

61A Lecture 32

Announcements

Local Tables

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A `create table` statement names a table globally

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```
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";
```

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  select "eisenhower"   , "fillmore";
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parents:

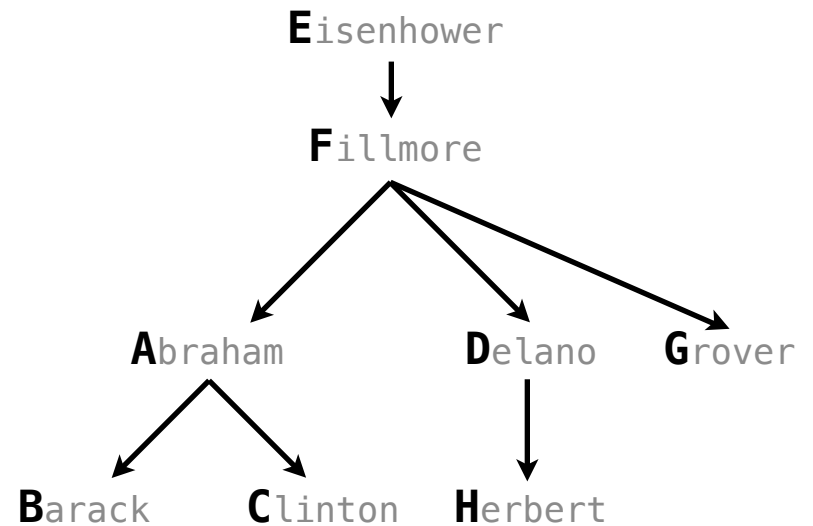
Parent	Child
abraham	barack
abraham	clinton
delano	herbert
fillmore	abraham
fillmore	delano
fillmore	grover
eisenhower	fillmore

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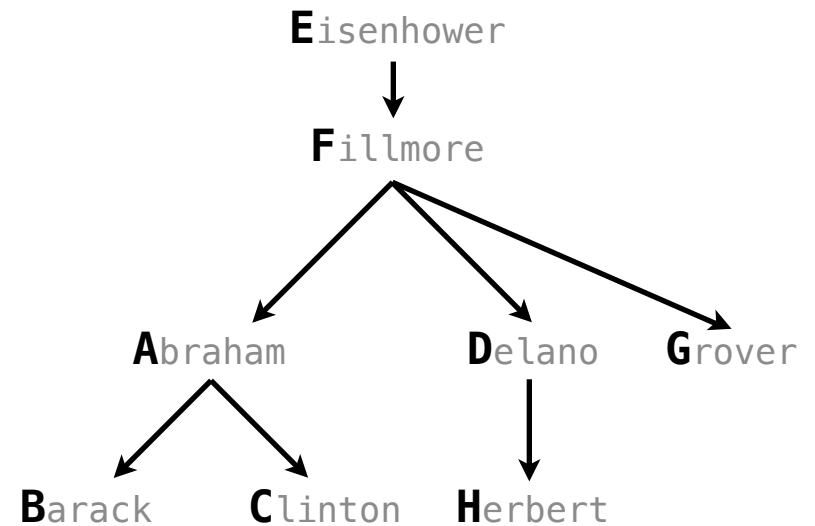
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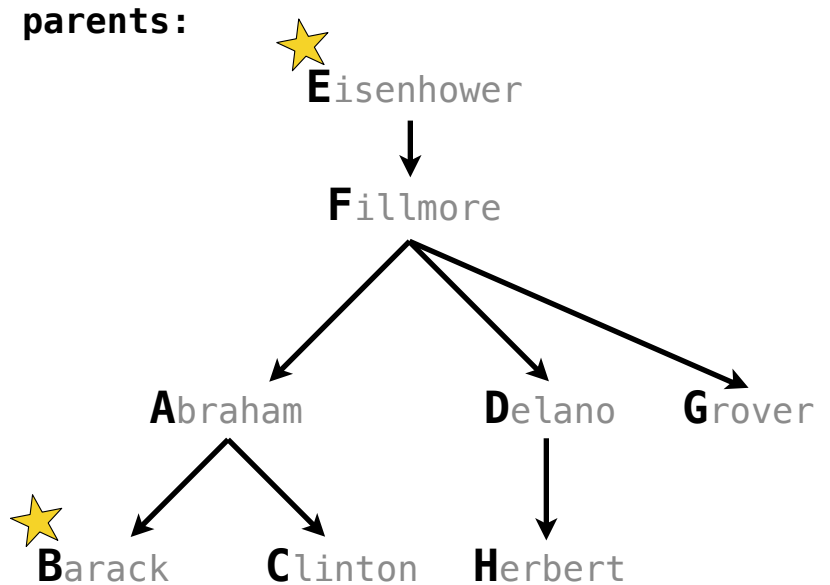


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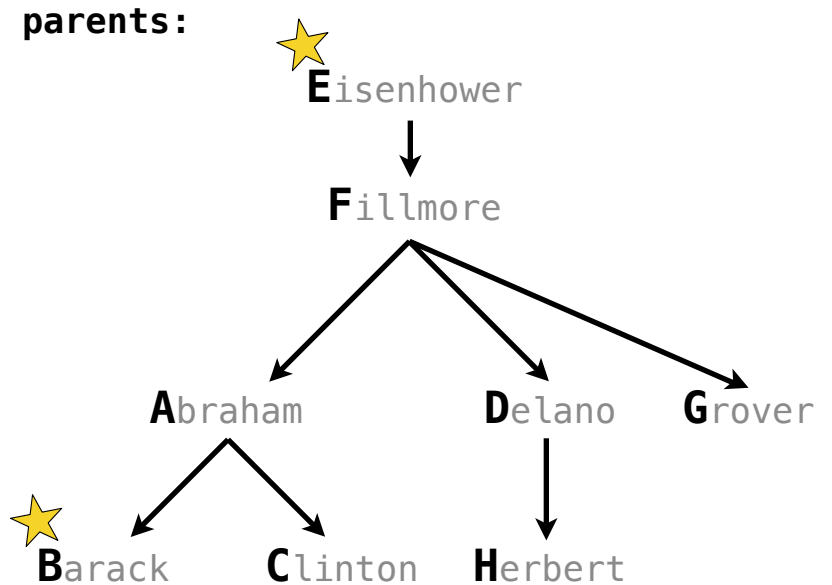
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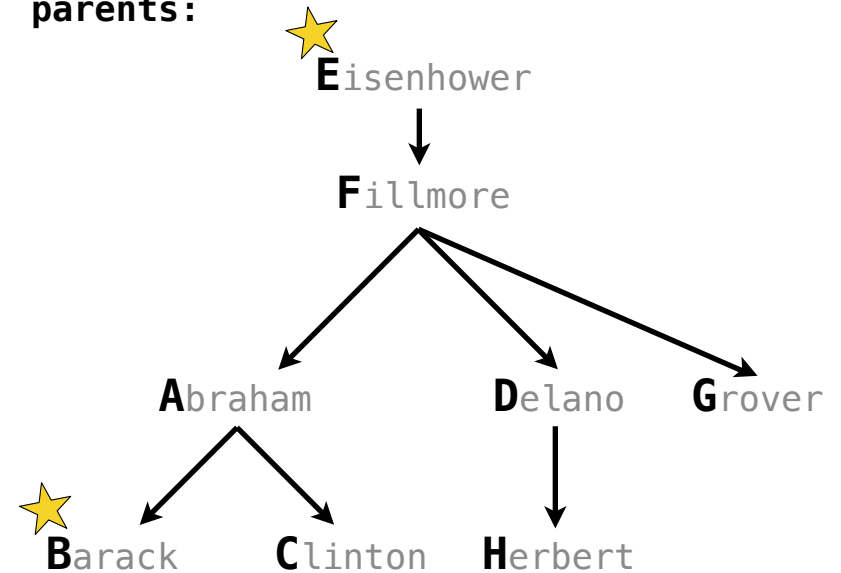
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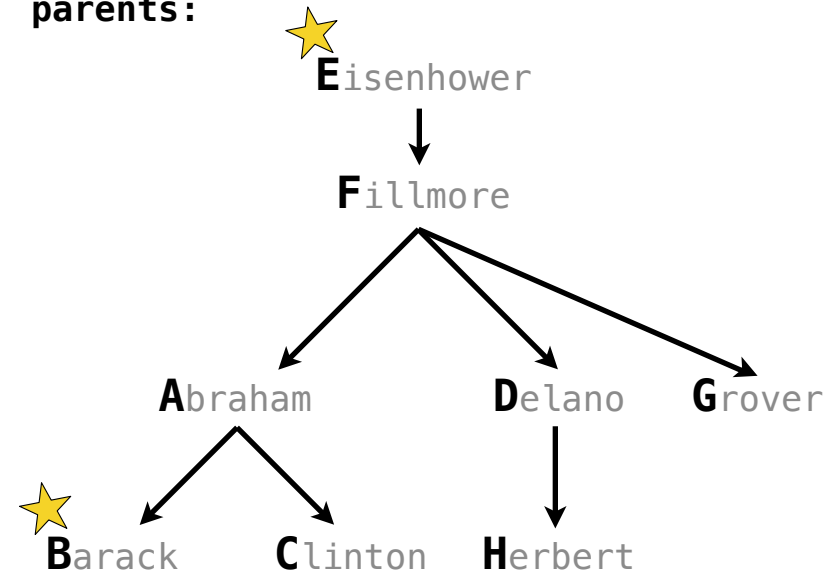
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with

```
best(dog) as (
```

```
select parent from ...
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parents:



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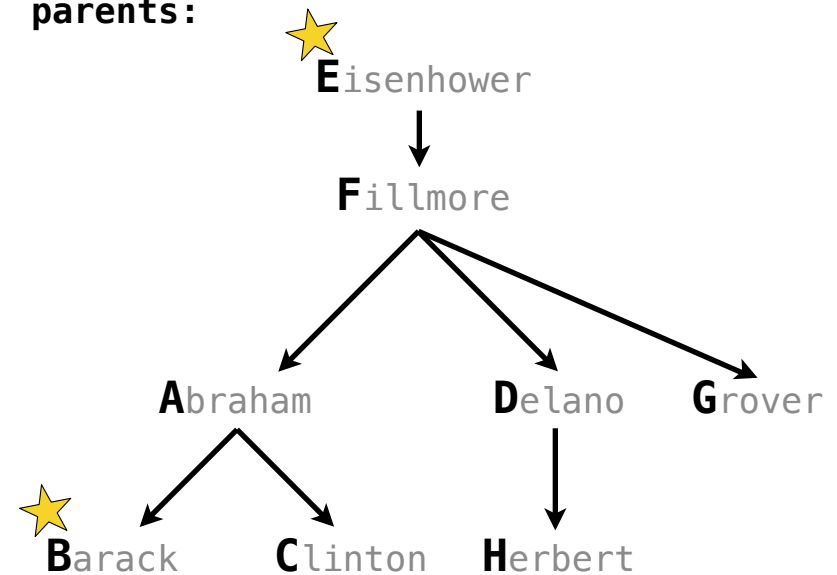
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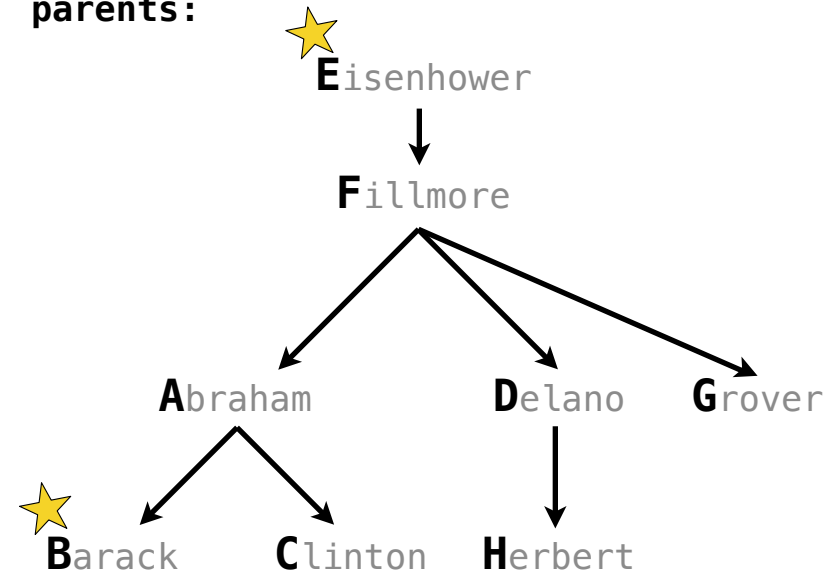
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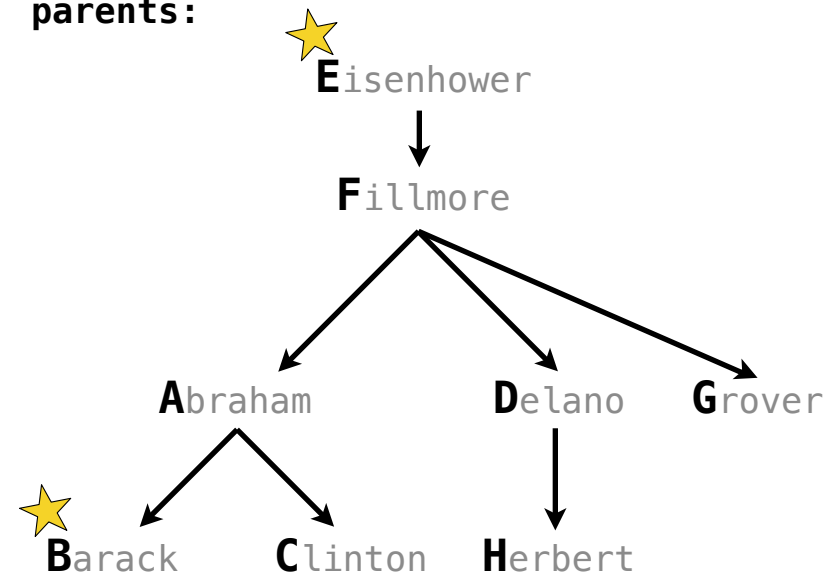
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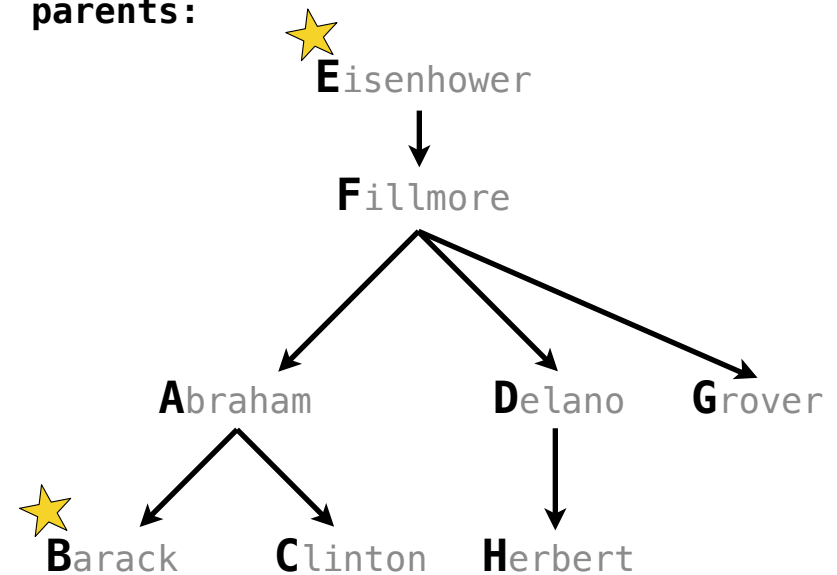
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```
select parent from ...
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best:

dog
eisenhower
barack

parents:



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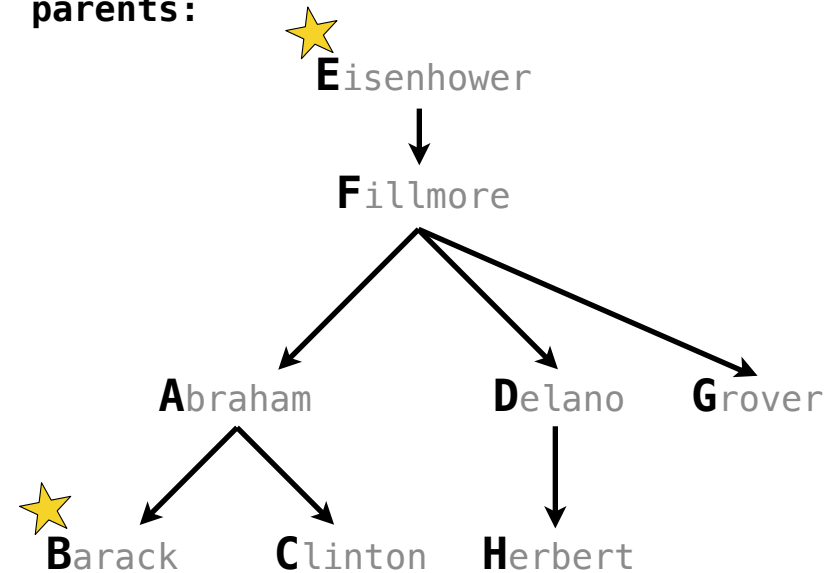
```
best(dog) as (
  select "eisenhower" union
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)
```

best:

dog
eisenhower
barack

```
select parent from parents, best where child=dog;
```

parents:



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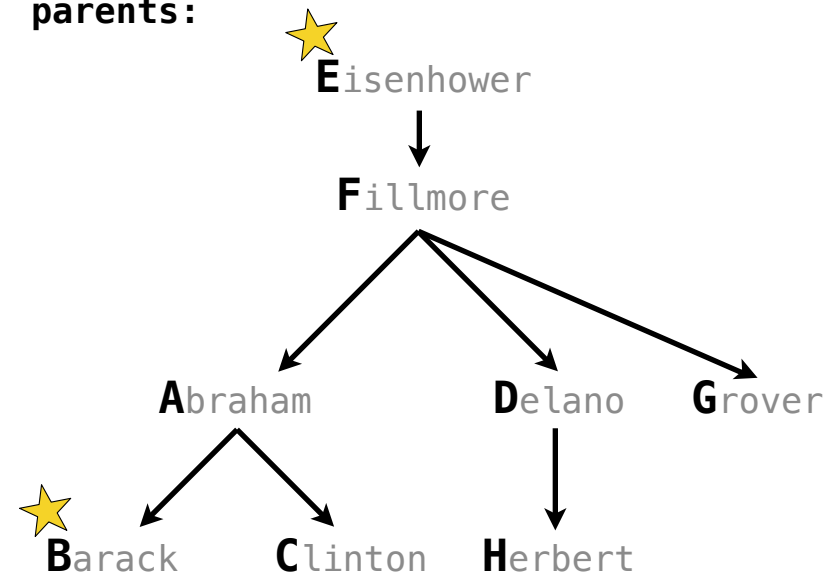
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dog
eisenhower
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```
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```

parent
abraham

parents:



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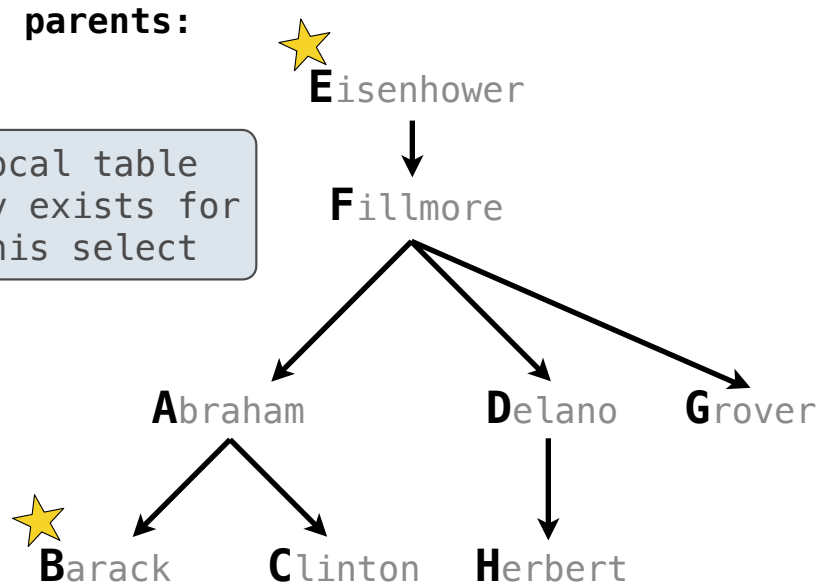
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```

parent
abraham

best:
dog
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Local table
only exists for
this select



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```
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```
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```

Part of the
select statement

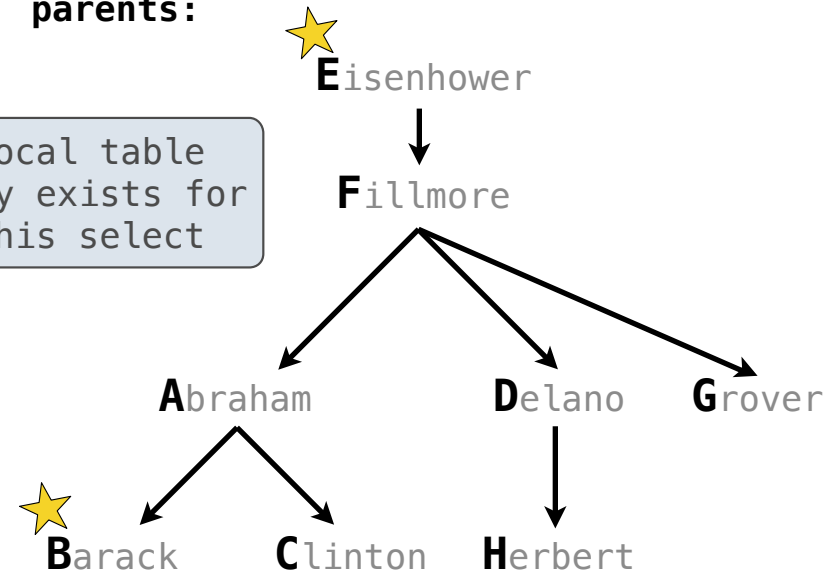
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Part of the
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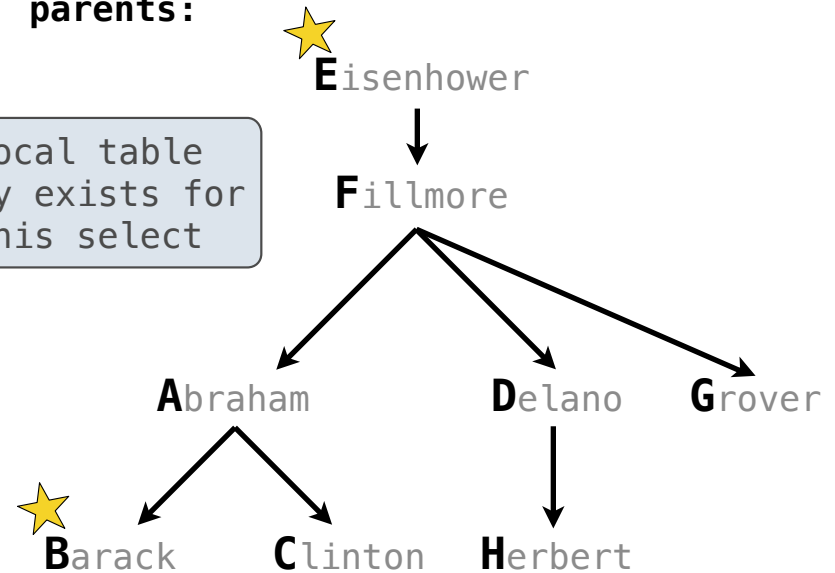
```
select parent from parents, best where child=dog;
```

parent
abraham

(Demo)

parents:

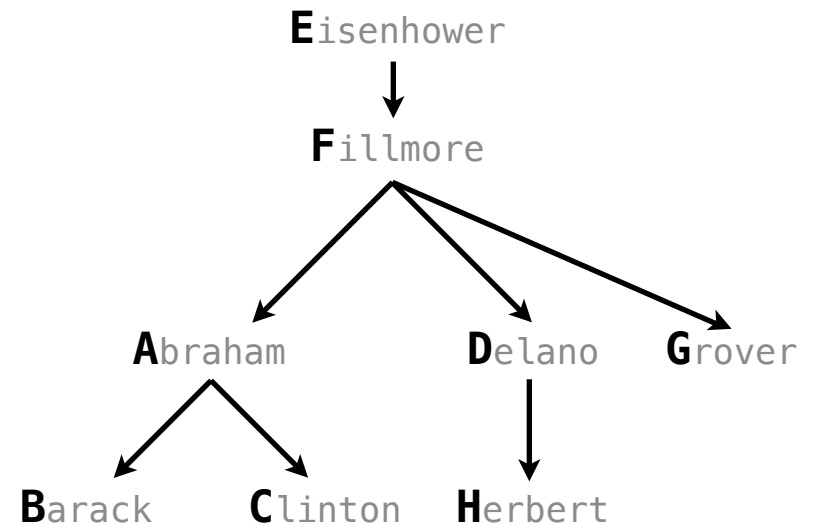
Local table
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Example: Relationships

```
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;
```

parents:

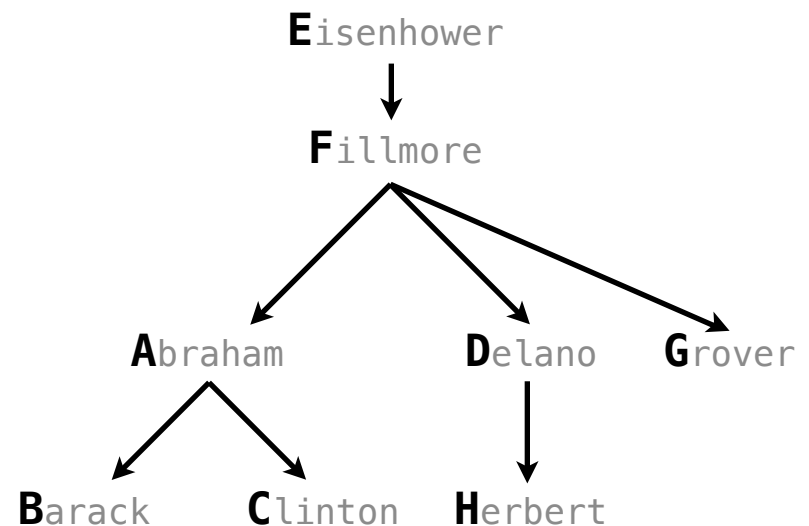


Example: Relationships

(A) What are appropriate names for the columns in this result?

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with
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parents:



Example: Relationships

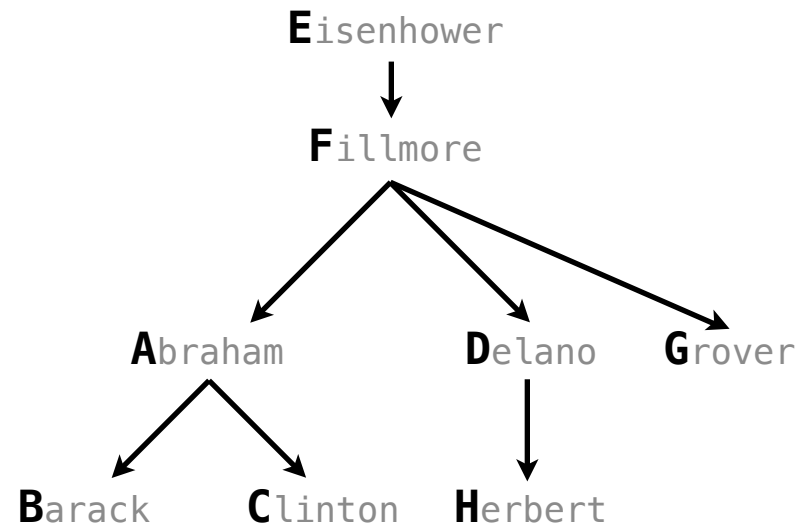
(A) What are appropriate names for the columns in this result?

(B) How many rows and columns will result?

with

```
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         from parents as a, parents as b  
         where a.parent = b.parent and  
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select child as _____, second as _____  
       from parents, what where parent=first;
```

parents:



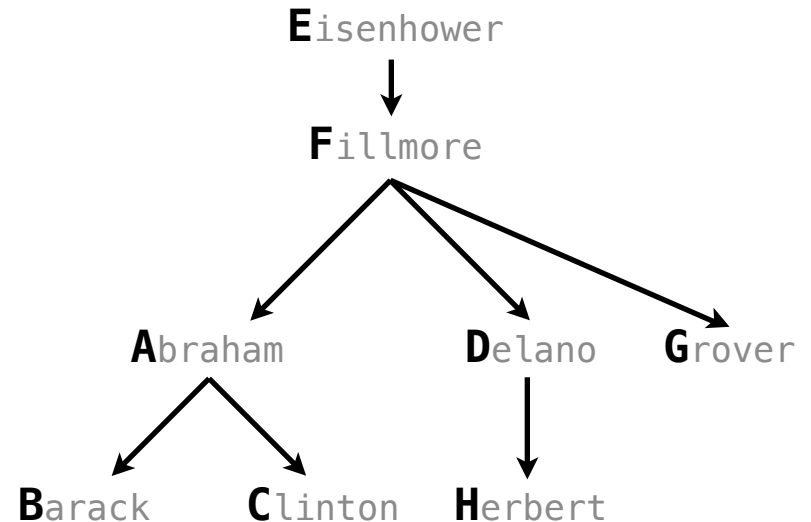
Example: Relationships

(A) What are appropriate names for the columns in this result?

(B) How many rows and columns will result?

```
with
siblings
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  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 siblings
       where parent=first;
```

parents:



Example: Relationships

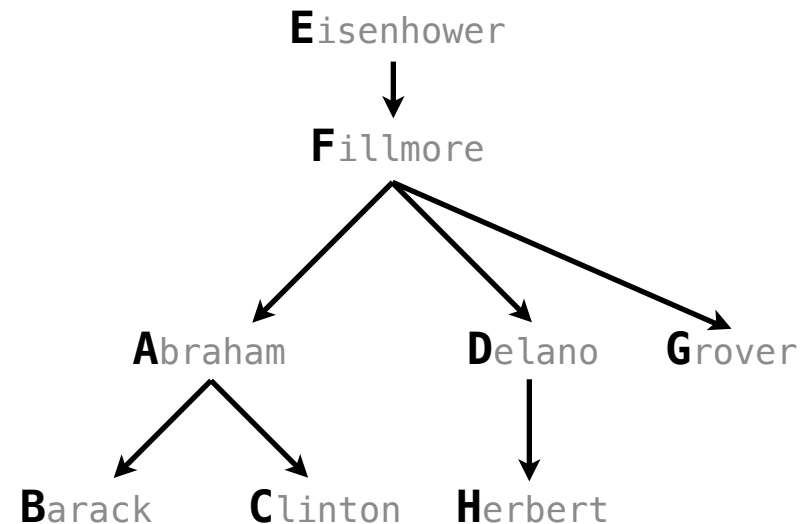
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      from parents, what siblings
              where parent=first;
```

parent	child	first	second
abraham	barack	abraham	delano

parents:



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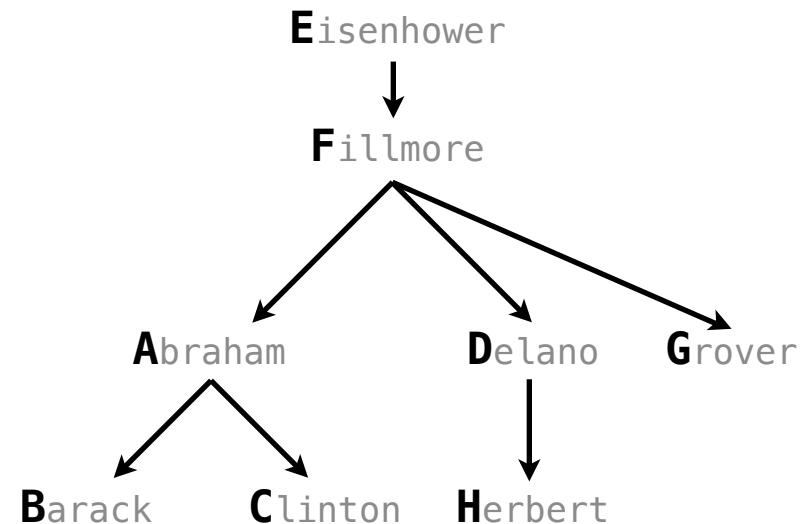
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parent	child	first	second
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parents:



Example: Relationships

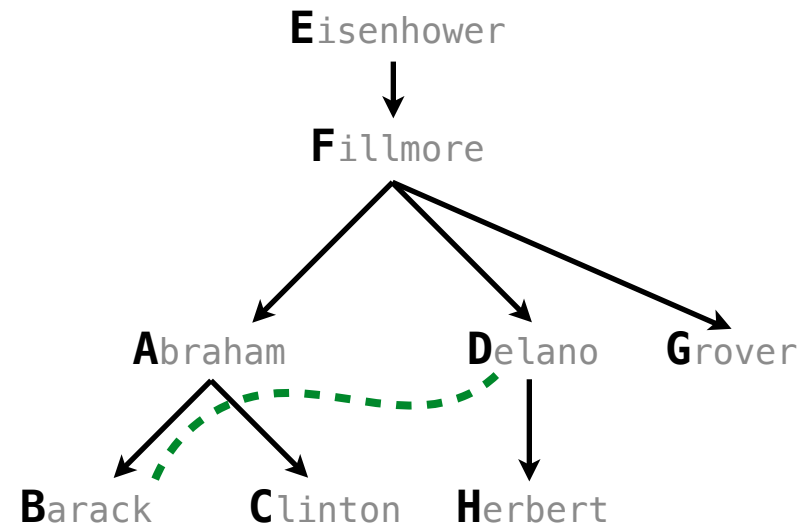
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parent	child	first	second
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parents:



Example: Relationships

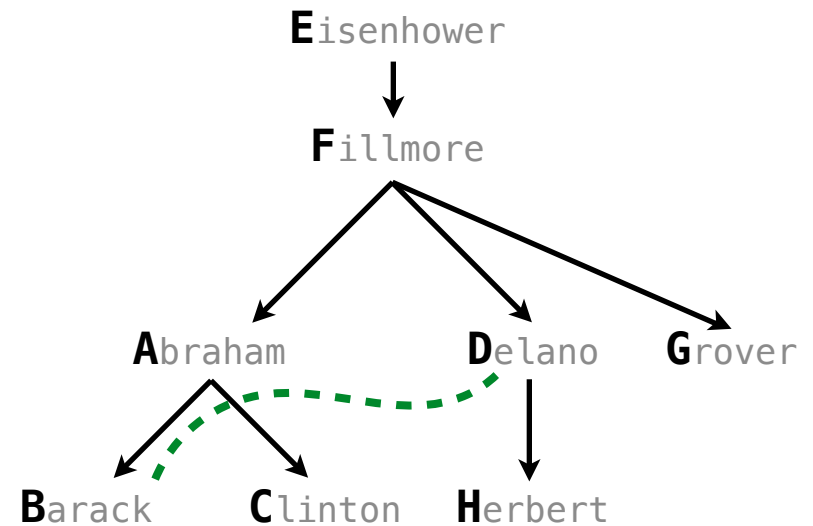
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         from parents as a, parents as b
         where a.parent = b.parent and
               a.child != b.child
)
select child as nephew, second as siblings
       from parents, what where parent=first;
              nephew
```

parent	child	first	second
abraham	barack	abraham	delano

parents:



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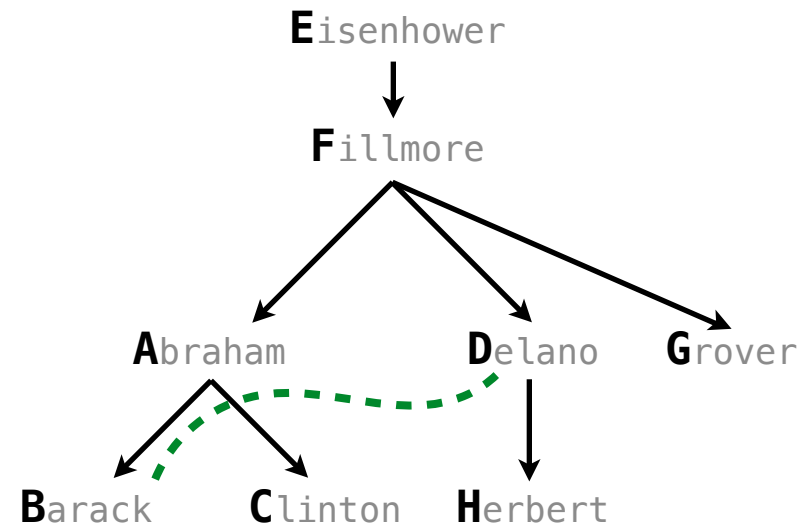
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)
select child as nephew, second as uncle
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```

parent	child	first	second
abraham	barack	abraham	delano

parents:



Recursive Local Tables

Local Tables can be Declared Recursively

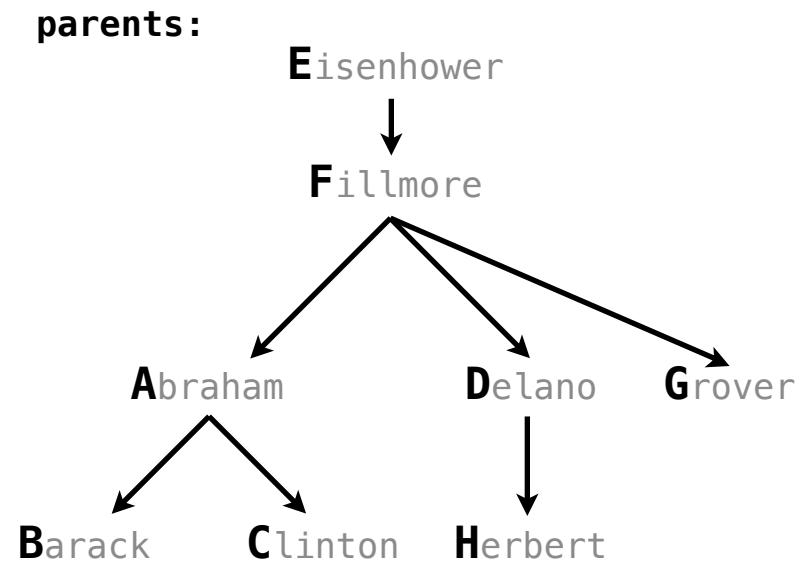
Local Tables can be Declared Recursively

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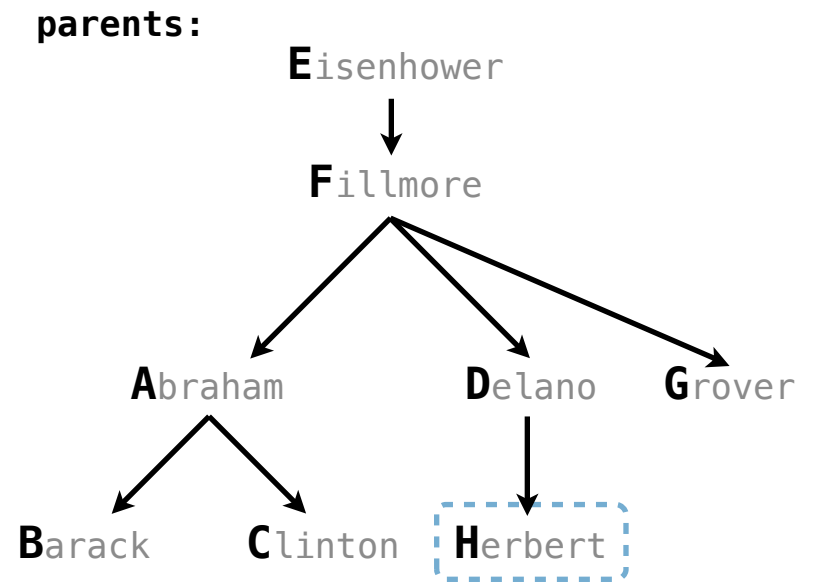
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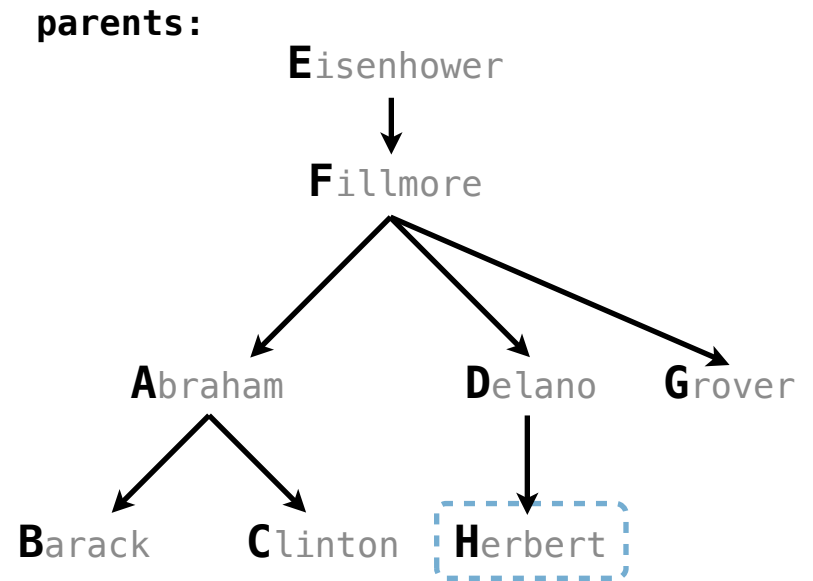


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ancestors(ancestor, descendent)

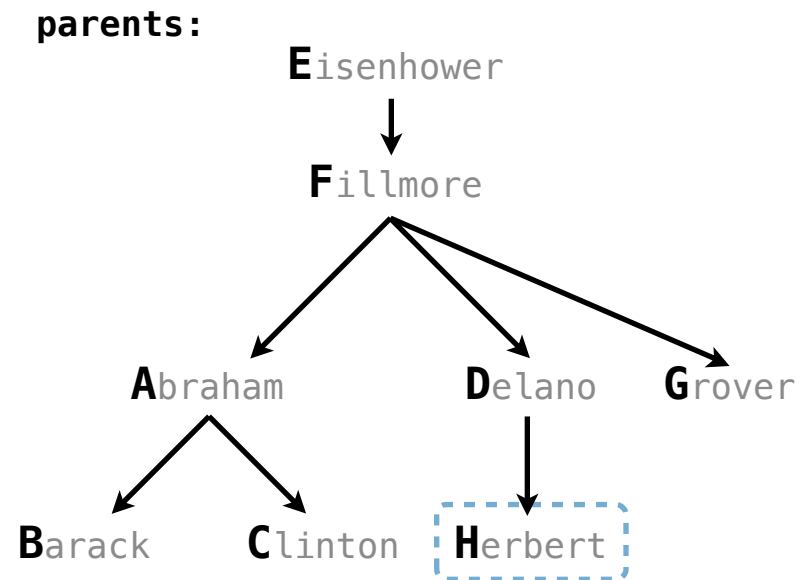


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```
ancestors(ancestor, descendent) as (
  select parent, child from parents union
  select ancestor, child
  from ancestors, parents
  where parent = descendent
)
```



Local Tables can be Declared Recursively

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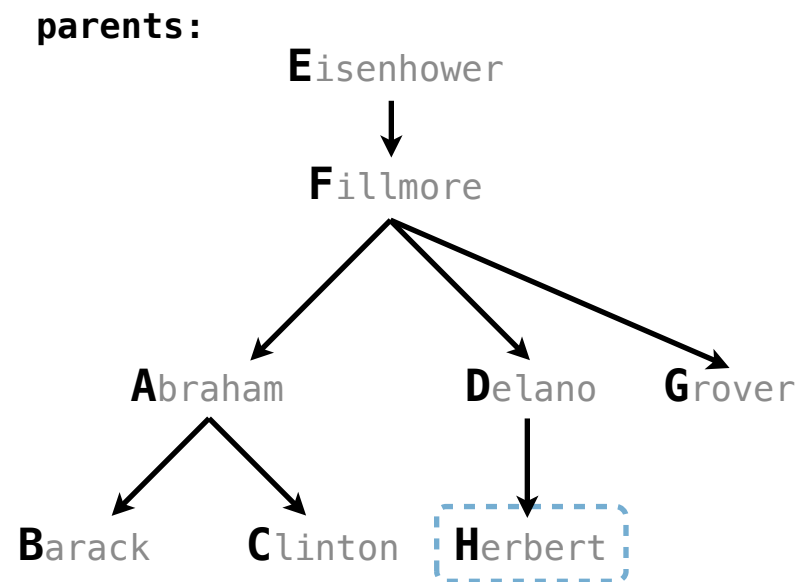
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  where parent = descendent
```

)

```
select ancestor from ancestors where descendent="herbert";
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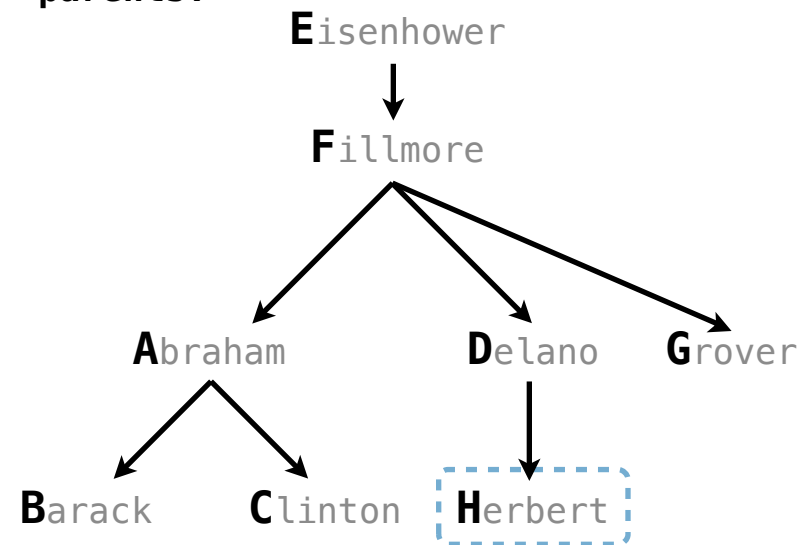
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  from ancestors, parents
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```

)

```
select ancestor from ancestors where descendent="herbert";
```

parents:



ancestor
delano
fillmore
eisenhower

Global Names for Recursive Tables

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

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odds:

n
1
3
5
7
9
11
13
15

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Which names above can change without affecting the result?

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Limits on Recursive Select Statements

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```
with
  odds(x) as (
    select 1 union select x+1 from evens
  ),
  evens(x) as (
    select x+1 from odds
  )
select x from odds
```

Limits on Recursive Select Statements

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No mutual recursion: two or more tables cannot be defined in terms of each other

Nope!

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No tree recursion: the table being defined can only appear once in a from clause

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  evens(x) as (
    select x+1 from odds
  )
select x from odds
```

No tree recursion: the table being defined can only appear once in a from clause

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

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No tree recursion: the table being defined can only appear once in a from clause

Nope!

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

```
with
  ints(x) as (
    select 1 union
    select a.x + b.x
      from ints as a, ints as b
  )
select x from ints;
```

Limits on Recursive Select Statements

Recursive table definitions are only possible within a with clause

No mutual recursion: two or more tables cannot be defined in terms of each other

Nope!

```
with
  odds(x) as (
    select 1 union select x+1 from evens
  ),
  evens(x) as (
    select x+1 from odds
  )
select x from odds
```

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    select x-1 from ints union
    select x+1 from ints
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String Examples

Language is Recursive

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Noun phrases can contain relative pronouns that introduce relative clauses


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(Demo)

Integer Examples

Input-Output Tables

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

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```
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;
```

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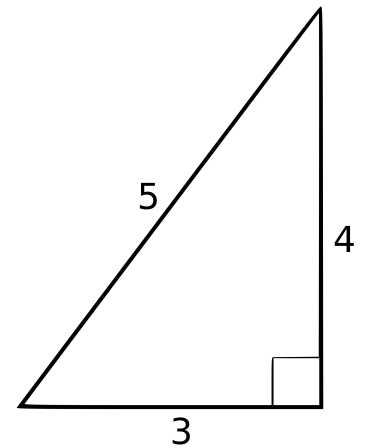
(Demo)

Example: Pythagorean Triples

All triples a, b, c such that $a^2 + b^2 = c^2$

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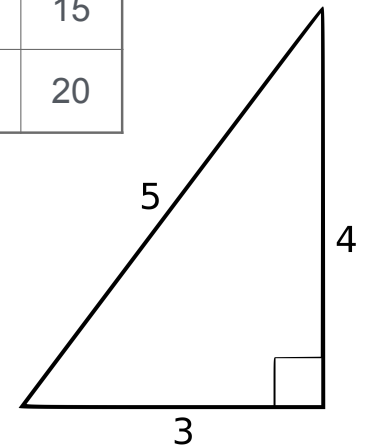
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Example: Pythagorean Triples

All triples a, b, c such that $a^2 + b^2 = c^2$

a	b	c
3	4	5
5	12	13
6	8	10
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9	12	15
12	16	20



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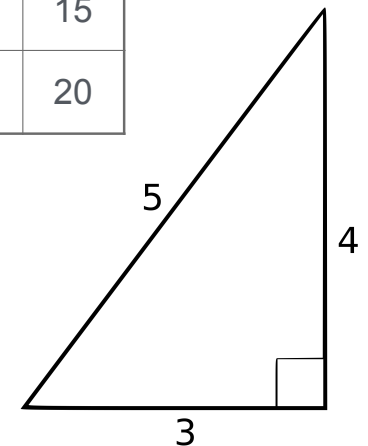
`)`

`select a.n as a, b.n as b, c.n as c`

`from _____`

`where _____ and a.n*a.n + b.n*b.n = c.n*c.n;`

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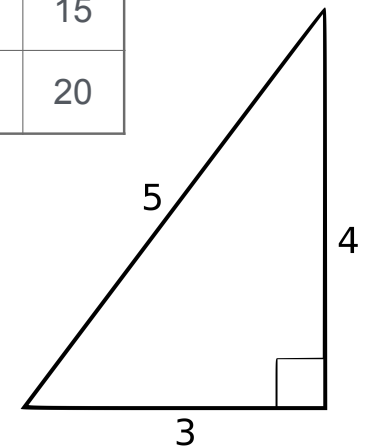
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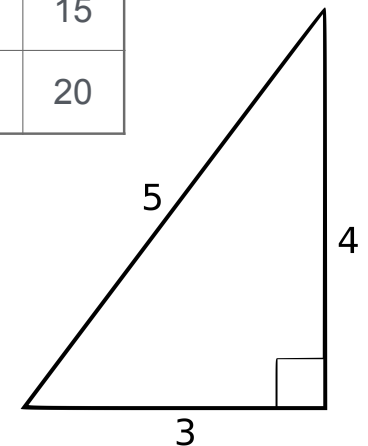
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`select a.n as a, b.n as b, c.n as c`

`from _____`
`i as a, i as b, i as c`

`where _____`
`a.n < b.n` and `a.n*a.n + b.n*b.n = c.n*c.n;`

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3	4	5
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Example: Fibonacci Sequence

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fibs:

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2
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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 <= _____
  )
select _____ as n from fib;
```

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create table fibs as
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    where current <= 14.15926535
  )
select previous as n from fib;
```

fibs:

n
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A Very Interesting Number

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

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