COS 425:
Database and Information
Management Systems

Relational model

Relational model

- A formal (mathematical) model to represent
  - objects (data/information),
  - relationships between objects
  - Constraints on objects and relationships
  - Queries about information
- Well-founded on mathematical principles :
  - Precise semantics of constraints and queries
  - Can prove equivalence of different ways to express queries

Relational model - practice

- Foundation of most Database Management Systems
- SQL language is a programming language to express constructs of formal model

Relational Database Definitions

1. A relation is a set of tuples over specified domains
   - R subset of D_1 X D_2 X D_3 X … D_k (k-ary)
   - Each D_i is a declared domain
2. A relational database is a set of relations and possibly constraints among the relations

Relational Database: Terminology

Schema for a relation:

1. Relation name
2. Domain (type) of each component
   i.e. declare D_i s

Equivalent:

- Instance of a scheme
- Table

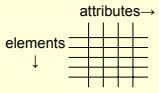
Term "relation" is used to refer to a schema and a particular instance – disambiguate by context

Relational Database: More Terminology

Each D_i of a schema is referred to as a component or attribute or field or column of the schema

Each d_i of a tuple = (d_1, d_2, d_3, … d_k) is referred to as component or attribute or field of the tuple

Each tuple of a relation is also referred to as an element or row of the relation



Translating ER model to relational

- Domains → domains
- Entity → relation
- Relationship → one* or more relations
  * come back to
- Constraints → constraints BUT
  - Not all ER constraints expressible in basic relational model

Relational model is FLAT – no hierarchy!

Our ER Example → Relational schema

For entities, get relations:

books: (title, ISBN#, edition, date)
authors:
(name, gender, birth date, place of birth, date of death)
publishers: (name, country, address)

Need declare domains:
e.g. title: string

Same defs *candidate keys*, *primary key*, *superkeys*

Our ER Example → Relational schema

For relationships:

ER *published by*: (***books***, ***publishers***, in print)
becomes
published by: (*isbn#, publisher_name*, in print)

ER *written by*: (***books***, ***authors***)
becomes
written by:
(*isbn#, author_name, birth date, place of birth*)

Keys for these?

Our ER Example → Relational schema

For relationships:

ER *published by*: (***books***, ***publishers***, in print)
becomes
published by: (*isbn#, publisher_name*, in print)
key constraint on entity *books* in relationship *published by* →
A book has at most one publisher

ER *written by*: (***books***, ***authors***)
becomes
written by:
(*isbn#, author_name, birth date, place of birth*)

Our ER Example → Relational schema

Because ER key constraint on entity *books* in relationship *published by*
Can fold relation *published by* into relation *books:*

books:
(title, ISBN#, edition, date, pub_name, in print)

What if some books not published?
i.e. entity *books* not totally participate in relationship *published by*

Our ER Example → Relational schema

books:
(title, ISBN#, edition, date, pub_name, in print)

What if some books not published?
i.e. entity *books* not totally participate in relationship *published by*

Must allow values
of attributes *pub_name* and *in print* to be null

Translating ER model to relational

General conclusion:

Relationship → ~~one~~ zero or more relations

Translating ER model to relational

- Get flat set of relations
- But relations are interrelated
  - Bring together primary keys of different relations to build new relation
  - Captures ER relationship
- How capture this in relational model?

  Foreign key constraints

Foreign key constraint

- Specify that a set of attributes in schema for one relation form the primary key for a specific other relation
  - "other relation" is referred to or referenced by first relation

Foreign Keys for Our Example

published by: (*isbn#, publisher_name*, in print)
isbn# is a foreign key referencing *books*
Primary key of *books* understood
Publisher_name is a foreign key referencing *publishers*

written by:
(*isbn#, author_name, birth date, place of birth*)
isbn# is a foreign key referencing *books;*
(author_name, birth date, place of birth) is a foreign key referencing *authors*

Board Examples