Chapter 4

The Relational Model

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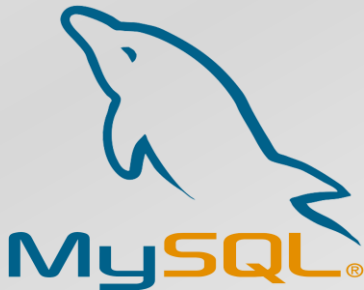
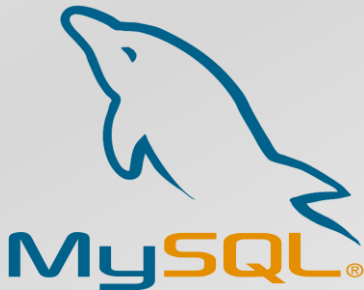


Relational Model Objectives

- To allow a high degree of **data independence**.
- To provide substantial grounds for dealing with data **semantics**, **consistency, and redundancy problems.**



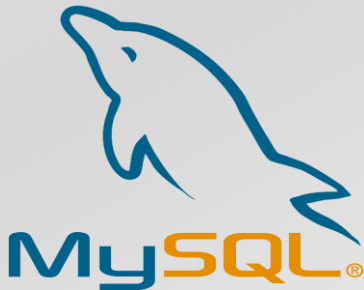
Terminologies

- **Relation:** A relation is a table with columns and rows.
- RDBMS requires only that the database be perceived by the user as tables.

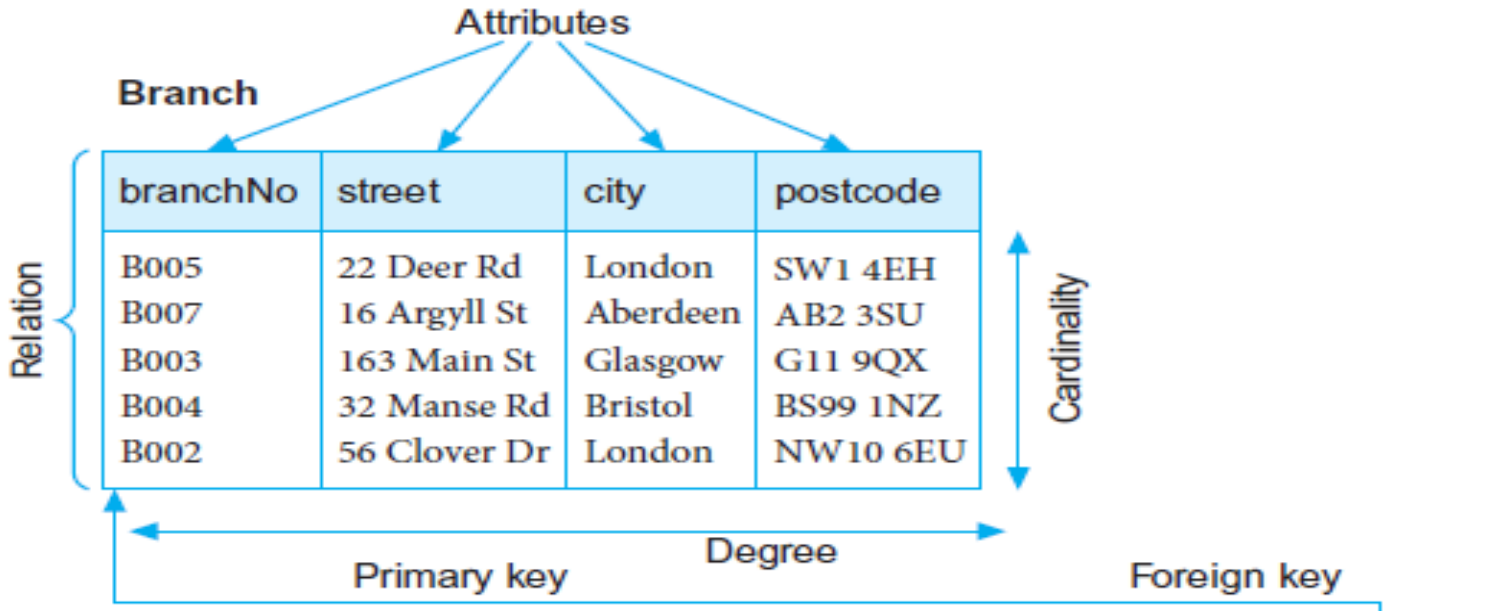
- **Attribute**: An attribute is a named column of a relation.

A relation is represented as a two dimensional table in which the rows of the table correspond to individual records and the table columns correspond to **attributes**.

- **Domain:** is the set of allowable values for one or more attribute



Example



branchNo	street	city	postcode
B005	22 Deer Rd	London	SW1 4EH
B007	16 Argyll St	Aberdeen	AB2 3SU
B003	163 Main St	Glasgow	G11 9QX
B004	32 Manse Rd	Bristol	BS99 1NZ
B002	56 Clover Dr	London	NW10 6EU

Staff

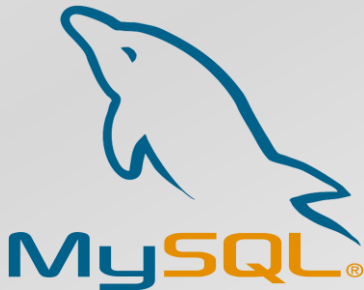
Relation

staffNo	fName	lName	position	sex	DOB	salary	branchNo
SL21	John	White	Manager	M	1-Oct-45	30000	B005
SG37	Ann	Beech	Assistant	F	10-Nov-60	12000	B003
SG14	David	Ford	Supervisor	M	24-Mar-58	18000	B003
SA9	Mary	Howe	Assistant	F	19-Feb-70	9000	B007
SG5	Susan	Brand	Manager	F	3-Jun-40	24000	B003
SL41	Julie	Lee	Assistant	F	13-Jun-65	9000	B005

Figure 4.1 Instances of the Branch and Staff relations.

Domain

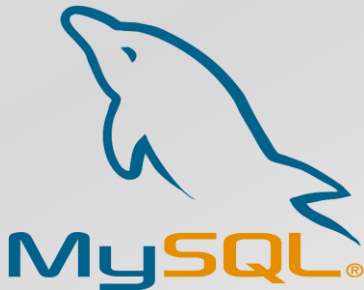
- A domain is the set of allowable values for one or more attributes.
- Domains are an extremely powerful feature of the relational model. Every attribute in a relation is defined on a **domain**



Domain

Attribute	Domain Name	Meaning	Domain Definition
branchNo	BranchNumbers	The set of all possible branch numbers	character: size 4, range B001–B999
street	StreetNames	The set of all street names in Britain	character: size 25
city	CityNames	The set of all city names in Britain	character: size 15
postcode	Postcodes	The set of all postcodes in Britain	character: size 8
sex	Sex	The sex of a person	character: size 1, value M or F
DOB	DatesOfBirth	Possible values of staff birth dates	date, range from 1-Jan-20, format dd-mmm-yy
salary	Salaries	Possible values of staff salaries	monetary: 7 digits, range 6000.00–40000.00

Figure 4.2
Domains for some attributes of the Branch and Staff relations.

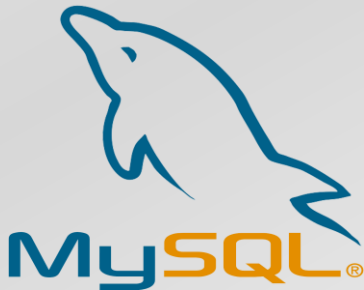


Terminologies

- **Tuple** A tuple is a row of a relation.

  The elements of a relation are the rows or **tuples** in the table. In the Branch relation, each row contains four values, one for each attribute.

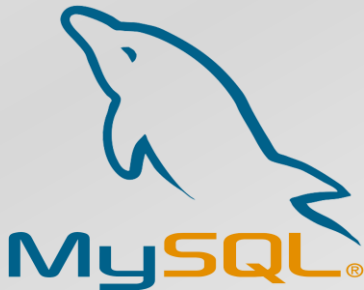
- **Cardinality** The cardinality of a relation is the number of tuples it contains.



Terminologies

- **Degree** The degree of a relation is the number of attributes it contains.

  A relation with only one attribute would have degree one and be called a **unary** relation or one-tuple. A relation with two attributes is called **binary**, one with three attributes is called **ternary**, and after that the term ***n*-ary** is usually used.



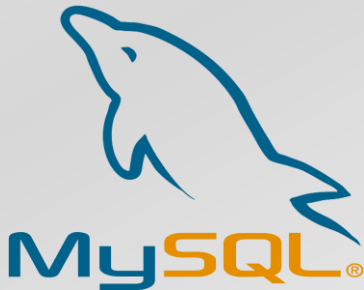
Terminologies

TABLE 4.1 Alternative terminology for relational model terms.

FORMAL TERMS	ALTERNATIVE 1	ALTERNATIVE 2
Relation	Table	File
Tuple	Row	Record
Attribute	Column	Field

Properties of Relations

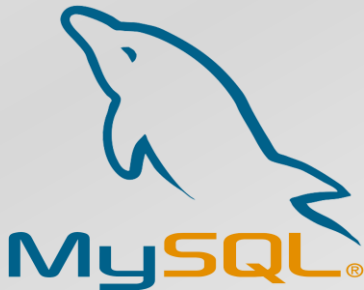
- The relation has a name that is distinct from all other relation names in the relational schema;
- Each cell of the relation contains exactly one atomic (single) value.
- Each attribute has a distinct name;
- The values of an attribute are all from the same domain;
- Each tuple is distinct; there are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



Relations Keys

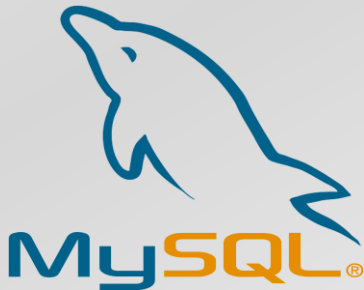
- We need to be able to identify one or more attributes (called **relational keys**) that uniquely identifies each tuple in a relation.

- A DBMS key is an attribute or set of an attribute which helps you to identify a row(tuple) in a relation(table).



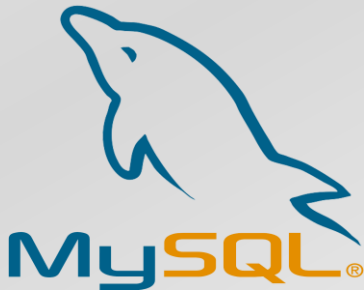
Why we need keys?

- Keys help you to identify any row of data in a table.
- Allows you to establish a relationship between and identify the relation between tables
- Help you to enforce identity and integrity in the relationship



Relations Keys

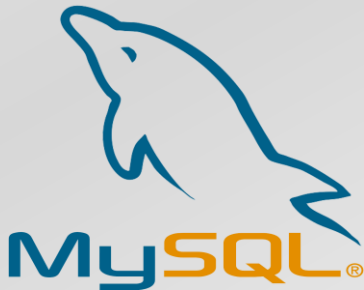
- **Super key** An attribute, or set of attributes, that uniquely identifies a tuple within a relation.
  - A superkey uniquely identifies each tuple within a relation. However, a superkey may contain additional attributes that are not necessary for unique identification
- **Candidate key** A superkey such that no proper subset is a superkey within the relation. **CANDIDATE KEY** is a set of attributes that uniquely identify tuples in a table. Every table must have at least a single candidate key. A table can have multiple candidate keys but only a single primary key.
  - *Uniqueness.* In each tuple of *R*, the values of *K* uniquely identify that tuple.
  - *Irreducibility.* No proper subset of *K* has the uniqueness property.



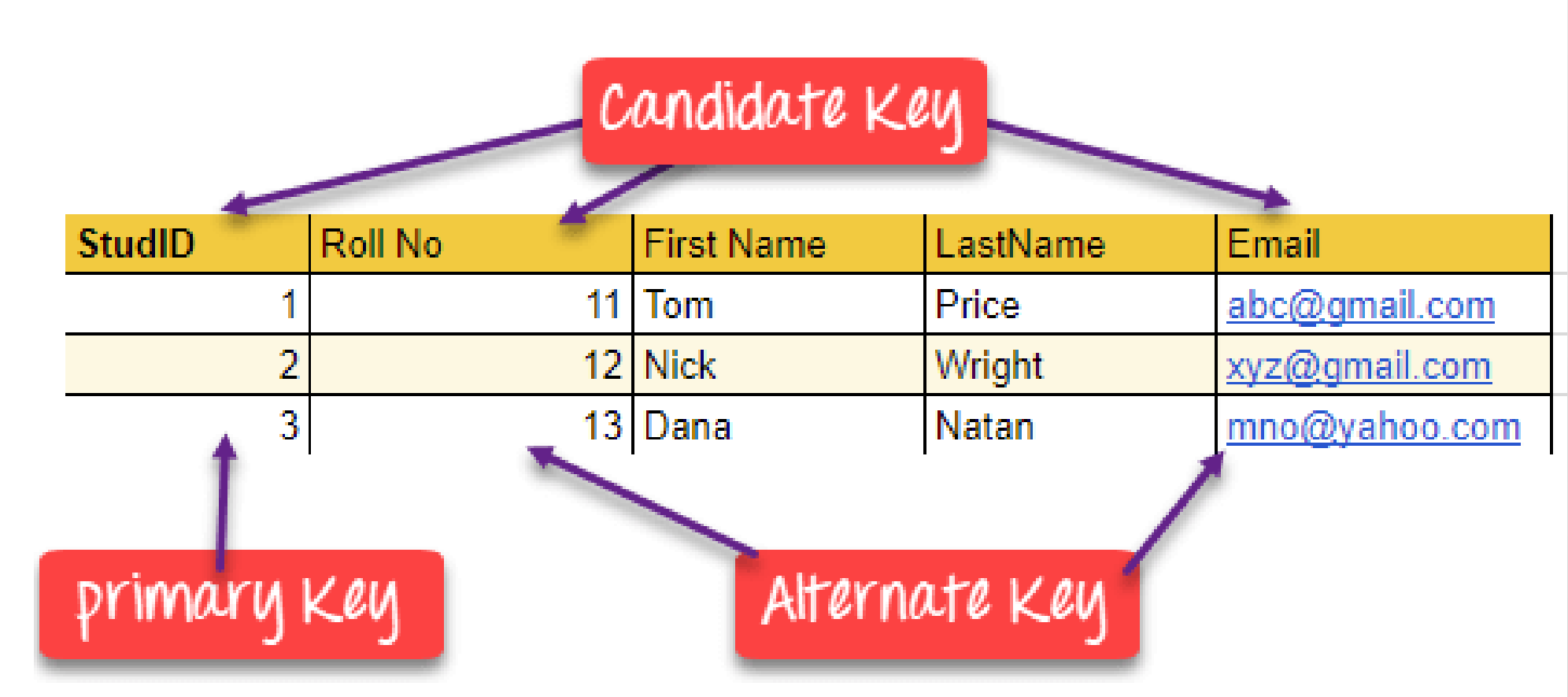
Example

EmpSSN	EmpNum	Empname
9812345098	AB05	Shown
9876512345	AB06	Roslyn
199937890	AB07	James

Super key: EmpSSN+EmpNum



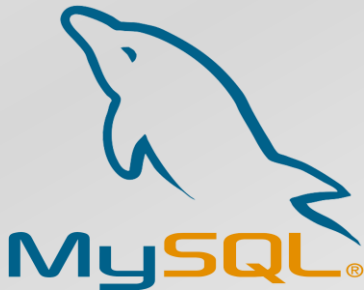
Example



StudID	Roll No	First Name	LastName	Email
1	11	Tom	Price	abc@gmail.com
2	12	Nick	Wright	xyz@gmail.com
3	13	Dana	Natan	mno@yahoo.com

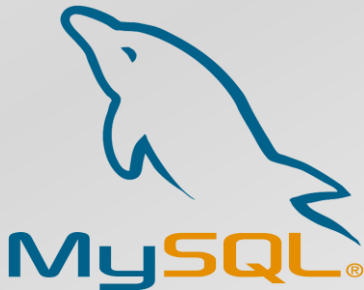
Primary Key

- The candidate key that is selected to identify tuples uniquely within the relation.
- Two rows can't have the same primary key value
- It must for every row to have a primary key value.
- The primary key field cannot be null.



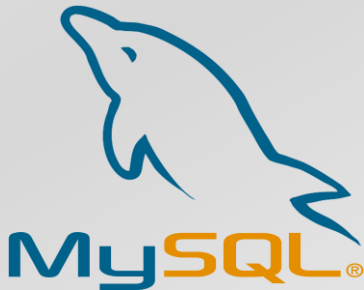
Key Types

- Keys may be:
  - simple: one attribute (SSN), or
  - composite: a set of attributes whose values together uniquely identify an entity type.



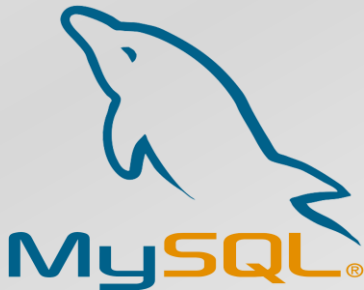
Composite Key

Weather				
Date	Time	Temp	Wind_Spd	Wind_Dir
2/3/2003	6:00 AM	56	9	SE
2/3/2003	9:00 AM	62	7	S
2/3/2003	12:00 AM	71	4	SE
2/3/2003	3:00 PM	71	9	E
2/3/2003	6:00 PM	66	6	E



Foreign Key

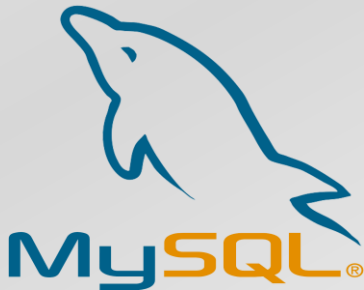
- FOREIGN KEY is a column that creates a relationship between two tables.
- The purpose of Foreign keys is to maintain data integrity and allow navigation between two different instances of an entity.
- When an attribute appears in more than one relation, its appearance usually represents a relationship between tuples of the two relations



Example

DeptCode	DeptName
001	Science
002	English
005	Computer

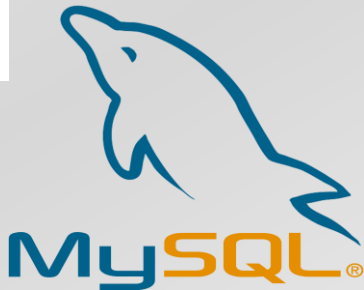
Teacher ID	Fname	Lname
B002	David	Warner
B017	Sara	Joseph
B009	Mike	Brunton



Example

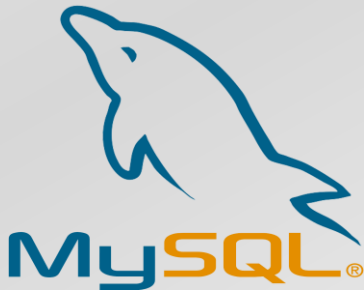
- In the previous example the two tables are not connected.
- In this table, adding the foreign key (Deptcode) to the Teacher name, we can create a relationship between the two tables.

Teacher ID	DeptCode	Fname	Lname
B002	002	David	Warner
B017	002	Sara	Joseph
B009	001	Mike	Brunton



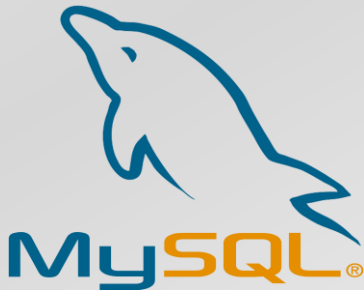
Summary

- A **superkey** is an attribute, or set of attributes, that identifies tuples of a relation uniquely, and a
- **Candidate key** is a minimal superkey.
- A **primary key** is the candidate key chosen for use in identification of tuples. A relation must always have a primary key.
- A **foreign key** is an attribute, or set of attributes, within one relation that is the candidate key of another relation.



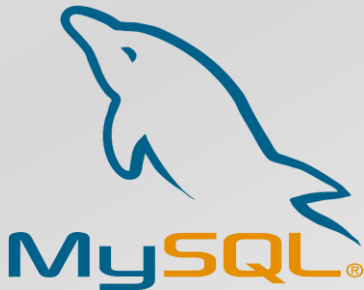
Example

- In a university system, the administration are offering set of courses to be registered by students. The courses belong to some specific departments. In addition each student is supervised by a specific tutor. Each tutor can supervise many students.



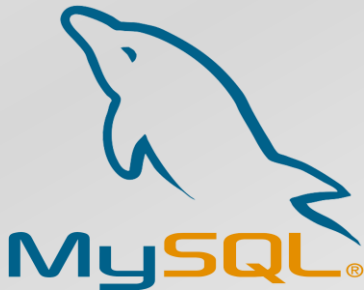
Solution

- In order to design the database for the above scenario we need to create the following entities
  - Student
  - Course
  - Department
  - Tutor



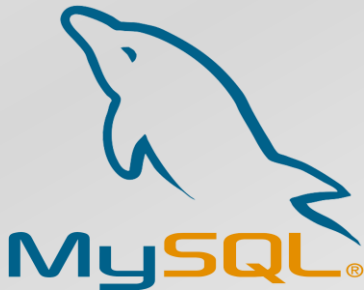
Solution - Students Table

sID	sName	Address	City	BOD	Phone
1	Ali	Tela Ali	Amman	1/1/99	789879890
2	Sami	Naowr	Amman	3/2/00	987654321
3	Aya	Khalda	Amman	2/2/01	965432890
4	Salma	Masoom	Zarqa	7/8/00	765432190



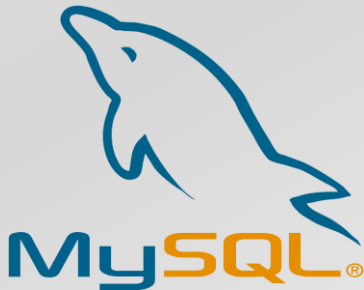
Solution - Courses Table

cNum	cTitle	Credit
1	Java	3
2	DB	3
3	Networking	3
4	English	3
5	Arabic	3



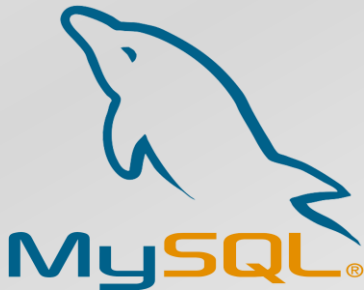
Solution - Department Table

dNum	dName	Phone
1	CS	78654321
2	Computing	32456789



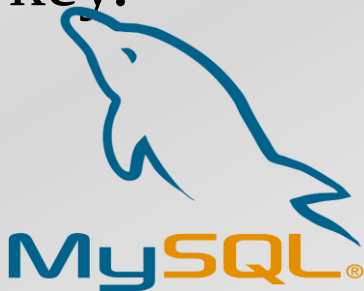
Solution - Tutor Table

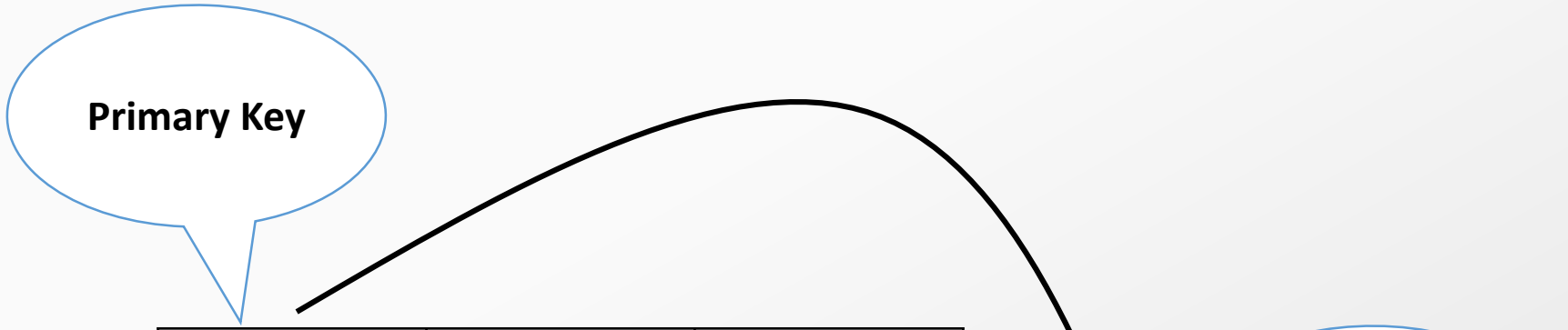
tID	tName	Office
1	Mohammed	201
2	Ahmad	202
3	Mariam	205



Solution - Course and Department Relation

- Each course is offered by a department which means that we have a relation between Courses and departments.
- Each course is offered by one department and many courses are offered by the same department.
- The relation is called **one to many.**
- In order to reflect one to many relations we need to use foreign key.
- The primary key of department is repeated in the course table.
- In department table, it is primary key. In course table it is foreign key.



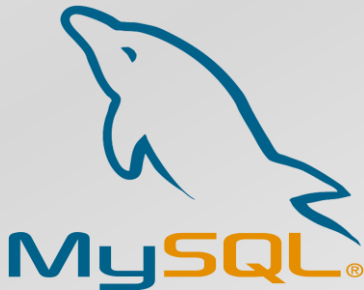


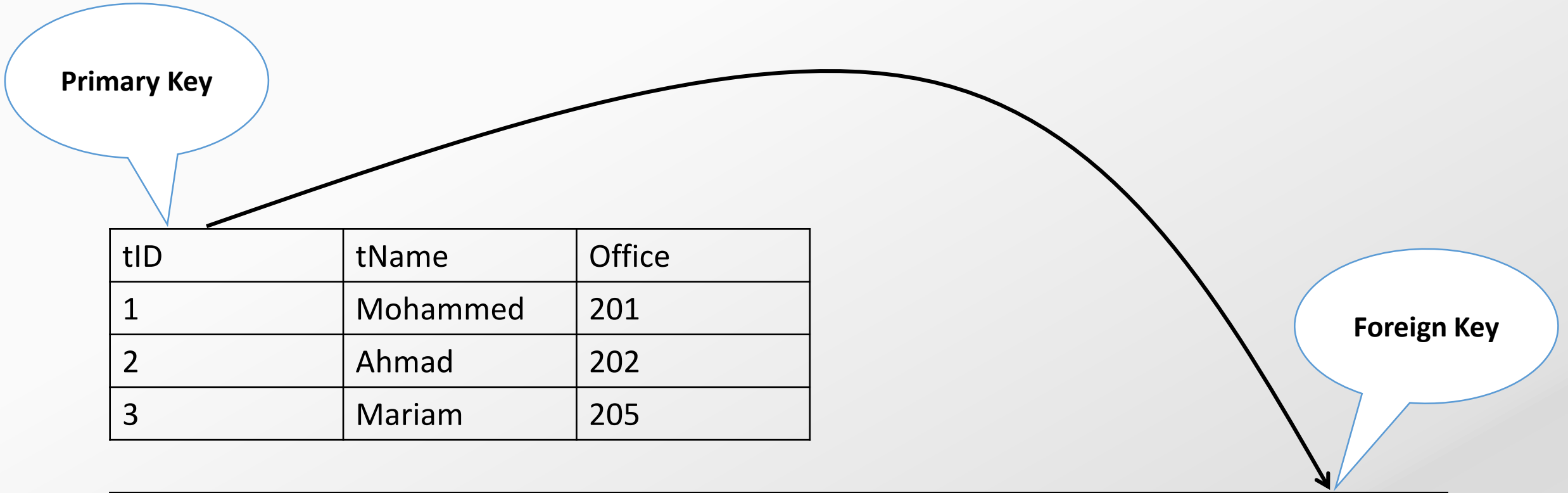
dNum	dName	Phone
1	Computing	78654321
2	General	32456789

cNum	cTitle	Credit	dNum
1	Java	3	1
2	DB	3	1
3	Networking	3	1
4	English	3	2
5	Arabic	3	2

Solution - Tutors and Students Relation

- Tutor supervises many students
- Student is supervised by one tutor
- **One to many relationship**
- **One** is the tutor
- **Many** is the students
- Primary key of tutor is used as a foreign key in student table.



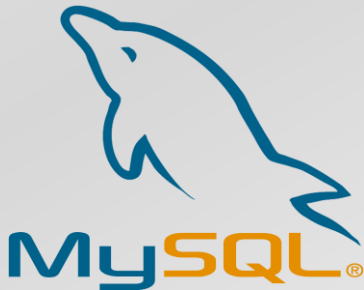


tID	tName	Office
1	Mohammed	201
2	Ahmad	202
3	Mariam	205

sID	sName	Address	City	BOD	Phone	tutorID
1	Ali	Tela Ali	Amman	1/1/99	789879890	1
2	Sami	Naowr	Amman	3/2/00	987654321	1
3	Aya	Khalda	Amman	2/2/01	965432890	2
4	Salma	Masoom	Zarqa	7/8/00	765432190	1

Solution - Students and Courses Relation

- Many students can register many courses
- Many courses can be registered by many students
- The relation is **many to many.**
- Solution is to create new table that contains the primary key from student and the primary key from courses.



Course			
cNum	cTitle	Credit	dNum
1	Java	3	1
2	DB	3	1
3	Networking	3	1
4	English	3	2
5	Arabic	3	2

Registration	
sID	cNum
1	1
1	2
1	5
2	3
2	4
3	5
4	1

Student						
sID	sName	Address	City	BOD	Phone	tutorID
1	Ali	Tela Ali	Amman	1/1/99	789879890	1
2	Sami	Naowr	Amman	3/2/00	987654321	1
3	Aya	Khalda	Amman	2/2/01	965432890	2
4	Salma	Masoom	Zarqa	7/8/00	765432190	1

Relational Schema

- The common convention for representing a relation schema is to give the name of the relation followed by the attribute names in parentheses. Normally, the primary key is underlined.

- The relational schema for of this case study is:

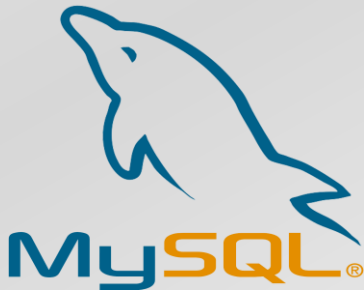
  Student (sID, sName, Address, city, BOD, phone, tutorID)

  Course (cNum, cTitle, credit hours, dNum)

  Department (dNum, dName, phone)

  Tutor (tNum, tName, officeNum)

  Registration (sID, cNum)



Exercise

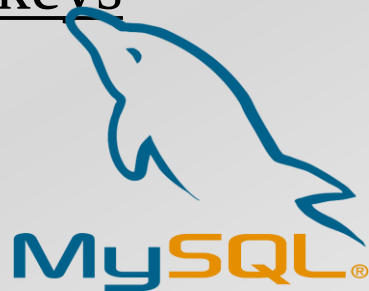
Book (ISBN, title, edition, year) contains details of book titles in the library and the ISBN is an id that identifies each book.

BookCopy (copyNo, available) contains details of the individual copies of books in the library

Borrower (borrowerNo, borrowerName, address) contains details of library members who can borrow .

BookLoan (dateout, dateDue) contains details of the book copies that are borrowed by library members.

Task: Identify the relationships between tables and specify the primary keys and the foreign keys in each table.



Solution

Book	(ISBN, title, edition, year)
BookCopy	(copyNo, ISBN, available)
Borrower	(borrowerNo, borrowerName, borrowerAddress)
BookLoan	(copyNo, dateOut, dateDue, borrowerNo)