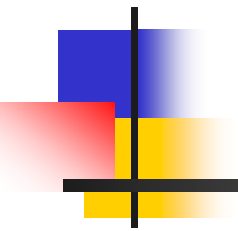
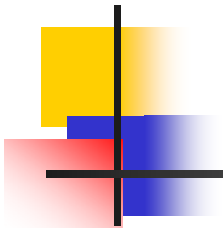
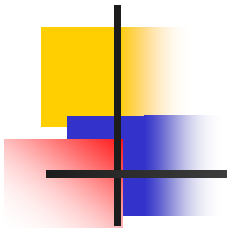


RELATIONAL DATA MODEL



Objectives

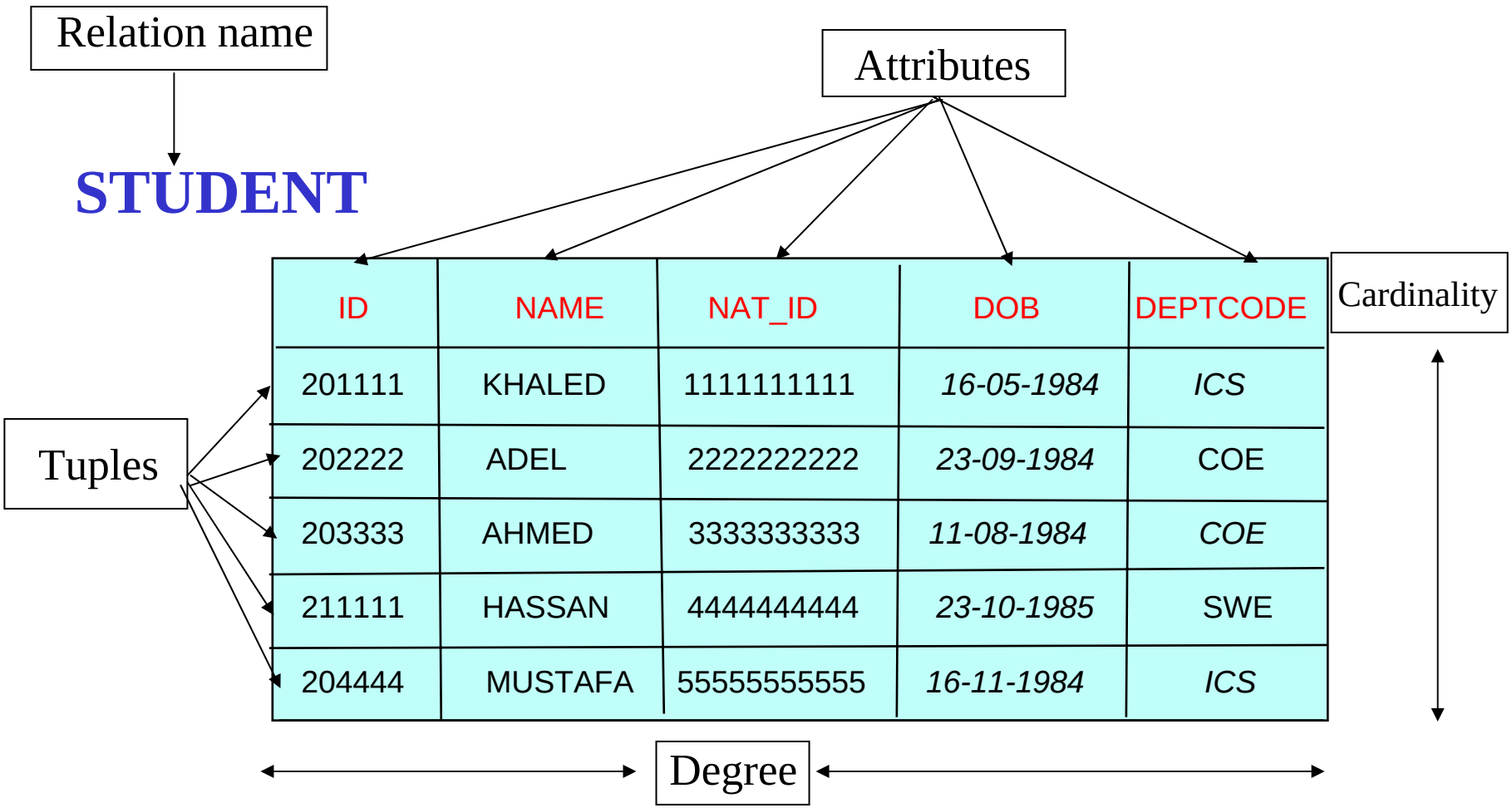
- Terminology +
- Characteristics of Relations +
- Relational Data Model Notations +
- Key constraints +
- Other Constraints +
- Relational Database Schema and State +
- Relational Data Model Operations +

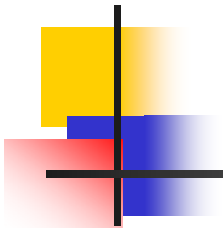


- Terminology

- A **relation** is a table (logical) with columns and rows.
- An **attribute** is a named column of a relation.
- A **domain** is a set of allowable values for one or more attributes.
- A **tuple** is a row of a relation.
- **Degree** is a number of attributes in a relation.
- **Cardinality** is a number of tuples in a relation.
- **Relational Database** is a collection of relations.

- Terminology



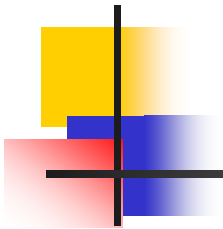


- Characteristics of Relations

- Each relation in the same relational database schema has a distinct name
- Each value in a tuple is atomic
- Each attribute in a relation has a distinct name.
- Values of an attribute are all from the same domain.
- Each tuple is distinct.
- Order of attributes has no significance.
- Order of tuples has no significance, theoretically.

- Relational Data Model Notations

- The letters Q, R, S denote the abstract relation names.
- R(A_1, A_2, A_3, ..., A_n) denotes a relation schema R of degree n.
  - Example: STUDENT(Name, Id, Phone, Address, Mobile, DOB)
- Both t[A_i] and t.A_i refers to the value v_i in t for attribute A_i
  - Example: in second tuple, both t[name] and t.name refers to “Adel”



- Key Constraints

- Superkey +
- Candidate Key +
- Primary Key +
- Alternate Key +
- Foreign Key +

-- Superkey

- An Attribute or a set of attributes that uniquely identify a tuple within a relation.
  - Example:
    - STU_ID, NAME, NAT_ID, DOB, DEPTCODE
    - STU_ID, NAME, NAT_ID
    - STU_ID
    - NAT_ID

STUDENT

STU_ID	NAME	NAT_ID	DOB	DEPTCODE

-- Candidate Key

- A superkey (K) such that no proper subset is a superkey within the relation.
  - In each tuple of R, the values of K uniquely identify that tuple (uniqueness).
  - No proper subset of K has the uniqueness property (irreducibility).
- Example:
  - STU_ID
  - NAT_ID

STUDENT

STU_ID	NAME	NAT_ID	DOB	DEPTCODE

-- Primary Key

- Is a candidate key selected to identify tuples uniquely within a relation.
- Example:
  - STU_ID

STUDENT

STU_ID	NAME	NAT_ID	DOB	DEPTCODE

-- Alternate Key

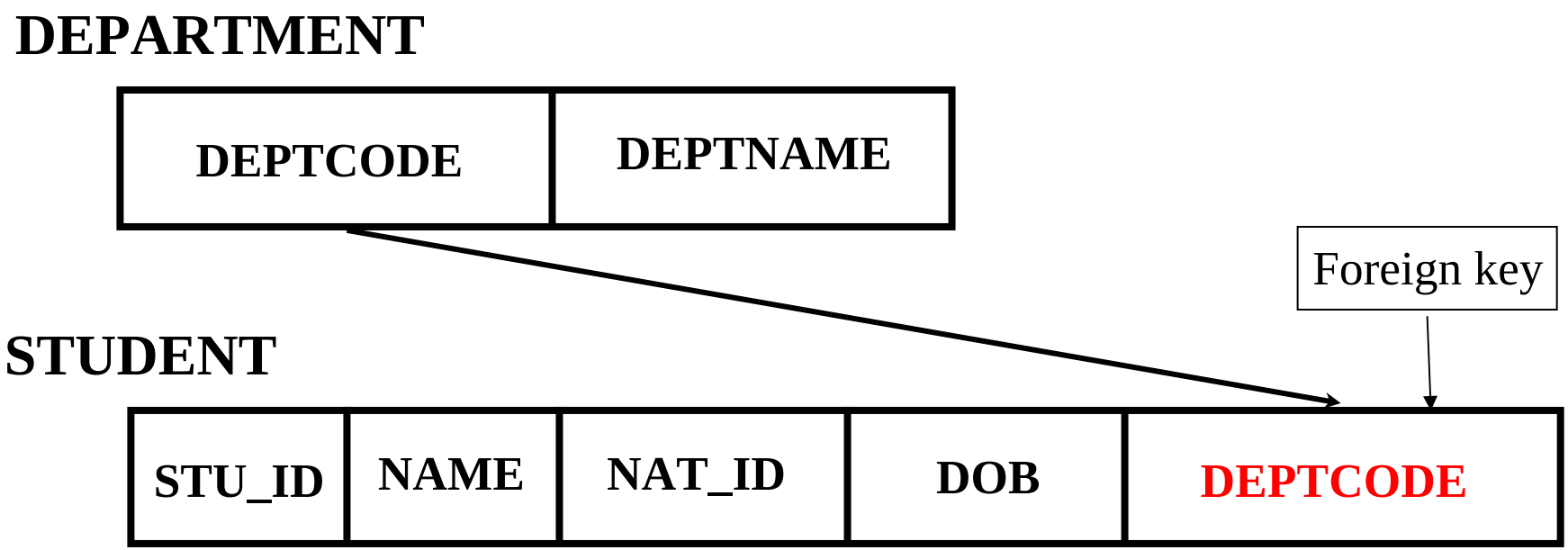
- candidate keys that are not selected to be the primary key.
- Example:
  - NAT_ID

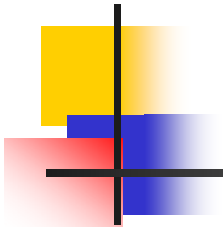
STUDENT

STU_ID	NAME	NAT_ID	DOB	DEPTCODE

-- Foreign Key

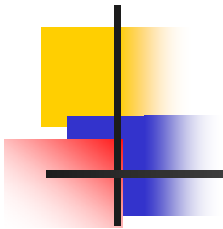
- An attribute or a set of attributes within one relation that matches the candidate key of some (possibly the same) relation.





- Other Constraints

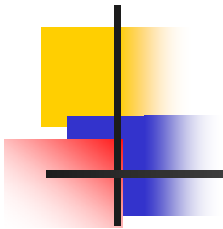
- Null: Represents a value of an attribute that is currently unknown or is no applicable for this tuple.
- Entity integrity Constraint: In a base relation, no attribute of a primary key can be ***null***.
- Referential Integrity Constraint: If a foreign key exists in a relation, either the foreign key value ***must match a candidate key*** value of some tuple in its home relation or the foreign key value must be ***wholly null***.
- Domain Constraint: Specifies that the value of attribute A must be an atomic value from the domain ***DOM(A)***



- Relational Database Schema & State

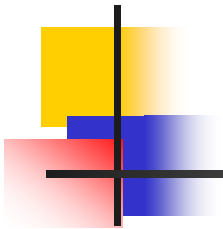
- A relational Database Schema is a non-empty set of relations schemas $\{R_1, R_2, R_3, \ldots, R_n\}$ and a set of integrity constraints that include domain, null, keys, entity, and referential.

- A relational database state S is a set of relation states $\{r_1, r_2, r_3, \ldots, r_n\}$ such that r_i is a relation state of R_i and it satisfies the constraints specified for R_i



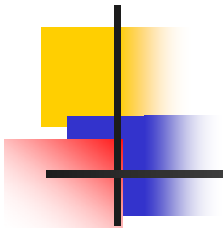
- Relational Data Model Operations

- There are two categories of relational data model operations:
  - Retrieval operations extract information from the relational database.
  - Update operations causes the relation (and the relational database) state changes. They Include:
    - Insert
    - Delete
    - Update



-- Update Operations

- Insert Operation +
  - Possible violations Caused by Insert Operation +
  - Handling Violations Caused by Insert Operation +
- Delete Operation +
  - Possible Violations Caused by Delete Operation +
  - Handling Violations Caused by Delete Operation +
- Update Operation +
  - Possible Violations Caused by Update Operation +
  - Handling Violations Caused by Update Operation +



--- Insert Operation

- Insert operation inserts a list of attribute values for a new tuple t into relation R.
- It is denoted by:

  INSERT <'list of attribute values'> INTO R;

- Example:
  - INSERT <'SWE', 'Software Engineering> INTO DEPARTMENT;

---- INSERT <'SWE', 'Software Eng.'> INTO DEPRATMENT

- Before INSERT operation

DEPTCODE	DEPTNAME
COE	Comp. Eng
ICS	Info. Comp. Sci.

DEPARTMENT

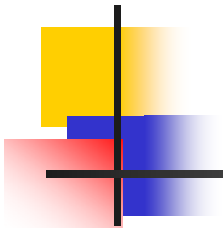
- After INSERT operation

DEPTCODE	DEPTNAME
COE	Comp. Eng.
ICS	Info. Comp. Sci.
SWE	Software Eng.

DEPARTMENT

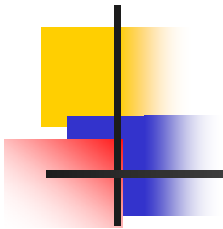
---- Possible INSERT Operation Violations

- **Domain constraint violation** can occur when a given value of an attribute does not belong to the specified domain of that attribute
  - Example: INSERT <1234, 'Software Eng.'> INTO DEPARTMENT
- **Key constraint violation** can occur when a key value in the tuple to be inserted already exists in the relation
  - Example: INSERT <'COE', 'Software Eng.'> INTO DEPARTMENT
- **Entity Integrity constraint violation** can occur if the primary key value of the new tuple is null.
  - Example: INSERT <null, 'Software Eng.'> INTO DEPARTMENT
- **Referential Integrity constraint violation** if the foreign key value of the new tuple t reference to a value that does't exist as a valid value in the corresponding attribute in the referenced relation.



---- Handling INSERT Operation Violations

- If an INSERT operation violates one or more constraints, there are two options to handle that:
  - Reject the operation (default)
  - Prompt the user to correct the values that cause the violation.



--- Delete Operation

- Deletes one or many tuples in a relation.
  - It is denoted as: DELETE FROM R WHERE <where clause>
- Example
  - DELETE FROM detpatment WHERE deptcode = 'SWE';

---- DELETE FROM department WHERE deptcode = ‘SWE’

- Before DELETE operation

DEPTCODE	DEPTNAME
COE	Comp. Eng
ICS	Info. Comp. Sci.
SWE	Software Eng.

DEPARTMENT

- After DELETE operation

DEPTCODE	DEPTNAME
COE	Comp. Eng.
ICS	Info. Comp. Sci.

DEPARTMENT

--- Possible Delete Operation Violations

- Referential integrity constraint violation can occur if the tuple being deleted by the foreign keys from other tuples in the database.

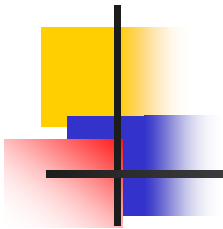
  Example: **DELETE FROM lecturer WHERE LID = 111;**

LECTURER

LID	Lname
111	Salah
222	Ejaz
333	Yahya

SUBJECT

SCODE	SNAME	LID
ICS334	Databases	333
ICS431	Operating Systems	111
ICS490	Data warehouse	222
ICS202	Data Structures	



--- Handling Delete Operation Violations

- There are three options to handle violations of a DELETE operation:
  - Reject the DELETE operation.
  - Cascade the DELETE operation by deleting tuples that refers to the deleted tuple.
  - Replace the referencing attribute value by null, provided it is not a primary key or other valid exist-tuple value.

--- Update Operation

- Changes the value of one or more attributes in one or more tuples of some relation R.
- Its is denoted by: UPDATE R SET <expression> WHERE <where cluase>;

  Example: **UPDATE lecturer set lname = 'Adam' WHERE LID = 111;**

LECTURER

LID	Lname
111	Salah
222	Ejaz
333	Yahya

Before UPDATE

LECTURER

LID	Lname
111	Adam
222	Ejaz
333	Yahya

After UPDATE

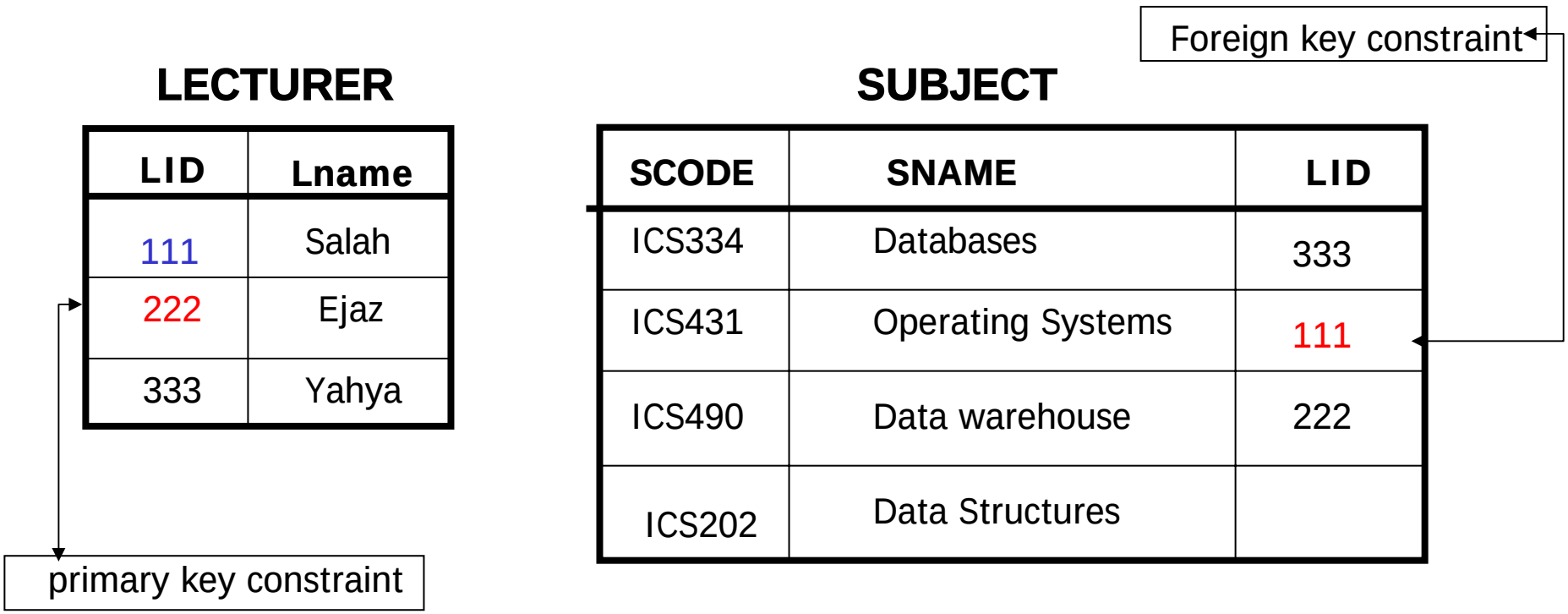
--- Possible Update Operation Violations

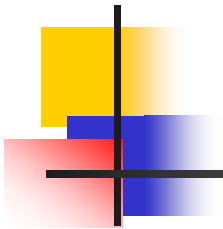
- In UPDATE operation two possible conditions that cause violations.
  - Modifying non-key attribute can cause:
    - Domain constraint violations
    - Example: Updating **sex** to '**B**' instead to ' **M**' or **'F**'.

      UPDATE employee SET sex = 'B' WHERE EMP_ID = 11111
  - Modifying key attribute can cause:
    - Key constraint violation
    - Entity Integrity Constraint violation
    - Referential Integrity Constraint violation

---- UPDATE lecturer SET lid = 111 WHERE LID = 222

- Violates primary key constraint because the new value 111 already exists in the lecturer table . It also violates referential integrity constraint because there are foreign keys which refer to 111.





--- Handling Update Operation Violations

- There are three options to handle violations of a UPDATE operation:
  - Reject the UPDATE operation.
  - Prompt the user to correct the values that cause the violation.
  - Replace the referencing attribute value by null, provided it is not a primary key or other valid exist-tuple value.