CS2102

Relational Algebra

$\sigma_{condition}(R)$ Select tuples from R that satisfy C eg. $\sigma_{a=b}(C)$
Conditions:

- $\sigma_{a=1}(R)$
- $\sigma_{a=b}(R)$
- $\sigma_{a=1 \wedge / \vee b=2}(R)$
- $\sigma_{\neg(a=1)}(R)$

$\pi_l(R)$ Projects attributes from R in list l eg. $\pi_{a,b}(C)$
$p_l(R)$ Renames attributes from R
Two formats:
$p_{(a,b,c)}(A)$ renames them in order
$p_{(a \leftarrow a1, b \leftarrow b1, c \leftarrow c1)}(A)$ renames a1 to a, b1 to b, c1 to c

Set Operators

$A \cup B$
$A \cap B$
$A - B$
Cross Product: $A \times B$

Inner Joins

$\theta - Join$ defined as $R \bowtie_\theta B = \sigma_\theta(R \times S)$
Equi-Join defined as θ-join with equal operator rather than other comparisons
Natural Join $\bowtie$ joins over attributes that R and S have in common

Outer Joins

$\rtimes_\theta$ Left Outer Join: Inner join on θ, then add dangling tuples (tuples from R that didn't join to any tuple from S)
$\ltimes_\theta$ Right Outer Join Same, but dangling tuples from S
$\rtimes\ltimes_\theta$ Full Outer Join Same, but with all dangling tuples
Natural outer joins exist too $\rtimes \ltimes \rtimes\ltimes$

Relational Model

Term	Description
Superkey	subset of attributes that uniquely identifies a tuple
(candidate) key	Minimal set of attributes that uniquely identify a tuple in a relation
primary key	Selected key (in case of multiple candidate keys)
foreign key	Set of attributes that is a key in referenced relation
prime attribute	Attribute of a primary key

Constraints

Foreign Keys must reference a primary key in another table (which can be itself).

SQL

"x IS DISTINCT FROM y"

- equivalent to "x ¡¿ y" if x and y are non-null values
- if x and y both null → evaluates to false
- if only one value is null → evaluates to true

IS (NOT) NULL Comparison Predicate

- Check if a values is equal to null (since "=" would return unknown)
- If x is a null value → "x IS NULL" evaluates to true
- If x is a non-null value → "x IS NULL" evaluates to false

Creating Tables

```
CREATE TABLE (
attribute INTEGER PRIMARY KEY
attribute2 TEXT REFERENCES table2(attribute2) NOT NULL
attribute3 INTEGER NOT NULL UNIQUE
attribute4 INTEGER constraint named_constraint
check(attribute4 > 5)
FOREIGN KEY (attribute3) REFERENCES table2(attribute3)
ON DELETE action ON UPDATE action
)
```

Possible actions for on delete and on update:

- NO ACTION rejects delete/update if it violates constraint (default value)
- RESTRICT similar to "no action" except that check of constraint cannot be deferred (deferrable constraints are discussed in a bit)
- CASCADE propagates delete/update to referencing tuples
- SET DEFAULT updates foreign keys of referencing tuples to some default value (important: default value must be a primary key in the referenced table!)
- SET NULL updates foreign keys of referencing tuples to null (important: corresponding column must allowed to contain null values!)

Inserting Data

```
INSERT INTO Employees (id, name)
VALUES (102, 'Judy'), (103, 'Max');
```

Updating Data

```
UPDATE Employees
SET age = age + 1
WHERE name = 'Sarah';
```

Deleting Data

```
DELETE FROM Employees
WHERE role='dev';
```

Alter Table

```
ALTER TABLE Projects
ALTER COLUMN start_year SET DEFAULT 2021;
-- set default value of column "start_year"

ALTER TABLE Projects ALTER COLUMN start_year DROP DEFAULT;
-- drop default value of column "start_year"

ALTER TABLE Projects ALTER COLUMN name TYPE VARCHAR(200);
-- change data type to VARCHAR(200)

ALTER TABLE Projects ADD COLUMN budget NUMERIC DEFAULT 0.0;
-- add new column with a default value

ALTER TABLE Projects DROP COLUMN budget;
-- drop column from table

ALTER TABLE Teams
ADD CONSTRAINT eid_fkey FOREIGN KEY (eid)
REFERENCES Employees (id);

ALTER TABLE Teams DROP CONSTRAINT eid_fkey;
```

ERD

Attributes

- specific information describing an entity represented by an oval in ER diagrams

4 subtypes of attributes

- Key attribute(s): uniquely identifies each entity (oval with the attribute name(s) underlines)
- Composite attribute: composed of multiple other attributes (oval comprising of ovals)
- Multivalued attribute: may consist of more than one value for a given entity (double-lined oval)
- Derived attribute: derived from other attributes (dashed oval)

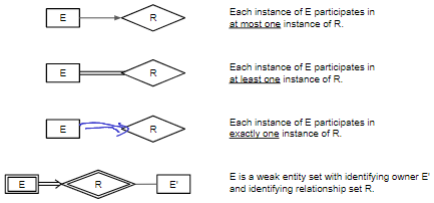


Figure 1: Summary of Participation Constraints

Implementations for constraints

Many A to Many B: Make a table A_B that contains primary keys of both A and B
One A to Many B: Put A's primary key in B
One A to One B: Make a table A_B that contains primary keys of both A and B as individually unique OR put one's primary key in the other table

Weak Entity Set

Use primary key from identifying relation + another attribute as primary key Set ON DELETE CASCADE and ON UPDATE CASCADE

Selecting

Basic pattern matching with (NOT) LIKE
"_" matches any single character
"%" matches any sequence of zero or more characters

```
SELECT NAME FROM CITIES WHERE NAME LIKE 'Si%re'
SELECT NAME FROM CITIES WHERE NAME LIKE 'Si_re'
SELECT XX FROM XX WHERE XX.A IN ('A','B')
SELECT XX FROM XX WHERE XX.A < ANY/ALL (SELECT XX FROM XX)

SELECT xx FROM xx c1 WHERE xx >= ALL
  (SELECT XX from xx c2 WHERE c2.xx IS NOT NULL)
--need to check if not null else >= ALL will be false

SELECT A.X FROM A WHERE EXISTS
      (SELECT B FROM C WHERE C.X = A.X)
--EXISTS

SELECT name, population, gdp
FROM countries
WHERE ROW(population, gdp) > ANY (SELECT population, gdp
FROM countries
WHERE name IN ('Germany', 'France'))
--row constructor to compare two values,
--if either is true it returns the row
```

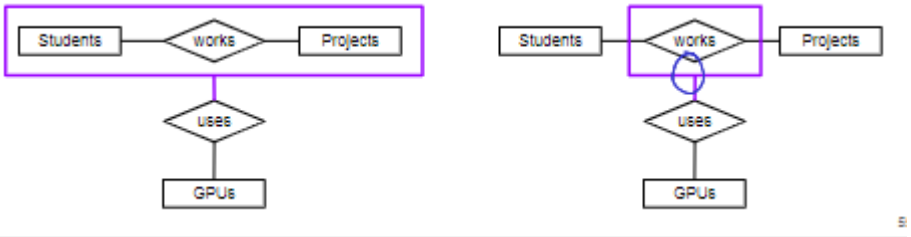
Recursive Queries

```
WITH RECURSIVE cte_name AS (
      Q1
      UNION [ ALL ]
      Q2(cte_name)
)
SELECT * FROM cte_name
```

Example:

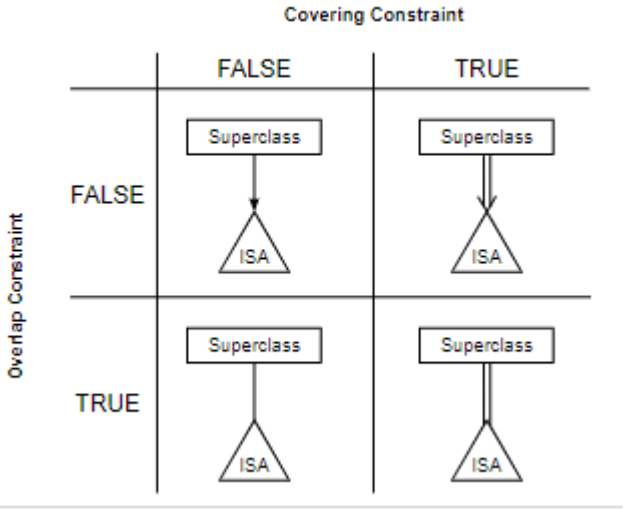
```
WITH RECURSIVE flight_path AS (
```

```
    SELECT from_code, to_code, 0 AS stops
    FROM connections
    WHERE from_code = 'SIN'
    UNION ALL
    SELECT c.from_code, c.to_code, p.stops+1
    FROM flight_path p, connections c
    WHERE p.to_code = c.from_code
    AND p.stops < 2
)
SELECT DISTINCT to_code, stops
FROM flight_path
ORDER BY stops ASC
```



ISA

If A ISA B, put foreign key in A that references B
Covering constraint: True if A needs to be at least a B Overlap constraint: True if A can be more than one B



Aggregation

Treat relationship as entity, make a table Relationship-Entity with primary keys of the relationship and the entity as the primary key