



# Assignment Project Exam Help

Relational Data Model – Part 2

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Integrity Constraints

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## Integrity Constraints over Relations

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- Constraints are **conditions** that must hold on *all* relations in a database state.

- The main types of constraints in the relational data model include:

- 1 Domain constraints;

- 2 Key constraints;

- 3 Entity integrity constraints;

- 4 Referential integrity constraints.

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## (1) Domain Constraints

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- Every value in a tuple must be from the **domain of its attribute**.

- INT

- VARCHAR

- DATE

- SMALLINT

- NOT NULL

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## (2) Key Constraints - Observation

- We observe that: data does not occur independently from one another within individual relations.

- No two students have the same student ID:

STUDENT			
StudentID	Name	DOB	Email
456	Tom	25/01/1988	tom@gmail.com
458	Peter	23/05/1993	peter@gmail.com
459	Fran	11/09/1987	frankk@gmail.com
...	...	...	...

- No two enrollments have the same student ID, the same course number in the same semester:

ENROL				
StudentID	CourseNo	Semester	Status	EnrolDate
456	COMP2400	2016 S2	active	25/05/2016
458	COMP1130	2016 S1	active	20/02/2016
459	COMP2400	2016 S2	active	11/06/2016
...	...	...	...	...

## (2) Key Constraints - Definitions

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- Let  $R(A_1, \dots, A_n)$  be a relation schema.
- A **superkey**  $SK$  of  $R$  is a subset of attributes of  $R$ , i.e.,  $SK \subseteq \{A_1, \dots, A_n\}$ , such that
  - no two distinct tuples in  $r(R)$  can have the same value for  $SK$ .
- A superkey  $SK$  of  $R$  is **minimal** if there is no other superkey  $SK' \subset SK$  held on  $R$ . A minimal superkey is also known as a **candidate key**.
- A **primary key**  $PK$  of  $R$  is a minimal superkey of  $R$ , (i.e., a primary key is one of the candidate keys). If a relation has only one candidate key then that would be the primary key.

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## (2) Key Constraints - Example

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STUDENT			
StudentID	Name	DoB	Email
456	Tom	25/01/1988	tom@gmail.com
458	Peter	23/05/1993	peter@gmail.com
459	Frank	11/09/1987	frank@gmail.com
460	Tyrion	11/05/1987	tyrion@hotmail.com

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- Is {DoB} a superkey of STUDENT? **No!**
- Is {StudentID, DoB} a superkey of STUDENT? **Yes!**
- Is {StudentID, DoB} a candidate key of STUDENT? **No!**
- Is {StudentID} a candidate key of STUDENT? **Yes!**
- Can {StudentID} be chosen as a primary key of STUDENT? **Yes!**
- Can {DoB} be chosen as a primary key of STUDENT? **No!**

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## (2) Key Constraints - Example

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ENROL				
StudentID	CourseNo	Semester	Status	EnrolDate
456	COMP2400	2016 S2	active	25/05/2016
458	COMP1130	2016 S1	active	20/02/2016
459	COMP2400	2016 S2	active	11/06/2016
458	COMP1130	2015 S1	inactive	20/02/2015

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- Is {CourseNo, Semester} a superkey of ENROL? **No!**
- Is {StudentID, CourseNo, Semester} a candidate key of ENROL? **Yes!**
- Can {StudentID, CourseNo} be chosen as a primary key of ENROL? **No!**

### (3) Entity Integrity Constraints

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- Specifying a primary key also invokes the entity integrity constraint.
- **null** is a special value, which represents the value of an attribute that may be unknown or inapplicable.

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- The **entity integrity constraint** states that **no primary key value can be NULL**.

• This is because primary key values are used to *identify* individual tuples in a relation.

- **Note:** Other attributes of  $R$  may be constrained to disallow null values, even though they are not attributes in the primary key.

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### (3) Entity Integrity Constraints – Example

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- If STUDENTID is specified as the primary key of STUDENT, then the following relation violates the entity integrity constraint.

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STUDENT			
StudentID	Name	DoB	Email
456	Tom	25/01/1988	tom@gmail.com
NULL	Peter	23/05/1993	peter@gmail.com
459	Fran	11/09/1987	frankk@gmail.com

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- How about the case when EMAIL is the primary key of STUDENT?

**Answer:** The relation does not violate the entity integrity constraint.



## (4) Referential Integrity Constraints - Observation

- We observe that: ~~data does not occur independently from one another across relations.~~

- Every course number appearing in ENROL must exist in COURSE:

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STUDENT			
StudentID	Name	Dob	Email
456	Tom	25/01/1988	tom@gmail.com
458	Peter	23/05/1993	peter@gmail.com
459	Fran	11/09/1987	frankk@gmail.com

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COURSE		
CourseNo	Cname	Unit
COMP1130	Introduction to Advanced Computing I	6
COMP2400	Relational Databases	6

ENROL				
StudentID	CourseNo	Semester	Status	EnrolDate
456	COMP2400	2016 S2	active	25/05/2016
458	COMP1130	2016 S1	active	20/02/2016
459	COMP2400	2016 S2	active	11/06/2016



## (4) Referential Integrity Constraints - Definition

- We use  $t[A]$  to denote the value of attribute  $A$  in tuple  $t$ .

**Example:** For the tuple  $t=(459, \text{Fran}, 11/09/1987, \text{frankk@gmail.com})$ ,  
 $t[\text{Name}]=\text{Fran}$  and  $t[\text{DoB}]=11/09/1987$ .

- A **referential integrity constraint** specifies a reference between **two** relations while the previous constraints involve **only one** relation.
- Let  $R_1$  and  $R_2$  be relation schemas in a database schema  $S$ , and  $R_2$  has the primary key  $\{B_1, \dots, B_n\}$ .
- A **foreign key** on  $R_1$  is a statement  $[A_1, \dots, A_n] \subseteq R_2[B_1, \dots, B_n]$  restricting states of  $S$  to satisfy the following property:
  - for each tuple  $t \in r(R_1)$  there exists a tuple  $t' \in r(R_2)$  with  $t[A_i] = t'[B_i]$  for  $i = 1, \dots, n$ .
- $R_1$  is called the **referencing relation** and  $R_2$  is called the **referenced relation**.



## (4) Referential Integrity Constraints – Example

- What foreign keys can be established in the database STUENROL?

STUDENT			
<u>StudentID</u>	Name	DoB	Email
456	Tom	25/01/1988	tom@gmail.com
458	Peter	23/05/1993	peter@gmail.com
459	Frank	11/09/1987	frank@gmail.com

COURSE		
<u>No</u>	Cname	Unit
COMP1130	Introduction to Advanced Computing I	6
COMP2400	Relational Databases	6

ENROL				
<u>StudentID</u>	<u>CourseNo</u>	<u>Semester</u>	Status	EnrolDate
456	COMP2400	2016 S2	active	25/05/2016
458	COMP1130	2016 S1	active	20/02/2016
459	COMP2400	2016 S2	active	11/06/2016

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#### (4) Referential Integrity Constraints – Example

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- In this case, we can establish the following foreign keys on ENROL.

1 [CourseNo]  $\subseteq$  COURSE[No];

2 [StudentID]  $\subseteq$  STUDENT[StudentID]

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- This database state satisfies the above two foreign keys because

• for each tuple  $t_1$  in ENROL, there is a tuple  $t_2$  in COURSE such that the CourseNo value in  $t_1$  is the same with the No value in  $t_2$ ;

- for each tuple  $t_1'$  in ENROL, there is a tuple  $t_2'$  in STUDENT such that the StudentID value in  $t_1'$  is the same with the StudentID value in  $t_2'$ .

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## (4) Referential Integrity Constraints – Question

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- If the database STUENROL is slightly changed as follows, does this database still satisfy the foreign keys in the previous example?

STUDENT			
<u>StudentID</u>	Name	DoB	Email
456	Tom	25/01/1988	tom@gmail.com
458	Peter	23/05/1993	peter@gmail.com
459	Fran	11/09/1987	frankk@gmail.com

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COURSE		
<u>No</u>	Cname	Unit
COMP1130	Introduction to Advanced Computing I	6
COMP2400	Relational Databases	6

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ENROL				
<u>StudentID</u>	<u>CourseNo</u>	<u>Semester</u>	Status	EnrolDate
456	COMP2400	2016 S2	active	25/05/2016
458	COMP1130	2016 S1	active	20/02/2016
459	COMP2600	2016 S2	active	11/06/2016



#### (4) Referential Integrity Constraints – Question

**Answer:** The following database does not satisfy the foreign key of  
ENROL: (COURSENO, COURSENO).

STUDENT			
<u>StudentID</u>	Name	DoB	Email
456	Tom	25/01/1988	tom@gmail.com
458	Peter	23/05/1993	peter@gmail.com
459	Fran	11/09/1987	frankk@gmail.com

COURSE		
No	Cname	Unit
COMP1130	Introduction to Advanced Computing I	6
COMP2400	Relational Databases	6

ENROL				
<u>StudentID</u>	<u>CourseNo</u>	<u>Semester</u>	Status	EnrolDate
456	COMP2400	2016 S2	active	25/05/2016
458	COMP1130	2016 S1	active	20/02/2016
459	COMP2600	2016 S2	active	11/06/2016



## Constraint Violations

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- There are three basic operations that can change a database state:
  - **Insert**: insert one or more new tuples in a relation;
  - **Delete**: delete tuples in a relation;
  - **Update (or Modify)**: change the values of attributes in existing tuples.
- Whenever these operations are applied, the integrity constraints specified in a database schema **should not be violated**.
- However,
  - Insert may violate ...
  - Delete may violate ...
  - Update may violate ...

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