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We have seen a few ways to produce a result set based on data from more than one table. With a join of two tables, each row in the result set can have data from the two tables being joined. The set operators provide a different way to associate data from two tables. The set operators are UNION ALL, UNION, INTERSECT and EXCEPT. With a Union operator, each row in the result set comes from one or the other of the two tables. The rows being "unioned" are returned combined into a single result set. (MySQL currently supports only the Union and Union All operators. We will implement the other set operators using other techniques)

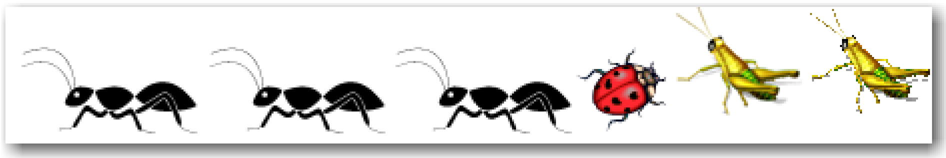
1. Theoretical concepts

First we should consider the terms Set and Bag (or MultiSet). A Set is a collection of data values, without any ordering and with no repeated values. A Bag is a collection of data values, without any ordering but it can have repeated values.

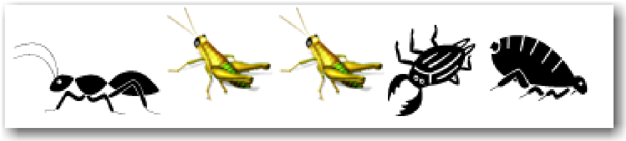
1.1. Demo

Suppose we have the following collections: (You could think of this as two children with their bug collections)

Collection_1 (ant, ant, ant, beetle, cricket, cricket)



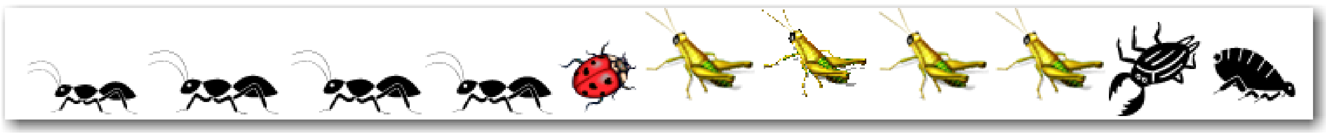
Collection_2 (ant, cricket, earwig, flea, cricket)



These are multisets/bags since they have duplicates.

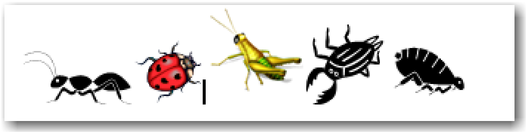
One way to combine these two collections is just to dump them all into one bag

Result_Collection_3 (ant, ant, ant, ant, beetle, cricket, cricket, cricket, cricket, earwig, flea)



Another way to combine these two collections is just to get one of each type and put them together

Result_Collection_4 (ant, beetle, cricket, earwig, flea)



Result_Collection_3 is called a Union All collection and Result_Collection_4 is a Union Distinct; Distinct suppresses duplicates.

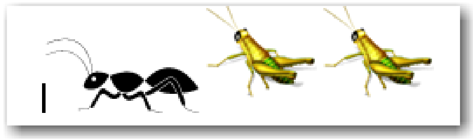
We could make a collection of all values that are in both sets

Result_Collection_5 (ant, cricket)

That is called an Intersection.

But we could think of this in a slightly different way and come up with the following

Result_Collection_6 (ant, cricket, cricket)



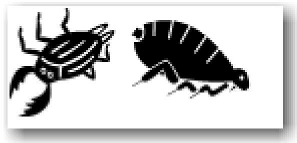
because there are two crickets in Collection_1 and two crickets in Collection_2. This is also an Intersection. We go to collection _1 and match ant (1) and ant(2), then we match 2-crickets(1) and 2 crickets(2)

We can classify Result_Collection_5 as an Intersection Distinct (no duplicates) and Result_Collection_6 as an Intersection All.

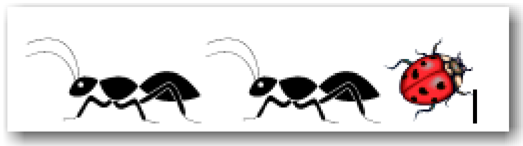
So far all of these operations have been commutative- that means that Collection_1 Union Collection_2 has the same meaning as Collection_2 Union Collection_1. Intersection is also commutative. There is another way to work with these collections and that is shown here

Result_Collection_7 (beetle) This is the values in Collection_1 that are not in Collection_2. This is not commutative.

Result_Collection_8 (earwig, flea) is the values in Collection_2 that are not in Collection_1. This uses the Except Distinct operator.



Result_Collection_9 (ant, ant, beetle) is the non-distinct set of values in Collection_1 that are not in Collection_2; this uses Except All.



Now consider what should happen if there are nulls in the original collections. (maybe the children have unidentified bugs.)

Collection_1v2 (ant, ant, ant, beetle, cricket, cricket, unknown-insect)

Collection_2v2 (ant, cricket, earwig, flea, cricket, unknown-insect , unknown-insect)

A Union Distinct result set contains only a single Null. Although we know that nulls are not equal to each other, for many situations SQL lumps the nulls together. A Union All results set contain a null for each null in one of the original collections.

2. SQL Concepts and Rules

To combine the result sets of two Select statements with a set operator, the two result sets must be union compatible. The result sets must have the same number of attributes and the same (or convertible) data types for the corresponding columns. Although it is not a syntax requirement that the corresponding columns have the same domain, you have the responsibility to make the output meaningful.

Demo 01: Using the vets animals table, we could write the following and we would get the ID and names of the cats and dogs

```
Select an_id, an_name
From a_vets.vt_animals
Where an_type = 'cat'
UNION
Select an_id, an_name
From a_vets.vt_animals
Where an_type = 'dog';
+-------+-----------------+
| an_id | an_name         |
+-------+-----------------+
| 10002 | Gutsy           |
| 16003 | Ursula          |
| 16004 | Napper          |
| 21314 | Adalwine        |
| 21315 | Baldric         |
| 21316 | Etta            |
| 21317 | Manfried        |
| 21318 | Waldrom         |
| 15165 | Burgess         |
| 19845 | Pinkie          |
| 21003 | Calvin Coolidge |
+-------+-----------------+
```

Demo 02: The following should give us an error because an_name is a string and an_dob is a date value MySQL is more flexible about type conversions than some other dbms. Understand- this is a bad query- the fact that mysql runs this does not make it a good query.

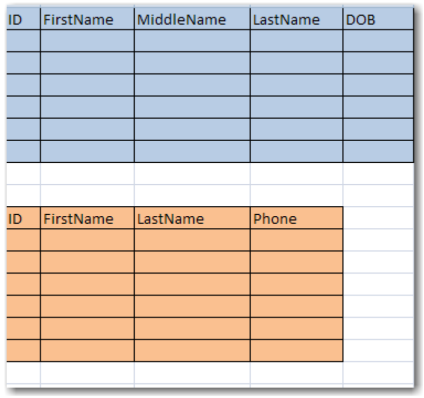
```
   Select an_id, an_name
   From a_vets.vt_animals
   Where an_type = 'cat'
UNION
   Select an_id, an_dob
   From a_vets.vt_animals
   Where an_type = 'dog';
+-------+------------+
| an_id | an_name    |
+-------+------------+
| 10002 | Gutsy      |
| 16003 | Ursula     |
| 16004 | Napper     |
| 21314 | Adalwine   |
| 21315 | Baldric    |
| 21316 | Etta       |
| 21317 | Manfried   |
| 21318 | Waldrom    |
| 15165 | 2005-11-20 |
| 19845 | 2009-02-02 |
| 21003 | 2004-06-18 |
+--------+------------+
```

Demo 03: It would be more standard to do a type conversion. This is still a rather silly query.

```
   Select an_id, an_name
   From a_vets.vt_animals
   Where an_type = 'cat'
UNION
   Select an_id, cast(an_dob as char(10))
   From a_vets.vt_animals
   Where an_type = 'dog';
```

Suppose we have different numbers of columns to display in each part of the set query. We can always play tricks such as adding a literal column to one part of the union.

Suppose I had two tables (the blue table and the orange table) with some differences in the attributes.



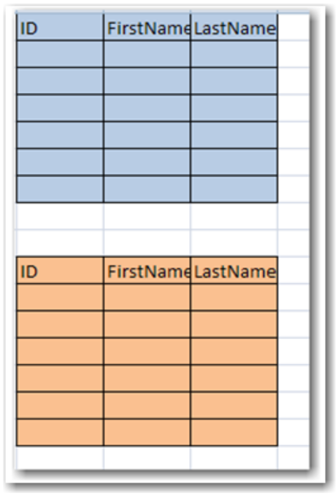
ID	FirstName	MiddleName	LastName	DOB

ID	FirstName	LastName	Phone

If I want to combine these tables with the set operators, I have several choices.

- I could select only the columns found in both tables.

```
SelectID, FirstName, LastName
From tblBlue
Union
SelectID, FirstName, LastName
From tblOrange
```

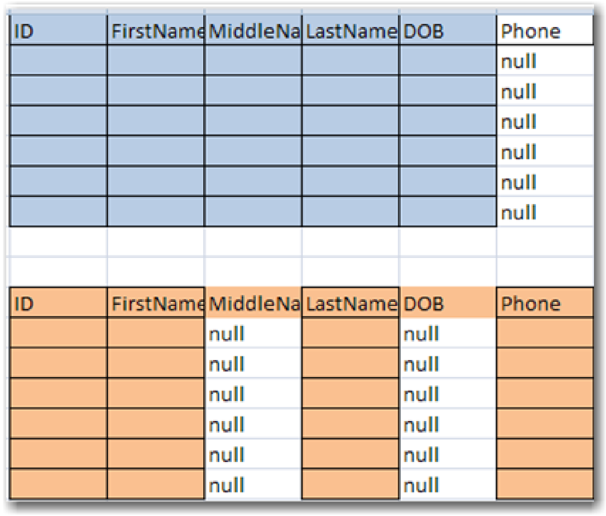


ID	FirstName	LastName

ID	FirstName	LastName

- I could return a default value- probably nulls, for the columns found in one table or the other.

```
SelectID, FirstName, MiddleName, LastName , DOB, null
From tblBlue
Union
SelectID, FirstName, null, LastName , null, Phone
From tblOrange
```



ID	FirstName	MiddleNa	LastName	DOB	Phone
					null
					null
					null
					null
					null
					null

ID	FirstName	MiddleNa	LastName	DOB	Phone
		null		null	
		null		null	
		null		null	
		null		null	
		null		null	
		null		null	

In the return table, the column headers and the Order By clause are based on the first Select columns and aliases.

If you have a query that uses more than one of these operators, the order of operations is top to bottom. You can use parentheses to change this order.

UNION ALL- returns all of the rows from each of the queries.

UNION or UNION DISTINCT- returns all of the rows but removes any duplicates. These two terms are interchangeable. Since some other dbms do not allow the use of the word Distinct here and it is the default, you might wish to avoid it.

MySQL does not directly implement the other set operators. See the discussion in the document on Subqueries and Set Operations for ways to implement the other set operators.

3. Union All

Demo 04: Query to show relevant orders

```
Select ord_id, prod_id, catg_id, prod_name
From a_oe.order_details
Join a_prd.products using (prod_id)
where catg_id in ('PET', 'SPG')
Order by ord_id
;
```

selected rows

```
+--------+---------+---------+--------------------+
| ord_id | prod_id | catg_id | prod_name          |
+--------+---------+---------+--------------------+
|    105 |    1020 | SPG     | Dartboard          |
|    105 |    1030 | SPG     | Basketball         |
|    105 |    1010 | SPG     | Weights            |
|    106 |    1060 | SPG     | Mountain bike      |
|    111 |    1150 | PET     | Cat exerciser      |
|    111 |    1141 | PET     | Bird cage- deluxe  |
|    117 |    1141 | PET     | Bird cage- deluxe  |
|    117 |    1030 | SPG     | Basketball         |
|    117 |    1150 | PET     | Cat exerciser      |
|    120 |    1010 | SPG     | Weights            |
|    121 |    1010 | SPG     | Weights            |
|    121 |    1040 | SPG     | Treadmill          |
|    124 |    1151 | PET     | Cat pillow         |
```

Demo 05: Union All to return orders with either a Sporting goods item or a pet supply item or both. This example is simply to show the Union technique. This also shows the use of the Order by clause at the very end of the query, where it applies to the final result set.

```
   Select ord_id, prod_id, catg_id, prod_name
   From a_prd.products
   Join a_oe.order_details using (prod_id)
   Where catg_id = 'PET'
UNION ALL
   Select ord_id, prod_id, catg_id, prod_name
   From a_prd.products
   Join a_oe.order_details using (prod_id)
   Where catg_id = 'SPG'
Order by ord_id;
```

selected rows

```
+--------+---------+---------+--------------------+
| ord_id | prod_id | catg_id | prod_name          |
+--------+---------+---------+--------------------+
|    105 |    1010 | SPG     | Weights            |
|    105 |    1020 | SPG     | Dartboard          |
|    105 |    1030 | SPG     | Basketball         |
|    106 |    1060 | SPG     | Mountain bike      |
|    111 |    1141 | PET     | Bird cage- deluxe  |
|    111 |    1150 | PET     | Cat exerciser      |
|    117 |    1150 | PET     | Cat exerciser      |
|    117 |    1141 | PET     | Bird cage- deluxe  |
|    117 |    1030 | SPG     | Basketball         |
|    120 |    1010 | SPG     | Weights            |
|    121 |    1010 | SPG     | Weights            |
```

Demo 06: The attempt to do Union All that has a syntax problem. The various selects need to have the same number of columns of compatible types

```
      Select ord_id, prod_id, catg_id, prod_name
      From a_prd.products
      Join a_oe.order_details using (prod_id)
      Where catg_id = 'PET'
   UNION ALL
      Select ord_id, prod_id
      From a_prd.products
      Join a_oe.order_details using (prod_id)
      Where catg_id = 'SPG'
   Order by ord_id
   ;
```

```
ERROR 1222 (21000): The used SELECT statements have a different number of columns
```

Demo 07: Union All from two tables

```
      Select name_last, name_first, 'Employee' as "Pers Type"
      From a_emp.employees
   UNION ALL
      Select cust_name_last, cust_name_first, 'Customers'
      From a_oe.customers
   ;
```

Selected rows

```
+------------+------------+-----------+
| name_last  | name_first | Pers Type |
+------------+------------+-----------+
| King       | Steven     | Employee  |
| Koch       | Karen      | Employee  |
| D'Haa      | Helen      | Employee  |
| Hunol      | Maria      | Employee  |
| Ernst      | Oliver     | Employee  |
| Green      | Oliver     | Employee  |
| Fiet       | Robert     | Employee  |
| Chen       | Helen      | Employee  |
| Russ       | Oliver     | Employee  |
. . . rows removed

| McCoy      | Tyner      | Customers |
| Jones      | Elton John | Customers |
| Williams   | Sally      | Customers |
| Otis       | Elisha     | Customers |
| Hamilton   | Alexis     | Customers |
| Stevenson  | James      | Customers |
| Stevenson  | JAMES      | Customers |
| O'Leary    | Mary       | Customers |
| O'Leary    | Mary       | Customers |
| Olmsted    | Frederick  | Customers |
| Button     | D. K.      | Customers |
. . . rows removed
```

4. Union All versus Union

Demo 08: Union ALL to return HW items purchased with either a Nov or Dec date. Union all is more efficient since it does not have to remove duplicates. These queries ignore years of the order date.

```
   Select prod_id, catg_id, prod_name
   From a_prd.products
   Join a_oe.order_details using (prod_id)
   Join a_oe.order_headers  using (ord_id)
   Where catg_id = 'HW'
   And extract(month from ord_date) = 11
UNION ALL
   Select prod_id, catg_id, prod_name
   From a_prd.products
   Join a_oe.order_details using (prod_id)
   Join a_oe.order_headers  using (ord_id)
   Where catg_id = 'HW'
   And extract(month from ord_date) = 12
order by prod_id;
+---------+---------+-----------------+
| prod_id | catg_id | prod_name       |
+---------+---------+-----------------+
|    1000 | HW      | Hand Mixer      |
|    1070 | HW      | Iron            |
|    1071 | HW      | Iron            |
|    1080 | HW      | Cornpopper      |
|    1080 | HW      | Cornpopper      |
|    1080 | HW      | Cornpopper      |
|    1090 | HW      | Gas grill       |
|    1100 | HW      | Blender         |
|    1100 | HW      | Blender         |
|    1100 | HW      | Blender         |
|    1110 | HW      | Pancake griddle |
|    1110 | HW      | Pancake griddle |
+---------+---------+-----------------+
```

Demo 09: Union to return HW items purchased with either a Nov or Dec date eliminating duplicates.

```
   Select prod_id, catg_id, prod_name
   From a_prd.products
   Join a_oe.order_details using (prod_id)
   Join a_oe.order_headers  using (ord_id)
   Where catg_id = 'HW'
   And extract(month from ord_date) = 11
UNION
   Select prod_id, catg_id, prod_name
   From a_prd.products
   Join a_oe.order_details using (prod_id)
   Join a_oe.order_headers  using (ord_id)
   where catg_id = 'HW'
   And extract(month from ord_date) = 12 ;
+---------+---------+-----------------+
| prod_id | catg_id | prod_name       |
+---------+---------+-----------------+
|    1000 | HW      | Hand Mixer      |
|    1070 | HW      | Iron            |
|    1071 | HW      | Iron            |
|    1080 | HW      | Cornpopper      |
|    1100 | HW      | Blender         |
|    1110 | HW      | Pancake griddle |
|    1090 | HW      | Gas grill       |
+---------+---------+-----------------+
```

5. Casting to handle syntax rules

MySQL does a lot of automatic casting of data types. The following union query has the first column as an integer in the first subquery and as a string in the second subquery. Since MySQL handles this cast for you, you can run the query shown below.

In some cases you might need to use a cast function to get compatible types.

Demo 10:

```
   Select prod_id  AS "Product ID"
   , prod_list_price as "List Price"
   From a_prd.products
   Where catg_id = 'APL'
UNION  ALL
   Select '---- Avg Price for all Appliances ----'
   , Avg(prod_list_price)
   From a_prd.products
   Where catg_id = 'APL' ;
+----------------------------------------+------------+
| Product ID                             | List Price |
+----------------------------------------+------------+
| 1120                                   | 549.990000 |
| 1125                                   | 500.000000 |
| 1126                                   | 850.000000 |
| 1130                                   | 149.990000 |
| 4569                                   | 349.950000 |
| ---- Avg Price for all Appliances ---- | 479.986000 |
+----------------------------------------+------------+
```

6. Sorting

MySQL supports an extension that gives you the choice of sorting the individual subqueries or the overall subquery but the results might not be what you expect.

Demo 11: Set up the following two tables in the a_testbed database.

```
Create table d_set_emp ( E_id int, E_name varchar(10), E_city varchar(10));

Create table d_set_cust ( C_id int, C_name varchar(10), C_city varchar(10));

Insert into d_set_emp values ( 101, 'Jones',     'Chicago');
Insert into d_set_emp values ( 102, 'Anderson',  'Chicago');
Insert into d_set_emp values ( 103, 'Baxter',    'Chicago');
Insert into d_set_emp values ( 104, 'Johnson',   'Chicago');
Insert into d_set_emp values ( 105, 'Miller',    'Chicago');

Insert into d_set_cust values ( 201, 'Oliver',   'Boston');
Insert into d_set_cust values ( 202, 'Athena',   'Boston');
Insert into d_set_cust values ( 203, 'Sanders',  'Boston');
Insert into d_set_cust values ( 204, 'Baxter',   'Boston');
```

Demo 12: Do a plain union query; this has not specified any ordering so we should not assume any row order.

```
Select E_id, E_name, E_city
From d_set_emp
Union all
Select C_id, C_name, C_city
From d_set_cust;
+------+----------+---------+
| E_id | E_name   | E_city  |
+------+----------+---------+
|  101 | Jones    | Chicago |
|  102 | Anderson | Chicago |
|  103 | Baxter   | Chicago |
|  104 | Johnson  | Chicago |
|  105 | Miller   | Chicago |
|  201 | Oliver   | Boston  |
|  202 | Athena   | Boston  |
|  203 | Sanders  | Boston  |
|  204 | Baxter   | Boston  |
+------+----------+---------+
```

Demo 13: Now do a sort at the end for the query and the final result set is sorted.

```
Select E_id, E_name, E_city
From d_set_emp
Union all
Select C_id, C_name, C_city
From d_set_cust
Order by E_name;
+------+----------+---------+
| E_id | E_name   | E_city  |
+------+----------+---------+
|  102 | Anderson | Chicago |
|  202 | Athena   | Boston  |
|  103 | Baxter   | Chicago |
|  204 | Baxter   | Boston  |
|  104 | Johnson  | Chicago |
|  101 | Jones    | Chicago |
|  105 | Miller   | Chicago |
|  201 | Oliver   | Boston  |
|  203 | Sanders  | Boston  |
+------+----------+---------+
```

Now add a sort to each subquery. You need to enclose the subqueries within parentheses. But the final result is not sorted. That is because the Union operator does not produce a sorted result so that operator removed the ordering of the rows.

Demo 14:

```
(Select E_id, E_name, E_city
 From d_set_emp
 Order by E_name)
Union all
(Select C_id, C_name, C_city
 From d_set_cust
 Order by c_name);
```

```
+------+----------+---------+
| E_id | E_name   | E_city  |
+------+----------+---------+
|  101 | Jones    | Chicago |
|  102 | Anderson | Chicago |
|  103 | Baxter   | Chicago |
|  104 | Johnson  | Chicago |
|  105 | Miller   | Chicago |
|  201 | Oliver   | Boston  |
|  202 | Athena   | Boston  |
|  203 | Sanders  | Boston  |
|  204 | Baxter   | Boston  |
+------+----------+---------+
```

The use of order by in the subqueries is used mainly with a limit clause. Now I get the first two sorted names lists for each of the subqueries.

Demo 15:

```
(Select E_id, E_name, E_city
 From d_set_emp
 Order by E_name Limit 2)
Union all
(Select C_id, C_name, C_city
 From d_set_cust
 Order by c_name Limit 2);
+------+----------+---------+
| E_id | E_name   | E_city  |
+------+----------+---------+
|  102 | Anderson | Chicago |
|  103 | Baxter   | Chicago |
|  202 | Athena   | Boston  |
|  204 | Baxter   | Boston  |
+------+----------+---------+
```

Demo 16:

```
(Select E_id, E_name, E_city
 From d_set_emp
 Order by E_name Limit 200)
Union all
(Select C_id, C_name, C_city
 From d_set_cust
 Order by c_name Limit 200);
+------+----------+---------+
| E_id | E_name   | E_city  |
+------+----------+---------+
|  102 | Anderson | Chicago |
|  103 | Baxter   | Chicago |
|  104 | Johnson  | Chicago |
|  101 | Jones    | Chicago |
|  105 | Miller   | Chicago |
|  202 | Athena   | Boston  |
|  204 | Baxter   | Boston  |
|  201 | Oliver   | Boston  |
|  203 | Sanders  | Boston  |
+------+----------+---------+
```