CS 4604: Introduction to Database Management Systems

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Midterm Review
MIDTERM REVIEW
Course Outline

- **Weeks 1–4: Query/Manipulation Languages and Data Modeling**
  - Relational Algebra
  - Data definition
  - Programming with SQL
  - Entity-Relationship (E/R) approach
  - Specifying Constraints
  - Good E/R design

- **Weeks 5–8: Indexes, Processing and Optimization**
  - Storing
  - Hashing/Sorting
  - Query Optimization
  - NoSQL and Hadoop

- **Week 9-10: Relational Design**
  - Functional Dependencies
  - Normalization to avoid redundancy

- **Week 11-12: Concurrency Control**
  - Transactions
  - Logging and Recovery

- **Week 13–14: Students’ choice**
  - Practice Problems
  - XML
  - Data mining and warehousing
Course Outline: For Midterm Exam

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No Query Processing/Optimization
## FUNDAMENTAL
### Relational operators

- **selection**
  \[ \sigma_{condition}(R) \]

- **projection**
  \[ \pi_{att-list}(R) \]

- **cartesian product**
  \[ R \times S \]

- **set union**
  \[ R \cup S \]

- **set difference**
  \[ R - S \]
Relational ops

- Surprisingly, they are enough!

- Derived/convenience operators:
  - set intersection \( \cap \)
  - `join` (theta join, natural join) \( \Join \)
  - ‘rename’ operator \( \rho_{R'}(R) \)
  - division \( R \div S \)
Basic SQL Query

SELECT [DISTINCT] target-list
FROM relation-list
WHERE qualification;

- **Relation-list**: A list of relation names (possibly with range-variable after each name).
- **Target-list**: A list of attributes of relations in relation-list
- **Qualification**: conditions on attributes
- **DISTINCT**: optional keyword for duplicate removal.
  - Default = no duplicate removal!
- **ORDER BY**: for sorting values
SQL

- Handling Sub-queries
- SQL Data Definition Commands
- Constraints
- Triggers
- ...
- Note how referential integrity can be enforced (foreign key; on delete cascade etc.)
E/R Diagrams

- **IMPORTANT:**
  - Follow only lecture slides for this topic!
  - Differences from the book:
    - More details
    - Slightly different notation
Relationships

- Show a many-one relationship by an arrow entering the “one” side.
  ![Many-One Relationship]

- Show a one-one relationship by arrows entering both entity sets.
  ![One-One Relationship]

- In some situations, we can also assert “exactly one,” i.e., each entity of one set must be related to exactly one entity of the other set. To do so, we use a rounded arrow.
  ![Exactly One Relationship]
E/R Example (does not contain ISA)

- Each department teaches multiple courses. Each course has a number. What is the key for the entity set Courses?
Converting E/R Diagrams to Relational Designs

- Entity Set $\rightarrow$ Relation
  - Attribute of Entity Set $\rightarrow$ Attribute of a Relation
- Relationship $\rightarrow$ relation whose attributes are
  - Attribute of the relationship itself
  - Key attributes of the connected entity sets
- Several special cases:
  - Weak entity sets.
  - Combining relations (especially for many-one relationships)
  - ISA relationships and subclasses
- Also note how referential integrity comes in (foreign keys)
Tree Indexes

- B+-Trees
  - Carefully understand the Definition!
  - Searching
  - Inserting
  - Deleting
Hashing/Sorting

- Extendible Hashing
- Linear Hashing
- External Sorting

- Again, how to search and build, internalize the structure
- Sorting: understand the process, how to cost it, how many passes it takes etc.
Exam

- **No** aids allowed EXCEPT:
  - Only written *(not typed)* 1 letter-size page *(you may use both sides)*
  - A calculator *(NOT your smartphone)*

- Duration: 75 mins, during class Oct 4, 2018

- More or less equal weightage to all the topics
  - Questions will be similar to the HWs, Handouts