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

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

SQLITE TUTORIAL

[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
```

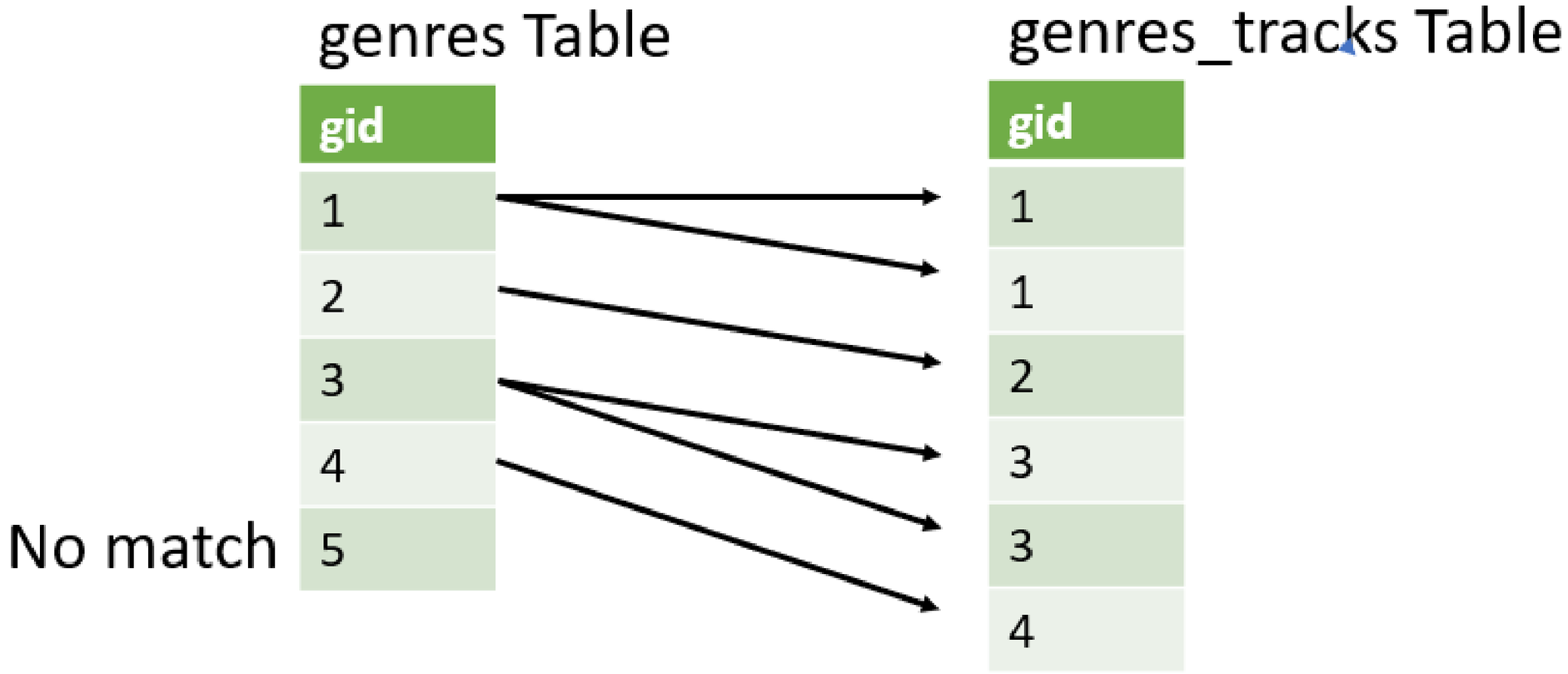
Step 1 - semi-join

```
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

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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
A1	B1	C1
A2	B2	C2
A3	B3	C3

C	D
C1	D1
C1	D2
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`

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

Table Name: `inv_mar`

iid	cid	invoice_date	total
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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