Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Relational Algebra

Relational Algebra:-

It's a procedural query language, which takes relation as input and generate Relation as output.

Basic fundamental operators:-

1. Selection (σ) → Unary (SQL where)
2. projection (Π) → Unary (SQL select)
3. Union ($\cup$) (OR অপারেটর) → Binary
4. Set difference ($-$) → Binary
5. Cartesian product ($\times$) → Binary
6. Rename (ρ) → Unary → $\rho_x(E)$ [E table renamed as x]

Additional / Derived operations:-

1. Join ($\bowtie$) → (Cartesian Product) → Binary
2. Set Intersection ($\cap$) → (AND অপারেটর) → Binary
3. Division ($\div$) → Binary

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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Unary:- যারা একটা relation এ operator করে থাকে তাকে Unary operator বলে।

Binary:- যারা দুইটা relation/ table এ Operate করে থাকে তাকে Binary operator বলে।

Selection operator:-

Database এর কোনো table থেকে row wise কোনো table select করতে হলে সেক্ষেত্রে selection operator লাগে।

Notation:- $\sigma_p(R)$

σ → selection

p → propositional logic formula

R → Relation

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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Example:-

ID	name	dept_name	salary
22222	Einstein	physics	95000
33456	Gold	physics	87000

To select those tuples of the instructor relation where the instructor is in the "Physics" department.

$$\sigma_{dept\_name = "Physics"}(instructor)$$

We can find all instructors with salary greater than $90,000.

$$\sigma_{salary > 90,000}(instructor)$$

To find the instructors in Physics with a salary greater than $90,000

$$\sigma_{dept\_name = "physics" \wedge salary > 90,000}(instructor)$$

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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Projection operation:-

Database এর কোনো table থেকে colourm wise কোনো table select করতে হলে সেক্ষেত্রে projection operator লাগে.

* distinct data নিবে কোনো duplicate data নিবে না.

Notations:- $\Pi_{a_1, a_2, a_3 \ldots\ldots}(r)$

Π -> projection

$a_1 \ldots a_n$ -> Attributes

r -> Relation

Example:-

① Fetch ID, Name, & Board data from student table for those students whose Board = 'Dhaka'.

$$\Pi_{ID, Name, Board}\left(\sigma_{Board='Dhaka'}(Student)\right)$$

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

(ii) Fetch ~~Age~~ Name, Age & Board data from student table for student ID = 2.

$$\Pi_{Name, Age, Board}\left(\sigma_{\text{~~student~~}\ ID=2}(Student)\right)$$

Rename Operator:-

Notation:- $\rho(R_1, R)$

Example:-

(i) Query to fetch the data corresponding Name, Age & Board attributes and rename the relation as StudentInfo.

$$\rho\left(StudentInfo, \Pi_{Name, Age, Board}(Student)\right)$$

(ii) Query to fetch the data for ID, Name attribute from Student table for those students whose Board is Dhaka. And rename the relation as BoardStudentInfo also rename the attributes:

ID = D.ID

Name = D.Name

$$\rho\left(BoardStudentInfo_{(D\_ID, D\_Name)}\left\{\Pi_{ID, Name}\left(\sigma_{Board="Dhaka"}(Student)\right)\right\}\right)$$

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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Union :-

Notation :-

$R_1 \cup R_2$

Example :- Rules :-

- Here, R_1 and R_2 must have the same number of attributes.
- Data types of the attributes between two relations should be same.
- Duplicate tuples are automatically eliminated.

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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Intersect Operation:-

Notation:-

$R_1 \cap R_2$

Rules:-

- Same
- Same
- The intersection operation always return the distinct rows. The duplicate rows will not be returned by the intersect operation.

Set difference operation:-

Notation:-

$R_1 - R_2$

Course
C
Java
DBMS

ID	Course
1	C
2	Java
1	DBMS
3	C
1	Java
3	Java

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Cartesian Product :-

Notation :-

$R_1 \times R_2$

Total no of columns: $R_1(C) + R_2(C)$

Total no of Tuples: $R_1(T) \times R_2(T)$

Division Operation :-

Notation :-

R_1 / R_2

$(\pi, -, \times)$ → এগুলো ব্যবহার করেও পারব

Fetch those students ID who has taken all the courses

Course Taken

ID	Course
1	C
2	Java
1	DBMS
3	C
1	Java
3	Java

Course

Course
C
Java
DBMS

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Ans:-

Course Taken $\div$ Course

ID
1

→ output

Another approach:-

ID	C
1	C
1	Java
1	DBMS
2	C
2	Java
2	DBMS
3	C
3	Java
3	DBMS

output

Π_{ID} (CourseTaken) − Π_{ID} ((Π_{ID} (Course Taken) × Course) − Course taken)

ID
1
2
3

ID
2
3

ID
1

ID
1
2
3

Course
C
Java
DBMS

output

ID	C
2	C
2	D
3	J
3	D

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Join:

এর কাজ হচ্ছে only ঐ সব tuple/rows গুলো return করবে যাদের condition match করবে।

matching condition

Theta Join:

Notation:-

$A \bowtie_\theta B$; $A \bowtie_\theta B = \sigma_\theta (A \times B)$

Example:-

Student

ID	NAME
1	Fahan
2	Hossen
3	Rana

Info

ID	ADD
1	Dhaka
3	Khulna

Student $\bowtie$ Info

Student.ID = Info.ID

ID	NAME	ID	NAME
1	Fanhan	1	Dhaka
3	Rana	3	Khulna

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Natural join:

Attribute name same হলেই আসবে

Notation:-

$R_1 \bowtie R_2$

Example:-

Employee

Name	Emp. ID	Dept
Farhan	01	Eng
Hassan	02	Eng
Rana	01	Finance
Abir	01	Sales

Department

Dept	Mngr.
Eng	Rasel
Finance	Monir
Sales	Karim

Employee $\bowtie$ Department

Name	Emp.ID	Dept.	Mngr.
Farhan	01	Eng	Rasel
Hassan	02	Eng	Rasel
Rana	01	Finance	Monir
Abir	01	Sales	Karim

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme: chapter-1 Date: / /

Sat Sun Mon Tue wed Thu Fri

Database system:-

A modern database system is a complex software system whose task is to manage a large, complex collection of data.

Summarise the three major purposes of database system. / Drawbacks of using file systems to store data

- Data redundancy and inconsistancy

  data is stored in multiple file formats resulting in duplication of information in different files.

- Difficulty in accessing data

  Need to write a new program to carry out each new task.

- Data isolation

  Multiple files and formats.

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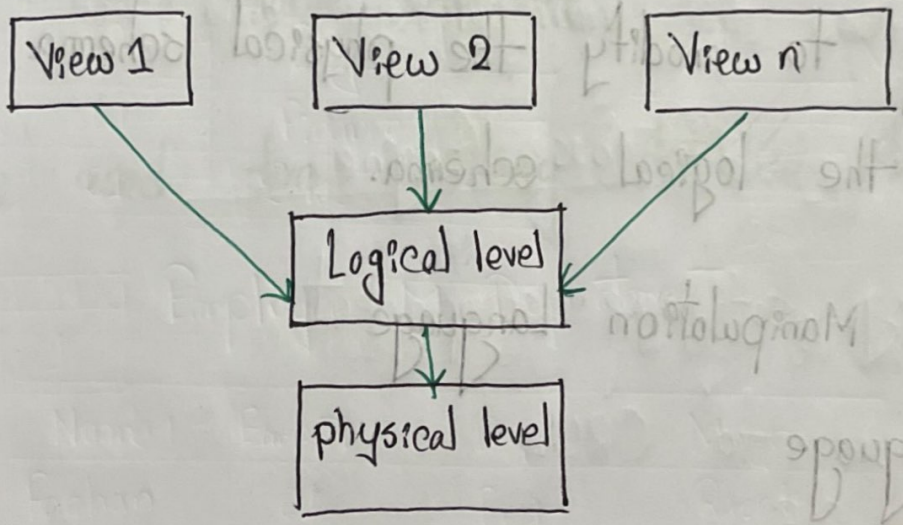
ONE-STOP SCHOOL SHOPPING

Security problems

Hard to provide user access to some, but not all data.

Database systems offer solutions to all the above problems.

Level of Abstraction:- is a process of hiding unwanted or irrelevent details from the end user.



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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Instances and Schemas:-

Logical Schema:-

The overall logical structure of the database.

physical Schema:-

The overall physical structure of the database.

physical data Independence:-

the ability to modify the physical schema without changing the logical schema.

DML -> Data Manipulation Language

Query Language

↳ Procedural Language

↳ Declrative Language (Non-Procedural Language)

↳ SQL

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

DDL

Key Command:-

Create:- creates new table or objects

Alter:- modifies the structure of an existing object

Drop:- deletes objects like tables or indexes.

Truncate:- removes all data from a table but keeps the table structure.

DDL used for defining database structures (like creating tables)

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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

DML

Key Command:-

Select → retrives data from the database

Insert → adds new data

Update → modifies existing data

Delete → removes records

DML is used for manipulating data (like inserting data)

Database Engine

→ underlying software component

→ DBM uses to CRUD

Functions of D.E

① Data Storage

② Query Processing

③ Transaction management component

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Storage Manager:-

→ responsible for managing how data stored, retrieved & updated on physical storage media.

It is responsible for

↳ interaction with OS file manager

↳ efficient storing, retrieving & updating data.

The SM components -

① Integrity manager

② Transaction manager

③ File manager

④ Buffer manager.

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Query Processor:-

The query proces is a critical component of a DBMS that ensures SQL queries and properly parsed, optimized and executed.

DDL Interpreter—

interprets DDL statements and records the definitions in the data dictionary.

DML Compiler:-

it performs query optimization

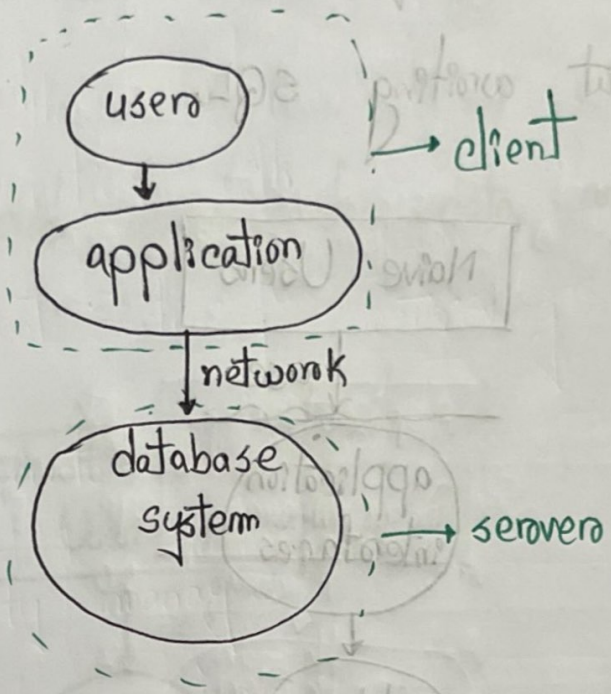
BD SCHOOL SHOP
ONE STOP SCHOOL SHOPPING

Theme:

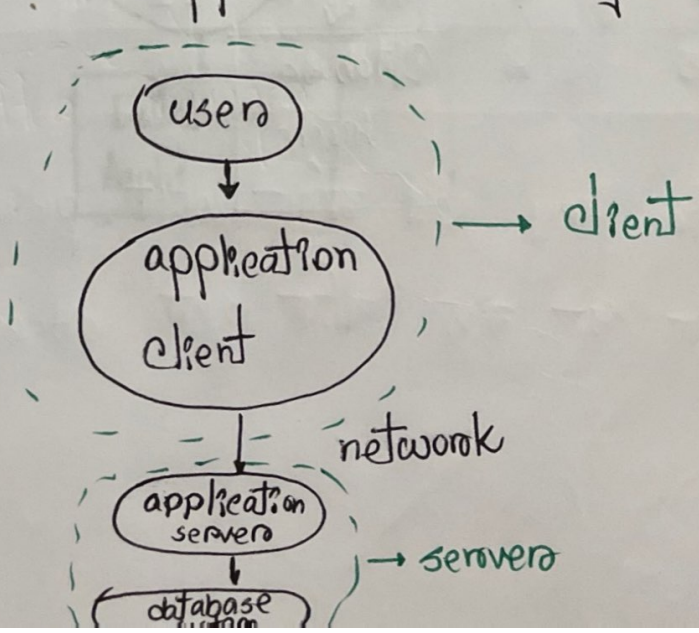
Date: / /

Sat Sun Mon Tue wed Thu Fri

Two tier Architecture is a common client servers architecture used in database system, where the application is divided into two tiers. client and the servers.



Three tier architecture is divided into three tiers, the client layers, the application serverslayers and the database layers.



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ONE-STOP SCHOOL SHOPPING

Theme:

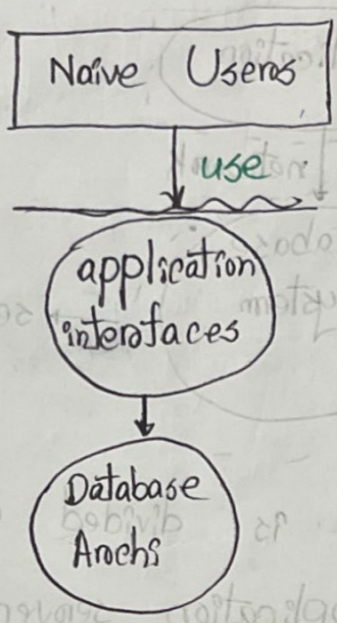
Date: / /

Sat Sun Mon Tue wed Thu Fri

Naive users: (tellers, agents, web users)

Role / Responsibility

Use pre-defined queries or forms to perform repetitive tasks without writing SQL.



Theme:

Date: / /

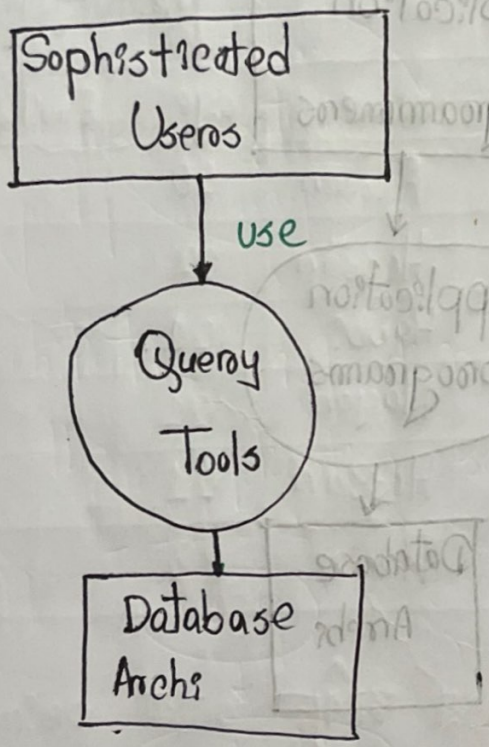
Sat Sun Mon Tue wed Thu Fri

Sophisticated Users :- (Analyst)

These users interact directly with the database using complex SQL queries.

Role :-

Write advanced queries for data analysis and reporting.



BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

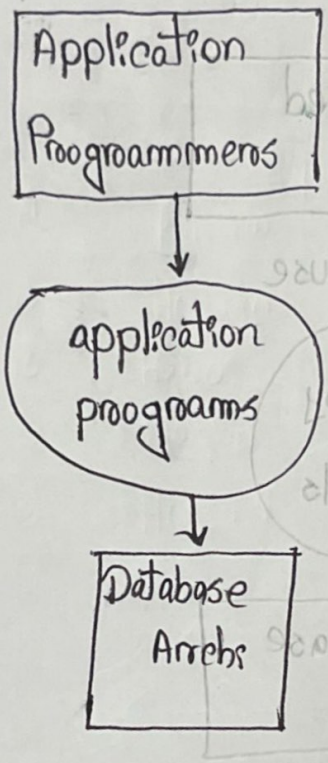
Sat Sun Mon Tue wed Thu Fri

Application Programmers :-

There are developers who build applications that interact with the database.

Role :-

They write application code and handles database connections.



Theme:

Date: / /

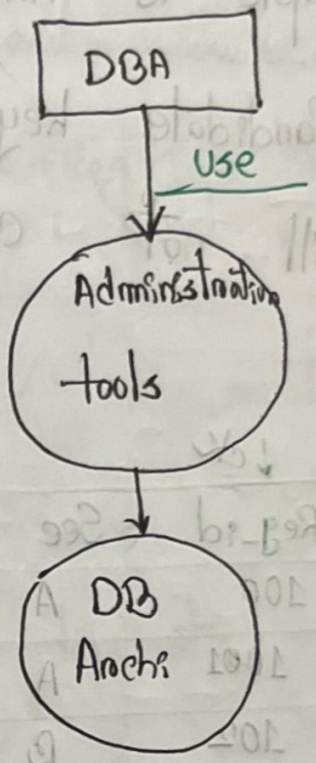
Sat Sun Mon Tue wed Thu Fri

Database Administrators:-

The DBA is responsible for the overall management of the database.

Responsibility:-

1. Schema defination
2. Access control
3. Performance tuning
4. Backup and recovery
5. Security



BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme: chapter-2 Date: / /

Sat Sun Mon Tue wed Thu Fri

Candidate key:-

The minimal set of attributes that can uniquely a tuple is known as a candidate key.

- Candidate key ^attributes can contain null values, but will not consider same value.

↓ck Reg_id	Sec	name	age	ck↓ Email id	ck↓ Phone_no
100	A	Farhan	20		
1001	A	Hossan	22		
102	B	Rabbi	21		
103	B	Nayon	21		
104	B	Hossan	21		
105	A	Rana	23		

- candidate key এর মধ্যে যাকে primary key হিসেবে ধরা হয় সে বাদে বাকি গুলো alternative key.

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Super key:-

A set of attributes that can uniquely identify each tuple in a relation.

(i) Reg_id
(ii) Email_id
(iii) Phone_no
} SK

Sec + name → x sk

Sec + Name + Reg_Id → sk

Super key বানাতে হলে একটা ck must থাকা লাগবে

Primary key:- (not null & not duplicate)

A candidate key chosen to uniquely identify tuples in a relation.

Example:-

'ID' is typically chosen as the primary key.

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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

foreign key:-

An ~~alter~~ attribute in one relation that refers to the primary key of another relation.

(Parent table-এ যা থাকবে must child table-এ থাকতে হবে)

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Chapter-3

SQL:- is a standardized language for interacting with database. It includes-

→ DDL
→ DML
→ Transaction Control

Parts of SQL:-

DML → Deals with querying, inserting, updating & deleting data.

Integrity Constraints → Defines rules to maintain accurate data.

View definition → allows creating views to simplify querying.

Transaction Control → manage database transactions.

Authorization → sets permissions for accessing data.

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

DDL defines the schema for databases.

Data types for each attribute

Integrity constraints.

Indexes and physical storage.

Domain Types in SQL:-

char (n) – Fixed - length character strings.

char(5) – 'ABC' – – –

varchar (n) = variable length strings.

varchar(5) – 'ABC'

int, smallint – integer data types

numeric (p,d) – fixed precision numbers

Salary numeric(8,2) – 22000000 22,000.51

float (n), real, double precision – floating - point numbers.

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Creating Table

```
Create table instructor (
    ID char (5),
    name varchar (20),
    dept_name varchar (20),
    Salary numeric (8,2)
);
```

Integrity Constraints

→ primary key

→ foreign key ..... references table-n

→ not null

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Example

```
Create table instructor (
        ID char (5)
    name varchar (20) not null
    dept_name varchar (20),
    salary numeric (8,2),
    primary key (ID),
    foreign key (dept_name) references dept
);
```

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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Updates to tables

insert

insert into instructor values ('10211', 'Smith', 'Bio', 66000)

Delete (Removes all tuples)

delete from student

Drop table

drop table r

Alter:-

alter table r add A D → new colourn data type

↓ ↓

table new colourn name

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

The select Clause (Same as projection operator)

Select clause আমার desired attribute গুলো show করাবে.

Example:-

Select TITLE from course → যেই table থেকে নিতে চাই

Select → Key word

TITLE → যেই coloum আমি নিতে চাই

from → Key word

SQL names are case insensitive

Example:- Name ≡ NAME ≡ name

To remove all duplicate tuples:-

Select distinct dept_name from course;

To show all attribute:-

Select * from course;

To rename a selected coloum:-

Select course_id as C_ID From course;

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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

To select more than one coloum;/

To rename a coloum /

To do arithmetic operation on a coloum;—

Select budget / 13 as Budget_of_1_roorm, dept_name
froorm departmeat;

The where Clause (selection operator)

Where clause ব্যবহার করে specfic condition এর উপর ভিত্তি করে table show করবে।

To find a colum with specfic condition

useing connectives

using comparisim oparator

Select name, dept_name froom student ~~where dept_name=~~
where dept_name = 'CSE' and tot_creedu

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

The from Clause (Cartesian Product)

To do cartesian product:-

Select * from student, department;

To find "building" of "individual person's" using dept-name:

Select name, building from student, department

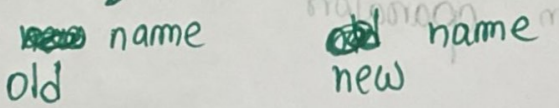
where student. dept-name = department. dept_name;

The Rename Operation

We rename table or attributes, old-name as new-name

OR

Student S



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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue Wed Thu Fri

String Operations

Names starting from 'j' : (exp: Jisan, Judisha etc)

select name from student where name like 'j%';

Names ending with 'mi' : (exp: Uromi, Nawmi etc)

select name from student where name like '%mi';

Names which have 'ai' somewhere : (exp: naina, Trainju etc)

Select name from student where name like '%ai%';

Names which has exactly 4 letters

Select name from student where name like '____';

Names that has 'a' after 1 letter

Select name from student where name like '_a%';

Names that starts with 'N' and has exactly 4 letters

Select name from student where name like 'N___';

escaping special characters

Select name from instructors where name like '100%%' ESCAPE '%';

Special characters এর আগে backslash দিয়া এবং শেষে ESCAPE দিয়া

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Ordering

for ascending

order by name asc

Using Comparation operator

Select name from student where tot_cred between 50 and 100;

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Normalization

→ It is the process of organizing the data in the database.

→ It is used to remove or reduce the redundancy from a relation.

redundancy = একই ধরনের data বা একই ধরনের value যদি একটা table এ multiple time থাকে।

✍ একটা table এ যদি duplicate value থাকে সেটাকে reduse করা বা remove করার উপায় হচ্ছে Normalization.

↓pk Emp_id	Emp_name	Contact_no	Dept.	Dept. Name
→ 101	A	01789.....	Eng.	FH
102	B	0198.....	HR	MR
103	C	0188.....	Marketing	MJ
104	D	0177.....	Eng	FH
105	E	0154.....	Marketing	MJ
→ 101	A	01789.....	Eng.	FH

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

① Insert Anomaly →

② Update Anomaly →

③ Delete Anomaly.

First Normal form (1NF)

→ An attribute of a relation can't hold multiple values.

- In a column multi-values not allowed.
- Attribute Domain should same.
- Every column will have a unique name
- Doesn't matter in which order data is stored.

Student_id	Name	Course
101	A	OS, DBMS
102	B	OS
103	C	DBMS
104	D	Algorithm, DBMS

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

⇓

Student_id	Course
101	OS
101	DBMS
102	OS
103	DBMS
104	Algorithm
104	DBMS

Student_id	Name
101	A
102	B
103	C
104	D

Second Normal Form (2NF):-

- Table should be in 1NF first
- Partial dependency not allowed.
  Need to remove Partial Dependency

Dependency বলতে বুঝায় Non-key যেই Column গুলো তাদেরগুলো যদি fully depended হয় pk ~~key~~ এর উপর তখন ~~তখন~~ হচ্ছে

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Student_ID	Name	Address	Course_id	Course_Name	Credit	Grade
101	A	DH	1	C	3	A+
101	A	DH	2	Java	3	A
102	B	GN	1	C	3	B
102	B	GN	2	Java	3	A

⇓

C_id	C_Name	Credit
1	C	3
2	Java	3

S_id	Name	Add
101	A	DH
102	B	GN

S_id	C_id	Grade
101	1	A+
101	2	A
102	1	B
102	2	A

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Third Normal Form (3NF):-

① Table must be in 2NF form

② Transitive Dependency not allowed.

Course_Name	Teacher_id	Teacher Name	Credit
C	1	Farhan	3
OS	2	Hossan	3
DBMS	1	Farhan	3
C_LAB	1	Farhan	2

⇓

C_Name	T_id	Credit
C	1	3
OS	2	3
DBMS	1	3
C_LAB	1	2

T_id	T_Name
1	Farhan
2	Hossan

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Chapter - 6

Date: / /

Sat Sun Mon Tue wed Thu Fri

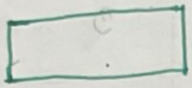
Design Phases

Client description → ERD → Schema Diagram → Table with constraints

logical design

↳ Business decision

↳ Computer science decision

 Entity Sets (represented by attributes)

An entity is an object that exists and is distinguishable from other objects.

Example:- specific person, company, event, plant

An entity set

↳ set of entity

↳ same properties

Exp: set of all persons, companies, holidays.

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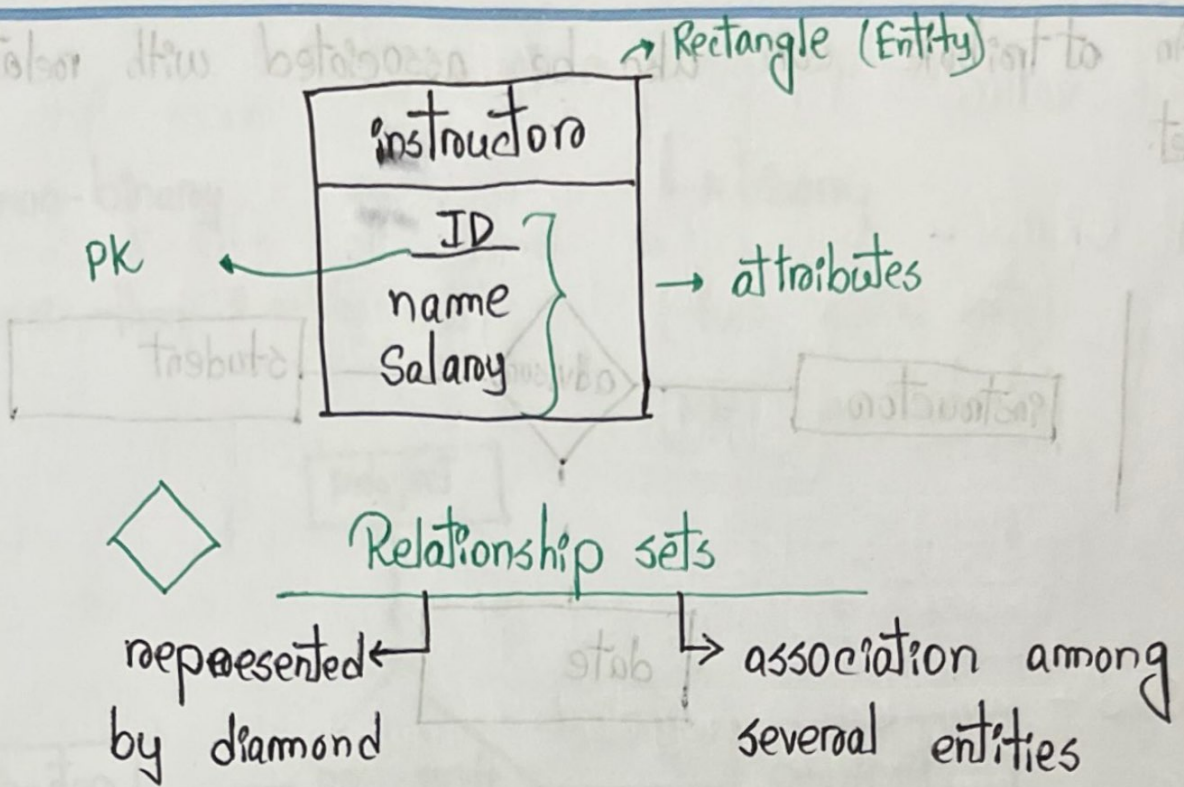
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

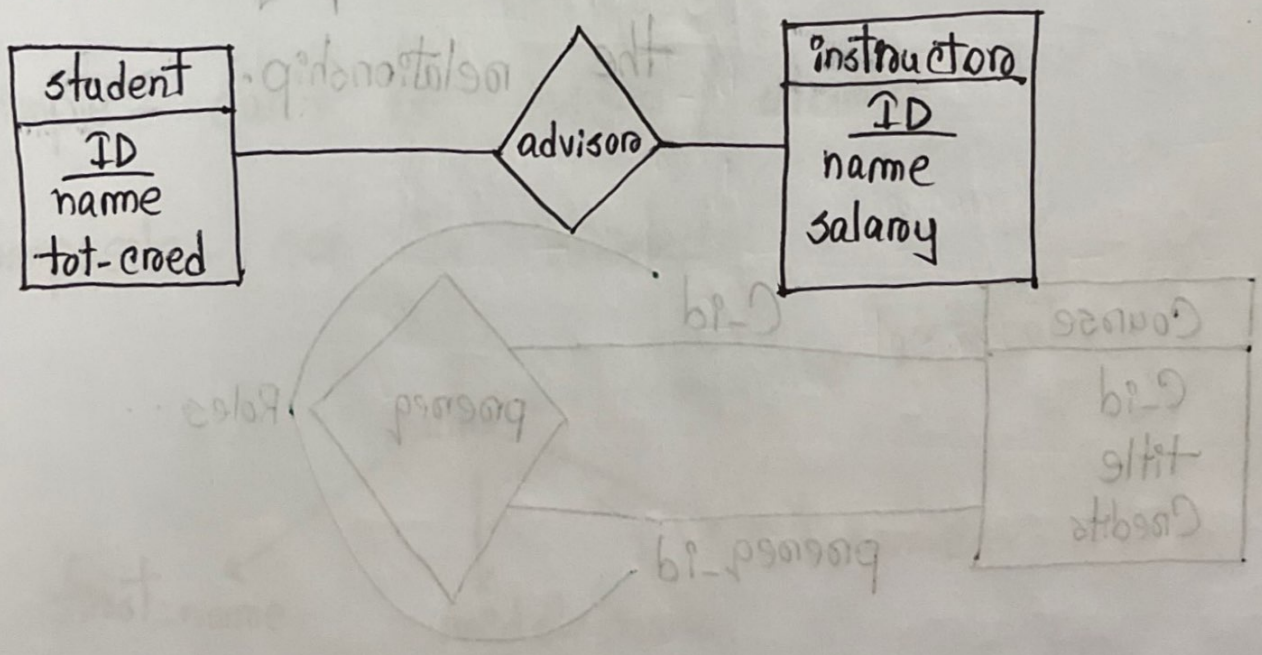
Sat Sun Mon Tue wed Thu Fri



Exp:

Umm: advisor

Helaly maam



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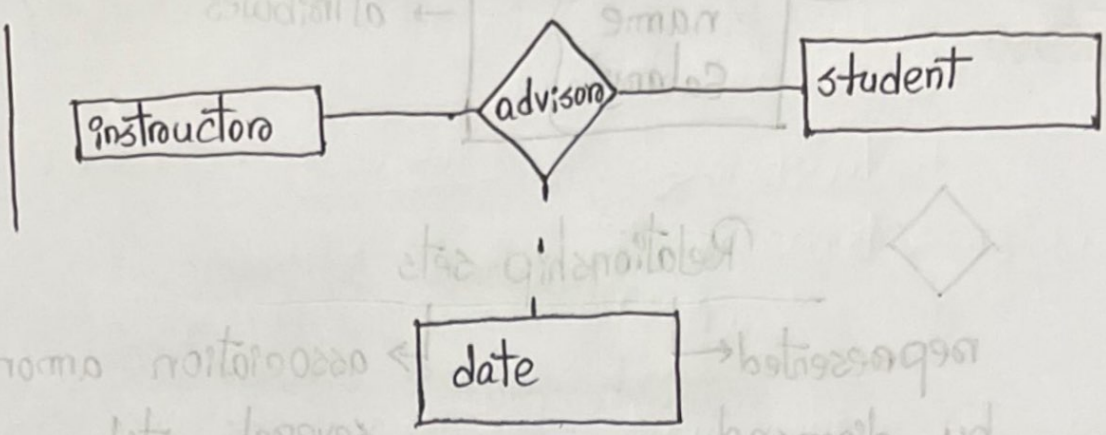
Theme:

Date: / /

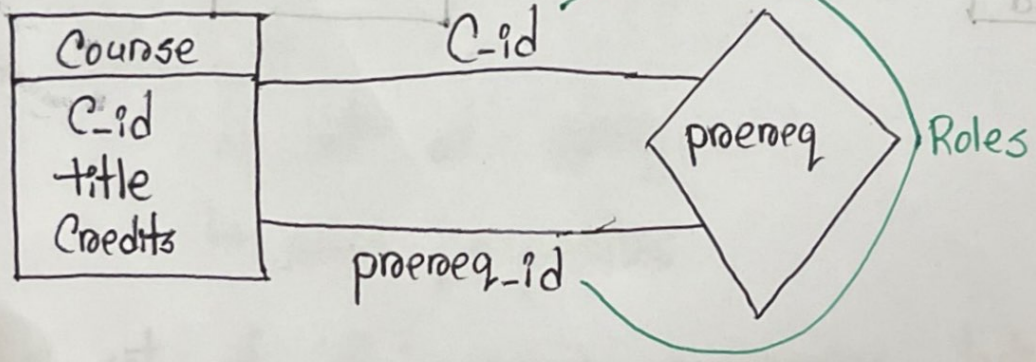
Sat Sun Mon Tue wed Thu Fri

An attribute can also be associated with relationship set.



Role

↳ each occurance of an entity set plays a "role" in the relationship.



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Theme:

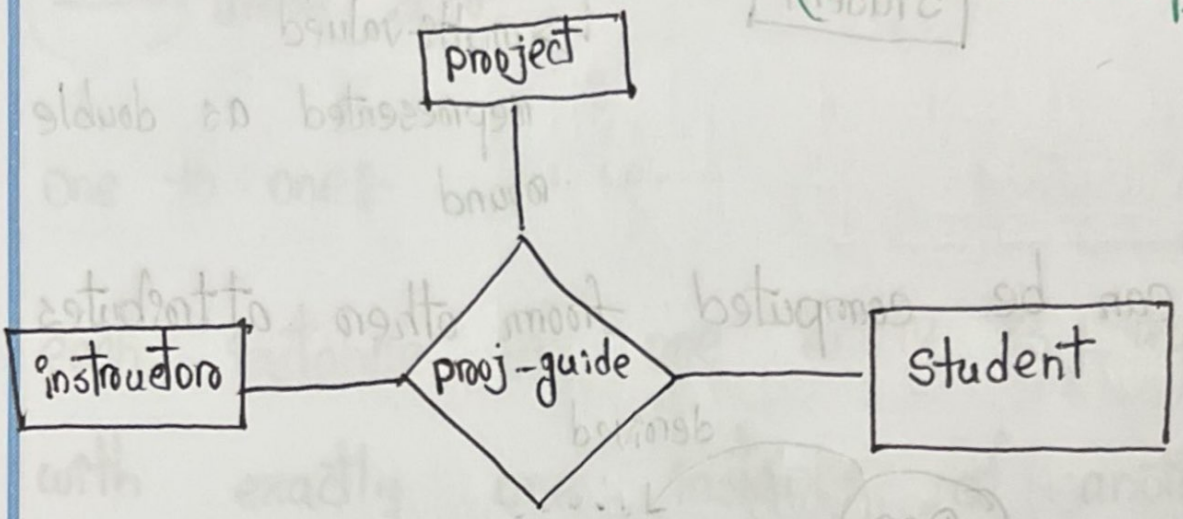
Date: /

Sat Sun Mon Tue wed Th

Degree of a relationship set

non-binary ← (more than 2 entity sets)

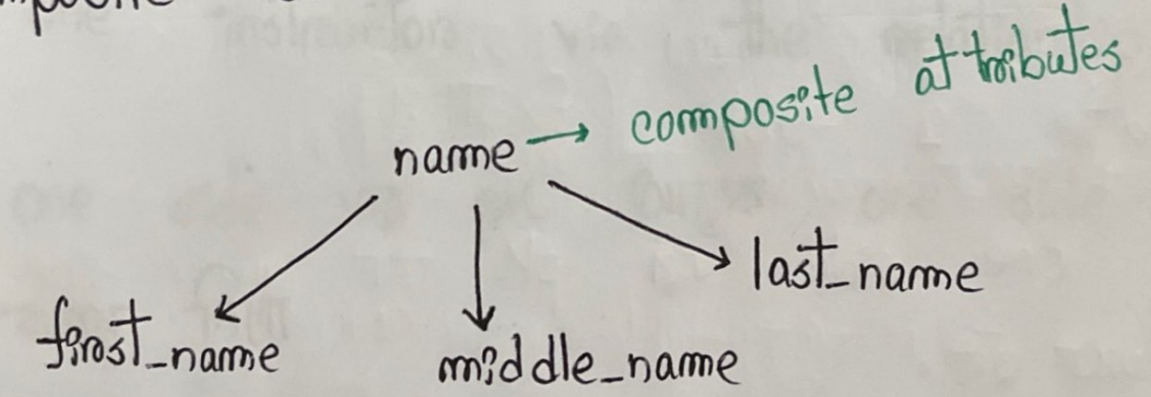
→ binary (two entity sets) (Most relationship)



Attribute type

Simple – can't be divided / atomic

Composite – can be divided



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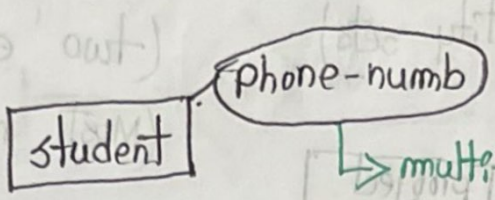
Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

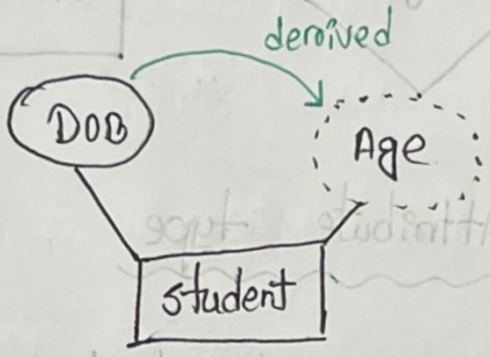
single-valued - unique / can't store more than one value

multi-valued - can store more than one value



multi-valued represented as double round

derived - can be computed from other attributes



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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

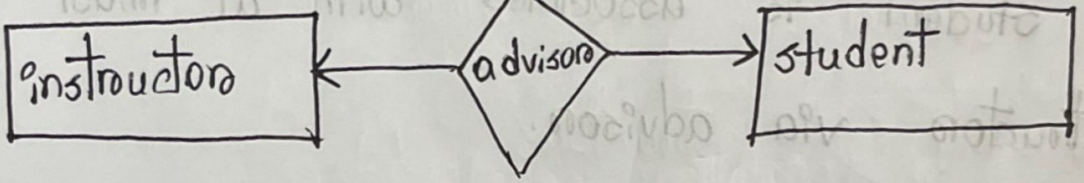
Mapping Cardinalities

(→) মাথা গুলা থাকে সেটা one side

(—) many বুঝায়

One to one:-

each instance of one entity is associated with exactly one instance of another entity.



a student is associated with at most one instructor via the relationship advisor.

one side এর pk আরেক one side এর Fk বানাবে দিবে

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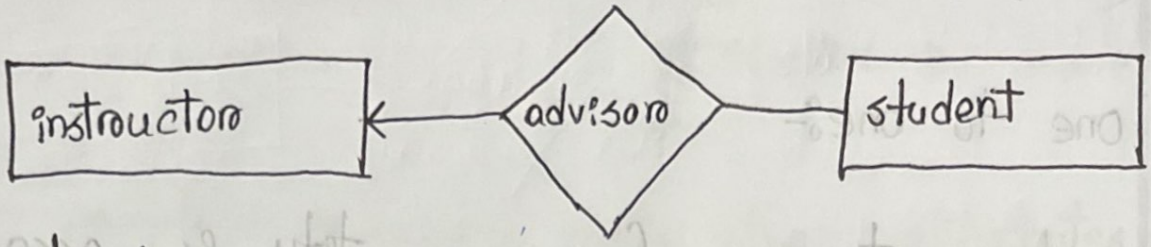
Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

one - to - many / many - to - one

one instance of an entity is associated with multiple instance of another entity.



an instructor is associated with several (including 0) students via advisor.

a student is associated with at most one instructor via advisor.

0 2 M / M 2 0 relationship এর ক্ষেত্রেঃ

① Create 2 table (Existing)

যেখানে one side এর pk কে many side-এ নিয়ে যেতে হবে।

Theme:

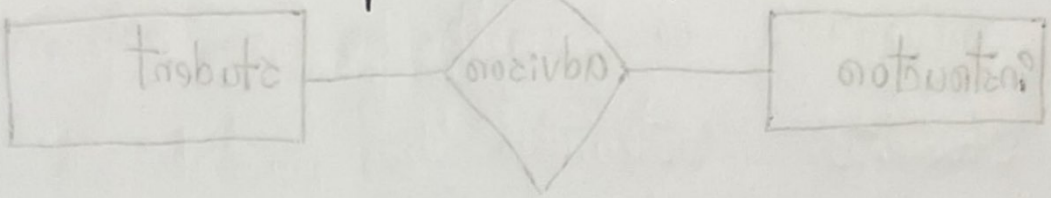
Date: / /

Sat Sun Mon Tue wed Thu Fri

এক্ষেত্রে one side এর data repeat হবে এবং data repeatation চলতে থাকে many side এর table এ।

(ii) create a table (new one)

both side এর pk নিয়ে নতুন table.



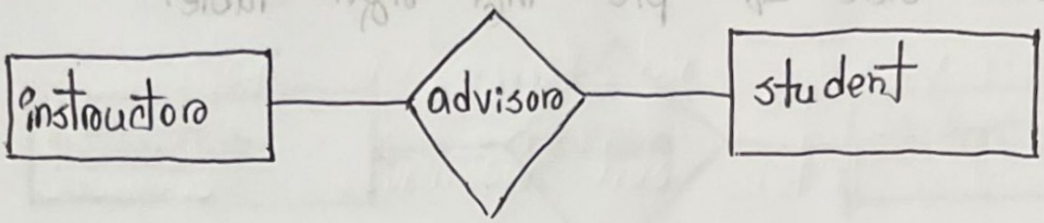
Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

many to many

each entity can be associated with multiple instances of other entity



an instructors is associated with several (possibly 0) students via advisors.

a student is associated with several (possibly 0) instructors via advisors

নতুন একটি table তৈরি করতে হবে both side এর pk নিয়ে যা উভয় table কে refers করে।

দুটো pk নিয়ে নতুন table এর composite pk বানাতে হবে।

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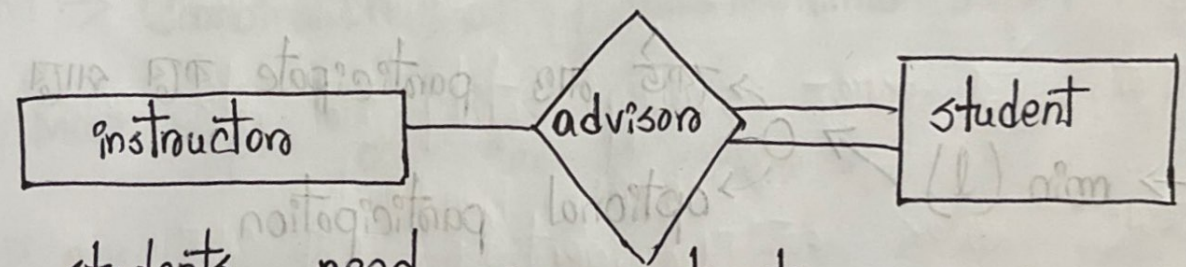
Theme:

Total participation

every entity in the entity set must participate in at least one relationship in the relationship set.



all students need an instructors, meaning participation is total for students in this relationship.

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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Partial Participation:

Some entities in the entity set may not participate in any relationship in the relationship set.

(#) An instructor may not be an advisor for any students. (instructor has partial relationship with advisor)

Minimum & Maximum Cardinality

↳ (l.....h notation)

↳ minimum (l) and max (h) কতবার entity set entity যেই relationship-এ participate করবে।

↳ min (l) → 0 → কেউ নাও participate করে পারে
→ optional participation

↳ max (h) → 1 → অবশ্যই / শুধু একজনই participate
→ single participation
→ * → 1 → ∞ অবধি করতে পারে
→ unlimited participation

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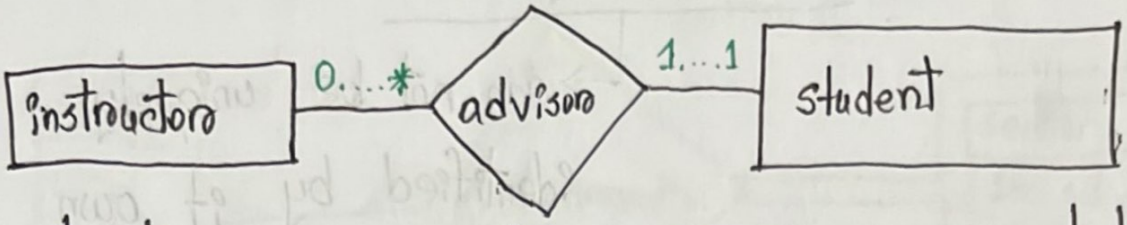
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri



→ instructor can advise 0 or more students.

→ a student must have 1 advisor, can't have multiple advisor.

Primary key

↓ Relationship sets (Combining pk/ attributes of relationship itself)

↳ Entity sets (unique for each each entity)

M2M → Combination of pk → minimal super key

02M / M20 → pk of "many" side → " "

02 → any pk from both entity → " "

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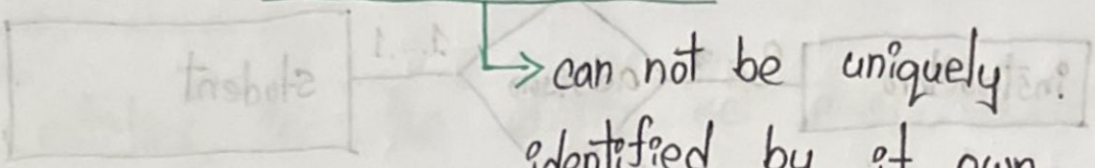
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Weak Entity Sets



↳ can not be uniquely identified by it own attributes (can't form PK)

↳ relies on strong entity sets

↳ participate in special relationship.

weak entity sets existence depends on identifying entity set (strong entityset)

weak entity set এর attribute গুলোকে discrimination বলে, এটার আগে strong entity এর pk combine করলে weak entity uniquely identify করা যায়।

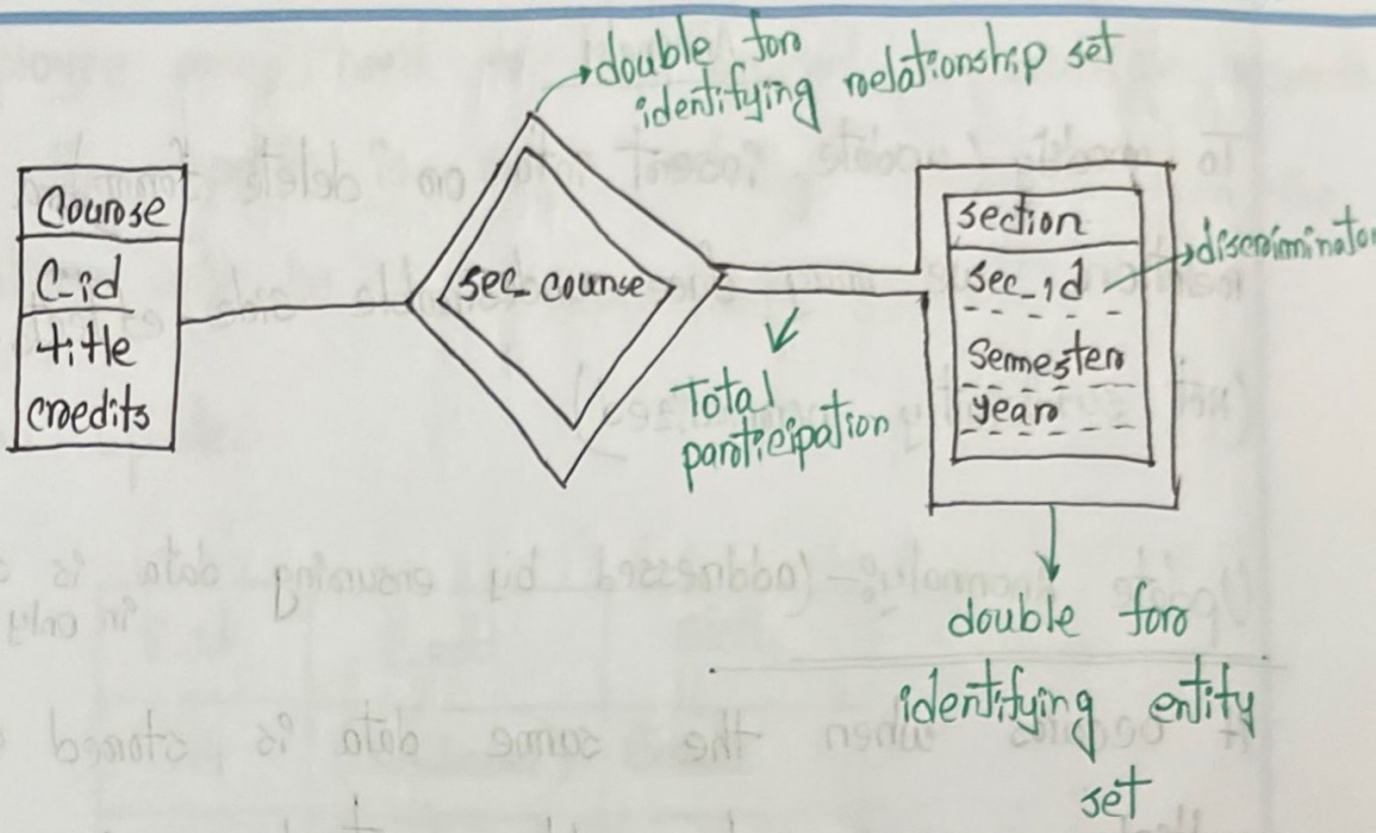
one side এর pk কে many side-এ add করাতে হবে।

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri



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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Anomaly

To modify (update, insert info or delete form) a relation, we may face undesirable side-effects. (Not sufficiently normalized)

Update Anomaly:- (addressed by ensuring data is stored in only one place)

It occurs when the same data is stored in multiple rows and update must be applied to all occurances. If some occurrences are not updated, the database ends up in inconsistent state.

E_id	E_add	Skill
214	Razabazar	Beauty
214	Razabazar	Handwriting
186	Panthapath	Running

a change in the address for a particular

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employee may need to be applied to multiple records. If the update is only partially successful then the relation will be in inconsistent state.

After update:

E_id	E_add	Skills
214	Razabazar	Beauty
214	Monipur	Handwriting
186	Panthapath	Running

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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Insertion Anomaly:- (reduced by creating separate tables)

Occurs when certain data can't be inserted into the database without the presence of other data.

FID	Ename	Date_hire	Course
212	Helaly	Feb 2015	CSE 201
213	Nadeem	Jan, 2008	CSE 211

200	Nayema	Jan, 2019

Until the new faculty member, Nayeema, is assigned to teach at least one course, his or her details can't be recorded. We have to assign course to null. This phenomenon is known as insertion anomaly.

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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

① Deletion Anomaly:- (keep important data in independent tables).

Occurs when the deletion of data in advantently results in the loss of additional, valuable data.

F_id	F_name	Hire_date	C_code
201	Helaly	Feb, 1995	CSE 201
205	Tahina	Jan, 2000	CE 101

delete

এরর ফলে আমরা

All information about Helaly is lost if she temporaly assigned to another course. This is deletion anomaly.

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme: Transaction

Date: / /

Sat Sun Mon Tue wed Thu Fri

Suppose, you were withdrawing from an ATM booth. You put the card inside the machine, gave password correctly & clicked 'OK' button. After few minutes, the machine failed & gave your card back to you. Which ACID property (s) can play role for the management of this transaction? Explain that properly.

Suppose, you were withdrawing money from an ATM booth in Dhaka. At the same time, your father was depositing cash money in another branch. Which ACID property (s) can play role for the management of this transaction? Explain that properly.

Discuss the four ~~transaction~~ properties of ACID in transaction management.

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Ans:-

Atomicity:-

A transaction is an indivisible unit of work that is executed entirely or not at all. It ensures that the database is never left in a partial or inconsistent state due to transaction failures. The database system keeps track (on disk) of the old values of any data on which a transaction performs a write. The information is written to a file called the log. If the transaction does not ~~work~~ complete its execution, the database system restores the old values from the log to make it appear as though the transaction never executed.

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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Example:-

A fund transfer transaction deducts $50 from account A and adds $50 to account B. If a system crash occurs after deducting $50 from account A but before adding it to account B, atomicity ensures that either both operation complete or nothing takes effect.

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Consistancy:-

A transaction must take the database froom one consistent state to anothen, maintaing all defined roules. It ensuroes that the database nemains valid accoroding to its defined roules & nelationship Ensuroing consistancy foro an individual transactior is the nesponsibility of the application proogroammen who codes the transaction. This task may be facilitated by automic testing of integnity constroaints.

Example:-

A transaction that transfero funds between accounts must ensune that the sum of all balances before & aftero the transaction nemains the same.

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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Isolation:-

Transactions are executed as if they are the only operations happening in the system, preventing interfences from other concurrent transactions. It ensures that concurrent transactions do not affect each other's results. A way to avoid the problem of concurrently executing transactions is to execute transactions serially. Ensuring the isolation property is the responsibility of a component of the database system called the concurrency-control system.

BD SCHOOL SHOP
ONE STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Example:-

Two transactions, T1 & T2

T1 reads Account A's balance, $50 and writes back.

T2 at the same time reads the balance & updates it.

Without isolation, T2 might see intermediate results or overwrite T1's updates.

Durability:-

Once a transaction commits, its changes must be permanent, even in the event of a system failure. It ensures that committed data is not ~~lost~~ lost. We can guarantee durability by ensuring that the updates carried out by the transaction have been

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

written to disk before the transaction completes. The recovery system of the database is responsible for ensuring durability.

Example:-

After a fund transfer transaction completes, the updated balances of account A & account B must be stored ~~persistancy~~ persistently so that they survive crashes or power failures.

A transaction is a unit of program execution that accesses and possibly updates various data items.

BD SCHOOL SHOP
ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Transaction access data:

Read(x):

it allows transactions to access the current value of data item without modifying it.

Write (x)

it allows transactions to make changes to data that are eventually stored in the data that are eventually stored in the database.

Example:-

T_1: read (A) read (B)

A: A-50; B: B+50;

write (A) write (B);

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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

Sat Sun Mon Tue wed Thu Fri

Draw the state diagram of transaction states with a brief discussion.

Ans:-

We establish a simple abstract transaction model. A transaction in a database system goes through a series of states from its initiation to its completion. A transaction must be in one of the following states:

Active:-

The initial state of a transaction while it executes it operations. If failure occurs during execution, it transitions to the failed state.

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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

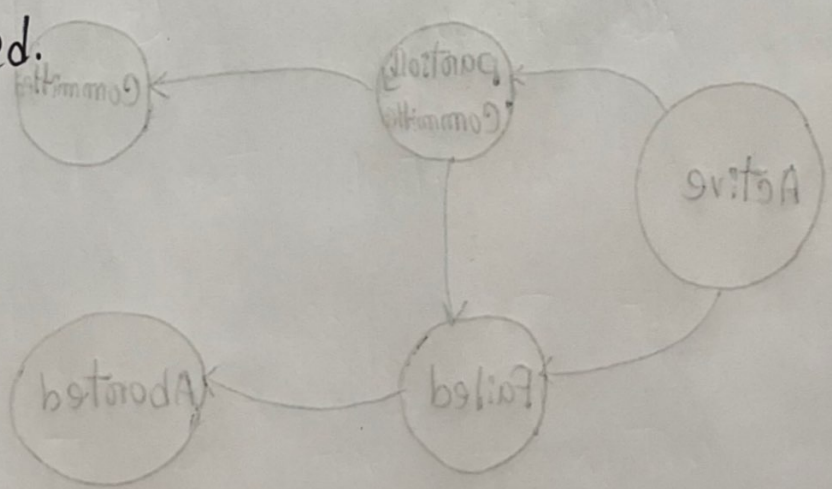
Sat Sun Mon Tue wed Thu Fri

Partially Committed:

The transaction executes but database has not recorded permanently. This state exists because some operations may still be buffered in memory. Even in this state if a failure occurs, it transitions to the failed state.

Failed:-

The transaction has encountered an errors or failure during ~~execusi~~ execution. The database is in inconsistent state due to partial updates made by the transaction. The transaction transitions to the aborted state after rollback is completed.



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ONE-STOP SCHOOL SHOPPING

Theme:

Date: / /

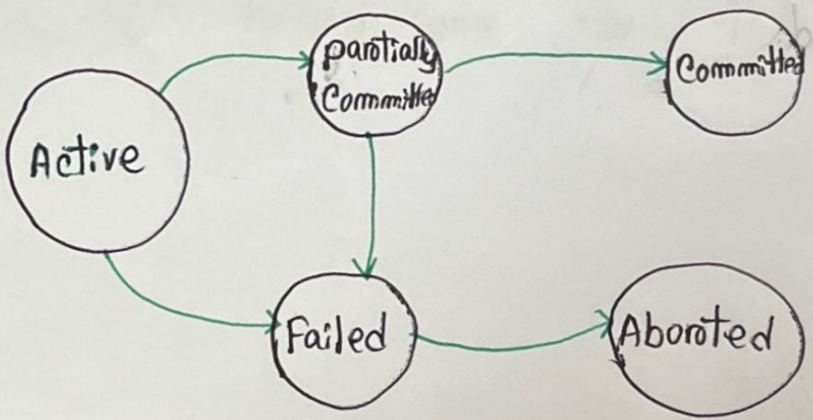
Sat Sun Mon Tue wed Thu Fri

Aborted:-

After the transaction has been rolled back & the database has been restored to its state prior to the start of the transaction. From here the transaction may restart or terminate.

Committed:-

The transaction has successfully completed all its operations; & the changes have been made permanent in the database. This is the final state & can't be rolled back.



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ONE-STOP SCHOOL SHOPPING