Midterm Review: Fall 2018

CS-6360 Database Design

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Midterm Parameters

- Closed Book, Closed Notes
  - Accessing eLearning course materials (lecture slides, notes, etc.) during an exam is **absolutely prohibited**
  - **Location**: Testing Center
  - **Time**: Reserve-A-Seat exact time per student
    - Arrive early
  - **Duration**: 90 minutes
    - Regardless of start time

Testing Logistics

- UTD Testing Center (*not classroom*)
  - **MAP**: http://www.utdallas.edu/studentsuccess/files/SPN2-Move-Final-2.pdf
- Reserve a seat in advance!
  - https://www.registerblast.com/utdallas/Exam/List

Testing Center

- **Testing Center**
  - Identification: Comet Card
  - Bathroom breaks are prohibited (please plan ahead)
  - No jackets or sweaters
  - No backpacks
  - No pencil boxes
  - Non-approved calculators prohibited
    (calculator supplied, if needed)
  - Scratch paper and whiteboard supplied, if needed.

Content Summary

- Review the textbook!!
  - These slides are an *outline*, not a comprehensive content
- Introduction (1,2)
- ER / EER model (3,4)
- Relational Model (5)
- SQL (6, 7)
- Relational Algebra (8)
- Relational Calculus (8)
- ER and EER Mapping (9)
- Normalization (14,15.1)
- Review homework
- Review end of chapter exercises and questions

Ch. 1: Databases and Database Users

UTD

- **Bold** concepts and definitions
  - §1.3 Characteristics of the Database Approach
  - §1.4 Actors on the Scene
  - §1.5 Workers behind the Scene
  - §1.6 Advantages of Using the DBMS Approach
- T/F, Multiple Choice, Multiple Answer, Matching
- No verbatim memorized definitions

Ch. 2: Database System Concepts and Architecture

UTD

- **Bold** concepts and definitions
  - §2.1 Data Models, Schemas, and Instances
  - §2.2 Three-Schema Architecture and Data Independence
  - §2.3 Database Languages and Interfaces
  - §2.4 The Database System Environment
  - §2.5 Centralized and Client/Server Architectures for DBMSs
  - §2.6 Classification of Database Management Systems
- T/F, Multiple Choice, Multiple Answer, Matching
- No verbatim memorized definitions

Ch. 3: ER Model

- Create ER diagrams from English descriptions
- Answer questions about existing ER diagrams
- Cardinality and Participation
  - Cardinality (1:1, 1:N, M:N) encodes only **max**
  - Participation (total, partial) encodes only **min**
- Be able to interpret ER diagrams using *either* (min, max) *or* Cardinality / Participation
- Know ER Notation (Textbook Figure 3.14)

Ch. 4: EER Model

- §4.1 Subclasses, Superclasses, and Inheritance
- §4.2 Specialization and Generalization
- §4.3 Constraints and Characteristics of Specialization and Generalization Hierarchies
- §4.4 Modeling of UNION Types Using Categories
- **NO UML**

Ch. 5: The Relational Data Model and SQL

UTD

- §5.1 Domains, Attributes, Tuples, and Relations
  - **Bold** concepts and definitions
- §5.2 Relational Model Constraints and Relational Database Schemas
  - Be able to interpret relational schemas
    - Schema diagrams
    - Text schemas
  - Be able to bidirectionally convert between **English ⇔ Relational Schema**

- §5.3 Update Operations, Transactions, and Dealing with Constraint Violations
  - Given a schema and an operation (insert, modify, delete), be able to identify constraint violations
    - Domain constraint
    - Key constraint
    - Constraint on NULL
    - Entity integrity constraint
    - Referential integrity constraint
  - Be able to suggest a resolution other than simply rejecting the operation

Ch. 6: Basic SQL

- Be able to write syntactically correct SQL Queries
- §6.1 Data Definitions and Data Types
  - CREATE TABLE syntax and options
  - Data types
- §6.2 Constraints (*three categories*)
  - **Implicit** – inherent in the data model
  - **Explicit** – directly expressed in the schema of the data model (foreign keys, assertions, triggers)
  - **Semantic** – applications-based / business rules

Ch. 6: Basic SQL

- §6.3 Basic Retrieval Queries in SQL
  - The **`SELECT-FROM-WHERE`** Structure
  - Review textbook Query Examples
- §6.4 **`INSERT`**, **`DELETE`**, and **`UPDATE`** Statements in SQL
  - Review textbook Examples
  - Be able to predict *allowed* and *disallowed* operations (i.e. like Chapter 5: Relational Model)
    - Reason for disallowance (SQL constraint violations)

- §7.1 More Complex SQL Retrieval Queries
  - §7.1.1 Comparisons Involving `NULL` and Three-Valued Logic
  - §7.1.2 Nested Queries, Tuples, and Set/Multiset Comparisons
  - **`EXISTS`** and **`UNIQUE`**
  - **`WHERE`** *attribute* **`IN`** *set / result set*
  - §7.1.6 Joined Tables in SQL (Inner and Outer Joins)

- §7.1.7 Aggregate Functions
  - COUNT, SUM, MAX, MIN, AVG
  - Do not confuse COUNT with SUM (Caveat: beware of query descriptions that use the words "total" or "how many".
  - Cannot appear in WHERE clause
- §7.1.7 Ordering and Grouping
  - `ORDER BY` *attributes*
  - `GROUP BY` *attributes*
    `HAVING` *condition*
  - GROUP BY attributes *should* also appear in the SELECT clause
  - Attributes that are not in the GROUP BY clause and are non-unique *should not* appear in the SELECT clause.

Ch. 7: Advanced SQL

- ~~§7.2 Specifying Constraints as Assertions and Actions as Triggers~~ **(NOT INCLUDED)**
- §7.3 Views (Virtual Tables) in SQL
  - Know **`CREATE`** syntax
  - Know usage
- 7.4 Schema Change Statements in SQL for Schemas, Tables, Constraints
  - **`DROP`**
  - **`ALTER`**

Ch. 8: The Relational Algebra and Relational Calculus

- Relational Algebra
  - Unary: SELECT (σ), PROJECT (π), RENAME (ρ)
  - Binary:
    - UNION ($\cup$), INTERSECTION ($\cap$), MINUS ($-$, $\setminus$)
    - CROSS PRODUCT ($\times$)
    - JOIN ($\bowtie$, $\rtimes$, $\ltimes$, $\rtimes$)
    - DIVISION ($\div$)
  - "Complete Set" of Relations, i.e. the six primitives

Ch. 6: The Relational Algebra and Relational Calculus

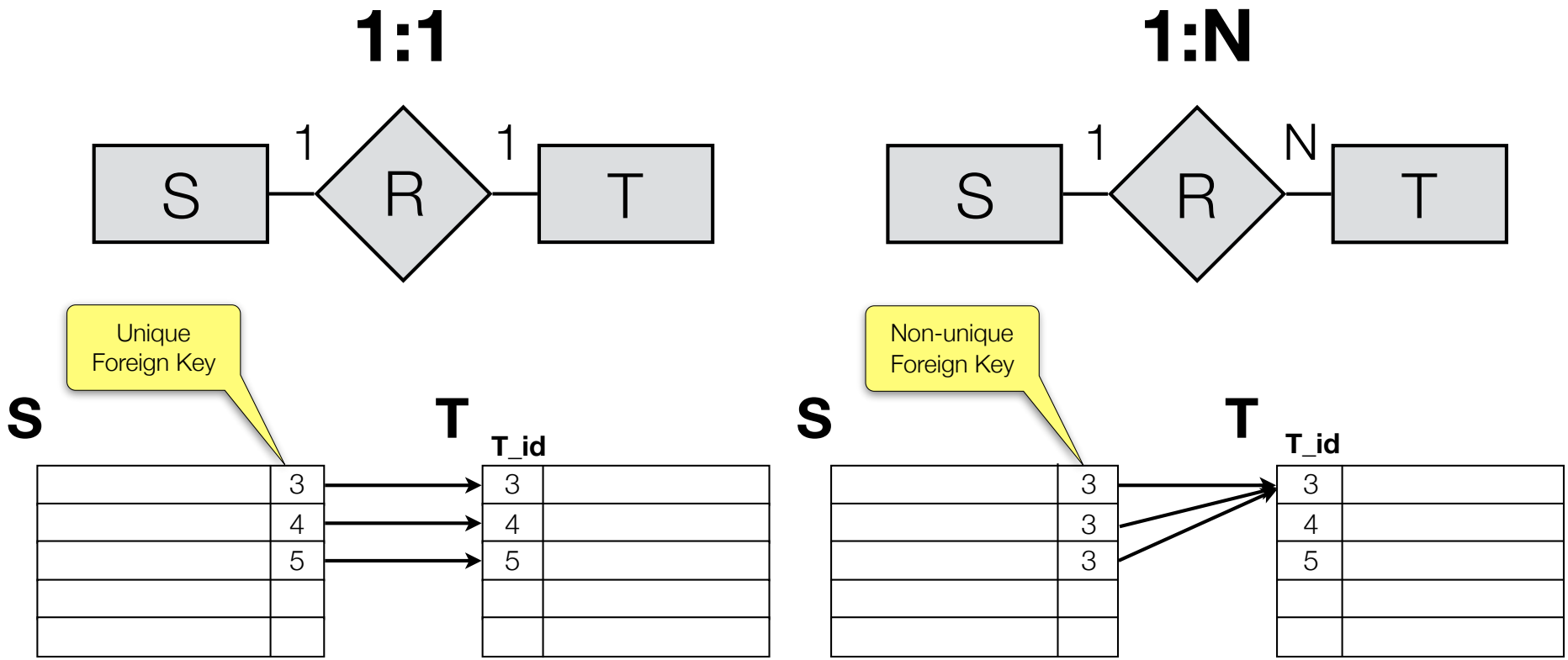
- Review textbook example *Queries*
  - Relational Algebra
  - Tuple Relational Calculus
  - Domain Relational Calculus
- ~~Relational Calculus **Query Graphs**~~

Query Equivalence

- Be able to convert between any combination of
  - English Description
  - Relational Model
  - SQL
  - Relational Algebra
  - Tuple Relational Calculus
  - Domain Relational Calculus

- ER Mapping 7 steps
  1. Regular Entities
  2. Weak Entities
  3. 1:1 Relationships
  4. 1:N Relationships
  5. M:N Relationships
  6. Multi-valued attributes
  7. *n*-ary Relationships

Foreign Key Mapping



- Foreign Key in S *may be* NULL if S participation is partial
- Foreign Key in S *must be* NOT NULL if S participation is total

- EER Mapping
  - Supertype/Subtype
    - 8A Both Super-type & Subtype mapped to relation
      - Best with overlap + partial (all others possible but require triggers)
    - 8B Subtypes only mapped to relations
      - Best with overlap + total (disjoint requires triggers; partial not possible)
    - 8C Super-types only mapped: (one attribute) predicate-defined
      - Best with disjoint (overlap not possible; partial uses NULL as predicate value; total requires NOT NULL as predicate value)
    - 8D Super-types only mapped: (multi-attribute) attribute-defined
      - Best with overlap (disjoint requires assertion; partial uses NULL as predicate value; total requires NOT NULL as predicate value)
  - Step 9: Union Type

- **1NF** – The only attribute values permitted by 1NF are single atomic (or indivisible) values. That is, no attribute for a given tuple is multi-valued, i.e. “nested relations”
- **1NF** violations are based on violations of (**Data**)

Ch. 14: Functional Dependencies and Normalization

- Be able to normalize into 1NF
- Be able to normalize → 2NF → 3NF → BCNF (**incl. 15.1**)
  - Schema diagram
  - Text schema
- Be able to normalize a relation and its data into either
  - 4NF (given ER/EER or data)
  - 5NF (given ER/EER)
- Both 4NF and 5NF violations may be detected using an accompanying ER diagram.
  - However, should also be able to detect 4NF violations based upon data analysis only.

Detect all minimal keys

- 4NF and 5NF normal forms are based on violation of both (**Data & Schema**)
- Note that if proper Chapter 9 schema design principles are observed, 4NF and 5NF violations will not occur
  - In practice however, schemas evolve over time
  - Later DBAs may not have access to original design requirements
- 14.6 – Multivalued Dependency and 4NF
  - Figure 14.15
- 14.7 – Join Dependencies and 5NF
  - Figure 14.15