3.2. Normal Forms

In this lecture we look at...
[Section notes PDF 121Kb]

3.2.01. Orthogonal design

- Information Principle:
  - The entire information content of the database is represented in one and only one way, namely as explicit values in column positions in tables
- Implies that two relations cannot have the same meaning
  - unless they explicitly have the same design/attributes (including name)

3.2.02. Normalization

- Reduced redundancy
- Organised data efficiently
- Improves data consistency
  - Reduces chance of update anomalies
  - Data duplicated, then updated in only one location
- Only duplicate primary key
  - All non-key data stored only once
- Data spread across multiple tables, instead of one Universal relation R

3.2.03. Good or bad?

- Depends on Application
- OLTP (Transaction processing)
  - Lots of small transactions
  - Need to execute updates quickly
- OLAP (Analytical processing/DSS)
  - Largely Read-only
  - Redundant data copies facilitate Business Intellegence applications, e.g. star schema (later)
- 3NF considered ‘normalised’
  - save special cases

3.2.04. Normal forms (1NF)

- First Normal form (1NF)
  - Disallows multivalued attributes
  - Part of the basic relational model

- Domain must include only atomic values
  - simple, indivisible
- Value of attribute-tuple in extension of schema
- $t[A_i] \in (A_i)$

3.2.05. Normalisation (1NF)

- Remove fields containing comma separated lists
- Multi-valued attribute (A_{MV}) of R_i
- Create new relation (R_{NEW})
  - with FK to R_i[PK]
  - R_{NEW}(UID, A_{MV}, FK_I)

3.2.06. Normalisation (1NF)

- On weak entity
- On strong entity

PersonDietWeak

Person	Dietary requirements
Bob	No eggs
Fred	No meat, diary or gluten
Jamal	No fish

->

PersonDietWeak1NF

Person	Dietary requirements
Bob	No eggs
Fred	No meat
Fred	No dairy
Fred	No gluten
Jamal	No fish

PersonDietStrong

ID	Person	Dietary requirements
1	Bob	No eggs
2	Fred	No meat, diary or gluten
3	Jamal	No fish

->

PersonDiet1NFK

ID	Person	DietFK
1	Bob	1
2	Fred	2
3	Jamal	3

FK(DietFK) to Diet1NFK(ID)

Diet1NFK

ID	Requirement
1	No eggs
2	No meat
2	No dairy
2	No gluten
3	No fish

3.2.07. Normal forms (2NF)

- A relation R_i is in 2NF if:
  - Every nonprime attribute A in R_i is
  - fully functionally dependent on 1y key of R
- If all keys are singletons, guaranteed
- If R_i has composite key are
  - all non-key attributes fully functionally dependent
  - on all attributes of composite key?

3.2.08. Normal forms (2NF)

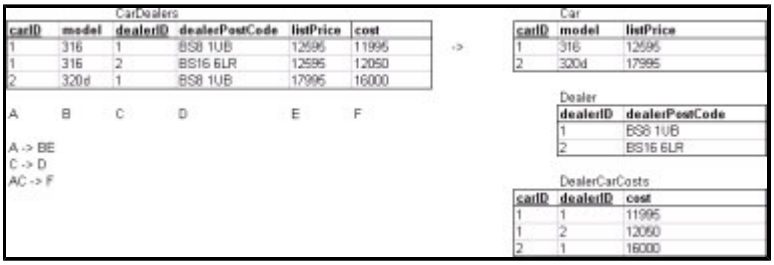
- Second normal form (2NF)
  - Full functional dependency X → Y
    - A ∈ X, (X - {A}) ¬→ Y
- If any attribute A is removed from X
- Then X → Y no longer holds
  - Partial functional dependency
  - A ∈ X, (X - {A}) → Y

3.2.09. Normal forms (2NF)

- In context
  - Not 2NF: AB → C, A → C
    - AB → C is not in 2NF, because B can be removed
  - Not 2NF: AB → CDE, B → DE
    - because attributes D&E are dependent on part of the composite key (B of AB), not all of it

3.2.10. Normalisation (2NF)

- Split attributes not depended on all of the primary key into separate relations



3.2.11. Normal forms (BCNF)

- Boyce-Codd Normal form (BCNF)
  - Simpler, stricter 3NF
    - BCNF → 3NF
    - 3NF does not imply BCNF
  - nontrivial functional dependency X → Y
  - Then X must be a superkey

3.2.12. Normal forms (3NF)

- Third Normal form (3NF)
- Derived/based on transitive dependency

- For all nontrivial functional dependencies
  X → A
- Either X must be a superkey
- Or A is a prime attribute
  (member of a key)

3.2.13. Normal forms in context

- AB → C, C → D, D → A
- In context
  - 3NF? Yes
    - Because AB is a superkey and
    - D and A are prime attributes
  - BCNF? No
    - Because C and D are not superkeys
    - (even though AB is)

3.2.14. Normalisation (3NF)

- CarMakes not in 3NF because:
  - singleton key A
  - non-trivial fd B → C
    - B not superkey, C not prime attribute