Review Second Normal Form

- Based on concept of full functional dependency
  - Versus partial dependency
    - A relation schema is in 2NF if every nonprime attribute is fully functionally dependent on the primary key of the relation.
- Second normalize into a number of 2NF relations
  - Nonprime attributes are associated only with part of primary key on which they are fully functionally dependent.

2NF

- Examples:
  - (SSN, Pnumber)->Hours is full.
  - (SSN, Pnumber)->EName is "not" full.
Third Normal Form

- Based on concept of transitive dependency
  - Definition: According to Codd's original definition, a relation schema $R$ is in 3NF if it satisfies 2NF and no nonprime attribute of $R$ is transitively dependent on the primary key.
- Problematic FD
  - Left-hand side is part of primary key
  - Left-hand side is a nonkey attribute

3NF

- Examples:
  - SSN->DMgrSSN is a transitive FD since SSN->DNumber and DNumber->DMgrSSN hold
  - SSN->EName is non-transitive since there is no $X$ such that SSN->$X$ and $X$->EName.

General Definitions

- Above definitions only consider primary key.
- General definitions:
  - A relation schema $R$ is in 2NF if every nonprime attributes is fully functionally dependent on every key of $R$.
  - A relation schema $R$ is in 3NF if whenever a FD $X$->$A$ holds, then either $X$ is a superkey or $A$ is a prime attribute.
Boyce-Codd Normal Form (BCNF)

- A relation schema R is in BCNF if whenever FD X→A holds in R, then X is a superkey of R.
- 2NF is stronger than 1NF.
- 3NF is stronger than 2NF.
- BCNF is stronger than 3NF.
Boyce-Codd Normal Form (BCNF)

- FD1: \( \text{Property_ID#} \rightarrow \{\text{County_Name, LOT#, Area} \) 
- FD2: \( \{\text{County_Name, LOT#} \rightarrow \text{Property_ID#, Area} \) 
- FD5: \( \text{Area} \rightarrow \text{County_Name} \)

Another BCNF Example...

- Why is this in 3NF not in BCNF?
Class Example

- Consider the relation R, which has attributes that hold schedules of courses and sections at a university: R = (CourseNo, SecNo, OfferingDept, CreditHours, CourseLevel, InstructorSSN, Semester, Year, Days_Hours, RoomNo, NoOfStudents). Suppose that the following functional dependencies hold on R:
  - \{CourseNo\} -> \{OfferingDept, CreditHours, CourseLevel\}
  - \{CourseNo, SecNo, Semester, Year\} -> \{Days_Hours, RoomNo, NoOfStudents, InstructorSSN\}
  - \{RoomNo, Days_Hours, Semester, Year\} -> \{InstructorSSN, CourseNo, SecNo\}

Project Requirements...

- Get into your project groups and discuss the functional dependencies between attributes in your relation schema.
- Discuss whether your mapping is in 2NF, 3NF or BCNF.
- What can you do to normalize these schema? **If you cannot achieve these normal forms please provide a justification.