



DATABASE SYSTEMS

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Lecture 3

Database Constraints

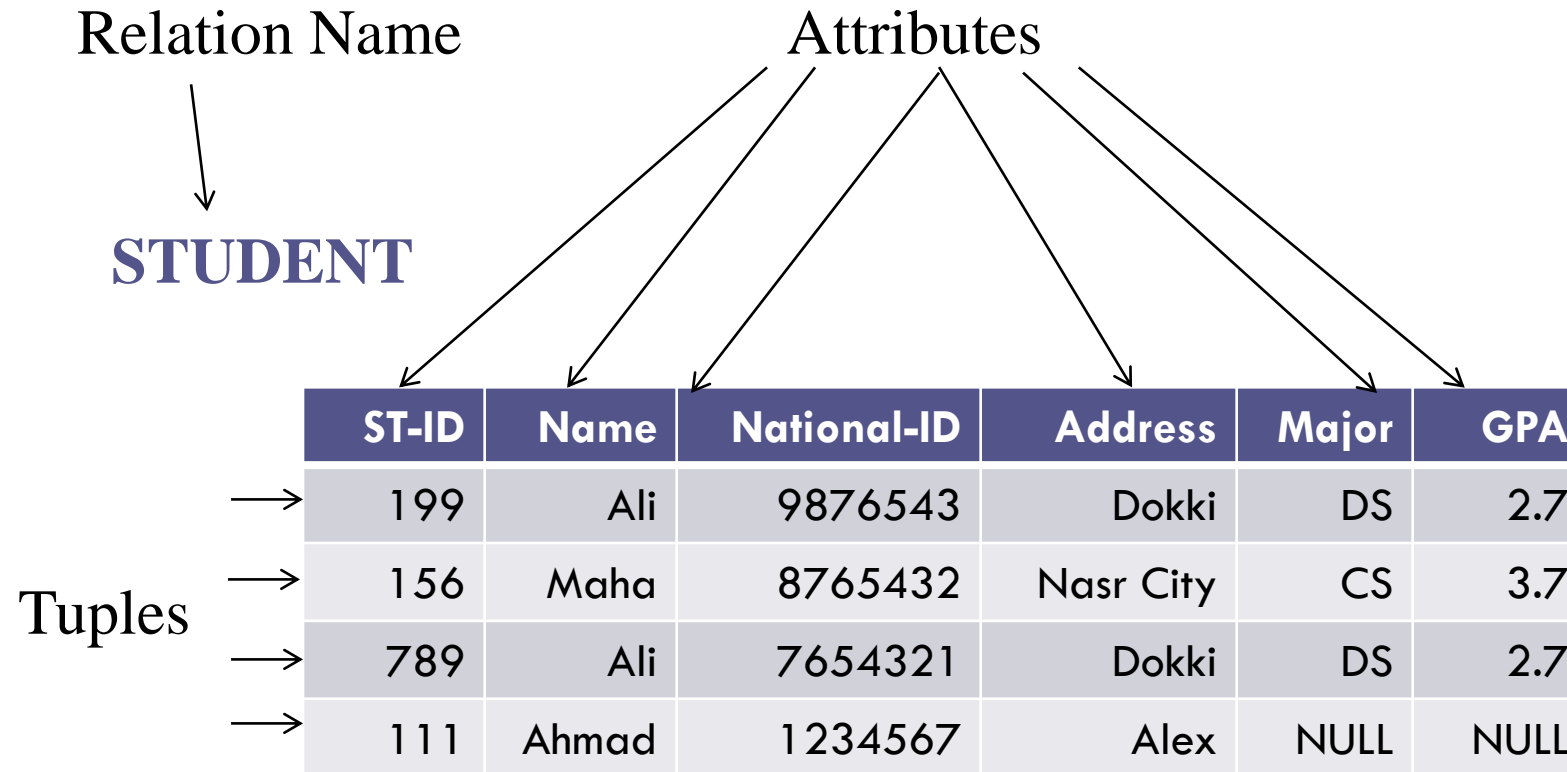
Data Model

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- A collection of concepts that can be used to define the **DB structure**
 - Data items & types
 - Relationships
 - Constraints

Relational Model

Relational Model



Schema

Student(ST-ID, Name, National-ID, Address, Major, GPA)

Attributes have ATOMIC values

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TRANSCRIPT 2

	ST-ID	COURSE	GRADE
→	123	Databae-1	B
	456	Compilers	C
→	123	Operating Systems	A
	789	Compilers	B

TRANSCRIPT 1

ST-ID	COURSE	GRADE
123	Databae-1	B
	Operating Systems	A
456	Compilers	C
789	Compilers	B

TRANSCRIPT2 is not correct as the attribute **COURSE** is **NOT ATOMIC**

- It is set valued.

Attributes have ATOMIC values

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TRANSCRIPT3

ST-ID	COURSE	GRADE
123	Databae-1, Operating Systems	B, A
456	Compliers	C
789	Compilers	B

- Attribute **COURSE** is **ATOMIC VARCHAR(100)**
- Answering Queries:
 - ▣ Find the grade of student 123 in course Operating Systems.
 - ▣ Find Course where the grade of student 123 is A in these courses

Characteristics of Relations

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- Tuples have no particular order
- Ordering of attributes not important
- All values belonging to a particular attribute are from the same domain
- Attributes are atomic. (Cannot put multiple values in the same cell)
- Attributes may have a null value
 - Null is not a zero and is not an empty string

Types of Constraints

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- Domain Constraints
- Key Constraints
- Integrity Constraints
 - Entity Integrity Constraint
 - Referential Integrity Constraint
 - Semantic Integrity Constraint

Domain Constraints

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- The value of each attribute, A , must be an atomic value from the domain of A .
- Example, list of governorates in Egypt.
- An attribute named “Governorate” should have a value that maps to one of the governorates in that list.

Key Constraints



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- Value of a key uniquely identifies a tuple in a relation
- Super key (K): is a subset of attributes of R that can identify a tuple. It might contain more than one attribute.
 - no 2 tuples have same values for K

Key Constraints (Cont'd)

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- A **key** is a minimal superkey; a superkey from which we cannot remove any attributes and still be able to uniquely identify tuples in a relation.
- A relational schema may have more than one key:
 - Each **key** is called a candidate key
 - *One* designated as the primary key

Examples from Premier Database – Primary Key

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OrderLine

OrderNum	PartNum	NumOrdered	QuotedPrice
21608	AT94	11	\$21.95
21610	DR93	1	\$495.00
21610	DW11	1	\$399.99
21613	KL62	4	\$329.95
21614	KT03	2	\$595.00
21617	BV06	2	\$794.95
21617	CD52	4	\$150.00
21619	DR93	1	\$495.00
21623	KV29	2	\$1,290.00



Composite PK

Ordernum and **Partnum** makes up the primary key Of the OrderLine table. This is what is known as a **Composite Primary key**, that is, primary key that is made up of more than one field.

Integrity Constraints

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- Integrity constraints are specified on a schema and hold for every instance of the schema
- • Entity integrity constraint
 - A primary key value cannot be null
- • Referential integrity constraint
 - If R_1 refers to R_2 then $t_1 \in r_1(R_1)$ must refer to an existing $t_2 \in r_2(R_2)$

Foreign Key

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- A Foreign key is how we relate relations to each other
- A Foreign key in R is a set of attributes FK in R such that FK is a primary key of some other relation R
- A foreign key is used to specify a referential integrity constraint.

Example

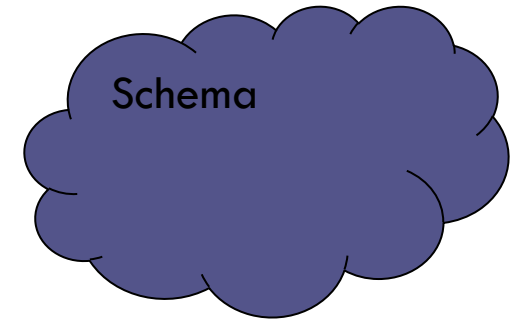
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Employee

<u>Enum</u>	Ename	phone	projectnum
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Project

<u>Pnum</u>	Pname	Location
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Example

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Employee

<u>Enum</u>	Ename	phone	Projectnum
<u>123</u>	Ahmed	01110025878	111
<u>124</u>	Ali	01225929785	
<u>127</u>	Ola	01024457896	111



Instances

Project

<u>Pnum</u>	Pname	Location
<u>111</u>	ABC	Giza
<u>112</u>	EFG	Cairo

Example of composite FK

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Employee

<u>Enum</u>	Ename	phone	Pname	Location
<u>123</u>	Ahmed	01110025878	ABC	Giza
<u>124</u>	Ali	01225929785		
<u>127</u>	Ola	0102457896	EFG	Cairo

Project

<u>Pname</u>	<u>Location</u>
ABC	Giza
EFG	Cairo

3-Integrity Constraints

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- Integrity constraints are specified on a schema and hold for every instance of the schema
- **Entity integrity constraint**
 - ▣ **Primary key**
 - Unique
 - Not null
 - Stable and minimum # of attributes
- **Referential integrity constraint**
 - ▣ **Foreign key**
 - Match a primary key
 - Null

Semantic Integrity Constraints

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- Constraints on data values
- Examples:
 - ▣ The salary of an employee must not exceed that of her supervisor.
 - ▣ The total of available seats must be > 0 in order for a reservation to be made.
 - ▣ A person's date of birth must be before the current date.

Operations on Relations

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- Operations include insert, delete, modify (update), and retrieval.
- Some operations can violate database constraints.

Insert Operation

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- Provide a list of attribute values to be inserted (ie. A new tuple)
- Example
 - Insert into Employee values ([Mary](#), 0102457896)

Employee

<u>Enum</u>	Ename	phone
<u>123</u>	Ahmed	01110025878
<u>124</u>	Ali	01225929785
	Mary	01024457896



Insert Operation

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- ❑ Inserts may violate constraints
- ❑ **Entity Integrity Constraint**: : Inserting a tuple without the primary key
- ❑ **Referential Integrity Constraint**: Inserting a tuple with a foreign key that is not available in the main relation. Example adding an employee in a department number that does not exist.

Example

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Employee

<u>Enum</u>	Ename	phone	Projectnum
<u>123</u>	Ahmed	01110025878	111
<u>124</u>	Ali	01225929785	
<u>127</u>	Ola	0102457896	115



Project

<u>Pnum</u>	Pname	Location
<u>111</u>	ABC	Giza
<u>112</u>	EFG	Cairo

Delete Operation

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- Deletes a tuple from a relation
- Example:
 - Delete a tuple with ID=123456
- The only constraint which can be violated is the referential integrity constraint (ie. A tuple in another relation references the tuple that is stated for deletion). If that employee works on some projects and is available as a foreign key the other relation named “Project”, the deletion of that employee will violate the referential integrity constraint.

Modify Operation

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- Change the value for one or more attributes in a relation
- Example:
 - Modify salary of employee 123 to 20000
- Modifying a primary key is like deleting a tuple and adding a new one (same violations may apply)

SQL

[STRUCTURED QUERY LANGUAGE]

SQL

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- *Structured Query language* SQL is pronounced as “S-Q-L” or sometimes as “See-Quel” which is the standard language for dealing with **Relational Databases**.
- It is effectively used to create, insert, search, update, delete, modify database records.

A Few Details

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- SQL **commands** are case insensitive:
 - ▣ Same: SELECT, Select, select
 - ▣ Same: Product, product

- Use single quotes for constants:
 - ▣ 'abc' - yes
 - ▣ "abc" - no

SQL is a...

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- **Data Definition Language (DDL)**
 - ▣ Define relational *schemata*
 - ▣ Create/alter/delete tables and their attributes
- **Data Manipulation Language (DML)**
 - ▣ Insert/delete/modify tuples in tables
 - ▣ Query one or more table
- **Data Control Language (DCL)**
 - ▣ Specify user permissions
 - ▣ Grant/revoke