MSiA-413 Introduction to Databases and Information Retrieval

Lecture 8
INNER Joins

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Slides adapted from Steve Tarzia

Last Lecture

SELECT description and examples in SQLite

SELECT steps (abbreviated):

1. `FROM` chooses the table of interest
2. `WHERE` throws out irrelevant rows
3. `GROUP BY` identifies rows to combine
4. `SELECT` tells what values to return (math and aggregation on each group)
5. `HAVING` throws out irrelevant rows (after aggregation)
6. `ORDER BY` sorts
7. `LIMIT` throws out rows based on their position in the results

What if you need to combine data from multiple tables?

1. `FROM` chooses the table of interest
2. `WHERE` throws out irrelevant rows
3. `GROUP BY` identifies rows to combine
4. `SELECT` tells what values to return (allowing math and aggregation)
5. `HAVING` throws out irrelevant rows (after aggregation)
6. `ORDER BY` sorts
7. `LIMIT` throws out rows based on their position in the results

A subquery can draw data from another table, but there is a better way …

JOINs create *virtual* tables from several tables

- Normalizing the staff directory left us with three tables
- Eliminated redundant information, but now we have to look in three different tables to answer some questions.

staff			
id	***name***	***room***	***departmentID***
11	Bob	100	1
20	Betsy	100	2
21	Fran	101	1
22	Frank	102	4
35	Sarah	200	5
40	Sam	10	7
54	Pat	102	2

department		
id	***name***	***buildingID***
1	Industrial Eng.	1
2	Computer Sci.	2
4	Chemistry	1
5	Physics	4
7	Materials Sci.	5

building		
id	***name***	***facilitiesExt***
1	Tech	1-1000
2	Ford	1-5003
4	Mudd	1-2005
5	Cook	1-3004
6	Garage	1-6001

What if we want to print the staff directory?

staff					
id	***name***	***department***	***building***	***room***	***facilitiesExt***
11	Bob	Industrial Eng.	Tech	100	1-1000
20	Betsy	Computer Sci.	Ford	100	1-5003
21	Fran	Industrial Eng.	Tech	101	1-1000
22	Frank	Chemistry	Tech	102	1-1000
35	Sarah	Physics	Mudd	200	1-2005
40	Sam	Materials Sci.	Cook	10	1-3004
54	Pat	Computer Sci.	Ford	102	1-5003

We can generate a virtual table like this with INNER JOIN

staff			
id	***name***	***room***	***departmentID***
11	Bob	100	1
20	Betsy	100	2
21	Fran	101	1
22	Frank	102	4
35	Sarah	200	5
40	Sam	10	7
54	Pat	102	2

department		
id	***name***	***buildingID***
1	Industrial Eng.	1
2	Computer Sci.	2
4	Chemistry	1
5	Physics	4
7	Materials Sci.	5

`ON` tells how rows are matched

```
SELECT * FROM staff JOIN department ON staff.departmentId=department.id
```

staff.***id***	staff.***name***	***staff.room***	staff.***departmentId***	department.***id***	department.***name***	department.***buildingID***
11	Bob	100	1	1	Industrial Eng.	1
20	Betsy	100	2	2	Computer Sci.	2
21	Fran	101	1	1	Industrial Eng.	1
22	Frank	102	4	4	Chemistry	1
35	Sarah	200	5	5	Physics	4
40	Sam	10	7	7	Materials Sci.	5
54	Pat	102	2	2	Computer Sci.	2

How JOIN builds a composite table

```
SELECT * FROM staff JOIN department
              ON staff.departmentId=department.id;
```

Start with the first table (staff)

Join with rows from the 2nd table (department) that match according to the `ON` columns

staff.*id*	staff.*name*	*staff.room*	staff.*departmentID*	department.*id*	department.*name*	department.*buildingID*
11	Bob	100	1	1	Industrial Eng.	1
20	Betsy	100	2	2	Computer Sci.	2
21	Fran	101	1	1	Industrial Eng.	1
22	Frank	102	4	4	Chemistry	1
35	Sarah	200	5	5	Physics	4
40	Sam	10	7	7	Materials Sci.	5
54	Pat	102	2	2	Computer Sci.	2

Just print the columns we need

```
SELECT staff.id, staff.name, room,
       department.name, department.buildingId
  FROM staff JOIN department
       ON staff.departmentId=department.id;
```

staff.*id*	staff.*name*	*staff.room*	department.*name*	department.*buildingID*
11	Bob	100	Industrial Eng.	1
20	Betsy	100	Computer Sci.	2
21	Fran	101	Industrial Eng.	1
22	Frank	102	Chemistry	1
35	Sarah	200	Physics	4
40	Sam	10	Materials Sci.	5
54	Pat	102	Computer Sci.	2

Reorder and rename the columns

```
SELECT staff.id AS staffID,
       staff.name AS name,
       department.name AS department,
       department.buildingId AS buildingId,
       staff.room AS room
  FROM staff JOIN department
       ON staff.departmentId=department.id;
```

staffId	*name*	*department*	*buildingID*	*room*
11	Bob	Industrial Eng.	1	100
20	Betsy	Computer Sci.	2	100
21	Fran	Industrial Eng.	1	101
22	Frank	Chemistry	1	102
35	Sarah	Physics	4	200
40	Sam	Materials Sci.	5	10
54	Pat	Computer Sci.	2	102

Add the third table

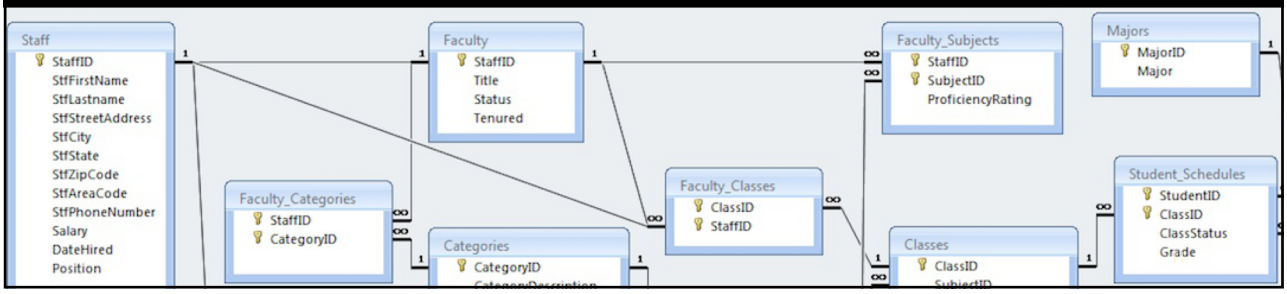
```
SELECT staff.id AS staffId, staff.name AS name,
       department.name AS department,
       building.name AS building, staff.room AS room,
       building.faxNumber AS faxNumber
  FROM staff JOIN department ON staff.departmentId    = department.id
             JOIN building   ON department.buildingId = building.id;
```

staffId	*name*	*department*	*building*	*room*	*faxNumber*
11	Bob	Industrial Eng.	Tech	100	1-1000
20	Betsy	Computer Sci.	Ford	100	1-5003
21	Fran	Industrial Eng.	Tech	101	1-1000
22	Frank	Chemistry	Tech	102	1-1000
35	Sarah	Physics	Mudd	200	1-2005
40	Sam	Materials Sci.	Cook	10	1-3004
54	Pat	Computer Sci.	Ford	102	1-5003

Who teaches the largest class and what is the average grade?

```
SELECT Student_Schedules.ClassID,
       AVG(Grade),
       StfLastname
FROM Student_Schedules JOIN Faculty_Classes
     ON Student_Schedules.ClassID=Faculty_Classes.ClassID
     JOIN Staff ON Faculty_Classes.StaffID = Staff.StaffID
GROUP BY Student_Schedules.ClassID
ORDER BY COUNT(*) DESC LIMIT 1;
```

ClassID	AVG(Grade)	StfLastname
2907	78.202	Waldal



How JOIN builds a composite table

```
SELECT * FROM staff JOIN department
            ON staff.departmentId=department.id
```

What if there are multiple matches in the second table?

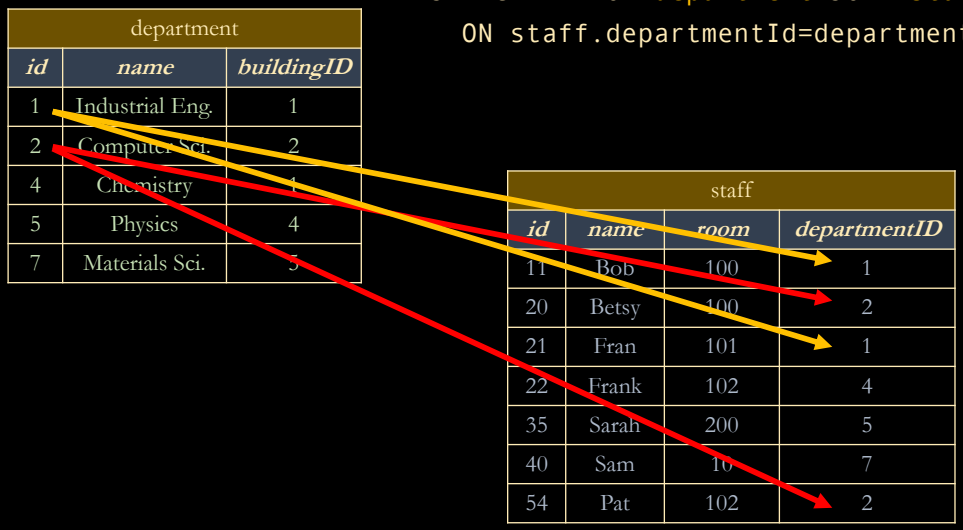
Start with the first table (staff)

Join with rows from the 2nd table (department) that match according to the ON columns

staff.*id*	staff.*name*	*staff.room*	staff.*departmentID*	department.*id*	department.*name*	department.*buildingID*
11	Bob	100	1	1	Industrial Eng.	1
20	Betsy	100	2	2	Computer Sci.	2
21	Fran	101	1	1	Industrial Eng.	1
22	Frank	102	4	4	Chemistry	1
35	Sarah	200	5	5	Physics	4
40	Sam	10	7	7	Materials Sci.	5
54	Pat	102	2	2	Computer Sci.	2

How JOIN deals with multiple matches

```
SELECT * FROM department JOIN staff
  ON staff.departmentId=department.id
```



department		
id	***name***	***buildingID***
1	Industrial Eng.	1
2	Computer Sci.	2
4	Chemistry	1
5	Physics	4
7	Materials Sci.	5

staff			
id	***name***	***room***	***departmentID***
11	Bob	100	1
20	Betsy	100	2
21	Fran	101	1
22	Frank	102	4
35	Sarah	200	5
40	Sam	10	7
54	Pat	102	2

How JOIN deals with multiple matches

```
SELECT * FROM department JOIN staff
  ON staff.departmentId=department.id
```

Create a row for every *unique pair* of matches

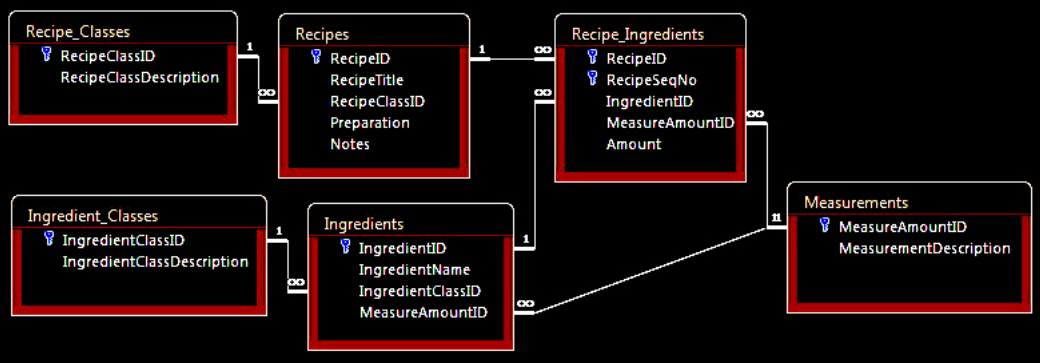
What if there are multiple matches in the second table?

department.***id***	department.***name***	department.***buildingId***	staff.***id***	staff.***name***	staff.***room***	department.***id***
1	Industrial Eng.	1	11	Bob	100	1
1	Industrial Eng.	1	21	Fran	101	1
2	Computer Sci.	2	20	Betsy	100	2
2	Computer Sci.	2	54	Pat	102	2
4	Chemistry	1	22	Frank	102	4
5	Physics	4	35	Sarah	200	5
7	Materials Sci.	5	40	Sam	10	7

Summary of INNER JOINs

- Introduced INNER JOIN
  - `table1 INNER JOIN table2 ON table1.col1 = table2.col2`
  - Creates a virtual table
  - Rows are matched according to columns specified with "ON"
    - Usually this is a foreign key
    - If "ON" is omitted, all columns with identical names are checked for a match
  - Joined table has all the columns from both tables
- NOTE:
  - The "`INNER`" keyword is optional
  - If a matching row is not found in the second table, the row is omitted
  - In other words, a row must exist in both tables to produce a row in the joined table

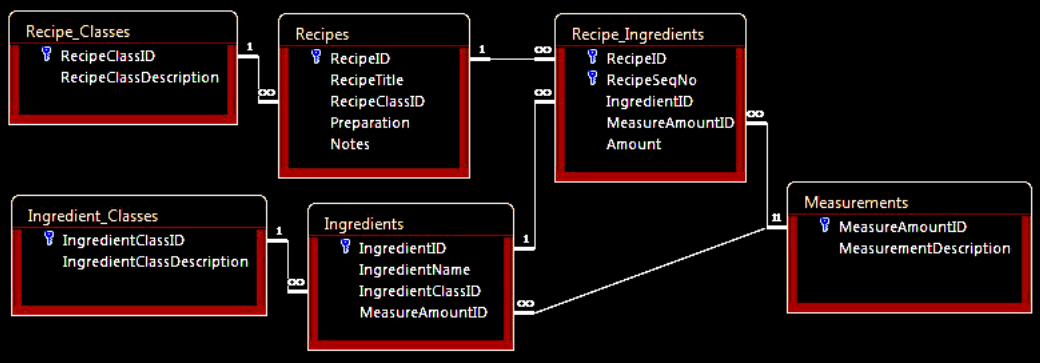
Print the recipe ingredients for Irish Stew (RecipeID = 1) *(Recipes.sqlite)*



Print the recipe ingredients for Irish Stew (RecipeID = 1) *(Recipes.sqlite)*

```
SELECT Amount,
       Measurements.MeasurementDescription,
       IngredientName
FROM Recipe_Ingredients
  JOIN Ingredients
    ON Recipe_Ingredients.IngredientId
       = Ingredients.IngredientID
  JOIN Measurements
    ON Recipe_Ingredients.MeasureAmountID
       = Measurements.MeasureAmountID
WHERE RecipeId=1
ORDER BY RecipeSeqNo;
```

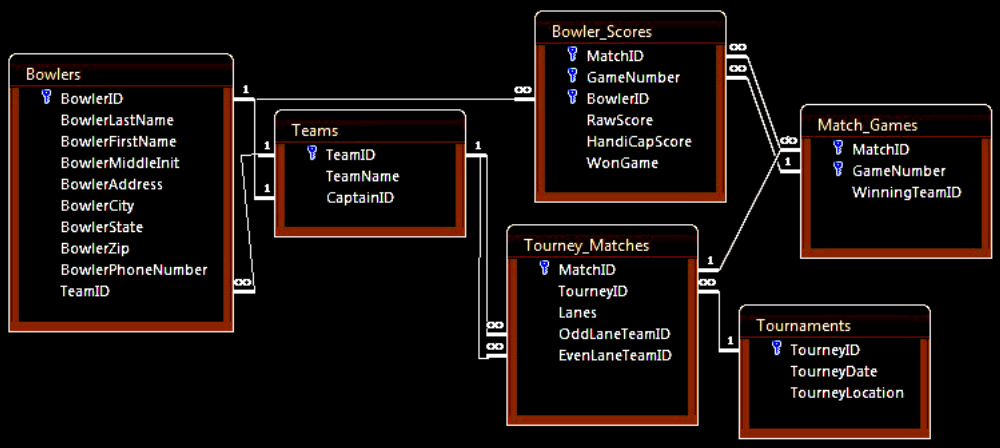

What is the name of the recipe with the most ingredients, and how many ingredients does it have? *(Recipes.sqlite)* (Can be done with either a subquery or a JOIN)



What is the name of the recipe with the most ingredients, and how many ingredients does it have? *(Recipes.sqlite)*

```
SELECT Recipes.RecipeTitle,
       COUNT(*) AS NumIngredients
FROM Recipe_Ingredients
  JOIN Recipes
    ON Recipes.RecipeID = Recipe_Ingredients.RecipeID
GROUP BY Recipes.RecipeID
ORDER BY NumIngredients DESC
LIMIT 1;
```

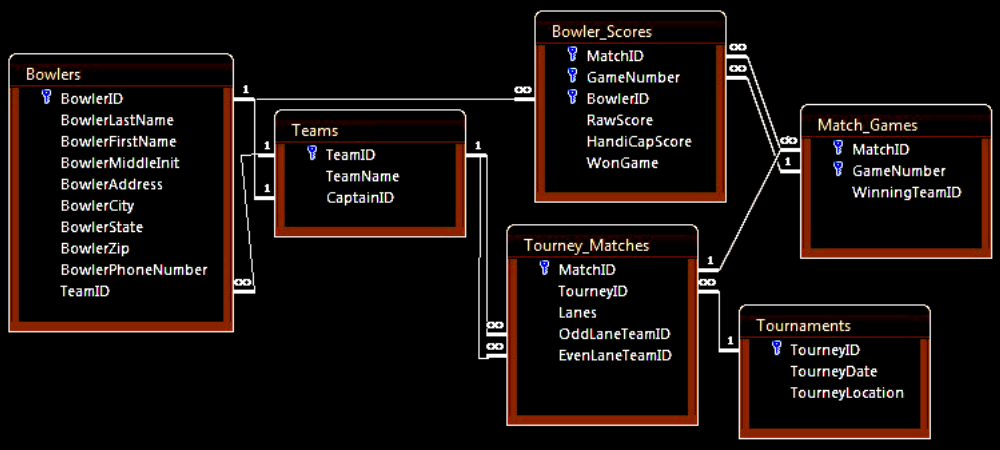

Print a schedule of all the team matchups over the whole season (Date, Location, TeamName, TeamName) *(BowlingLeague.sqlite)*



Print a schedule of all the team matchups over the whole season (Date, Location, TeamName, TeamName) *(BowlingLeague.sqlite)*

```
SELECT TourneyDate,
       TourneyLocation,
       OddTeam.TeamName,
       EvenTeam.TeamName
FROM Tourney_Matches
  JOIN Tournaments
    ON Tourney_Matches.TourneyID = Tournaments.TourneyID
  JOIN Teams AS OddTeam
    ON OddLaneTeamID = OddTeam.TeamID
  JOIN Teams AS EvenTeam
    ON EvenLaneTeamID = EvenTeam.TeamID;
```


Print game results for Tournament #1, including bowler names, team names, & raw score *(BowlingLeague.sqlite)*



Print game results for Tournament #1, including bowler names, team names, & raw score *(BowlingLeague.sqlite)*

```
SELECT
  Bowler_Scores.MatchID, GameNumber, TeamName,
  BowlerFirstName || " " || BowlerLastName AS Bowler,
  RawScore
FROM Bowler_Scores
  JOIN Tourney_Matches
    ON Bowler_Scores.MatchID = Tourney_Matches.MatchID
  JOIN Bowlers
    ON Bowlers.BowlerID = Bowler_Scores.BowlerID
  JOIN Teams
    ON Bowlers.TeamID = Teams.TeamID
WHERE TourneyId=1;
```