar	0	14	2009-03-04	1.98
	1	15	2009-03-04	1.98
	2	16	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

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`

	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

Table Name: `inv_mar`

	cid	invoice_date	total
iid			
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)
```

iid	cid	invoice_date	total
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!

JOINING DATA WITH PANDAS