INFSCI 1022
Database Management Systems

Today's Evil Plan

- More SQL
- Aggregate functions
- Even More SQL
- Working with string data types
- Joining multiple tables with SQL
- More SQL…

Query Clauses

Clauses - constituent components of statements and queries.

- **FROM**
- **WHERE**
- GROUP BY
- HAVING
- ORDER BY
- LIMIT

ORDER OF CLAUSES

- CLAUSES must appear in the following order
  - **FROM**
  - **WHERE**
  - **GROUP BY**
  - **HAVING**
  - **ORDER BY**
  - **LIMIT**
- Not all clauses must appear in a query – **FROM** clause is the only one that's required

FROM

- Indicates the table(s) from which data is to be retrieved.
- The FROM clause can include optional JOIN subclauses to specify the rules for joining tables.

```
SELECT * FROM Employees
```

WHERE

- Includes a comparison predicate, which restricts the rows returned by the query.
- The WHERE clause eliminates all rows from the result set for which the comparison predicate does not evaluate to True.

```
SELECT * FROM Employees
WHERE lastName = 'Smith'
```

Operators

Operator	Description	Example
=	Equal to	`Author = 'Alcott'`
<>	Not equal to (most DBMS also accept != instead of <>)	`Dept <> 'Sales'`
>	Greater than	`Hire_Date > '2012-01-31'`
<	Less than	`Bonus < 50000.00`
>=	Greater than or equal	`Dependents >= 2`
<=	Less than or equal	`Rate <= 0.05`
BETWEEN	Between an inclusive range	`Cost BETWEEN 100.00 AND 500.00`
LIKE	Match a character pattern	`First_Name LIKE 'Will%'`
IN	Equal to one of multiple possible values	`DeptCode IN (101, 103, 209)`
IS *or* IS NOT	Compare to null (missing data)	`Address IS NOT NULL`

LIKE + WILDCARDS

- LIKE statement allows you to search for matches within character fields.
- % (percent) is a wildcard

```
SELECT * FROM Employees
WHERE lastName LIKE '%Sm';
```

LIKE + WILDCARDS

- WHERE lastName **LIKE 'Sm%'** – find all records where the value of lastName **begins** with **sm**
- WHERE lastName **LIKE '%th'** – find all records where the value of lastName **ends** with **th**
- WHERE lastName **LIKE '%sm%'** – find all records where the value of lastName **contains** character sequence **sm** anywhere in value

LIMIT

- Limits the number of records (table rows) returns by an SQL query
- Always the last clause in the query
- Note that LIMIT is specific to MySQL and Oracle – might not work with other database systems

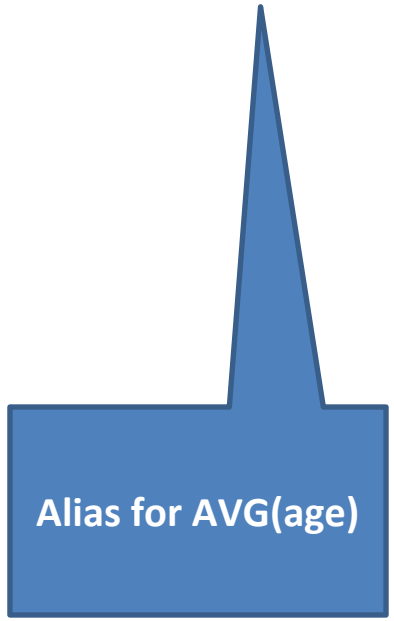
```
SELECT * FROM Employees WHERE lastName = 'Smith'
LIMIT 5;
```

Aggregate Functions

- An aggregate function performs a calculation on a set of values and returns a single value.
- Most common MySQL aggregate functions are
  - AVG
  - COUNT
  - SUM
  - MIN
  - MAX

AVG(expression)

SELECT AVG(age) AS averagePatientAge **FROM** Patients



http://www.mysqltutorial.org/mysql-avg/

COUNT Function

```
SELECT COUNT(*) patientCount
FROM Patients
WHERE patientAge > 10
```

http://www.mysqltutorial.org/mysql-count/

SUM Function

```
SELECT SUM(medicationPrice)
FROM Prescription p JOIN Medication m
ON p.medicationID = m.medicationID
WHERE patientID = 5
```

http://www.mysqltutorial.org/mysql-sum/

MAX Function

```
SELECT MAX(medicationPrice)
FROM Medication
```

http://www.mysqltutorial.org/mysql-max-function/

MIN Function

```
SELECT MIN(medicationPrice)
FROM Medication
```

http://www.mysqltutorial.org/mysql-min/

SQL Joins

Aggregate functions review

GROUP BY Clause

HAVING clause

GROUP BY

- Used to combine rows having common values into a smaller set of rows.
- GROUP BY is often used in conjunction with SQL aggregation functions or to eliminate duplicate rows from a resultset.
- The WHERE clause is applied before the GROUP BY clause.

Table: patient_visit

visitID (pk)	fk_patientID (fk)	weight	BPS	BPD	OSAT
1	1	150	140	90	98
2	3	178	127	75	94
3	3	170	125	70	97
4	3	140	130	81	92
5	7	220	160	100	99
6	1	148	148	95	96
7	3	165	125	72	94
8	7	148	161	98	98
9	1	152	143	88	96

I want to know the average weight of each patient

fk_patientID	AVERAGE(weight)
1	150
3	163.25
7	184

I want to know the average weight of each patient

fk_patientID	AVERAGE(weight)
1	150
3	163.25
7	184

```
SELECT fk_patientID, AVG(weight)
FROM patient_visit
GROUP BY fk_patientID
```

SQL Joins

Aggregate functions review

GROUP BY Clause

HAVING clause

HAVING

- Used to filter rows resulting from the GROUP BY clause.
- Limits results returned by the GROUP BY clause
- Because it acts on the results of the GROUP BY clause, aggregation functions can be used in the HAVING clause predicate.

Table: patient_visit

visitID (pk)	fk_patientID (fk)	weight	BPS	BPD	OSAT
1	1	150	140	90	98
2	3	178	127	75	94
3	3	170	125	70	97
4	3	140	130	81	92
5	7	220	160	100	99
6	1	148	148	95	96
7	3	165	125	72	94
8	7	148	161	98	98
9	1	152	143	88	96

I want to know the average weight of each patient whose average weight is greater than 150 lb

fk_patientID	AVERAGE(weight)
3	163.25
7	184

I want to know the average weight of each patient

fk_patientID	AVERAGE(weight)
3	163.25
7	184

```
SELECT fk_patientID, AVG(weight)
FROM patient_visit
GROUP BY fk_patientID
HAVING AVG(weight) > 150
```

String Functions

- Most DBMS provide useful functions that allow us to manipulate strings
- These functions may vary from DBMS to DBMS
- MySQL – specific string functions: http://dev.mysql.com/doc/refman/5.0/en/string-functions.html

CONCAT()

- Combines multiple strings into one

SELECT **CONCAT**(‘My’, ‘ name’, ‘ is’, ‘ Dmitriy’);

will return **My name is Dmitriy**

CONCAT()

SELECT **CONCAT**(firstName, ‘ ‘, lastName)
FROM employees;

will return the value of firstName field followed by a space, followed by the value of lastName field

LCASE() and LOWER()

- LOWER(str) - returns the string str with all characters changed to lowercase

SELECT LOWER('HI, HOW ARE YOU?')

returns hi, how are you?

LCASE() and LOWER()

SELECT LOWER(firstName)
FROM employees;

returns the value of firstName field with all characters changed to lowercase

UCASE() and UPPER()

- UPPER(str) - returns the string str with all characters changed to uppercase

SELECT UPPER('hi, how are you?')

returns HI, HOW ARE YOU?

UCASE() and UPPER()

```
SELECT UPPER(firstName)
FROM employees;
```

returns the value of firstName field with all characters changed to uppercase

TRIM(), LTRIM(), RTRIM()

- TRIM() – removes preceding and trailing spaces from a string
- LTRIM() – removes preceding spaces from a string
- RTRIM() – removes trailing spaces from a string

REPLACE()

- REPLACE(str,from_str,to_str) - returns the string **str** with all occurrences of the string **from_str** replaced by the string **to_str**.
- REPLACE() performs a **case-sensitive** match when searching for from_str.

SELECT **REPLACE**('www.mysql.com', 'w', 'Ww');

returns 'WwWwWw.mysql.com'

SUBSTRING()

- SUBSTRING(str,pos) – returns a section of string **str** starting from position **pos** and going to the end of string **str**.

SELECT **SUBSTRING**('This is a test', 5);

returns **'is a test'**

SUBSTRING()

- SUBSTRING(str,pos,len) – returns a section of string **str** starting from position **pos** and going for a number of characters specified by **len**.

SELECT **SUBSTRING**(‘This is a test’, 5, 4);

returns **‘is a’**

SQL JOINS

Users
userID **(pk)**
lastName
firstName
dateOfBirth
ssn

Address
addressID **(pk)**
fk_userID **(fk)**
streetAddress
city
state
zip

SQL JOINS

userID	lastName	firstName	dateOfBirth	ssn
1	Doe	John	04/01/2001	111-11-1111
2	Brown	Michael	01/02/1986	222-22-2222
3	Green	Evelyn	03/14/1976	333-33-3333

addressID	fk_userID	streetAddress	city	state	zip
1335235	1	101 Phillips Avenue	Pittsburgh	PA	15217
5436543	1	325 Hobart Street	Pittsburgh	PA	15217
3675476	3	722 Darlington Avenue	Pittsburgh	PA	15217

SQL JOINS

lastName	firstName	streetAddress	city	state	zip
Doe	John	101 Phillips Avenue	Pittsburgh	PA	15217
Doe	John	325 Hobart Street	Pittsburgh	PA	15217
Green	Evelyn	722 Darlington Avenue	Pittsburgh	PA	15217

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SQL JOINS

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addressID	fk_userID (fk)	streetAddress	city	state	zip
1335235	1	101 Phillips Avenue	Pittsburgh	PA	15217
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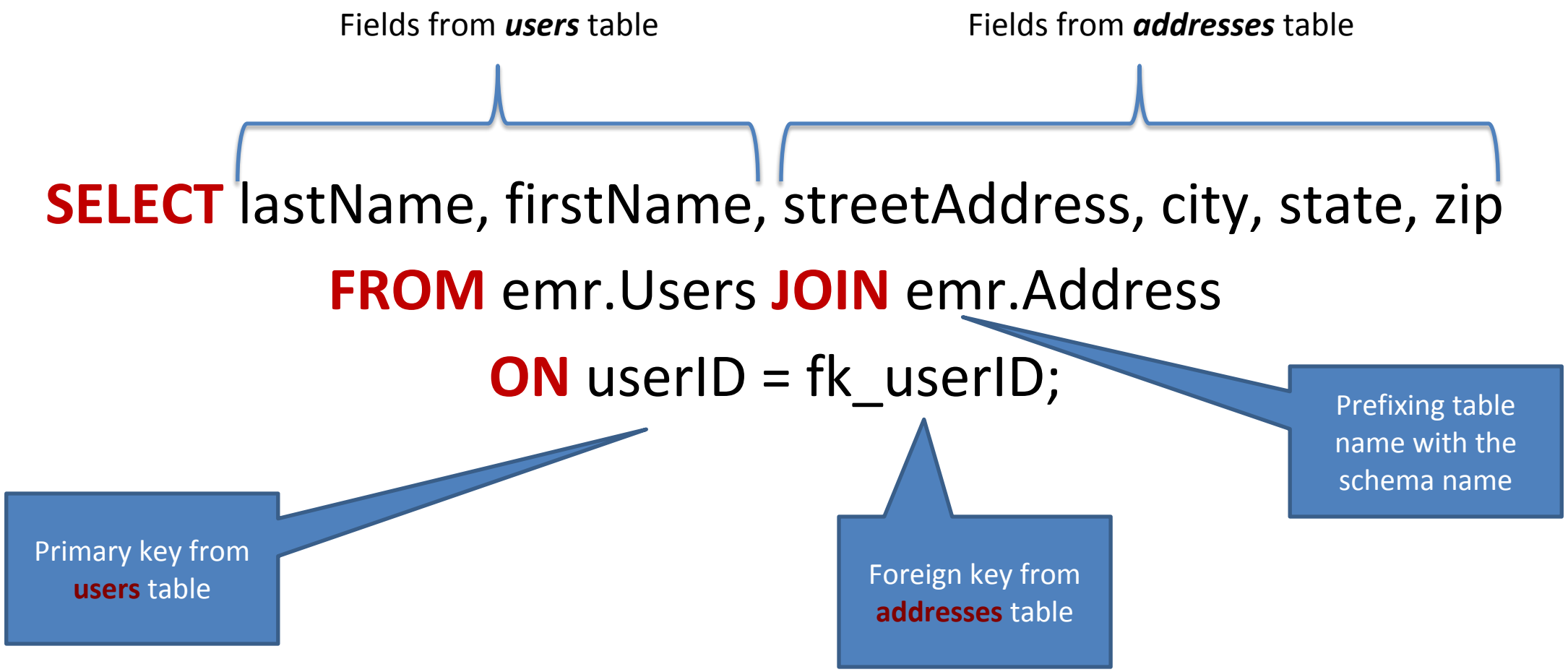
JOIN – Concatenating Data From Multiple Tables



INNER JOIN

- This join returns rows when there is at least one match in both the tables.
- Inner join is the default join in SQL language.

userID	lastName	firstName	dateOfBirth	ssn
1	Doe	John	04/01/2001	111-11-1111
2	Brown	Michael	01/02/1986	222-22-2222
3	Green	Evelyn	03/14/1976	333-33-3333

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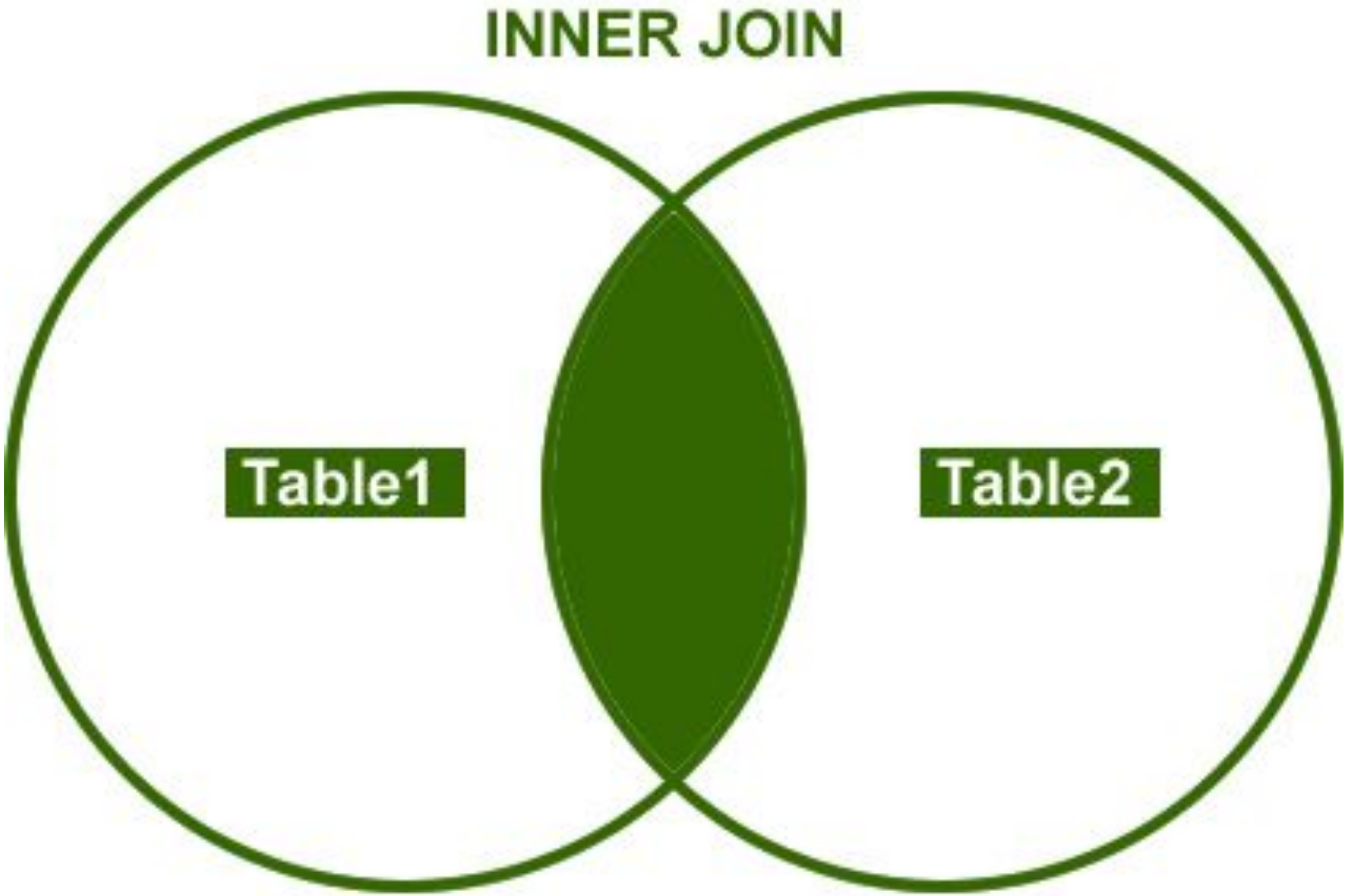
http://blog.sqlauthority.com/2009/04/13/sql-server-introduction-to-joins-basic-of-joins/



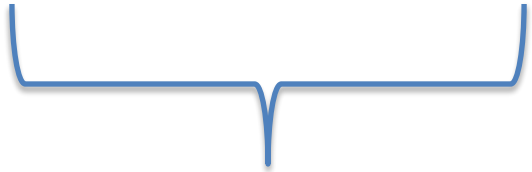
SQL JOINS

Users
userID (pk)
lastName
firstName
dateOfBirth
ssn

Address
addressID
userID (fk)
streetAddress
city
state
zip

TABLE ALIASES

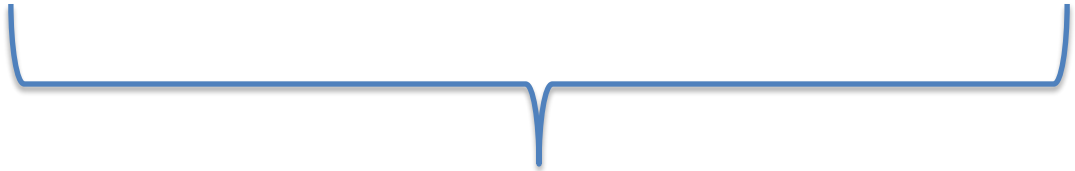
```
SELECT lastName, firstName, streetAddress, city, state, zip
FROM emr.Users INNER JOIN emr.Address
ON userID = userID;
```



Note that these two columns have same names. How would SQL interpreter know which column belongs to which table?

TABLE ALIASES

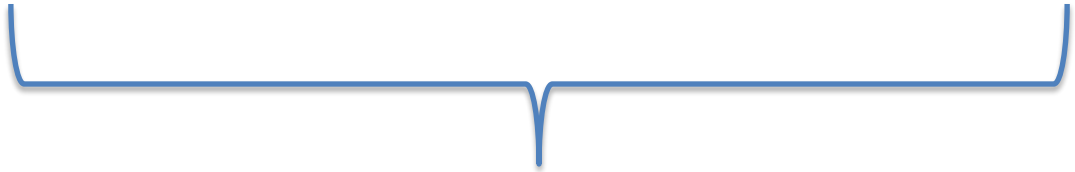
```
SELECT lastName, firstName, streetAddress, city, state, zip
FROM emr.Users INNER JOIN emr.Address
ON Users.userID = Address.userID;
```



We can prefix columns that have identical names with names of the tables to which they belong.

TABLE ALIASES

```
SELECT lastName, firstName, streetAddress, city, state, zip
FROM emr.Users u INNER JOIN emr.Address a
ON u.userID = a.userID;
```



Or, because typing sucks, we can create aliases.

TABLE ALIASES

Note that you can use table aliases in SELECT clause

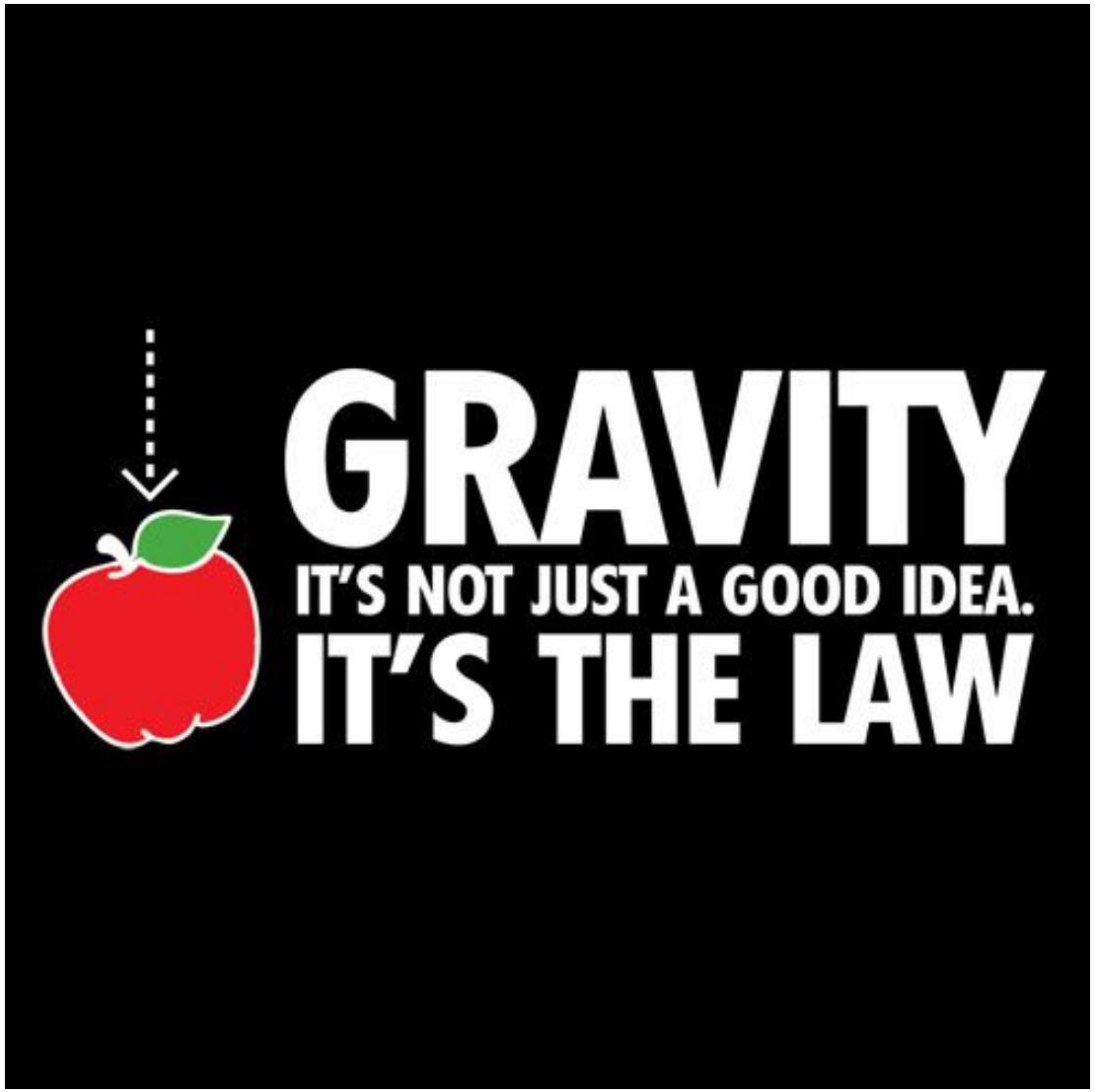
```
SELECT u.lastName, u.firstName,
a.streetAddress, a.city, a.state, zip
FROM emr.Users u INNER JOIN emr.Address a
ON u.userID = a.userID;
```

AIN’T NO DIFFERENCE

```
SELECT lastName, firstName, streetAddress, city, state, zip
FROM Users INNER JOIN Address
ON userID = fk_userID;
```

```
SELECT lastName, firstName, streetAddress, city, state, zip
FROM Users JOIN Address
ON userID = fk_userID;
```

FOLLOW THE RULES



JOIN RULES

- You **should** join table on primary/foreign key relationships
- Fields on which you are joining must be of the same data type
- When joining on character fields, they do not necessarily have to be of the same length
- Character fields must have the same collation

TABLE ALIASES VS COLUMN ALIASES

```
SELECT CONCAT(lastName, ', ', firstName) AS userName,
    streetAddress AS userAddress, city, state, zip
    FROM emr.Users u JOIN emr.Address a
    ON u.userID = a.userID;
```

Column alias

Table alias