Chapter 3
Relational Model

Department: Computer
Course: DBMS
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Topics to be covered:

- Introduction to the Relational Model
- Relational Model Concepts
- Relational schema
- Concept of Relational keys

Learning Outcomes:

Students should be able to:

- Describe Relational Model Concepts
- Describe properties of a relation and relational keys
- Understand the need of various types of relational keys

The Relational Model

• The relational model was introduced by **Dr. Edgar F. Codd (1924-2003)** in 1970.
– Dr. Codd. a mathematician from Oxford (UK), was at that time working as an IBM researcher in the IBM San Jose Research Laboratory (USA).

• Many **DBMS's are based on the relational data model**.

• It **support simple declarative**, but yet powerful, languages for describing operations on data.

• Operations in the relational model applies to relations (tables) and **produce new relations.**
– This means that an operation can be applied to the result of another operation and that several different operations can be combined.
– Operations are described in an algebraic notation that is based on relational algebra.

Relational Model Concepts

Relation:

Domain:

Attribute:

Relational Schema:

Degree of a Relation:

Tuple:

Cardinality of relation:

Relation Instance:

Relational Model Concepts

Relation:

- We shall represent a relation as a table with columns and rows.
- Each column of the table has a name, or attribute.
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Relational Schema:

The design of one table, containing the name of the table (i.e. the name of the relation), and the names of all the columns, or attributes. Example: STUDENT(Name, SID, Age, GPA)

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Tuple: t, of R(A1, A2, A3, ..., An): an ORDERED set of values, < v1, v2, v3,..., vn>, where each vi is a value from dom(Ai).

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Cardinality of relation: the number of tuples in the relation

Relation Instance: r(R): a set of tuples; thus, r(R) = { t1, t2, t3, ..., tm}

Relational Model Concepts

NOTES:

1. The tuples in an instance of a relation are not considered to be ordered putting the rows in a different sequence does not change the table.
2. Once the schema, R(A1, A2, A3, ..., An) is defined, the values, vi, in each tuple, t, must be ordered as t = <v1, v2, v3, ..., vn>

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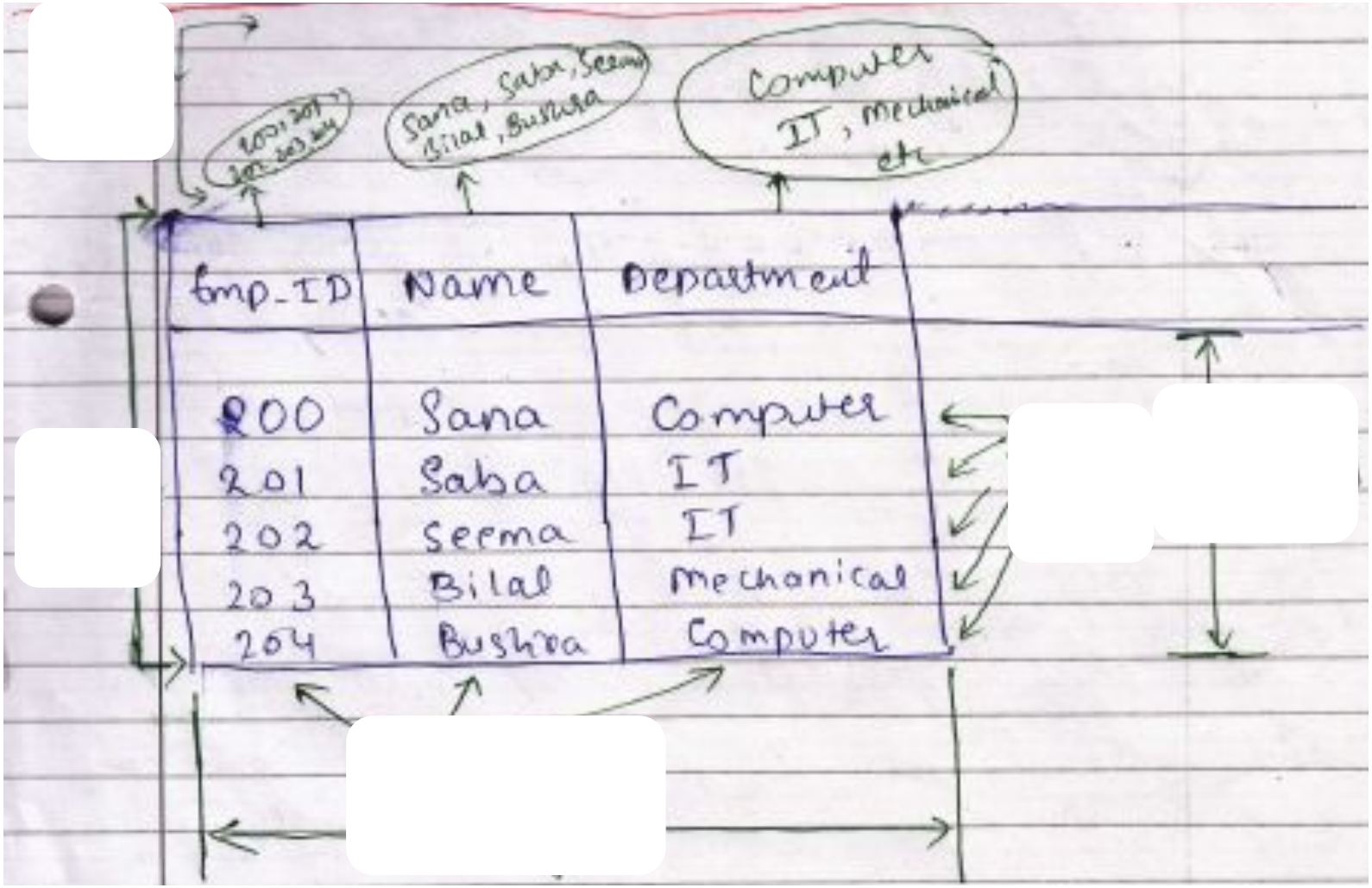
Properties of relations:

Properties of database relations are:

- relation name is distinct from all other relations
- each cell of relation contains exactly one atomic (single) value
- each attribute has a distinct name
- values of an attribute are all from the same domain
- order of attributes has no significance
- each tuple is distinct; there are no duplicate tuples
- order of tuples has no significance, theoretically.

Relational Data Structure



Relational Schema: ???

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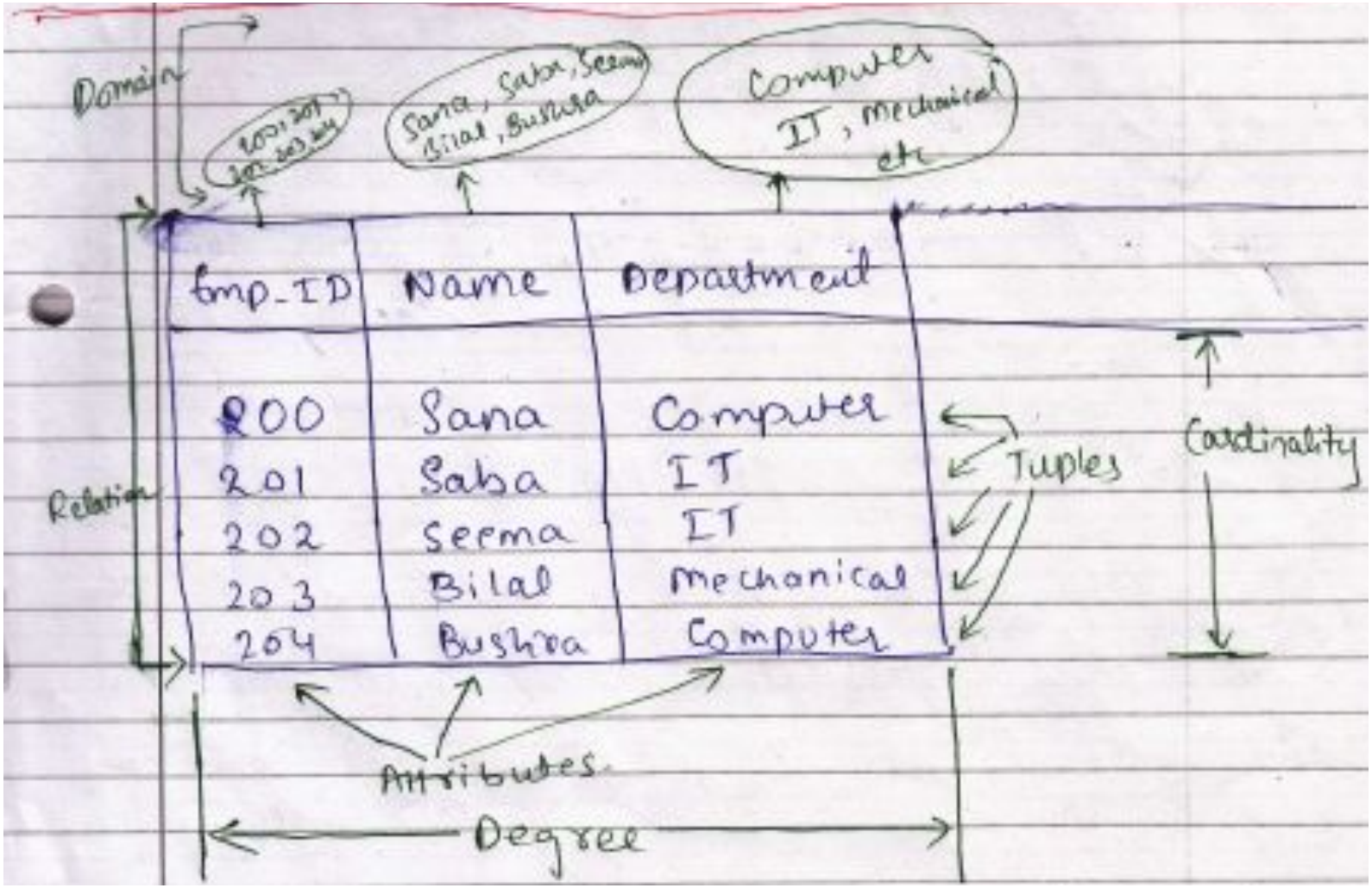
Relational Data Structure



Relational Schema:

Employee(Emp-ID, Name, Department)

Relation Instance:

r(Employee) = {t1,t2,t3,t4,t5}

RDBMS Terminologies

Informal Terms	Formal Relational Terms
Table	
Row / Record	
No. of rows	
Column / Field	
No. of Columns	
Unique Identifier	
Set of Legal Values	

RDBMS Terminologies

Informal Terms	Formal Relational Terms
Table	Relation
Row / Record	Tuple
No. of rows	Cardinality
Column / Field	Attribute
No. of Columns	Degree
Unique Identifier	Primary Key
Set of Legal Values	Domain

RDBMS

A **Relational Database management System**(RDBMS) is a database management system based on the relational model introduced by E.F Codd. In relational model, data is stored in **relations**(tables) and is represented in form of **tuples**(rows).

RDBMS is used to manage Relational database. **Relational database** is a collection of organized set of tables related to each other, and from which data can be accessed easily.

Relational Database is the most commonly used database these days.

Concept of Determination

- **Attribute A determines attribute B (A → B):** if you know the value of A, you can determine the corresponding value of B.

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STU_NUM	STU_LNAME	STU_FNAME	STU_INIT	STU_PHONE	STU_HRS	STU_CLASS	STU_GPA
321452	Bowser	William	C	2134	66	So	2.11
324257	Smith	Anne	K	2256	81	Jr	3.27
324258	Bowser	John	H	2256	36	So	2.26
324269	Oblonski	Walter	D	2114	66	Jr	3.09
324273	Smith	John	P	2231	81	Sr	2.11

Figure 3.1: Table demonstrating the concept of Determination

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1. STU_LNAME does not determine STU_NUM

STU_LNAME's value 'Smith' is appearing with two different STU_NUM values (324257 & 324273).

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2. STU_FNAME doesn't determine STU_NUM

STU_FNAME's value 'John' is appearing with two different STU_NUM values (324258 & 321273).

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- **Attribute A determines attribute B (A → B):** if you know the value of A, you can determine the corresponding value of B.

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3. STU_NUM determines STU_LNAME

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- **Attribute A determines attribute B (A → B):** if you know the value of A, you can determine the corresponding value of B.

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STU_FNAME's value 'John' is appearing with two different STU_NUM values (324258 & 321273).

3. STU_NUM determines STU_LNAME (STU_NUM → STU_LNAME)

For a particular value of STU_NUM, always the same value appear in STU_LNAME.

For example, whenever 324257 appears in the table, it always comes with Smith in STU_LNAME.

Functional Dependence

INVOICE_DETAIL

INV_NUMBER	LINE_NUMBER	PROD_CODE	LINE_UNITS	LINE_PRICE
1001	1	123-21UUY	1	$189.99
1001	2	SRE-657UG	3	$2.99
1002	1	123-21UUY	2	$18.63
1003	1	ZZX/3245Q	1	$6.79
1003	2	SRE-657UG	1	$2.99
1003	3	001278-AB	1	$12.95

Figure 3.2: Table demonstrating the concept Full Functional Dependence

1. INV_NUMBER doesn't determine PROD_CODE

2. LINE_NUMBR doesn't determine PROD-CODE

3. A combination of INV_NUMBER & LINE_NUMBER determines PROD_CODE

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Figure 3.2: Table demonstrating the concept Full Functional Dependence

1. INV_NUMBER doesn't determine PROD_CODE

INV_NUMBER Value '1001' appears with more than one value Of PROD_CODE (123-21UUY & SRE-657UG)

2. LINE_NUMBR doesn't determine PROD-CODE

LINE_NUMBER value '1' appears with more than one values of PROD_CODE (12321UUY& ZZX/3245Q)

3. A combination of INV_NUMBER & LINE_NUMBER determines PROD_CODE

Any particular value combination for INV_NUMBER & LINE_NUMBER (say, 1001 & 1) appears only with a single value of PROD_CODE (123-21UUY)

* What is Key?

- Key is a set of one or more columns whose combined values are unique among all the occurrences of the given table.

- A key is a relational means of specifying uniqueness.

* Types of Keys in Relational Database Model

1. Superkey is an attribute or a composite attribute which functionally determines all of the entity's attributes.

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* Types of Keys in Relational Database Model

2. Candidate Key is a super key whose values are not repeated in the table records. In other words, when the values in a super key are not repeated in the table's records, then such a key is called a candidate key.

Considering the example in Figure 3.1

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Figure 3.1: Table demonstrating the concept of Determination

1. **The superkey attribute STU_NUM** → **can also be termed as a candidate key**

2. **The composite superkey (STU_NUM, STU_LNAME)** → **cannot be considered as a candidate key**

3. **The combination (STU_LNAME, STU_FNAME, STU_INIT, STU_PHONE)** → **can also be considered as a candidate key provided values under the combination are not be repeated**

* Types of Keys in Relational Database Model

3. Primary Key is a candidate key which doesn't have repeated values nor does it comes with a NULL value in the table.

- **A primary key can uniquely identifies each row in any table, thus a primary key is mainly utilized for record searching.**

- **A primary key in any table is both a superkey as well as a candidate key.**

4. Secondary Key, like Primary Key doesn't fulfill the property of unique record searching.

- **Nevertheless, a secondary key is used occasionally to narrow down the searching of particular records in a table.**

- **The favorable feature of the key is 'easier-to-remember' as compared with the primary key values.**

* Types of Keys in Relational Database Model

5. Unique key: In relational database design, a unique key or primary key is a candidate key to uniquely identify each row in a table.

•A unique key or primary key comprises a single column or set of columns.

•No two distinct rows in a table can have the same value (or combination of values) in those columns.

•NOT NULL constraint is not automatically enforced

* Types of Keys in Relational Database Model

6. Foreign Key is a table's primary key attribute which is repeated in another related table (having related data) to maintain the required data relationship.

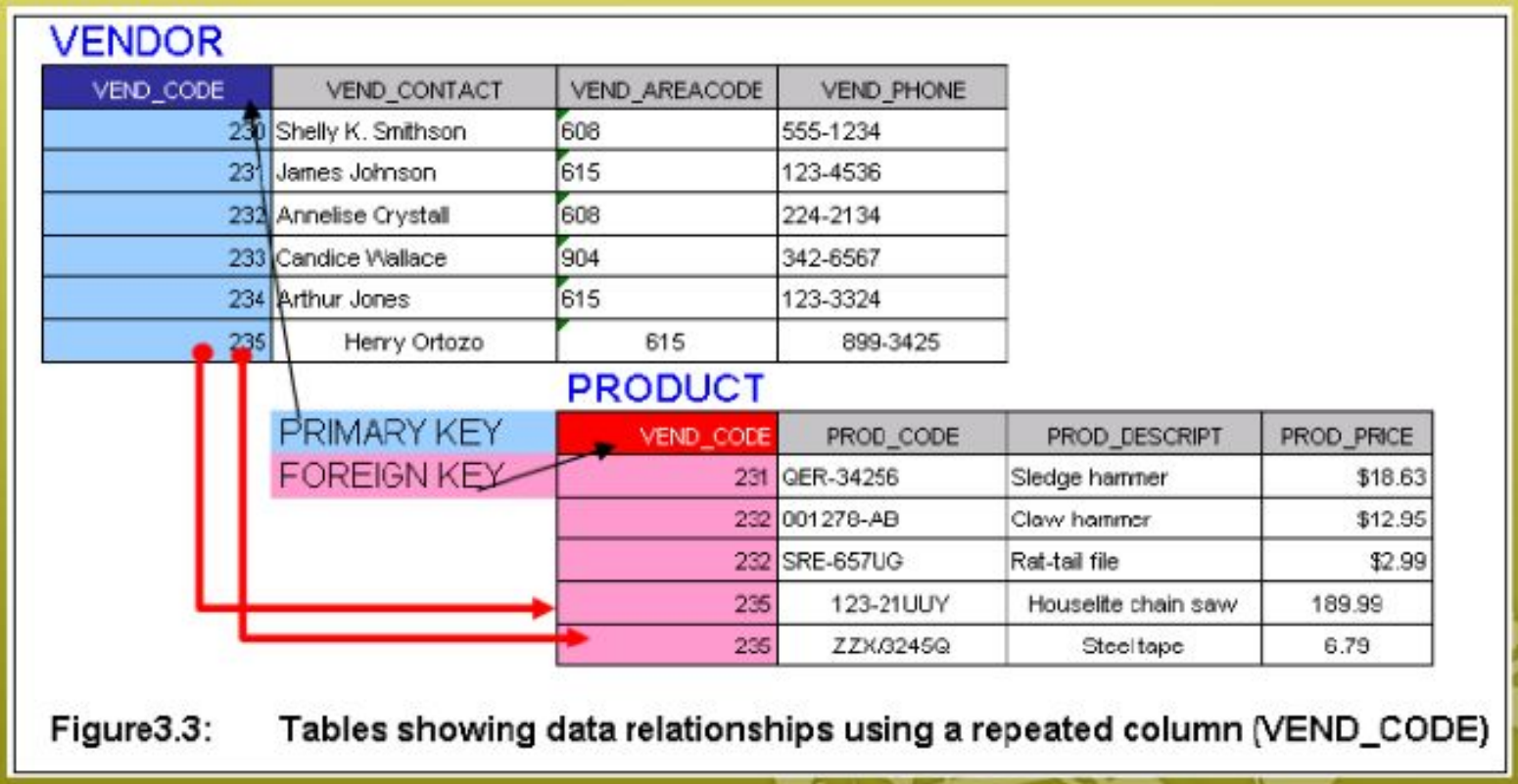


Figure3.3: Tables showing data relationships using a repeated column (VEND_CODE)

* Types of Keys in Relational Database Model

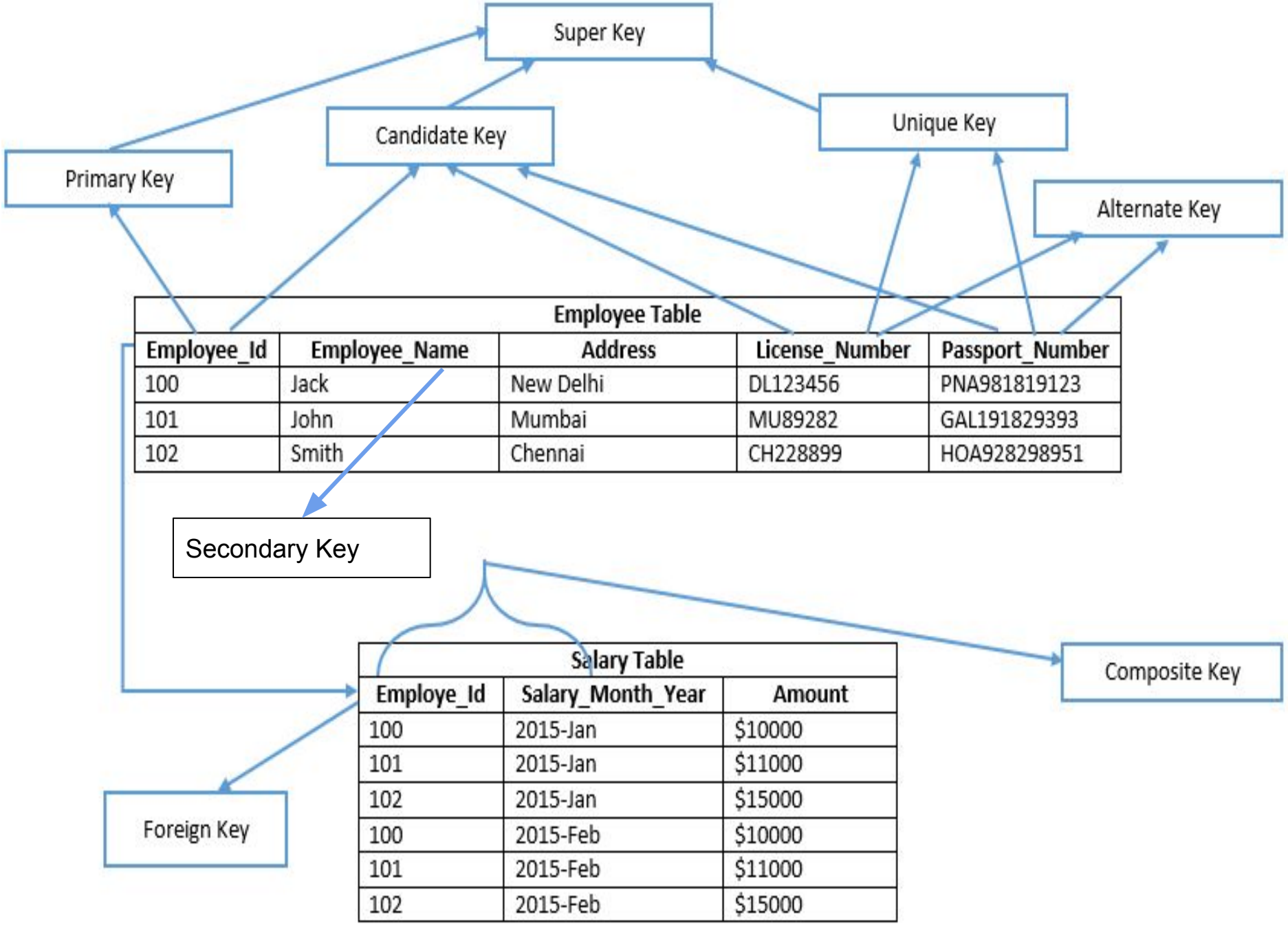
7. Alternate Key: The alternate keys of any table are simply those candidate keys, which are not currently selected as a primary key.

• An alternate key is a function of all the candidate keys minus the primary key.

8. Composite Keys: Sometimes it requires more than one attribute to uniquely identify the entity. A primary key that is made up of more than one attribute is known as composite key.

Summary

- Super key:- Set of an attribute which can uniquely identify a tuple
- Primary key :- The attribute or combination of attributes that uniquely identifies a row or record.
- Unique key:- ensures that all values in a column are different.
- Foreign Key:- an attribute or combination of attribute in a table whose value match a primary key in another table.
- Composite key:- A primary key that consists of two or more attributes is known as composite key.
- Candidate key:- is a column in a table which has the ability to become a primary key.
- Alternate Key:- Any of the candidate keys that is not part of the primary key is called an alternate key.
- Secondary key:- alternate of primary key.



Employee Table

Employee_Id	Employee_Name	Address	License_Number	Passport_Number
100	Jack	New Delhi	DL123456	PNA981819123
101	John	Mumbai	MU89282	GAL191829393
102	Smith	Chennai	CH228899	HOA928298951

Salary Table

Employe_Id	Salary_Month_Year	Amount
100	2015-Jan	$10000
101	2015-Jan	$11000
102	2015-Jan	$15000
100	2015-Feb	$10000
101	2015-Feb	$11000
102	2015-Feb	$15000

Discussion Questions

1. Choose the correct statement regarding superkeys

a) A superkey is an attribute or a group of multiple attributes that can uniquely identify a tuple
b) A superkey is a tuple or a set of multiple tuples that can uniquely identify an attribute
c) Every superkey is a candidate key
d) A superkey is an attribute or a set of attributes that distinguish the relation from other relations

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2. What is an Instance of a Database?

a) The logical design of the database system
b) The entire set of attributes of the Database put together in a single relation
c) The state of the database system at any given point of time
d) The initial values inserted into the Database immediately after its creation

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b) A foreign key is a superkey of a relation which is an attribute in more than one other relations
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b) Column
c) Value
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Statement 1: A tuple is a row in a relation
Statement 2: Existence of multiple foreign keys in a same relation is possible

a) Both the statements are true
b) Statement 1 is correct but Statement 2 is false
c) Statement 1 is false but Statement 2 is correct
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6. State true or false:

If a relation consists of a foreign key, then it is called a referenced relation of the foreign key dependency.

a) True
b) False

6. State true or false:

If a relation consists of a foreign key, then it is called a referenced relation of the foreign key dependency.

a) True
b) False

Explanation: If a relation has a foreign key, then it is called a referencing relation of the foreign key dependency.

7. **MCQ**: In formal relational model, the set of indivisible values is called

A. range
B. domain
C. relation
D. tuple

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b.Primary key
c.Composite key
d.Foreign key

Identify various types of keys?

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno
John	B	Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
Franklin	T	Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	40000	888665555	5
Alicia	J	Zelaya	999887777	1968-01-19	3321 Castle, Spring, TX	F	25000	987654321	4
Jennifer	S	Wallace	987654321	1941-06-20	291 Berry, Bellaire, TX	F	43000	888665555	4
Ramesh	K	Narayan	666884444	1962-09-15	975 Fire Oak, Humble, TX	M	38000	333445555	5
Joyce	A	English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	333445555	5
Ahmad	V	Jabbar	987987987	1969-03-29	980 Dallas, Houston, TX	M	25000	987654321	4
James	E	Borg	888665555	1937-11-10	450 Stone, Houston, TX	M	55000	NULL	1

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date
Research	5	333445555	1988-05-22
Administration	4	987654321	1995-01-01
Headquarters	1	888665555	1981-06-19