Announcements

- Project 4 due Friday 11/21 @ 11:59pm
- Please submit project 4 in two different ways:
  - `python3 ok --submit` and set your group on ok.cs61a.org
  - Copy files to class account and submit proj4
- A correction to tests/q20.py was released yesterday afternoon
- Homework 9 (6 pts) due Wednesday 11/26 @ 11:59pm
- Homework Party Monday evening, location TBD
- Guest in live lecture, TA Soumya Basu, on Monday 11/24 (videos by John)
- No lecture on Wednesday 11/26 (turkey)
- No lab next Tuesday 11/25 & Wednesday 11/26

Local Tables

A `create table` statement names a table globally

```
create table parents as
    select
        "abraham"
    as parent,
        "barack"
    as child
union
    select
        "abraham",
        "clinton"
union
    select
        "delano",
        "herbert"
union
    select
        "fillmore",
        "abraham"
union
    select
        "fillmore",
        "delano"
union
    select
        "fillmore",
        "grover"
union
    select
        "eisenhower",
        "fillmore";
```

Example: Relationships

(A) What are appropriate names for the columns in this result?
(B) How many rows will result?

```
with what(first, second) as (
    select a.child, b.child
    from parents as a, parents as b
    where a.parent = b.parent and
      a.child != b.child
)
select child as ____________,
     second as ____________
from parents, what
where parent=first;
```

Local Tables can be Declared Recursively

```
create table parents as
    select
        "abraham"
    as parent,
        "barack"
    as child
union
    select
        "abraham",
        "clinton"
union
    select
        "delano",
        "herbert"
union
    select
        "fillmore",
        "abraham"
union
    select
        "fillmore",
        "delano"
union
    select
        "fillmore",
        "grover"
union
    select
        "eisenhower",
        "fillmore";
```

Recursive Local Tables

An ancestor is your parent or an ancestor of your parent

```
create table parents as
    select
        "abraham"
    as parent,
        "barack"
    as child
union
    select
        "abraham",
        "clinton"
union
    select
        "delano",
        "herbert"
union
    select
        "fillmore",
        "abraham"
union
    select
        "fillmore",
        "delano"
union
    select
        "fillmore",
        "grover"
union
    select
        "eisenhower",
        "fillmore";
```
Global Names for Recursive Tables

To create a table with a global name, you need to select the contents of the local table

```
create table odds as
  with
    odds(n) as
      (select 1 union select n+2 from odds where n < 15)
  select n from odds;
```

Which names above can change without affecting the result?

Limits on Recursive Select Statements

Recursive table definitions are only possible within a `with` clause

```
with
  odds(x) as
    (select 1 union select x+1 from evens)
  evens(x) as
    (select x+1 from odds)
select x from odds
with
  ints(x) as
    (select 1 union select x-1 from ints union select x+1 from ints)
select x from ints;
```

Language is Recursive

Noun phrases can contain relative pronouns that introduce relative clauses

```
The dog chased the cat
  that chased the bird
The dog chased the cat
  that the bird chased
The dog chased the cat
  the bird chased
Bulldogs bulldogs bulldogs fight fight fight
```

Input-Output Tables

A table containing the inputs to a function can be used to map from output to input

```
create table pairs as
  with
    i(n) as
      (select 1 union select n+1 from i where n < 50)
  select a.n as x, b.n as y
  from
    i as a, i as b
  where
    a.n <= b.n;
```

What integers can I add/multiply together to get 24?

```
Example: Pythagorean Triples

All triples a, b, c such that \(a^2 + b^2 = c^2\)

```
create table fibs as
  with
    fib(previous, current) as
      (select 0, 1 union select current, previous + current from fib
       where current <= 150)
  select 
```

Example: Fibonacci Sequence

Computing the next Fibonacci number requires both the previous and current numbers

```
create table fibs as
  with
    fib(previous, current) as
      (select 0, 1 union select current, previous + current from fib
       where current <= 150)
  select 
```

```
```
The mathematician G. H. Hardy once remarked to the mathematician Srinivasa Ramanujan...

(Demo)