CS4.301 Data & Applications

Ponnurangam Kumaraguru (“PK”)
#ProfGiri @ IIIT Hyderabad

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Protocol

Who am I?

~~Assistant~~ ~~Associate~~ Professor of Computer Science

Ph.D. from School of Computer Science, Carnegie Mellon University (CMU)

Research interests

- Responsible & Safe AI
- Anything students get excited about ☺

Courses I teach

- Data & Applications (3), 4+
- Responsible & Safe AI (1), 4+
- Online Privacy (1)
- Privacy and Security in Online Social Media (8), 4+
- Designing Human Centered Systems (5), 4+
- Research methods / Advanced research methods (2), 4+
- Foundations of Computer Security (5), 4+
- Big Data & Policing (1), 4+

Who you are?

CND

ECD

EHD

CSD

ECE

CLD

CSE

???

Good luck with the course.. Super excited ...
by Ponnurangam Kumaraguru - Saturday, 27 September 2025, 11:53 AM

Hope all of you had a decent mid-semester exams... Look forward to seeing all (given the class is at 11:40AM, assuming more of you attend) of you on Monday... Super excited to interact with your batch...

Good luck with the course.. Super excited ...
by Ponnurangam Kumaraguru - Saturday, 27 September 2025, 11:53 AM

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Good luck with the course.. Super excited ...
by Samarth Rao - Saturday, 27 September 2025, 2:28 PM

Super excited for the class on Monday! #DNA2025 #profgiri

Good luck with the course.. Super excited ...
by Harith Yerragolam - Saturday, 27 September 2025, 2:30 PM

Excited to interact with you sir! Looking forward to the wonderful course on Monda

Good luck with the course.. Super excited ...
by PranavSwarup Kumar - Saturday, 27 September 2025, 2:32 PM

Likewise, Excited to attend! #profgiri

Permanent link to this post

Good luck with the course.. Super excited ...
by Anushka Singh - Saturday, 27 September 2025, 2:33 PM

can't wait for the monday class! #profgiri #excited

Good luck with the course.. Super excited ...
by Aarnav Pai - Saturday, 27 September 2025, 2:39 PM

Excited for the course sir... Can't wait to attend! #profgiri #DNA

Good luck with the course.. Super excited ...
by Neharika Rajesh - Saturday, 27 September 2025, 2:43 PM

Eagerly waiting for the class on Monday, sir!

#DNA2025

Good luck with the course.. Super excited ...
by Vedant Kulkarni - Saturday, 27 September 2025, 2:48 PM

Thank you sir! 🙏 Super excited for the #MondayMorning cla

Good luck with the course.. Super excited ...
by Gursahib Singh - Saturday, 27 September 2025, 2:57 PM

Thank you sir, the excitement is mutual. Can't wait to attend

Good luck with the course.. Super excited ...
by Hemang Joshi - Saturday, 27 September 2025, 2:59 PM

Looking forward to greeting you with smiles and #CoffeeMu

Good luck with the course.. Super excited ...
by Shardul Kholam - Saturday, 27 September 2025, 2:59 PM

Thankyou sir, can't wait to explore a new avenue of knowled

Good luck with the course.. Super excited ...
by Veena Ramadas - Saturday, 27 September 2025, 3:49 PM

So excited to have a class with you sir!! #DNA2025 #profgiri

Good luck with the course.. Super excited ...
by Mathamsetty Viswaj - Saturday, 27 September 2025, 4:10 PM

Looking forward to interact and learn from you sir.
#DnA2025 #profgiri 📈📈📊

Good luck with the course.. Super excited ...
by Vansh Goyal - Saturday, 27 September 2025, 4:40 PM

Super excited and eager to learn from you professor!!! Can't Wait!! #profgiri #DNA

Good luck with the course.. Super excited ...
by Poreddy Reddy - Sunday, 28 September 2025, 3:18 PM

Thank you sir! counting time for your class sir!

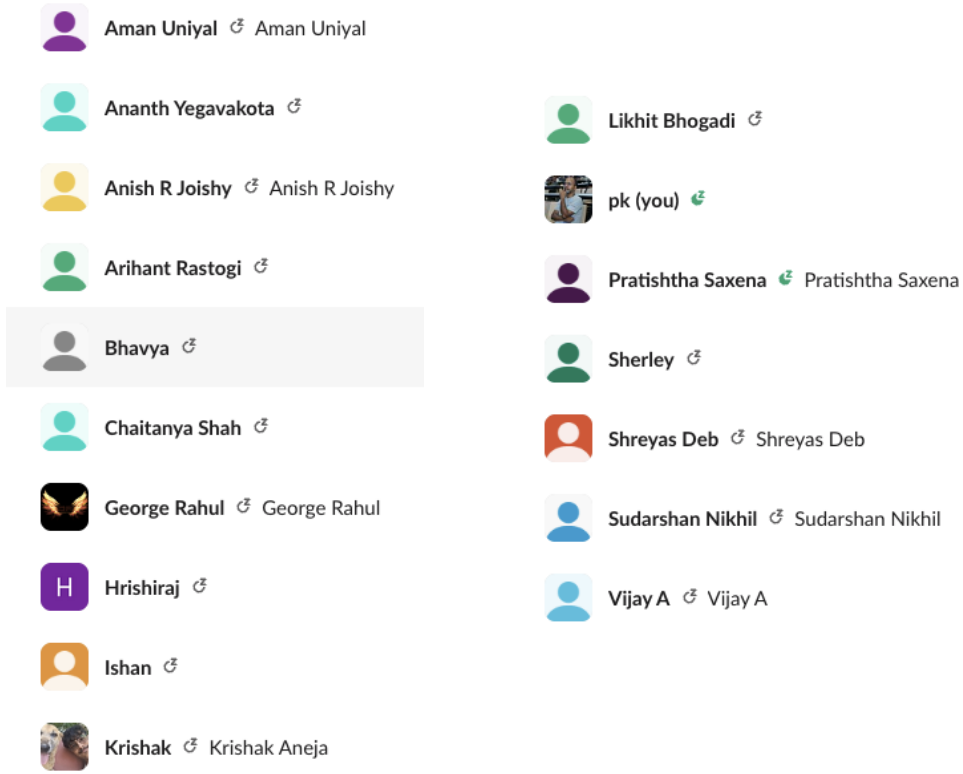
Grading, Relative

Type of Evaluation	Weightage (in %)
Class Quizzes (3)	45
Assignments / Project	25
End Sem Exam	30

TAs

16 TAs

Students will be assigned among TAs for all evaluations



Memory challenge for me ☺

Plagiarism

What is it?

Copying HWs

Any content taken from another source without citation

Whatever policy from IIITH

Moodle

We will use Moodle for all content sharing – slides, HWs, announcements, clarifications, etc.

Service Level Agreement

Any question / clarification ask, if not urgent, will be answered in 24 hrs

If anything urgent, feel free to attach the time in which you want the answer, we will try to respond

TAs are your 1st point of contact only on escalation, you will bring it up to me

Please do not email only me ☹

Topics that we will cover

Relational Database Systems

SQL

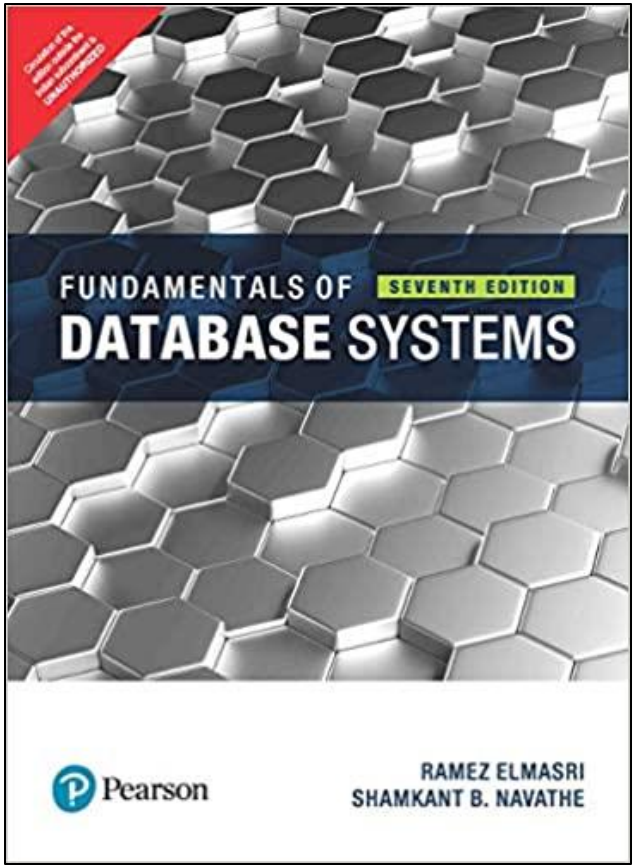
Database design process

Data Models, Normalization

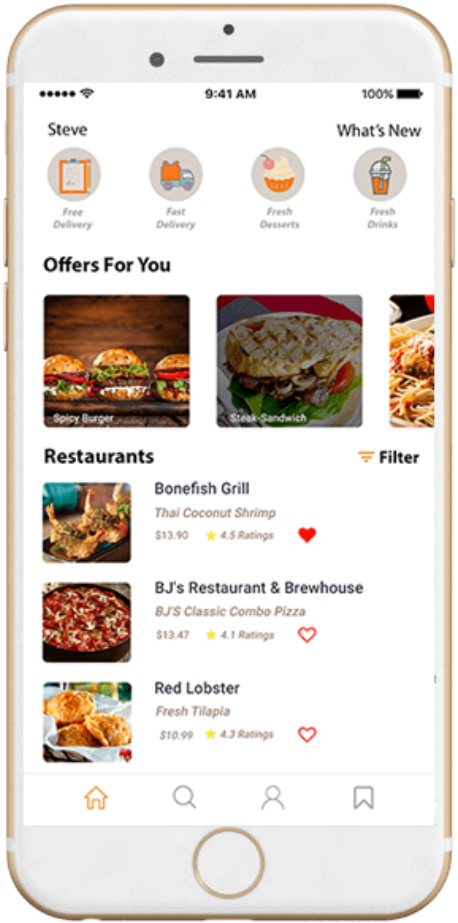
https://www.dineout.co.in/hyderabad/chutneys-madhapur-west-hyderabad-11747/menu

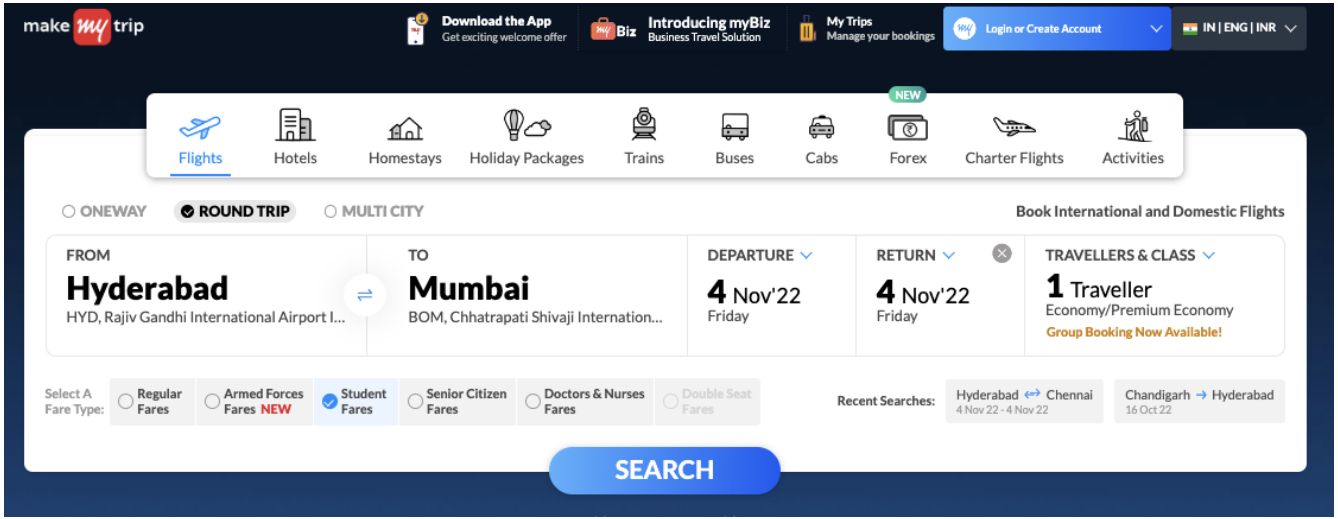
Date	Day	Time	Type	Topic	Quizzes	Project
29-Sep-25	Monday	11:40 AM - 1:05 PM	Lecture - 1	Intro & Data Models		Team Formation Form Out
1-Oct-25	Wednesday		Tutorial - 1	Data Requirements		
2-Oct-25	Thursday	11:40 AM - 1:05 PM	Holiday - Vijaya Dasami/Gandhi Jayanti			
6-Oct-25	Monday	11:40 AM - 1:05 PM	Lecture - 2	Intro & Data Models		Team Formation Deadline
8-Oct-25	Wednesday		Tutorial - 2	Data Models		Team Formation Results
9-Oct-25	Thursday	11:40 AM - 1:05 PM	Lecture - 3	DB Design & ER Models		
13-Oct-25	Monday	11:40 AM - 1:05 PM	Lecture - 4	DB Design & ER Models	Quiz 1	
15-Oct-25	Wednesday	11:40AM - 12:40 PM	Tutorial - 3	DB Design & ER Models		Data Requirements
16-Oct-25	Thursday	11:40 AM - 1:05 PM	Lecture - 5	Relational DB		
20-Oct-25	Monday	11:40 AM - 1:05 PM	Holiday - Deepavali			
22-Oct-25	Wednesday	11:40AM - 12:40 PM	Holiday - No Classwork			
23-Oct-25	Thursday	11:40 AM - 1:05 PM	Lecture - 6	Relational DB		
27-Oct-25	Monday	11:40 AM - 1:05 PM	Lecture - 7	Normalization		
29-Oct-25	Wednesday	11:40AM - 12:40 PM	No Tutorial (Institute Quiz)			
30-Oct-25	Thursday	11:40 AM - 1:05 PM	Lecture - 8	Normalization		ER Model
3-Nov-25	Monday	11:40 AM - 1:05 PM	Lecture - 9	Normalization	Quiz 2	
4-Nov-25	Tuesday	11:40AM - 12:40 PM	Tutorial - 4 (Wednesday's Schedule)	SQL		
6-Nov-25	Thursday	11:40 AM - 1:05 PM	Lecture - 10	Transaction		
10-Nov-25	Monday	11:40 AM - 1:05 PM	Lecture - 11	Transaction		Relational Database Design
12-Nov-25	Wednesday	11:40AM - 12:40 PM	Tutorial - 5	Normalization		
13-Nov-25	Thursday	11:40 AM - 1:05 PM	Lecture - 12	Practical Applications		
17-Nov-25	Monday	11:40 AM - 1:05 PM	Lecture - 13	TBD	Quiz 3	
19-Nov-25	Wednesday	11:40AM - 12:40 PM	Tutorial - 6	Revision		
20-Nov-25	Thursday	11:40 AM - 1:05 PM	Lecture - 14	Storage		Final Project Submission

Book we will follow

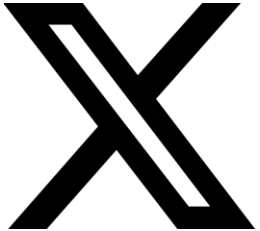


Any questions / clarifications?





What kind of data are we generating here?



What kind of data are we generating here?

Types of Databases and Database Applications

Traditional Applications:

- Numeric and Textual Databases

More Recent Applications:

- Multimedia Databases
- Geographic Information Systems (GIS)
- Biological and Genome Databases
- Data Warehouses
- Mobile databases
- Real-time and Active Databases
- Anything more?

Developments

Social Networks started capturing a lot of information about people and about communications among people-posts, tweets, photos, videos in systems such as:

- Facebook

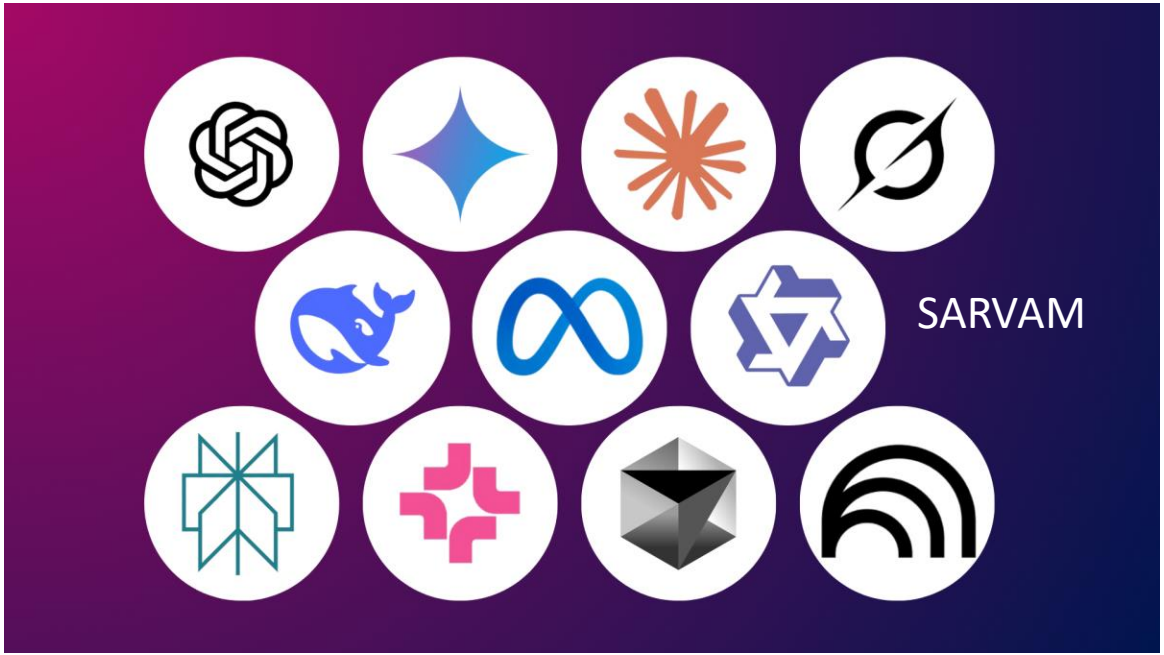
- Twitter

- LinkedIn

All of the above constitutes data

Search Engines, Google, Bing, Yahoo: collect their own repository of web pages for searching purposes

Developments



Basic Definitions

Database:

A collection of related data.

Data:

Known facts that can be recorded and have an implicit meaning.

Mini-world:

Some part of the real world about which data is stored in a database. For example, student grades and transcripts at a university.

Database Management System (DBMS):

A software package/ system to facilitate the creation and maintenance of a computerized database.

Database System:

The DBMS software together with the data itself. Sometimes, the applications are also included.

Impact of Databases and Database Technology

Businesses: Banking, Insurance, Retail, Transportation, Healthcare, Manufacturing

Service Industries: Financial, Real-estate, Legal, Electronic Commerce, Small businesses

Education : Resources for content and Delivery

More recently: Social Networks, Environmental and Scientific Applications, Medicine and Genetics, LLMs, VLMs

Personalized Applications: based on smart mobile devices

Typical DBMS Functionality

Define a particular database in terms of its data types, structures, and constraints

Construct or Load the initial database contents on a secondary storage medium

Manipulating the database:

- Retrieval: Querying, generating reports
- Modification: Insertions, deletions and updates to its content
- Accessing the database through Web applications

Processing and *Sharing* by a set of concurrent users and application programs – yet, keeping all data valid and consistent

Application Activities Against a Database

Applications interact with a database by generating

- Queries: that access different parts of data and formulate the result of a request
- Transactions: that may read some data and “update” certain values or generate new data and store that in the database

Applications must not allow unauthorized users to access data

Applications must keep up with changing user requirements against the database

Additional DBMS Functionality

DBMS may additionally provide:

- Protection or Security measures to prevent unauthorized access
- “Active” processing to take internal actions on data
- Presentation and Visualization of data
- Maintenance of the database and associated programs over the lifetime of the database application
  - Called database, software, and system maintenance

What is a Database?

Data: factual (undoubted) information that can be recorded and have implicit meaning

A database is a collection of related data

What is a Database?

A database has the following implicit properties:

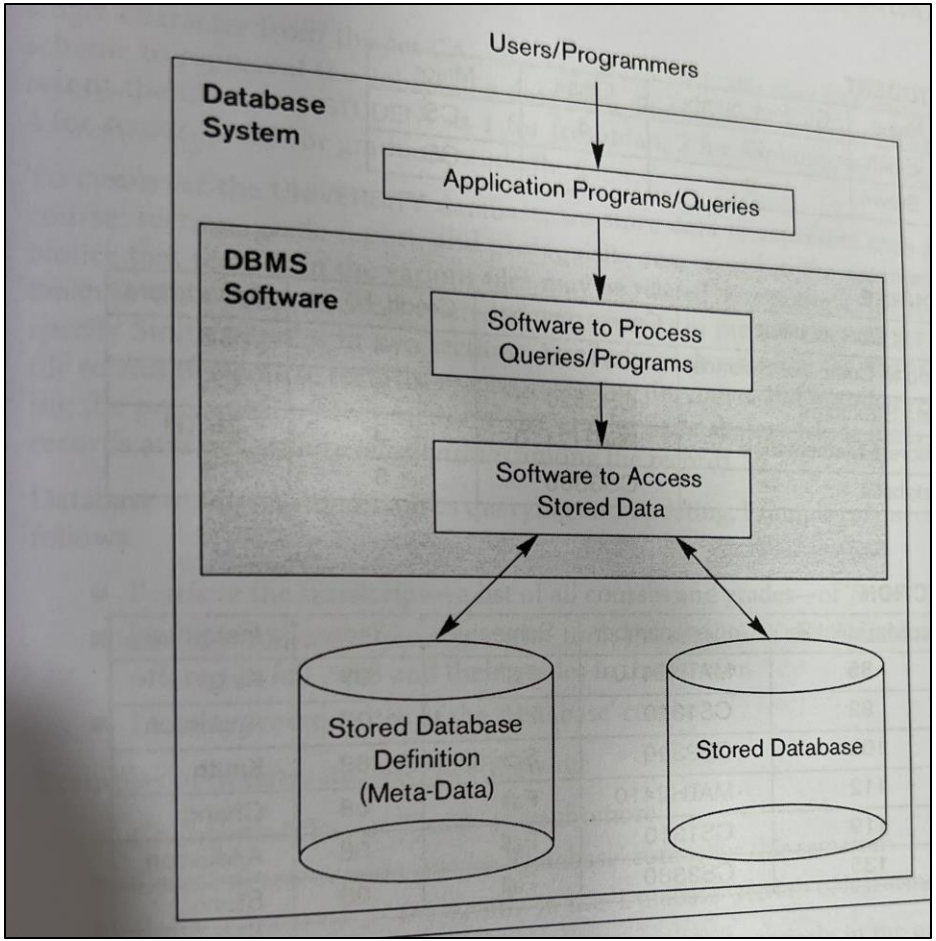
A database represents some aspect of the real world (mini-world or Universe of Discourse (UoD))

A database is a logically coherent (associated, related) collection of data with some inherent meaning

A database is designed, built and populated with data for a specific purpose

It has an intended group of users and some preconceived (already thought of) applications in which these users are interested

Simplified Database



Book

Example of Database: University

Data:

STUDENTs

COURSEs

SECTIONs (of COURSEs)

(academic) DEPARTMENTs

INSTRUCTORs

Relation:

SECTIONs are of specific COURSEs

STUDENTs take SECTIONs

COURSEs have prerequisite COURSEs

INSTRUCTORs teach SECTIONs

COURSEs are offered by DEPARTMENTs

STUDENTs major in DEPARTMENTs

Example of a simple database

COURSE

Course_name	Course_number	Credit_hours	Department
Intro to Computer Science	CS1310	4	CS
Data Structures	CS3320	4	CS
Discrete Mathematics	MATH2410	3	MATH
Database	CS3380	3	CS

SECTION

Section_identifier	Course_number	Semester	Year	Instructor
85	MATH2410	Fall	04	King
92	CS1310	Fall	04	Anderson
102	CS3320	Spring	05	Knuth
112	MATH2410	Fall	05	Chang
119	CS1310	Fall	05	Anderson
135	CS3380	Fall	05	Stone

GRADE_REPORT

Student_number	Section_identifier	Grade
17	112	B
17	119	C
8	85	A
8	92	A
8	102	B
8	135	A

PREREQUISITE

Course_number	Prerequisite_number
CS3380	CS3320
CS3380	MATH2410
CS3320	CS1310

Figure 1.2
A database that stores student and course information.

Example of a simplified database catalog

RELATIONS

Relation_name	No_of_columns
STUDENT	4
COURSE	4
SECTION	5
GRADE_REPORT	3
PREREQUISITE	2

COLUMNS

Column_name	Data_type	Belongs_to_relation
Name	Character (30)	STUDENT
Student_number	Character (4)	STUDENT
Class	Integer (1)	STUDENT
Major	Major_type	STUDENT
Course_name	Character (10)	COURSE
Course_number	XXXXNNNN	COURSE
….	….	…..
….	….	…..
….	….	…..
Prerequisite_number	XXXXNNNN	PREREQUISITE

Note: Major_type is defined as an enumerared type with all known majors. XXXXNNNN is used to define a type with four alpha characters followed by four digits

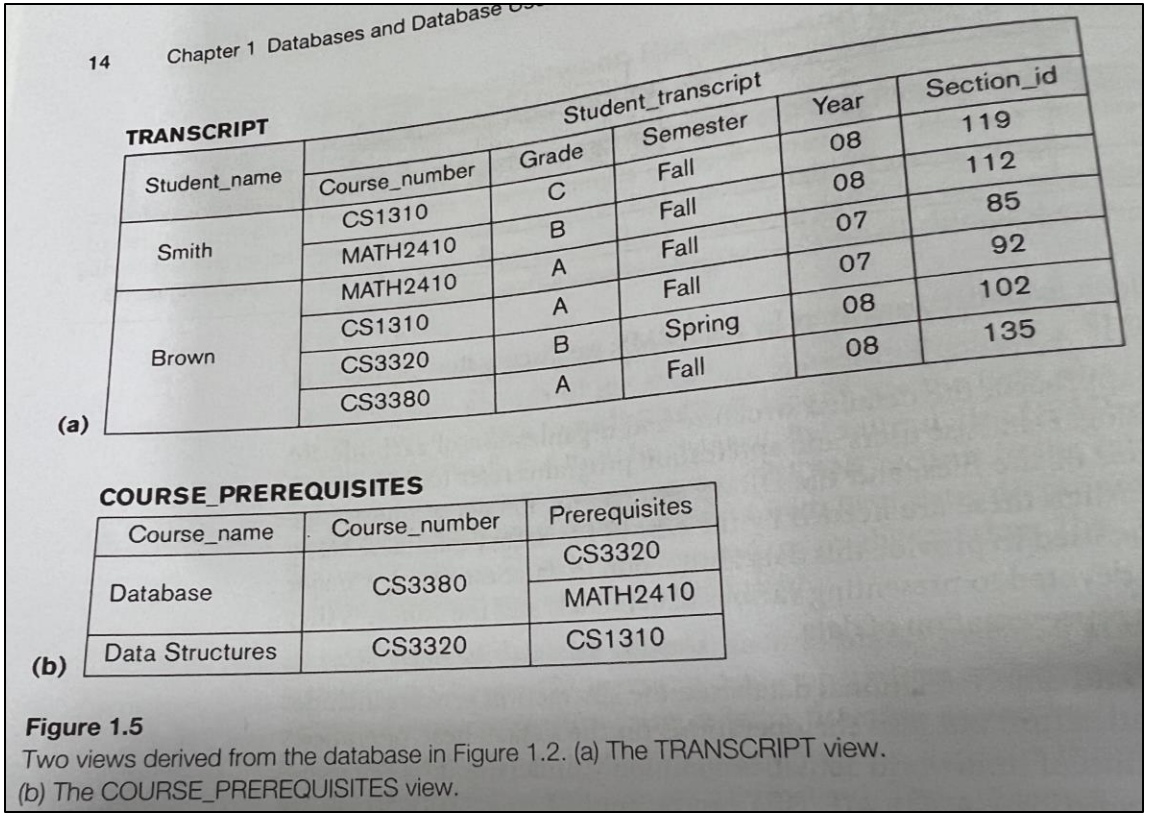
Figure 1.3
An example of a database catalog for the database in Figure 1.2.

Views

Many users to DB

Each users may require a different view

View may be a subset or virtual data derived



TRANSCRIPT

Student_name	Student_transcript				
	Course_number	Grade	Semester	Year	Section_id
Smith	CS1310	C	Fall	08	119
	MATH2410	B	Fall	08	112
Brown	MATH2410	A	Fall	07	85
	CS1310	A	Fall	07	92
	CS3320	B	Spring	08	102
	CS3380	A	Fall	08	135

(a)

COURSE_PREREQUISITES

Course_name	Course_number	Prerequisites
Database	CS3380	CS3320
		MATH2410
Data Structures	CS3320	CS1310

(b)

Figure 1.5

Two views derived from the database in Figure 1.2. (a) The TRANSCRIPT view. (b) The COURSE_PREREQUISITES view.

Online Transaction Processing (OLTP)

Multiuser DB

Concurrency control

Flight ticket booking, seats available

Transaction

Executing program or process that includes one or more database accesses, reading or updating of database records

Properties [ACID]

- Atomicity: either all are executed or none are executed [A/c A → A/c B]
- Consistency: any data written to a DB must be valid according to the defined rules [telephone number]
- Isolation: each transaction appears to execute in isolation, even though 100s may be executing at the same time [updating the seat preference]
- Durability: guarantees that once a transaction has been committed, it will remain committed even in the case of a system failure

Actors on the Scene: Day-to-Day use of DB

Database administrators

- authorizing access to DB, coordinating & monitoring its use, accountable for security breaches & response time

Database designers

- responsible for identifying the data to be stored in the DB, interact with potential group of users and develop *views* of the DB

End Users: Casual, naïve / parametric, sophisticated, stand-alone users

- Casual: occasional users, typically middle or high-level managers
- Naïve / parametric: constantly updating the db using *canned transaction,* done using mobile apps
  - bank tellers checking balances post withdrawals & deposits
  - reservation agents checking for availability
  - social media users post and read items on platforms

Any questions?

Bibliography / Acknowledgements

Instructor materials from Elmasri & Navathe 7e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ponguru

Thank you for attending the class!!!


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