

Lecture 4: Relational Model

BADM/ACCY 352

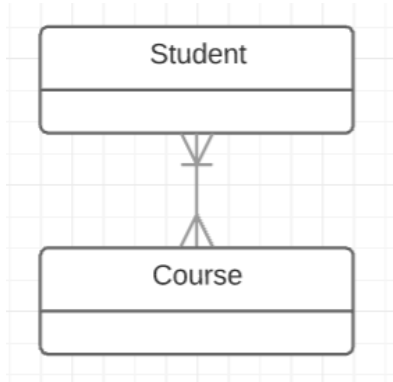
Spring 2017

Instructor: Yi Yang, PhD

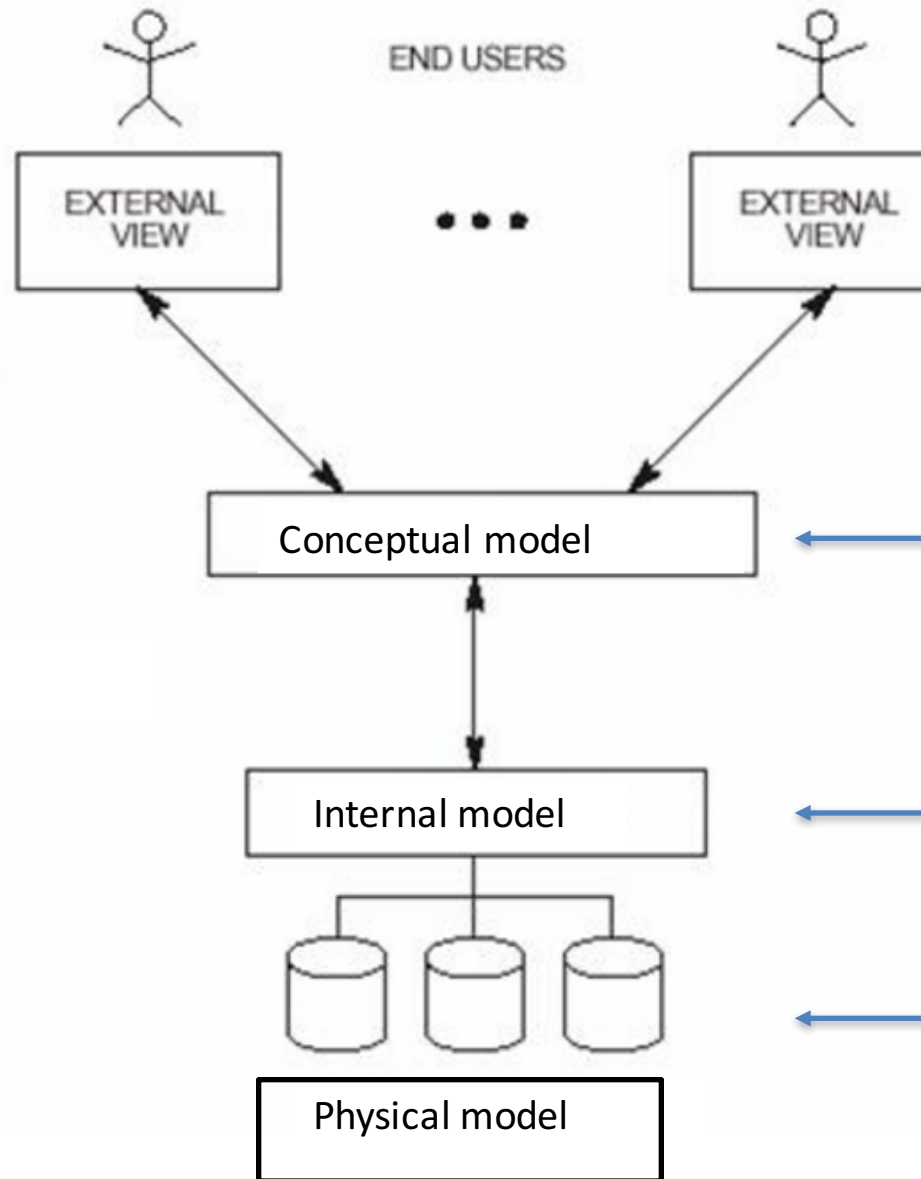
Review

- **ER Model** states **what** data will be stored in the database, and **what** are the relationships of the data.
- **Relational Model** states **how** the data will be stored in the relational database.

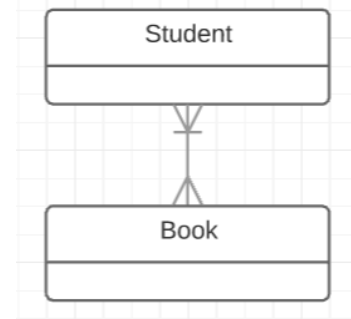
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Entity Relationship Modeling

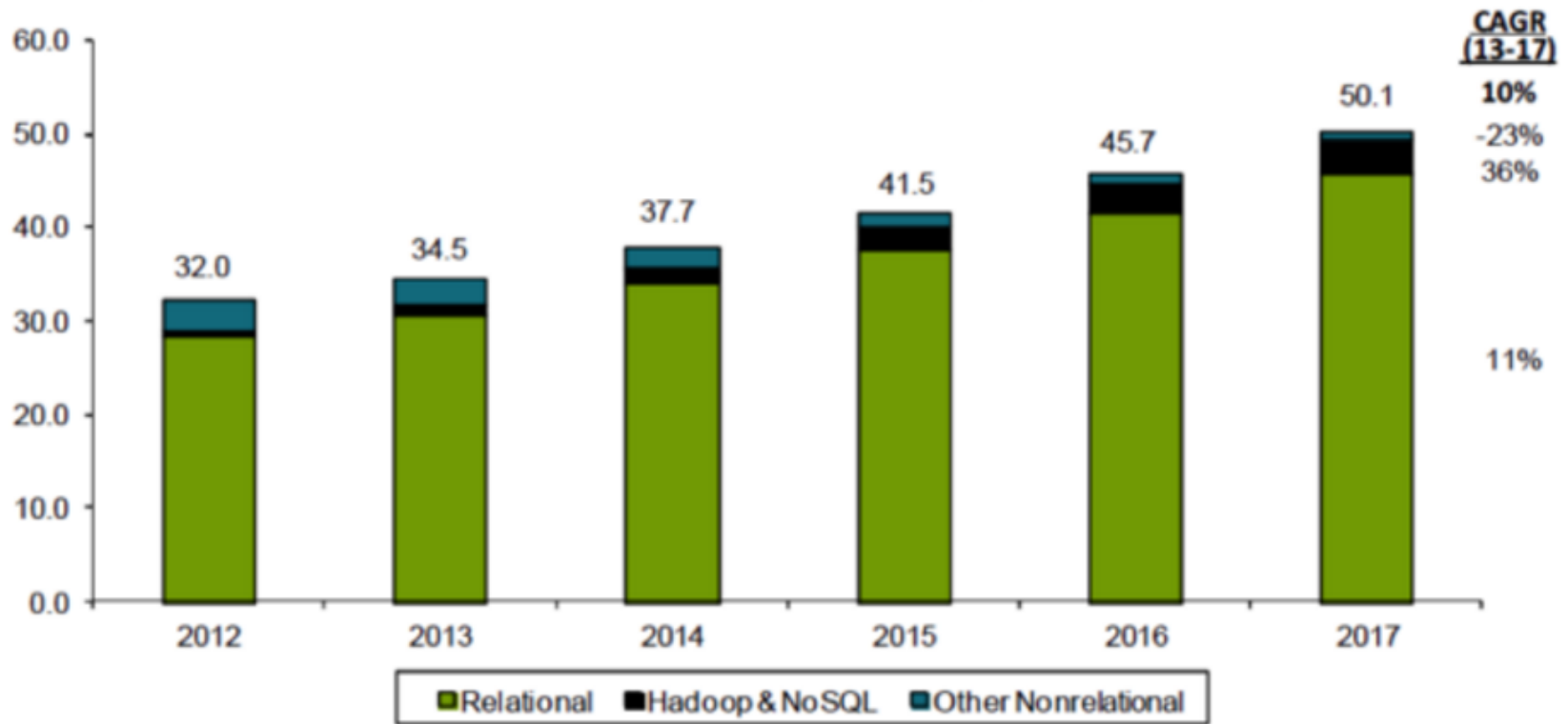
Relational Modeling

SQL

Relational Database






- It is a database whose organization is based on the **relational model** of data.
- The DBMS used to maintain a relational database is known as a relational DBMS (RDBMS)
- **All** relational database systems use **SQL** as the language for querying and maintaining the database.

Global Database Market (\$B)



Source: IDC, Bernstein analysis

124 systems in ranking, January 2017

Rank			DBMS	Database Model	Score		
Jan 2017	Dec 2016	Jan 2016			Jan 2017	Dec 2016	Jan 2016
1.	1.	1.	Oracle 	Relational DBMS	1416.72	+12.32	-79.36
2.	2.	2.	MySQL 	Relational DBMS	1366.29	-8.12	+67.03
3.	3.	3.	Microsoft SQL Server	Relational DBMS	1220.95	-5.70	+76.89
4.	4.	4.	PostgreSQL	Relational DBMS	330.37	+0.35	+47.97
5.	5.	5.	DB2	Relational DBMS	182.49	-1.85	-13.88
6.	6.	6.	Microsoft Access	Relational DBMS	127.45	+2.75	-6.59
7.	7.	7.	SQLite	Relational DBMS	112.38	+1.54	+8.64
8.	8.	 9.	Teradata	Relational DBMS	74.17	+0.79	-0.78
9.	9.	 8.	SAP Adaptive Server	Relational DBMS	69.10	-1.32	-14.08
10.	10.	 11.	FileMaker	Relational DBMS	53.49	-0.63	+4.66

Relational Database Popularity Ranking

Relational Model

- It models data into one or more **related tables** of **columns and rows**, with **a unique key** identifying each row.
- A relational database contains a group of related tables.
- It's an implementation of ER Model (we will see how)

Table

- Two-dimensional structure composed of rows and columns.
- It's a collection of related data.
- Entities are implemented as Tables.
 - *eg. Student*
- Each row is an instance of an entity.
 - *eg. A single student*
- Each column is an attribute of an entity.
 - *eg. Name of Student*
- We will use Entity/Table, Entity Instance/Row, Attribute/Column interchangeably.

A Table Example

Student

ID	First	Last
S103	John	Smith
S104	Mary	Jones
S105	Jane	Brown
S106	Mark	Jones
S107	John	Brown

How many attributes?

How many records?

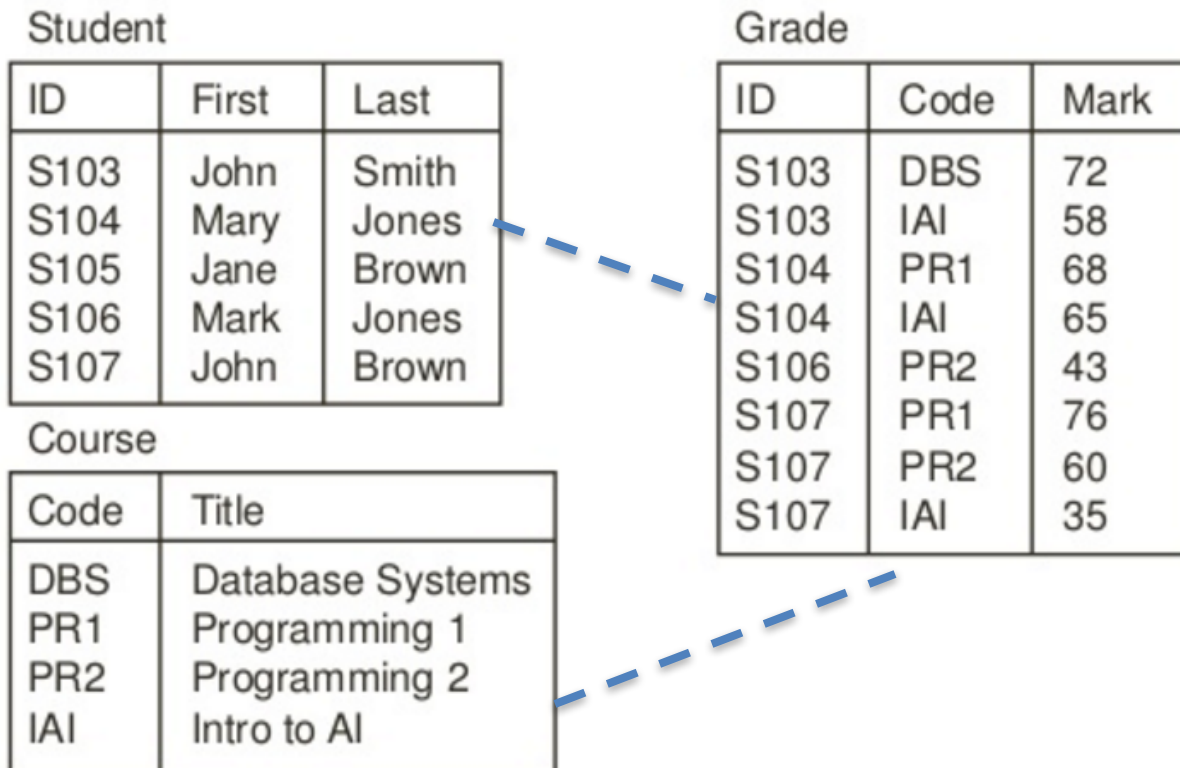
Which attribute uniquely identify each record?

More on Tables

- Each **table** should have an attribute (column) or combination of attributes that uniquely identifies each record (row)
- Each column/row intersection represents a single data value (could be empty)
- All values in a attribute must conform to the same data format. Some examples are number, text, date, currency
- **Table** is a logical construct—not necessarily how data are actually stored physically

Relational Database

- Relational database contains a set of related tables.



Key

- A **key** is one or more attributes that determine other attributes.
- **Determination**: if you know the value of attribute A, you can look up (determine) the value of attribute B.
- In Student table, student_ID->name, email, etc
- If a key is consist of multiple attributes, it's called **composite key**.
 - Given an ADDRESS table,
(Street Address, City, State)→ZipCode

Primary Key (PK)

- A key that is selected as the identifier that uniquely determines any given row in a table.
- Every table in relational database has a PK.

Student

ID	First	Last
S103	John	Smith
S104	Mary	Jones
S105	Jane	Brown
S106	Mark	Jones
S107	John	Brown

Course

Code	Title
DBS	Database Systems
PR1	Programming 1
PR2	Programming 2
IAI	Intro to AI

Grade

ID	Code	Mark
S103	DBS	72
S103	IAI	58
S104	PR1	68
S104	IAI	65
S106	PR2	43
S107	PR1	76
S107	PR2	60
S107	IAI	35

How to choose a PK

- For a PERSON table, is full name a good primary key?
- For a PERSON table, is social security number (SSN) a good primary key?
- For a STUDENT table, is email address a good primary key?
- In the NFL TEAM table, assume there are currently no cities with 2 teams, could TEAM_CITY be a primary key?

Natural Key or Surrogate Key

- A **natural key** is a key with a business value and logically related to a table
- A **surrogate key** is a unique number (randomly) generated by a database itself, and has no business logic.

Course

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Natural key

Student

ID	First	Last
S103	John	Smith
S104	Mary	Jones
S105	Jane	Brown
S106	Mark	Jones
S107	John	Brown

Surrogate key

A few rules

- Uniqueness
- Stability: it should never change.
- Irreducibility: minimum combination
- Simplicity

Super key, Candidate key

- **Super key**: a set of one or more attributes that uniquely identify each record.
- **Candidate key**: a super key without any redundant attributes.
- **Primary key**: a candidate key that is chosen to be the table identifier.

Book

BookId

BookName

Author

(BookId)
(BookId, BookName)
(BookId, BookName, Author)
(BookId, Author)
(BookName, Author)

Super keys

(BookId)
(BookName, Author)

Candidate keys

(BookId)

Primary key

i-clicker question

- In a Grade table, Which of the following key is a candidate key? Assume that all the following keys can uniquely identify each record.

Course_ID	Student_ID	Instructor	Student_Name
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- a) (Course_ID, Student_ID)
- b) (Course_ID, Student_ID, Instructor)
- c) (Course_ID, Student_ID, Student_name)

Foreign Key (FK)

- FK is an attribute in a table which is also a primary key in another (related) table.

<u>CUSTOMERS</u>	
customer_id	customer_name
101	John Doe
102	Bruce Wayne

<u>ORDERS</u>			
order_id	customer_id	order_date	amount
555	101	12/24/09	\$156.78
556	102	12/25/09	\$99.99
557	101	12/26/09	\$75.00

FK example

Student

ID	First	Last
S103	John	Smith
S104	Mary	Jones
S105	Jane	Brown
S106	Mark	Jones
S107	John	Brown

Course

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PK: (ID + Code)

FK: ID, Code

PK and FK

- Primary key and Foreign key are the most important concepts in relational database.
- Primary key uniquely determines each row.
- Foreign key links related tables together.

Null

- A null is the absence of any data value.
- It cannot be avoided, eg. STU_INIT.
- A null is different from 0, or space
 - An unknown attribute value
 - A known, but missing, attribute value
 - A “not applicable” condition

Can primary key have null value?

ID	NAME	GPA	YEAR
123	Alice	3.6	Sophomore
456	Bob	3.4	Junior
789	Charlie	NULL	Junior

Integrity rules

- **Entity Integrity**

- All primary key values are unique
- Primary key can never have null value
- Example: No student can have a duplicate netid, and it cannot be null

- **Referential Integrity**

- Foreign key can have null value
- Every non-null foreign key value must reference an existing primary key value
- Example: A customer's number in an order in the Order table must match the customer number in the Customer table

Integrity Rules Explain

EMPLOYEE

EMP_ID	EMP_NAME	JOB_ID
E1	Alice	J2
E2	Bob	J1
E3	Charlie	J2
E4	Doug	

JOB

JOB_ID	JOB_ROLE
J1	CEO
J2	Manager
J3	Clerk
J4	Accountant

Entity Integrity --- PK

Referential Integrity --- FK

What happens to your comments/likes, if you delete your Facebook account

USER

FB_ID	FB_PROFILE
Alice.001	...
Bob.001	...
Charlie.001	...

Comments

FB_ID	Comm_ID	Comment
Alice.001	C001	I like it
Alice.001	C002	LOL..
Charlie.001	C003	Love it!

More on PK FK

- Primary Key is used to enforce that there is no duplicate row (redundancy) in a table.
 - what if we have duplicate row in a table?
- Foreign Key is used to enforce that there is no inconsistent data in the database.
 - what if foreign key refers to an non-existing primary key value?

Relational database design: Minimize data redundancy and inconsistency

iclicker question

- Which key accepts NULL values?
 - a) Foreign Key
 - b) Candidate Key
 - c) Primary Key
 - d) None of the above

Learning objective

- What is Relation Model
- What is Primary key, Foreign Key
- How to identify Primary Key
- Understand integrity rules