Intro to Programming for Public Policy Week 9
More SQL and Python Integration

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More SQL

Saved scripts

Save a query to a file, e.g. `p_bachelors.sql`:

```
SELECT AVG(educational_attainment > 42)
FROM cps
WHERE educational_attainment > 0;
```

Then execute it from the command line like so:

```
$ sqlite3 atus.sqlite < p_bachelors.sql
0.242895945308274
```

GROUP BY

```
SELECT number_of_hh_children,
       count(*),
       AVG(daily_time_alone/60)
FROM respondents
GROUP BY number_of_hh_children;
```

number_of_hh_children	count(*)	AVG(daily_time_alone/60)
0	6360	7.10943396226415
1	1944	3.92181069958848
2	1734	3.42214532871972
3	599	2.779632721202
4	190	3.07368421052632
5	49	3.26530612244898
6	23	3.30434782608696
7	3	2.33333333333333
8	2	0.5
9	1	0.0

GROUP BY with ORDER BY

```sql
SELECT state_code,
       COUNT(*) as Count,
       AVG(educational_attainment > 42) AS Bachelors
FROM cps
WHERE educational_attainment > 0 -- i.e. defined
GROUP BY state_code
ORDER BY Bachelors DESC
LIMIT 10;
```

Notes:

- In a `GROUP BY`, the `WHERE` clause filters the rows going in to the aggregation
- `ORDER BY` orders the resulting groups, not the rows in the source table (cps).
- `AS` gives the column an alias

HAVING

- In a `GROUP BY`, the `WHERE` clause filters the rows going in to the aggregation.
- To filter the resulting groups use `HAVING`:

```
SELECT state_code,
       COUNT(*) as Count,
       AVG(educational_attainment > 42) AS Bachelors
FROM cps
WHERE educational_attainment > 0 -- i.e. defined
GROUP BY state_code
HAVING Count > 100
ORDER BY Bachelors DESC
LIMIT 10;
```

JOIN

Relational databases are all about relationships! We can harness the relationships in the data with a `JOIN` query:

```
SELECT cps.case_id,
       educational_attainment,
       spouse_or_partner_present
FROM respondents
JOIN cps
ON respondents.case_id = cps.case_id AND
   cps.line_no = 1;
```

Use `LEFT JOIN`, `RIGHT JOIN`, `FULL OUTER JOIN` as needed.

The result of this query has a row for each respondent (all respondents are in the CPS table).

JOIN with GROUP BY

The combination of JOIN and GROUP BY is very powerful:

```
SELECT
  educational_attainment,
  AVG(spouse_or_partner_present = 1) Married
FROM cps JOIN respondents
ON cps.case_id = respondents.case_id AND
   cps.line_no = 1
WHERE number_of_hh_children > 0
GROUP BY educational_attainment;
```

Hours of sleep

```
SELECT case_id,
       SUM( (activity_code = 010101) * duration) / 60
           AS sleep
FROM activities
GROUP BY case_id
```

Subqueries

We can treat the result of one query as a temporary table in a new query:

```
SELECT case_id, edited_labor_force_status, sleep
FROM respondents JOIN
(SELECT case_id,
        SUM( (activity_code = 010101) * duration) / 60
            AS sleep
    FROM activities
    GROUP BY case_id
)
USING (case_id);
```

Adding a GROUP BY

```
SELECT edited_labor_force_status, AVG(sleep)
FROM respondents JOIN
(SELECT case_id,
        SUM( (activity_code = 010101) * duration) / 60
           AS sleep
    FROM activities
    GROUP BY case_id
)
USING (case_id)
GROUP BY 1;
```

```
edited_labor_force_status  AVG(sleep)
-------------------------  ----------------
1                          8.10439043512348
2                          8.67241379310345
3                          8.86080178173719
4                          8.93861174267754
5                          8.79434148088459
```

CREATE TABLE AS

```
CREATE TABLE sleep AS
    SELECT case_id,
           SUM( (activity_code = 010101) * duration) / 60
           AS sleep
    FROM activities
    GROUP BY case_id
;
```

```
SELECT edited_labor_force_status, AVG(sleep)
FROM sleep JOIN respondents
USING (case_id)
GROUP BY 1;
```

DROP TABLE

We can drop the `sleep` table:

```
DROP TABLE sleep;
```

Alternatively, you might find it useful to make the table temporary, so that it is not saved in the `atus.sqlite` database file:

```
CREATE TEMP TABLE sleep AS
    ...
;
```

CREATE TABLE

We can create a new database by passing a non-existent file to `sqlite3`:

```
$ sqlite3 new_db.sqlite
```

Now we can create a new table with the following SQL:

```
CREATE TABLE test (
    id INTEGER PRIMARY KEY,
    Name TEXT,
    Birthday TEXT
);
```

INSERT

We can insert a record into the table using an `INSERT` statement:

```
INSERT INTO test (Name, Birthday)
VALUES ('Eric', '1987-09-23');
```

We can check that it worked:

```
sqlite> SELECT * FROM test;
id          Name        Birthday
----------  ----------  ----------
1           Eric        1987-09-23
```

Because the `id` column is an `INTEGER PRIMARY KEY`, sqlite automatically populates it with an integer that it automatically increments.

INSERT multiple records

```
INSERT INTO test (Name, Birthday)
VALUES ('Washington', '1732-02-22'),
       ('Adams', '1735-10-30');
```

```
sqlite> SELECT * FROM test;
id          Name        Birthday
----------  ----------  ----------
1           Eric        1987-09-23
2           Washington  1732-02-22
3           Adams       1735-10-30
```

Import a CSV

```
CREATE TABLE chicago (
    Last TEXT, First TEXT,
    Position TEXT, Department TEXT, FP TEXT, SH TEXT,
    Hours INTEGER, Salary REAL, Wage REAL
);
```

Databases have special functions for loading data from various file formats:

```
.import salaries.csv chicago
```

Python Integration

sqlite3 module

sqlite3 module allows python to connect to sqlite and execute queries:

```
import sqlite3

con = sqlite3.connect('atus.sqlite')
result = con.execute("SELECT * FROM cps")
for row in result:
    print(row)
```

pandas and sqlite3

```
import sqlite3
import pandas as pd

con = sqlite3.connect('atus.sqlite')
cps = pd.read_sql('SELECT * FROM CPS',
                  con,
                  index_col='case_id')
```

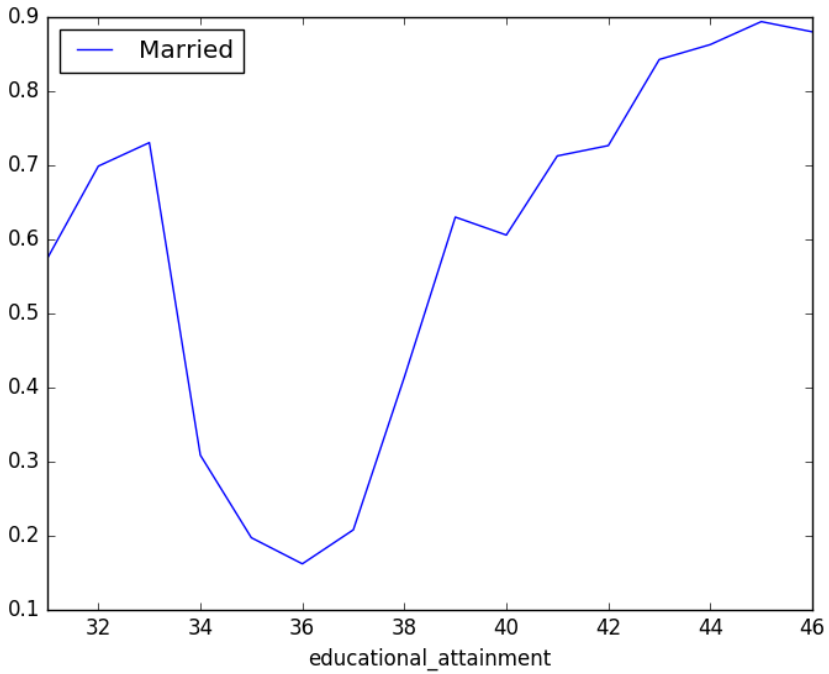
Read query from file

Save `marriage_by_education.sql`:

```
SELECT
  educational_attainment,
  AVG(spouse_or_partner_present = 1) Married
FROM cps JOIN respondents
ON cps.case_id = respondents.case_id AND
   cps.line_no = 1
WHERE number_of_hh_children > 0
GROUP BY educational_attainment;
```

Plot query results

```
with open('marriage_by_education.sql') as f:
    sql = f.read()
m = pd.read_sql(sql, con,
                index_col='educational_attainment')
m.plot()
```



Child engagement example

- Want to explore the relationship between years of education and time spent with children.
  - Years education is in the `cps` table
  - Time spent with children is codes 301XX, 302XX, and 303XX.
- Also want to restrict to:
  - respondents with at least one child (`number_of_hh_children > 0`)
  - employed (`edited_labor_force_status < 3`)
  - These columns are in the`respondents` table.
- So we need to `JOIN` three tables: `respondents`, `cps`, and `activities`

Child engagement SQL

```sql
SELECT
  respondents.case_id,
  cps.years_education AS Education,
  SUM (( activity_code/100 IN (301, 302, 303))
          * duration /60.0) AS Engagement
FROM respondents
JOIN cps ON
  respondents.case_id = cps.case_id AND
  respondents.line_no = cps.line_no
JOIN activities ON
  respondents.case_id = activities.case_id
WHERE
  number_of_hh_children > 0 AND
  edited_labor_force_status < 3
GROUP BY respondents.case_id;
```

Child engagement Python

```
import sqlite3
import pandas as pd
from matplotlib import pyplot as plt

con = sqlite3.connect('atus.sqlite')
with open('child_engagement.sql') as f:
    sql = f.read()

df = pd.read_sql(sql , con)
ax = df.boxplot('Engagement', 'Education')
ax.set(ylim = (0, 7),
       xlabel="Parental Education (Years)",
       ylabel="Direct Engagement (Hours)")
```

Child engagement plot