Announcements
Joining Tables
Reminder: John the Patriotic Dog Breeder
Reminder: John the Patriotic Dog Breeder

```sql
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";
```
Reminder: John the Patriotic Dog Breeder

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";
Reminder: John the Patriotic Dog Breeder

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";

Parents:

<table>
<thead>
<tr>
<th>Parent</th>
<th>Child</th>
</tr>
</thead>
<tbody>
<tr>
<td>abraham</td>
<td>barack</td>
</tr>
<tr>
<td>abraham</td>
<td>clinton</td>
</tr>
<tr>
<td>delano</td>
<td>herbert</td>
</tr>
<tr>
<td>fillmore</td>
<td>abraham</td>
</tr>
<tr>
<td>fillmore</td>
<td>delano</td>
</tr>
<tr>
<td>fillmore</td>
<td>grover</td>
</tr>
<tr>
<td>eisenhower</td>
<td>fillmore</td>
</tr>
</tbody>
</table>
Joining Two Tables
Joining Two Tables

Two tables A & B are joined by a comma to yield all combos of a row from A & a row from B.
Joining Two Tables

Two tables A & B are joined by a comma to yield all combos of a row from A & a row from B.

```
create table dogs as
select "abraham" as name, "long" as fur union
```
**Joining Two Tables**

Two tables A & B are joined by a comma to yield all combos of a row from A & a row from B

```sql
create table dogs as
    select "abraham" as name, "long" as fur
union
    select "barack" , "short"
union
```
Joining Two Tables

Two tables A & B are joined by a comma to yield all combos of a row from A & a row from B

create table dogs as
select "abraham" as name, "long" as fur union
select "barack" , "short" union
select "clinton" , "long" union

A
B
C
Joining Two Tables

Two tables A & B are joined by a comma to yield all combos of a row from A & a row from B

create table dogs as
  select "abraham" as name, "long" as fur union
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  select "clinton" , "long" union
  select "delano" , "long" union
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create table dogs as
    select "abraham" as name, "long" as fur union
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create table dogs as
  select "abraham" as name, "long" as fur union
  select "barack"    , "short"     union
  select "clinton"   , "long"      union
  select "delano"    , "long"      union
  select "eisenhower", "short"     union
  select "fillmore"  , "curly"     union
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Two tables A & B are joined by a comma to yield all combos of a row from A & a row from B

create table dogs as
    select "abraham" as name, "long" as fur union
    select "barack" , "short" union
    select "clinton" , "long" union
    select "delano" , "long" union
    select "eisenhower" , "short" union
    select "fillmore" , "curly" union
    select "grover" , "short" union
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create table dogs as
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    select "delano" , "long" union
    select "eisenhower" , "short" union
    select "fillmore" , "curly" union
    select "grover" , "short" union
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select "eisenhower" , "short" union
select "fillmore" , "curly" union
select "grover" , "short" union
select "herbert" , "curly";

create table parents as
select "abraham" as parent, "barack" as child union
select "abraham" , "clinton" union
...;
Joining Two Tables

Two tables A & B are joined by a comma to yield all combos of a row from A & a row from B

create table dogs as
  select "abraham" as name, "long" as fur union
  select "barack" , "short" union
  select "clinton" , "long" union
  select "delano" , "long" union
  select "eisenhower" , "short" union
  select "fillmore" , "curly" union
  select "grover" , "short" union
  select "herbert" , "curly";

create table parents as
  select "abraham" as parent, "barack" as child union
  select "abraham" , "clinton" union
  ...;

Select the parents of curly-furred dogs
Joining Two Tables

Two tables $A$ & $B$ are joined by a comma to yield all combos of a row from $A$ & a row from $B$

create table dogs as
   select "abraham" as name, "long" as fur union
   select "barack" , "short" union
   select "clinton" , "long" union
   select "delano" , "long" union
   select "eisenhower" , "short" union
   select "fillmore" , "curly" union
   select "grover" , "short" union
   select "herbert" , "curly";

create table parents as
   select "abraham" as parent, "barack" as child union
   select "abraham" , "clinton" union
   ...;

Select the parents of curly-furred dogs

   select parent from parents, dogs
      where child = name and fur = "curly";
Joining Two Tables

Two tables A & B are joined by a comma to yield all combos of a row from A & a row from B

create table dogs as
  select "abraham" as name, "long" as fur union
  select "barack" , "short" union
  select "clinton" , "long" union
  select "delano" , "long" union
  select "eisenhower" , "short" union
  select "fillmore" , "curly" union
  select "grover" , "short" union
  select "herbert" , "curly";

create table parents as
  select "abraham" as parent, "barack" as child union
  select "abraham" , "clinton" union
  ...;

Select the parents of curly-furred dogs

  select parent from (parents, dogs)
  where child = name and fur = "curly";
Joining Two Tables

Two tables \( A \) & \( B \) are joined by a comma to yield all combos of a row from \( A \) & a row from \( B \)

```sql
create table dogs as
    select "abraham" as name, "long" as fur union
    select "barack" as name, "short" as fur union
    select "clinton" as name, "long" as fur union
    select "delano" as name, "long" as fur union
    select "eisenhower" as name, "short" as fur union
    select "fillmore" as name, "curly" as fur union
    select "grover" as name, "short" as fur union
    select "herbert" as name, "curly" union;

create table parents as
    select "abraham" as parent, "barack" as child union
    select "abraham" as parent, "clinton" union
    ...;
```

Select the parents of curly-furred dogs

```sql
select parent from parents, dogs
    where child = name and fur = "curly";
```

(Demo)
Aliases and Dot Expressions
Joining a Table with Itself
Joining a Table with Itself

Two tables may share a column name; dot expressions and aliases disambiguate column values.
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Two tables may share a column name; dot expressions and aliases disambiguate column values

```
select [columns] from [table] where [condition] order by [order];
```
Joining a Table with Itself

Two tables may share a column name; dot expressions and aliases disambiguate column values

```sql
select [columns] from [table] where [condition] order by [order];
```

[table] is a comma-separated list of table names with optional aliases.
Joining a Table with Itself

Two tables may share a column name; dot expressions and aliases disambiguate column values

```
select [columns] from [table] where [condition] order by [order];
```

[table] is a comma-separated list of table names with optional aliases

Select all pairs of siblings
Joining a Table with Itself

Two tables may share a column name; dot expressions and aliases disambiguate column values

```
select [columns] from [table] where [condition] order by [order];
```

[table] is a comma-separated list of table names with optional aliases

Select all pairs of siblings

```
select a.child as first, b.child as second
from parents as a, parents as b
where a.parent = b.parent and a.child < b.child;
```
Joining a Table with Itself

Two tables may share a column name; dot expressions and aliases disambiguate column values

```
select [columns] from [table] where [condition] order by [order];
```

[table] is a comma-separated list of table names with optional aliases

Select all pairs of siblings

```
select a.child as first, b.child as second
from (parents as a, parents as b)
where a.parent = b.parent and a.child < b.child;
```
Joining a Table with Itself

Two tables may share a column name; dot expressions and aliases disambiguate column values

```
select [columns] from [table] where [condition] order by [order];
```

[table] is a comma-separated list of table names with optional aliases

Select all pairs of siblings

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

<table>
<thead>
<tr>
<th>First</th>
<th>Second</th>
</tr>
</thead>
<tbody>
<tr>
<td>barack</td>
<td>clinton</td>
</tr>
<tr>
<td>abraham</td>
<td>delano</td>
</tr>
<tr>
<td>abraham</td>
<td>grover</td>
</tr>
<tr>
<td>delano</td>
<td>grover</td>
</tr>
</tbody>
</table>
Example: Grandparents

Which select statement evaluates to all grandparent, grandchild pairs?

1. `select a.grandparent, b.child from parents as a, parents as b
   where b.parent = a.child;

2. `select a.parent, b.child from parents as a, parents as b
   where a.parent = b.child;

3. `select a.parent, b.child from parents as a, parents as b
   where b.parent = a.child;

4. `select a.grandparent, b.child from parents as a, parents as b
   where a.parent = b.child;

5. None of the above
Joining Multiple Tables
Joining Multiple Tables

Multiple tables can be joined to yield all combinations of rows from each
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Multiple tables can be joined to yield all combinations of rows from each

create table grandparents as
    select a.parent as grandog, b.child as granpup
    from parents as a, parents as b
    where b.parent = a.child;
Joining Multiple Tables

Multiple tables can be joined to yield all combinations of rows from each

create table grandparents as
    select a.parent as grandog, b.child as granpup
    from parents as a, parents as b
    where b.parent = a.child;

Select all grandparents with the same fur as their grandchildren
Joining Multiple Tables

Multiple tables can be joined to yield all combinations of rows from each

```sql
create table grandparents as
    select a.parent as grandog, b.child as granpup
    from parents as a, parents as b
    where b.parent = a.child;
```

Select all grandparents with the same fur as their grandchildren

Which tables need to be joined together?
Joining Multiple Tables

Multiple tables can be joined to yield all combinations of rows from each

```sql
create table grandparents as
    select a.parent as granddog, b.child as granpup
    from parents as a, parents as b
    where b.parent = a.child;
```

Select all grandparents with the same fur as their grandchildren

```
select granddog from grandparents, dogs as c, dogs as d
    where granddog = c.name and
    granpup = d.name and
    c.fur = d.fur;
```
Example: Dog Triples
Fall 2014 Quiz Question (Slightly Modified)
Fall 2014 Quiz Question (Slightly Modified)

Write a SQL query that selects all possible combinations of three different dogs with the same fur and lists each triple in \textit{inverse} alphabetical order.
Fall 2014 Quiz Question (Slightly Modified)

Write a SQL query that selects all possible combinations of three different dogs with the same fur and lists each triple in *inverse* alphabetical order.

```sql
create table dogs as
    select "abraham" as name, "long" as fur union
    select "barack" , "short" union
    ...;
```
Write a SQL query that selects all possible combinations of three different dogs with the same fur and lists each triple in *inverse* alphabetical order.

```sql
create table dogs as
    select "abraham" as name, "long" as fur union
    select "barack", "short" union
    ...

create table parents as
    select "abraham" as parent, "barack" as child union
    select "abraham", "clinton" union
    ...
```
Fall 2014 Quiz Question (Slightly Modified)

Write a SQL query that selects all possible combinations of three different dogs with the same fur and lists each triple in inverse alphabetical order.

create table dogs as
  select "abraham" as name, "long" as fur union
  select "barack" , "short" union
  ...;

create table parents as
  select "abraham" as parent, "barack" as child union
  select "abraham" , "clinton" union
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```sql
create table dogs as
    select "abraham" as name, "long" as fur union
    select "barack" , "short" union
    ...
;

create table parents as
    select "abraham" as parent, "barack" as child union
    select "abraham" , "clinton" union
    ...
;
```

Expected output:

```
delano|clinton|abraham
grover|eisenhower|barack
```
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```sql
create table dogs as
    select "abraham" as name, "long" as fur union
    select "barack" , "short" union
    ...
create table parents as
    select "abraham" as parent, "barack" as child union
    select "abraham" , "clinton" union
    ...
```

Expected output:

```
delano|clinton|abraham
grover|eisenhower|barack
```

(Demo)
Numerical Expressions
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Expressions can contain function calls and arithmetic operators
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Expressions can contain function calls and arithmetic operators

```
select [columns] from [table] where [expression] order by [expression];
```
Numerical Expressions

Expressions can contain function calls and arithmetic operators

```sql
(expression) as [name], (expression) as [name], ...
```

```sql
select [columns] from [table] where [expression] order by [expression];
```
Numerical Expressions

Expressions can contain function calls and arithmetic operators

\[
\text{[expression] as [name], [expression] as [name], ...}
\]

\[
\text{select [columns] from [table] where [expression] order by [expression];}
\]

Combine values: +, -, *, /, %, and, or
Numerical Expressions

Expressions can contain function calls and arithmetic operators

```
select [columns] from [table] where [expression] order by [expression];
```

Combine values: +, -, *, /, %, and, or

Transform values: abs, round, not, −
Numerical Expressions

Expressions can contain function calls and arithmetic operators

```
[expression] as [name], [expression] as [name], ...
```

```
select [columns] from [table] where [expression] order by [expression];
```

Combine values: +, -, *, /, %, and, or

Transform values: abs, round, not, -

Compare values: <, <=, >, >=, <>, !=, =
Numerical Expressions

Expressions can contain function calls and arithmetic operators

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[expression] as [name], [expression] as [name], ...
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(Demo)
String Expressions
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String values can be combined to form longer strings
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```
sqlite> select "hello," || " world";
hello, world
```
String Expressions

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```

Basic string manipulation is built into SQL, but differs from Python
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Basic string manipulation is built into SQL, but differs from Python

```sql
sqlite> create table phrase as select "hello, world" as s;
```
String Expressions

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```
sqlite> select "hello," || " world";
hello, world
```

Basic string manipulation is built into SQL, but differs from Python

```
sqlite> create table phrase as select "hello, world" as s;
sqlite> select substr(s, 4, 2) || substr(s, instr(s, " ")+1, 1) from phrase;
```
String Expressions

String values can be combined to form longer strings

    sqlite> select "hello," || " world";
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Basic string manipulation is built into SQL, but differs from Python

    sqlite> create table phrase as select "hello, world" as s;
    sqlite> select substr(s, 4, 2) || substr(s, instr(s, " ")+1, 1) from phrase;
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Strings can be used to represent structured values, but doing so is rarely a good idea
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Strings can be used to represent structured values, but doing so is rarely a good idea

```sql
sqlite> create table lists as select "one" as car, "two,three,four" as cdr;
```
String Expressions

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Strings can be used to represent structured values, but doing so is rarely a good idea

```
sqlite> create table lists as select "one" as car, "two,three,four" as cdr;
sqlite> select substr(cdr, 1, instr(cdr, ",")-1) as cadr from lists;
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String Expressions

String values can be combined to form longer strings

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```sql
sqlite> create table lists as select "one" as car, "two,three,four" as cdr;
ssqlite> select substr(cdr, 1, instr(cdr, ",")-1) as cadr from lists;
two
```
String Expressions

String values can be combined to form longer strings

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sqlite> select "hello," || " world";
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Basic string manipulation is built into SQL, but differs from Python

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```

(Demo)
Database Management Systems
Database Management System Architecture

Architecture of a Database System by Hellerstein, Stonebreaker, and Hamilton
Query Planning

The manner in which tables are filtered, sorted, and joined affects execution time
Query Planning

The manner in which tables are filtered, sorted, and joined affects execution time

Select the parents of curly-furred dogs:

```sql
select parent from parents, dogs
where child = name and fur = "curly";
```
Query Planning

The manner in which tables are filtered, sorted, and joined affects execution time

Select the parents of curly-furred dogs:

```sql
select parent from (parents, dogs)
where child = name and fur = "curly";
```
Query Planning

The manner in which tables are filtered, sorted, and joined affects execution time.

Select the parents of curly-furred dogs:

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Select the parents of curly-furred dogs:

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select parent from parents, dogs
where child = name and fur = "curly";
```

Join all rows of parents to all rows of dogs, filter by `child = name` and `fur = "curly"`
Query Planning

The manner in which tables are filtered, sorted, and joined affects execution time

Select the parents of curly-furred dogs:

```sql
select parent from parents, dogs
where child = name and fur = "curly";
```

Join all rows of parents to all rows of dogs, filter by `child = name` and `fur = "curly"`

Join only rows of parents and dogs where `child = name`, filter by `fur = "curly"`
Query Planning

The manner in which tables are filtered, sorted, and joined affects execution time.

Select the parents of curly-furred dogs:

```
select parent from parents, dogs
where child = name and fur = "curly";
```

Join all rows of parents to all rows of dogs, filter by child = name and fur = "curly"

Join only rows of parents and dogs where child = name, filter by fur = "curly"

Filter dogs by fur = "curly", join result with all rows of parents, filter by child = name
Query Planning

The manner in which tables are filtered, sorted, and joined affects execution time

Select the parents of curly-furred dogs:

```sql
select parent from parents, dogs
where child = name and fur = "curly";
```

Join all rows of parents to all rows of dogs, filter by `child = name` and `fur = "curly"`

Join only rows of parents and dogs where `child = name`, filter by `fur = "curly"`

Filter dogs by `fur = "curly"`, join result with all rows of parents, filter by `child = name`

Filter dogs by `fur = "curly"`, join only rows of result and parents where `child = name`