CS 338 course note

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Contents

1 Introduction to database

1. Terms
   Data redundancy: presence of duplicate data in multiple data files
   Data inconsistency: the same attribute may have different values

2. Database
   a collection of related information stored in a stuctured form

3. DBMS:
   a collection of programs that manipulate a database

4. Data Model

   - Relational Model
   - Object-oriented model
   - semi-structed data model
   - network model
   - Hierarchical model

5. Schema

   - Physical schema: database at physical level
   - logical schema: database at logical schema
   - External schema: database at external schema

2 Relational

1. Terms
   - attribute: each column with in a table
   - domain: all possible value of a attribute
   - Primiary key: a attribute in a row that must be unique in a table
   - Tuple: rows
   - Schema of a relation: definiton of a table
   - a instance: table content
2. Integrity Constaints
   is a condition that must be true for any instance of the database
   Domain constrain: must satisifeid domain
   Primary key constraints: each relation must have a primary key, and they must be unique
   Foreign key: set of filed in one relation used to refert to a tuple in another relation

3 Relational algebra and calculus

1. Relational Quesry language
   A major strengh of the relational model: supports simple, powerful querying of data

2. Relational algebra
   Result of a retrieval is new relation
   sqquence of relational algebra operations forms a relational algebra expression

3. Operations

   - selection (σ): select a subset of rows from relation
   - projection(π) deletes unwated columns from relation
   - cross-product(X) allows us combines 2 relation
   - Set-difference (-) tuples in relation1 but not 2
   - Union(Y) tuple in one of 1 or 2

   Format: $(\text{operation})_{boolean}$ (relation)

4. Boolean
   used to show true value

5. Assignment operation
   $<-$ allowed to assign variable

6. Union compatible
   if 2 relation have the same degree and all attributes are defined on same domains

7. Foreign key
   Assume R1(ABC), R2(EFG) there is a FK: R1.A referrece R2.G
   the value of R1.A must be
   Null or unique in R2
   however, R2.G does not need to be PK

8. Rename operation (useless)
   format: $p_{(relation)}(relation)$ or $p_{(col,col)}(relation)$
   the first one rename relation, but the second one only rename column

9. Join operation
   symbol: $\bowtie$
   a combination of cross product and selection, notice must have different attributes name
   The following are the same:

   - $e <- R1XR2$
     result $<- \sigma_{bool}(e)$

- R1 (join)$_{bool}$(R2)

10. Natural join operation
    result $< -R1 * R2$
    Assume $R(ABC), S(AD)$, $R * S- > (ABCD)$
    will auto=same attributes, and combine attributes, also allowed same attribute name

11. Division Operation
    Assume $R1(r1_i)$, $R2(r2_i)$, $R1 \div R2 =$
    $(r1_i)$ such that $r1_i \notin R2$ and keep all tuple that all not included $r1_i$ appear in R2

12. Aggreation:
    ${}_{G_i}g_{f_i(A_i)}(E)$, allowed optional As to change the name of function F1
    function includes

    - avg
    - min
    - max
    - sum
    - count

4 SQL mannipulation

4.1 Data mainipulation

1. select basic format
   select (attribute) **from** (table) **where** (condition)
   if mutiple table selected, they will be cross prodected
   can use table**.**attribute to for duplicate column namess
   where, order by, group by,having must be in this order

2. rename
   can rename attribute name **AS**
   can give table temp name right after it's name

3. **distinct**
   a key word to eliminate duplicates in rows
   usage: **select distinct** (attributes).....

4. nested query
   when nest a table in from, must give the table a name
   when used in where, no need to give name

5. **join**
   usage: (table) **join** (table) **on** (condition (only equality))

6. **natural join**
   usage: (table) **natural join** (table)
   other join is the same by different name

7. **Like**
   compare text value in pattern
   % compare zero or more characters
   _ compare exactly one character

8. **IN** and **NOT IN**
   check if the attribute value is in the subsequence table

9. explicit sets
   like (1,2,3) for in and not in

10. **exsits**
    will return true if the table have atleast one row

11. **Unique/not unique**
    not supported in SQLite
    will check if there is any duplicate rows

12. **any** and **all**
    used with compare operation like (<)

13. **order by**
    sort result on one or more of attribute
    from small to big
    used desc to reverse

14. **group by**
    include grouping attributes
    if used, **select** (attribute) can only include aggregation function and groupting attributes

15. **having**
    is like use aggregation in where

16. **union** and **intersection**, minus
    (q1) union/intersect/except (q2),

4.2 Data modification

1. Create table
   Create table table name (Attribute Domain, or integrity-constraint)
2. Domain type
   - char(n): a fixed length string
   - varchar(n): not fixed string length with maximum length n
   - int: integer
   - smallint: small integer
   - numeric(p, d): fixed point number: p is digit, n is the position of decimal
   - read, double precision: floating point and double precision floating pointnumbers
   - float(n): floating point number with n is digit
   - not null: can't be null
   - customed domain: create a specificy domain
3. Date/time type
   - date: date
   - time: Time with day, hour minutes and second
   - timestamp: date+time
   - Interval: period of time
4. Integrity Constraint in SQL I
   - not null
   - primary key (A_i)
   - check (P): p is a condition
5. Foreign key
   Foreign key (A_i) **References** R(b_i)
   allow A_i refer to $R(B_I)$
6. Drop table
   Drop table simply remove the table from databse with all information
7. Alter table
   is used to add/change attibute type,domain
   Alter table (r) add (A D) drop (A D)

Data modifications

1. Delete
   Deleta from R **where** P
   delete row from R where satisified P

2. Insert
   Insert into R **values** (v)
   v must match the correct order of R's attributes

3. Update
   Update R **set** (attribute = expression) **where** (condition)

4. Case
   Case when then else end

4.3 advance topic

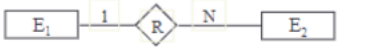
1. Views
   create a "temp" table
   create view view name **as** query
2. Assertion

5 ER

5.1 Basic

1. Entity (square)
   Real-word object distringuishable from other obejcts
2. Entity Set
   A collection of similar entites
3. Attribute (oval)
   a entity represent a set of attributes
4. Type of attributes
   - Simple: one atomic value
   - Composite: a attribute composed of several components
   - Multi-valued: an entry may have multiple values for the attribute
5. Keys
   - Super key
     an entity set is a set of one or more attributes whose values uniquely determine each entity
   - Canadidate key
     of an entity set is a minimal super key
   - primary key (underline)
     is when canadidate key have only one attribute
6. Relationship (ling xing)
   connected between 2 entity with a name and some attributes
7. Cardinality
   - 1-1
     means that a enity can only be connected with only one other entity
   - 1-many
     means that the a object can be associate with many other entity
   - Many-many
     mneas that many can associate with many entity
8. Participation Constraint
   - Total participation (double line connected to the diamind)
     every entity in the entity set participate in at least one other entity
   - Partical participation
     can have no relation
9. Week entity (double rectangle)
   Does not have a primary key
   must be total participate within a relationship

SUMMARY OF ER NOTATION

Symbol	Meaning
	ENTITY TYPE
	WEAK ENTITY TYPE
	RELATIONSHIP TYPE
	IDENTIFYING RELATIONSHIP TYPE
	ATTRIBUTE
	KEY ATTRIBUTE
	MULTIVALUED ATTRIBUTE
	COMPOSITE ATTRIBUTE
	DERIVED ATTRIBUTE
	TOTAL PARTICIPATION OF E_2 IN R
	CARDINALITY RATIO 1:N FOR E_1:E_2 IN R
	SOME USE ARROW TO REPRESENT TOTALPARTICIPATION

5.2 Mapping

1. Basic Principles
   - No loss of information
   - Minimal redundancy
   - Minimize the use of NULL
2. Mapping steps
   - Step1: Mapping of regular entity types
   - Step2: Mapping of MUltivalued attributes
   - Step3: Mapping of Week Enity Types
   - Step4: Map 1:1 relationship
   - Step5: Map 1:N relationship
   - Step6: map M:N relationship
   - Step7: Map N-ary relationship types
3. Step1:
   For each strong entity, create a relation R, and include all simple attribute break composite attribute
   PK are still PK
4. Step2:
   For each multivalued attribute A belong to S, create a new relationship C such that C have 2 cloumn, one for A of for FK to PK of S
   PK for C is A+FK
5. Step3: weak entity
   For each weak eneity W , create a relation R, include the PK of owner entity E
   PK of R is: FK from owner + partial key of W
6. Step4
   for each 1 to 1, have 3 way:
   - Both total: combine both relation to 1 attribute but only remain one of the PK
   - One total: add a FK of PK from the 1 side to N relation
   - No total: create a new relation
7. Step5:
   in the N side, include a FK from the 1 entity
8. Step6
   Create a new relation include PK from both entity
   the PK in new relation is the combine of both PK from entity

9. Step7
   For each n-ary relationship type R, create new relation C to represent R include all PK from all participant, combinition is the PK of C

Summary of ER Mapping

ER Model	Relational Model
Entity type	"Entity" relation
1:1 or 1:N relationship type	Foreign key (or "relationship" relation)
M:N relationship type	"Relationship" relation and two foreign keys
n-ary relationship type	"Relationship" relation and n foreign keys
Simple attribute	Attribute
Composite attribute	Set of simple attributes
Multivalued attribute	Relation and foreign key
Value set	Domain
Primary key	Primary key