Relational databases

Intro >> Lecture’ s Map

Learning Maps

Sequence	Title
1	Introduction to databases
2	Relational Databases
3	Relational Algebra
4	Structured Query Language – Part 1
5	Structured Query Language – Part 2
6	Constraints and Triggers
7	Entity Relationship Model
8	Functional Dependency
9	Normalization
10	Storage - Indexing
11	Query Processing
12	Transaction Management – Part 1
13	Transaction Management – Part 2

Intro > Overview

□ A : Voice and PPT Overview
□ B : Text-based Overview
■ C : Video and PPT Overview

Opening Message	→ In this lesson, we will study the relational model concepts, relational model constraints
Lesson topic	1. Relational data model 2. Constraints
Learning Goals	Upon completion of this lesson, students will be able to: 1. Recall the concepts of relational data model. 2. Show some basic concepts of relational data model 3. Identify some constraints of relational data model

Intro > Keywords

Keyword	Description
Data model	A set of concepts used to describe the structure of a database: data types, relationships, constraints, semantics, …
Relation	Is thought of as a table of values, each row in the table represents a collection of related data values.
Key	An attribute or a set of attributes in the relation, which can identify a tuple uniquely.
Integrity constraints	Provide a way of ensuring that changes made to the database by authorized users do not result in a loss of data consistency.

Lesson > Topic 1: Relational data model

- 1.1. Introduction
- 1.2. Basic concepts

1.1. Introduction

- Some of data models:
  - Hierarchical database model.
  - Network model.
  - Object-oriented database model.
  - Relational model.
  - Entity-relationship model.
  - Document model.
  - …

1.1. Introduction (cont.)

- Relational data model
  - Was first introduced by Ted Codd of IBM Research in 1970.
  - Used by most of commercial database systems.
  - Very simple model.
  - Query with high-level languages.
  - Efficient implementations.
  - Based mathematical theory, closed to file structure and data structure, there are three sets of terminology:

Relation	Table	File
Tuple	Row	Record
Attribute	Column	Field

1.2. Basic concepts

- Relations: are saved in the format of tables, which have rows and columns.
- Relation instance/state: actual contents at given point in time. The lowercase letters q, r, s denote relation states.
- Database: a set of named relations (or tables)
- Tuple: a single row of a table, which contains a single record for that relation. The letters t, u, v denote tuples.
- Cardinality: is the number of tuples in a relation.
- Degree (arity): is the number of attributes in a relation.

1.2. Basic concepts (cont.)

- Relation schema: structural description of relations in database.
  - A relation schema R of degree n, denoted by R(A_1, A_2, ..., A_n), is made up of a relation name R and a list of attributes A_1, A_2, ..., A_n
  - Each attribute A_i has values belong to domain D_i of A_i, denoted by dom(A_i)
  - An n-tuple t in a relation r(R) is denoted by t = <v_1, v_2, ..., v_n>, where v_i is the value corresponding to attribute A_i. Both t[A_i] and t.A_i (and sometimes t[i]) refer to the value v_i in t for attribute A_i
- Notice that the uppercase letters Q, R, S denote relation names.

1.2. Basic concepts (cont.)

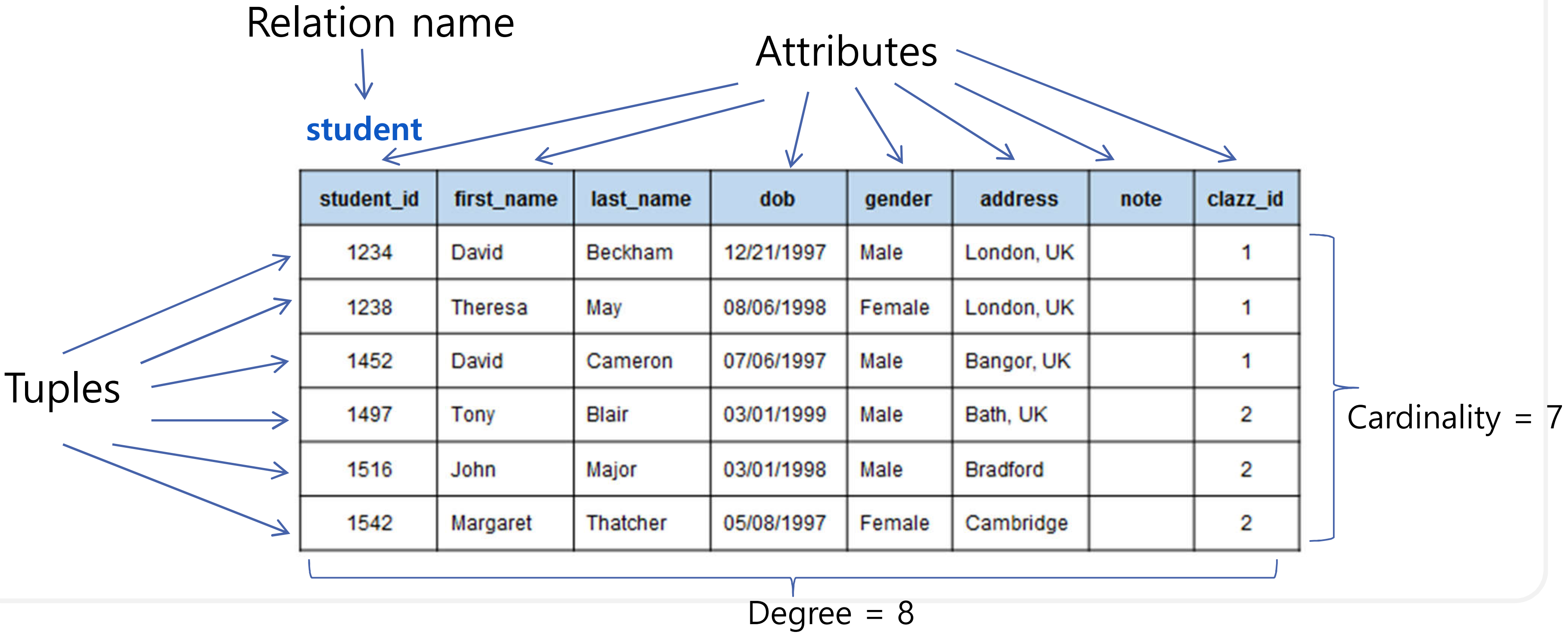
- A relation (or relation state) r of the relation schema R(A_1, A_2, ..., A_n), also denoted by r(R), is a set of n-tuples r = {t_1, t_2, ..., t_m}. Each n-tuple t is an ordered list of n-values t =<v_1, v_2, ..., v_n>, where each value v_i, $1 \le i \le n$, is an element of dom(A_i) or is a special NULL value.
- A relation (or relation state) r(R) is a mathematical relation of degree n on the domains dom(A_1), dom(A_2), ..., dom(A_n), which is a subset of the Cartesian product of the domains that define R:

$$r(R) \subseteq (dom(A_1) \times dom(A_2) \times \ldots \times dom(A_n))$$

1.2. Basic concepts (cont.)

- An example:

student(student_id, first_name, last_name, dob, gender, address, note, clazz_id)



student_id	first_name	last_name	dob	gender	address	note	clazz_id
1234	David	Beckham	12/21/1997	Male	London, UK		1
1238	Theresa	May	08/06/1998	Female	London, UK		1
1452	David	Cameron	07/06/1997	Male	Bangor, UK		1
1497	Tony	Blair	03/01/1999	Male	Bath, UK		2
1516	John	Major	03/01/1998	Male	Bradford		2
1542	Margaret	Thatcher	05/08/1997	Female	Cambridge		2

Lesson > Topic 2: Constraints

- 2.1. Introduction
- 2.2. Types of constraints
- 2.3. An example

2.1. Introduction

- Every relation has some conditions that must hold for it to be a valid relation.
- These conditions are called Relational Integrity Constraints.
- Provide a way of ensuring that changes made to the database by authorized users do not result in a loss of data consistency.

2.2. Types of constraints

- 2.2.1. Key constraints
- 2.2.2. Domain constraints
- 2.2.3. Referential integrity constraints

2.2.1. Key constraints

- A key is an attribute or a set of attributes in the relation, which can identify a tuple uniquely.
- Key constraints force that:
  - in a relation with a key, no two tuples can have identical values for key attributes.
  - a key can not have NULL values.
  - Key constraints are also referred to as Entity Constraints.

2.2.1. Key constraints (cont.)

- Some types of key:
  - Superkey: An attribute, or a set of attributes, that uniquely identifies a tuple within a relation
  - Candidate Key:
    - Superkey (K) such that no proper subset is a superkey within the relation
    - In each tuple of the relation, values of K uniquely identify that tuple (uniqueness)
    - No proper subset of K has the uniqueness property (irreducibility)
  - Primary Key: Candidate key selected to identify tuples uniquely within a relation. Each key attribute of primary key has its name underlined.

2.2.1. Key constraints (cont.)

- Some types of key:
  - Alternate Keys: Candidate keys that are not selected to be the primary key.
  - Minimal key: a minimal set of attributes that can be used to identify a single tuple
  - Foreign Key:
    - Attribute, or set of attributes, within one relation that matches candidate key of some relation
    - Used to model relationships between relations
    - Each key attribute of foreign key has its name *italic*

2.2.2. Domain Constraints

- Attributes have specific values in real-world scenario. Every attribute is bound to have a specific range of values.
- Within each tuple, the value of each attribute *A* must be an atomic value from the domain dom(*A*).
- The data types associated with domains
  - standard numeric data types for integers (short integer, integer, and long integer) and real numbers (float, double precision float).
  - Characters, Booleans, fixed-length strings, and variable-length strings, date, time, timestamp, and money, or other special data types.
  - a subrange of values from a data type .
  - an enumerated data type in which all possible values are explicitly listed.

2.2.2. Domain Constraints (cont.)

- Null value:
  - Represents value for an attribute that is currently unknown or not applicable for any tuple;
  - deals with incomplete or exceptional data;
  - represents the absence of a value and is not the same as zero or spaces

2.2.3. Referential integrity Constraints

- Referential integrity constraints work on the concept of Foreign Keys. A foreign key is a key attribute of a relation that can be referred in other relation.
- Referential integrity constraint states that if a relation refers to a key attribute of a different or same relation, then that key element must exist.

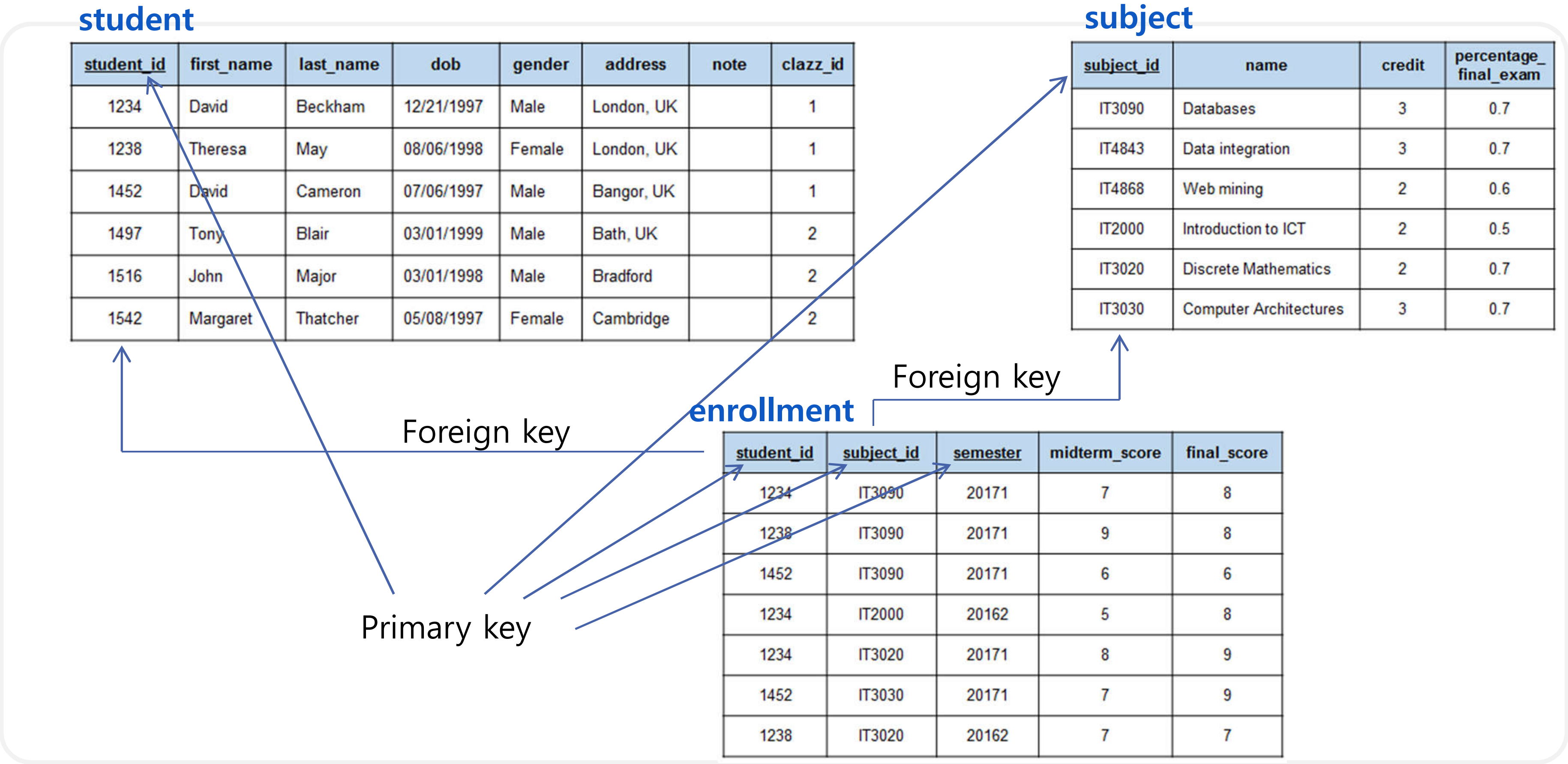
2.3. An example

student(**student_id**, first_name, last_name, dob, gender, address, note, *clazz_id*)

subject(**subject_id**, name, credit, percentage_final_exam)

enrollment(***student_id, subject_id*, semester,** midterm_score, final_score)

2.3. An example (cont.)



student

student_id	first_name	last_name	dob	gender	address	note	clazz_id
1234	David	Beckham	12/21/1997	Male	London, UK		1
1238	Theresa	May	08/06/1998	Female	London, UK		1
1452	David	Cameron	07/06/1997	Male	Bangor, UK		1
1497	Tony	Blair	03/01/1999	Male	Bath, UK		2
1516	John	Major	03/01/1998	Male	Bradford		2
1542	Margaret	Thatcher	05/08/1997	Female	Cambridge		2

subject

subject_id	name	credit	percentage_final_exam
IT3090	Databases	3	0.7
IT4843	Data integration	3	0.7
IT4868	Web mining	2	0.6
IT2000	Introduction to ICT	2	0.5
IT3020	Discrete Mathematics	2	0.7
IT3030	Computer Architectures	3	0.7

Foreign key

enrollment

Foreign key

student_id	subject_id	semester	midterm_score	final_score
1234	IT3090	20171	7	8
1238	IT3090	20171	9	8
1452	IT3090	20171	6	6
1234	IT2000	20162	5	8
1234	IT3020	20171	8	9
1452	IT3030	20171	7	9
1238	IT3020	20162	7	7

Primary key

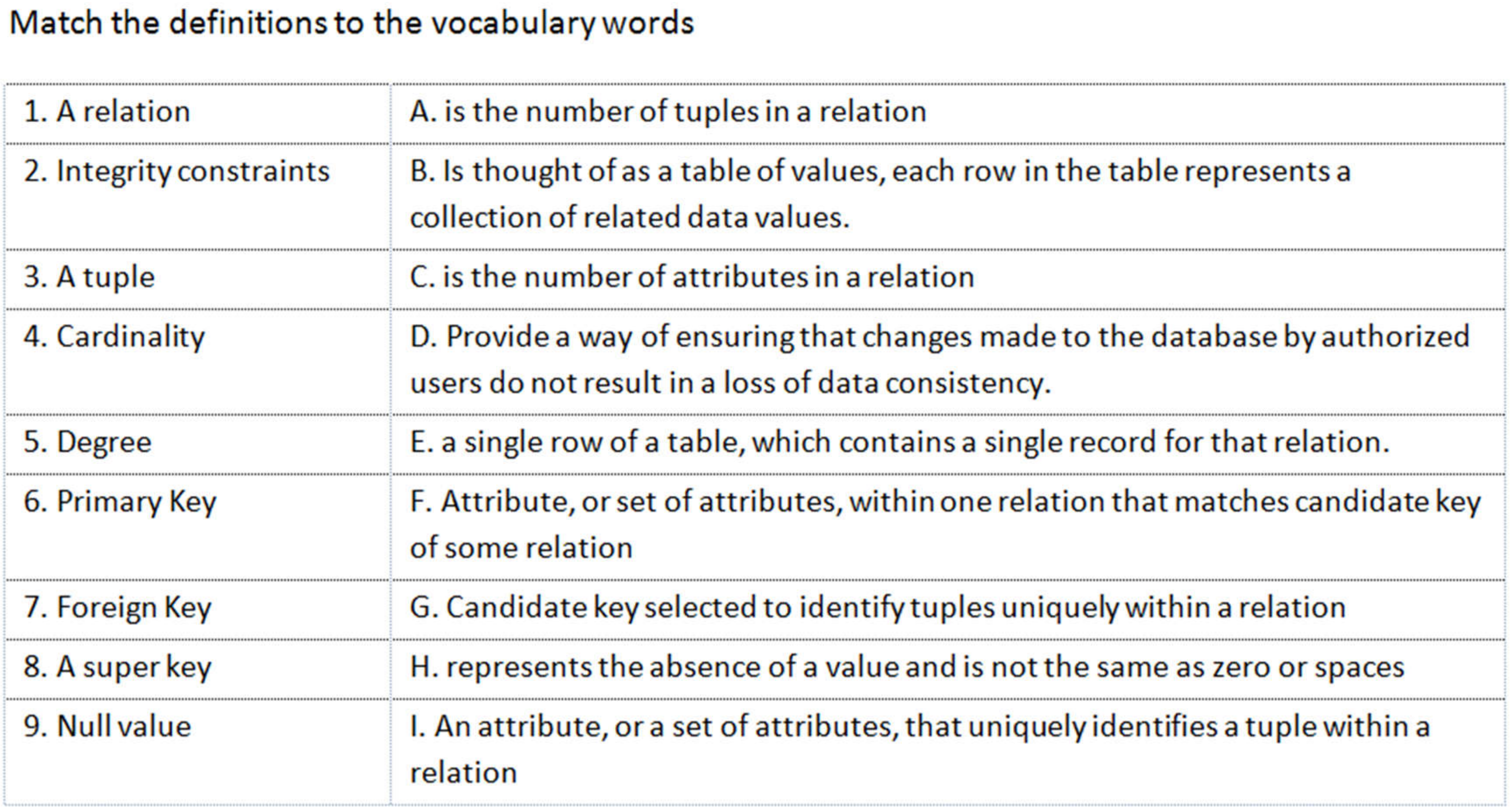
Remarks

- Relational data model
- Constraints
  - Key constraints
  - Domain constraints
  - Referential integrity constraints

Quiz

No	Question (Multiple Choice)	Answer (1,2,3,4)	Commentary
1	Relations: are saved in the format of 1. Tables 2. Rows 3. Columns 4. Tuples	1	
2	Each key attribute has its name underlined 1. Super key 2. Primary key 3. Foreign key 4. Candidate key	2	Reaction rate: $\frac{1}{6}\frac{d[CO_2]}{dt} = -\frac{1}{2}\frac{d[C_3H_6]}{dt}$ Formation rate of CO_2: $\mathrm{R}_{CO_3} = \frac{d[CO_2]}{dt}$ Consumption rate of C_3H_6 $\mathrm{R}_{C_3H_6} = -\frac{d[C_3H_6]}{dt}$
3			

Quiz



Match the definitions to the vocabulary words

1. A relation	A. is the number of tuples in a relation
2. Integrity constraints	B. Is thought of as a table of values, each row in the table represents a collection of related data values.
3. A tuple	C. is the number of attributes in a relation
4. Cardinality	D. Provide a way of ensuring that changes made to the database by authorized users do not result in a loss of data consistency.
5. Degree	E. a single row of a table, which contains a single record for that relation.
6. Primary Key	F. Attribute, or set of attributes, within one relation that matches candidate key of some relation
7. Foreign Key	G. Candidate key selected to identify tuples uniquely within a relation
8. A super key	H. represents the absence of a value and is not the same as zero or spaces
9. Null value	I. An attribute, or a set of attributes, that uniquely identifies a tuple within a relation

Result:
1-B
2-D
3-E
4-A
5-C
6-G
7-F
8-I
9-H

Outro > Summary

No	Topic	Summary
1		
2		
3		
4		

Outro > Next Lesson Guide

Ending Message	→You have just learnt the following topics: 1. Relational data model 2. Constraints • Key constraints • Domain constraints • Referential integrity constraints
Next Lesson Title	Relational Algebra
Next topic	

→You have just learnt the following topics:

1. Relational data model
2. Constraints

- Key constraints
- Domain constraints
- Referential integrity constraints

Next lesson:

Relational Algebra