

# Lecture 1 – Introduction to Databases

## CPE241 – Database Systems

13 January 2026

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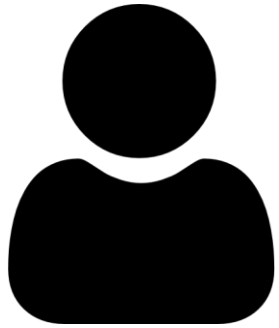


# Today's Goals

- What is a database?
- History of databases
- Database types
- What is a relational database?
- What is SQL?



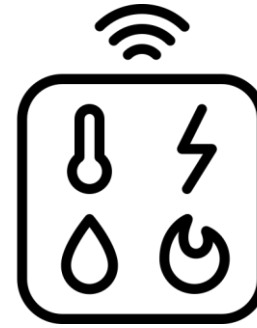
# Define “data”



Personal Data



Shopping Data  
(Consumer Data)



Sensor Data

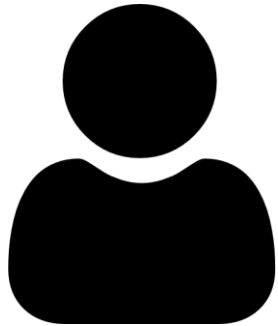


Geographical  
Data

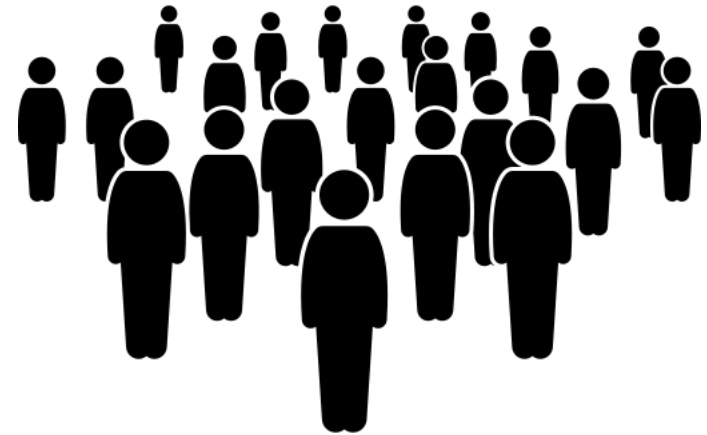
# Data

Facts and figures about anything

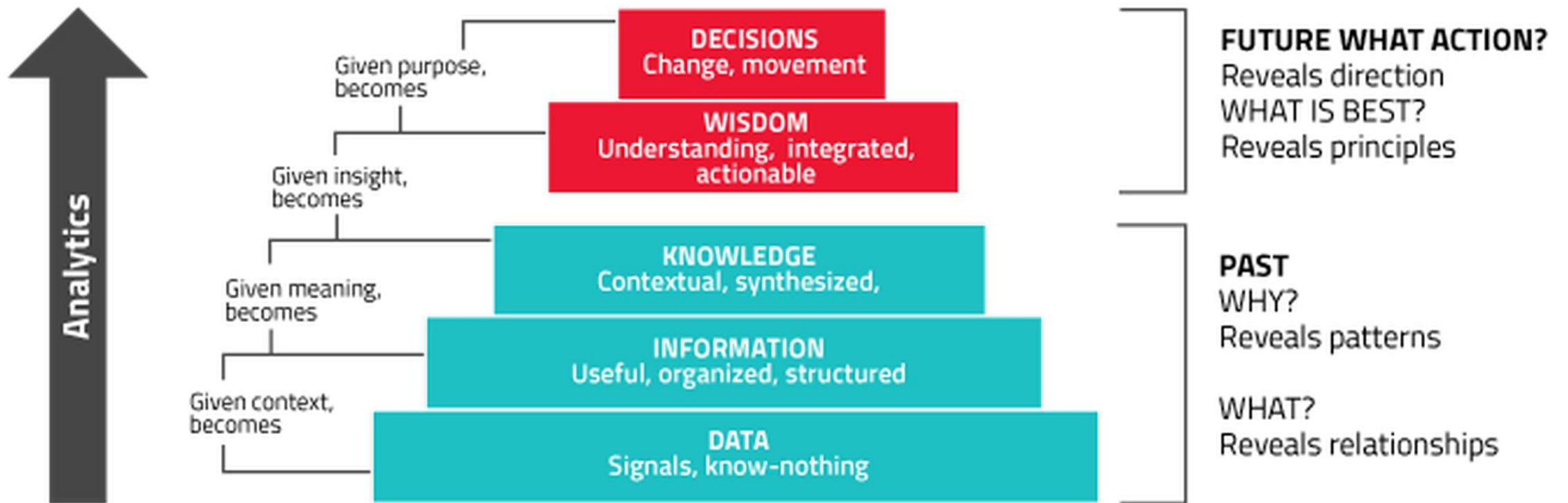
**One personal data**



**More data...**



# DIKW Pyramid

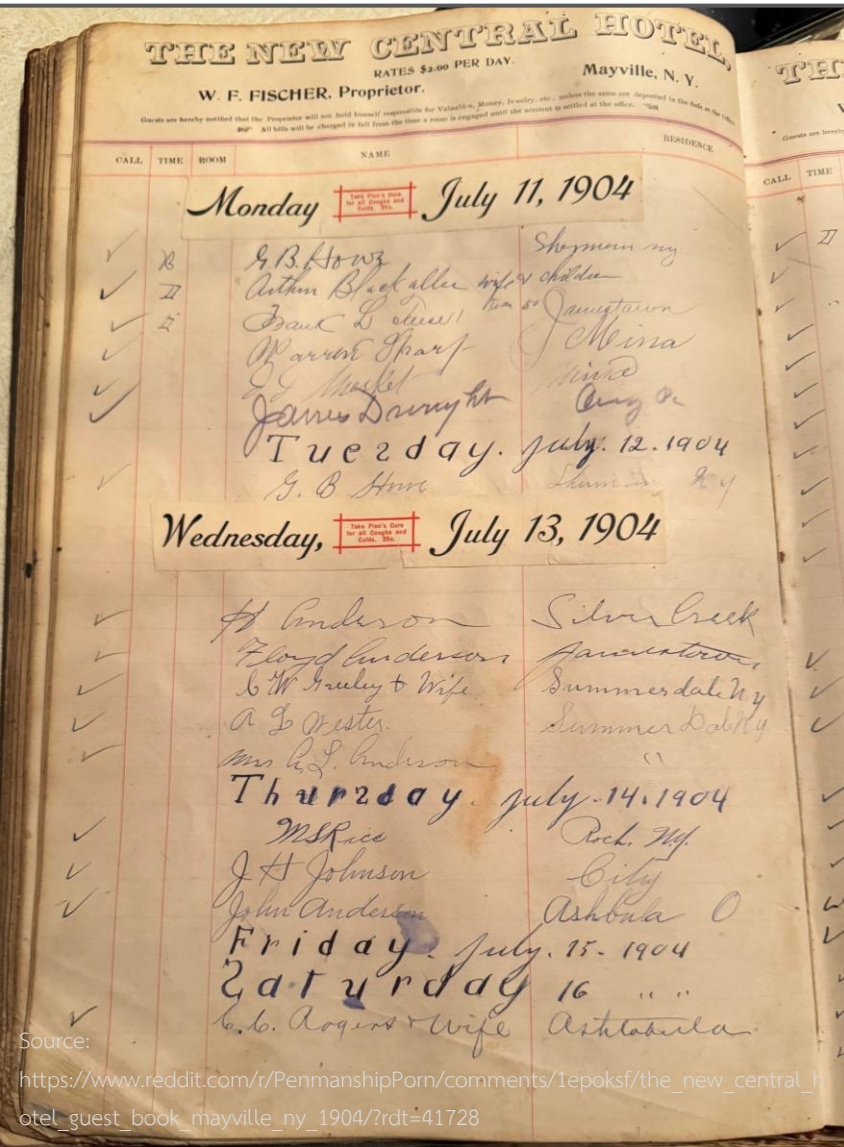


Source: <https://electronics360.globalspec.com/article/4890/optimal-analysis-algorithms-are-iiot-s-big-opportunity>

# More Complex Data

Cases	Data	Need to know (Information)
Library		
CPE		
Bank		
Online shopping		
Hospital		
Online games		

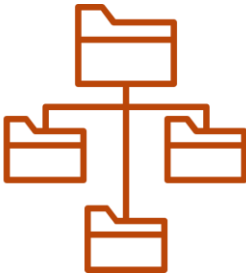
# How to store data?



Can we derive information?

# Database History

- KMUTT library

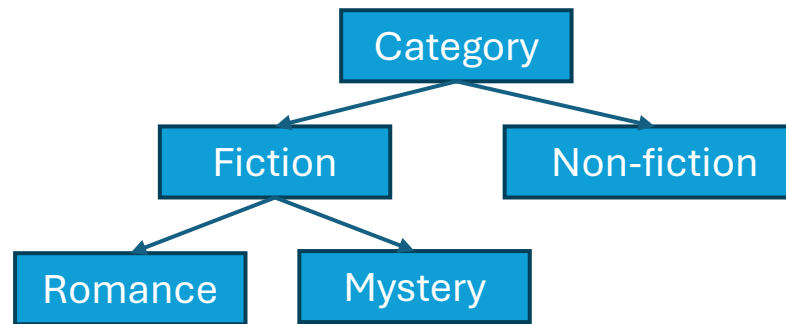


## File Cabinets (1950s-1960s)

**Problem:** Searching & updating

**Solution:** File

**Next problem:** Each file is isolated.

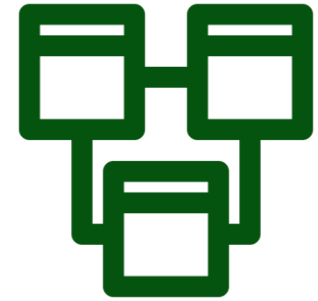


## Hierarchical & Network Databases (1960s-1970s)

**Problem:** Rigid. How about a multiple category book?

**Solution:** A network structure

**Next problem:** The complexity increases. Hard to navigate and update.



## Relational Databases (1970s-1980s)

E.F. Codd proposed **tables** to store everything that can relate to each other.

*Example: 1."Books" 2."Authors" 3."Borrowers" ...*

**Key Idea:** A common identifier (like AuthorID) to link data between tables.

**Result:** Easier to organize, update, and retrieve.

**Standard:** SQL (a query language)

*Example: Find "all mystery books written after 2000"*

# Database History

- KMUTT library



## NoSQL & Big Data (2000s)

The library grows beyond books with the Internet.

**Problem:** Volume and variety of data

**Solution:** NoSQL databases designed for flexibility and speed.



## Modern Databases (2010s and Beyond)

The library becomes virtual, accessible worldwide.

**Problem:** Physical servers is costly and hard to scale.

**Solution:** Cloud databases



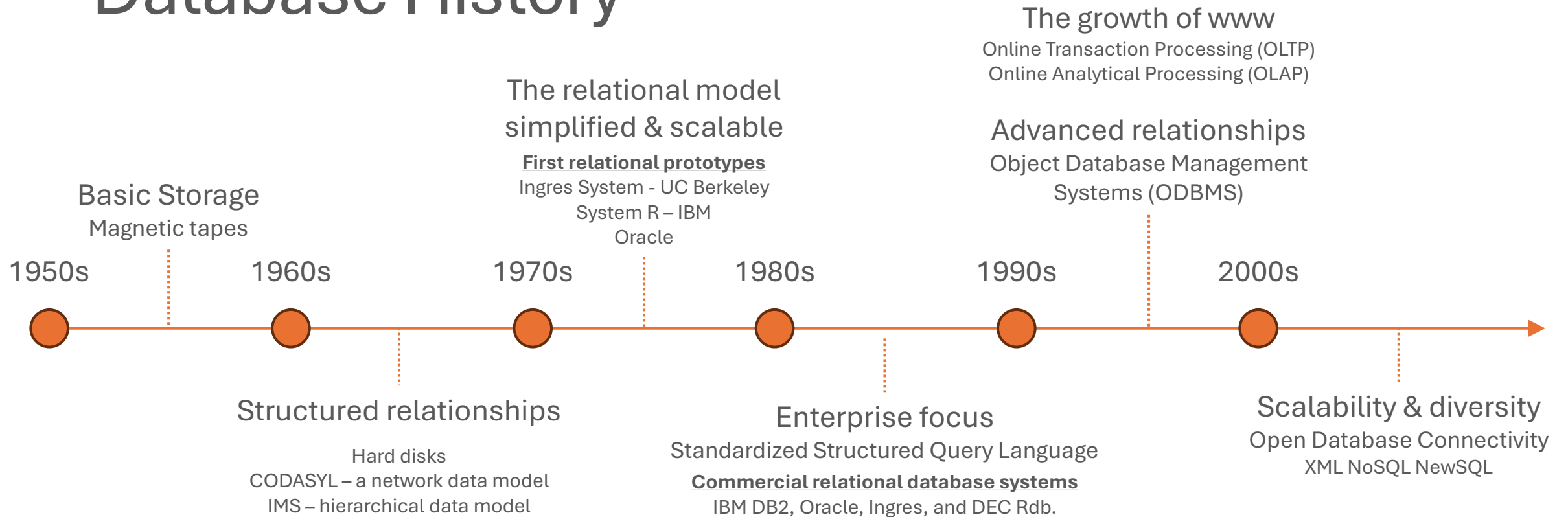
## Intelligent Libraries (Today)

Databases are evolving.

*Examples: AI for book recommendation.*

*Blockchain for secure records.*

# Database History



More challenges await...

# Database

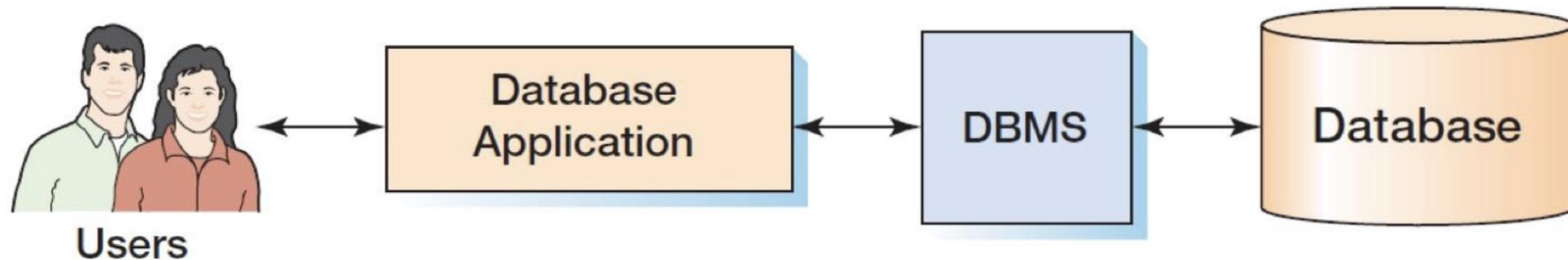
- Purpose: to help individuals focus on topics or areas of their interest.
- A collection of related data
- Scalability
- A form of data storage that can **manipulate data** to make it more **manageable, efficient, and secure**.
  - Store data in a structured way that is can be easily retrieved.
  - Quickly and accurately provide data.

# Database Tasks

- Store data
- Filter data
- Search data
- Perform Create Read Update Delete (CRUD) operations
- Form relationships
- Etc.

# Database Management Systems (DBMS)

- A collection of programs that enables users to create and maintain a database.



- Create database
- Create tables
- Create supporting structures (e.g., indexes)
- Read database data
- Modify (insert, update, or delete) database data
- Maintain database structures
- Enforce rules
- Control concurrency
- Provide security
- Perform backup and recovery

- **Create**
- **Process**
- **Administer**

# Prominent DBMS Products

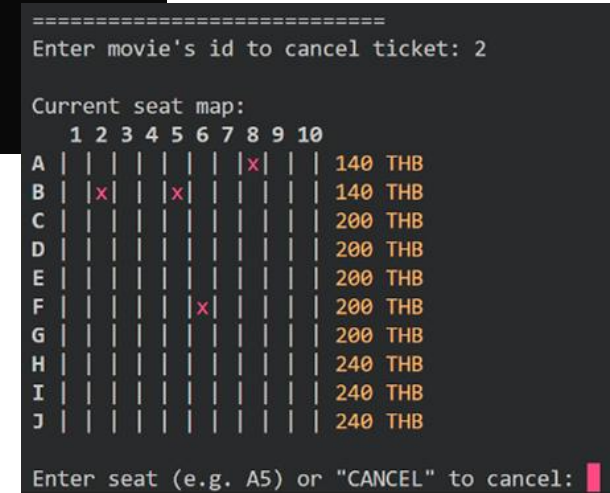
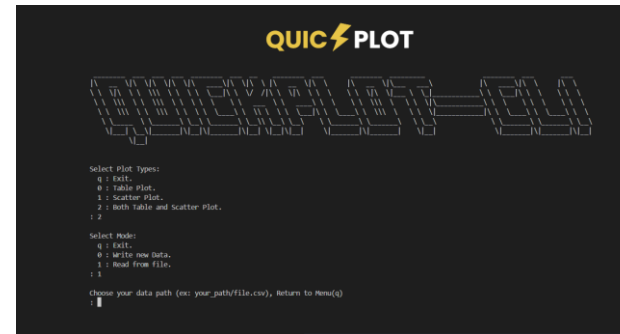
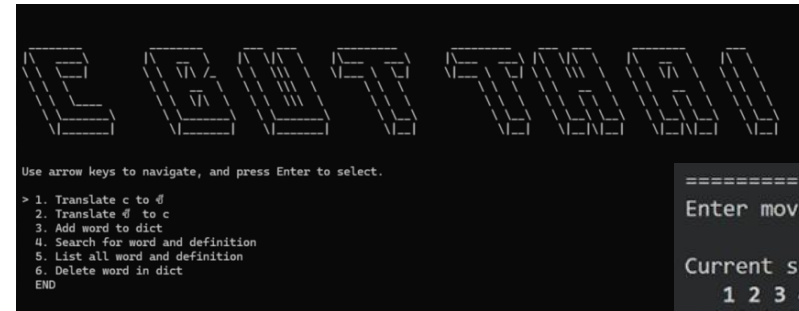
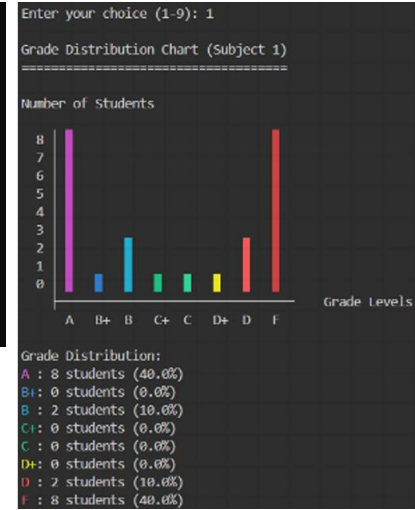
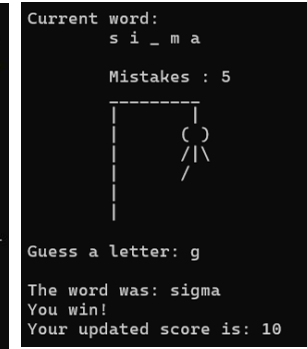
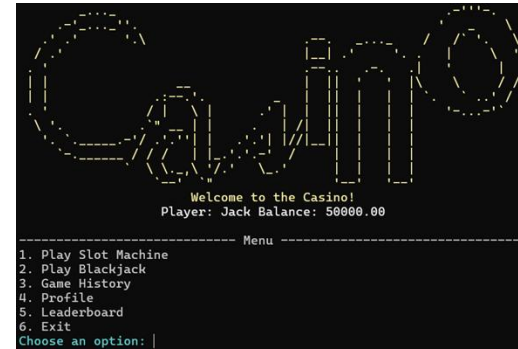


# More Examples

Application	Example Users	Number of Users	Typical Size	Remarks
Sales contact manager	Salesperson	1	2,000 rows	Products such as GoldMine and Act! are database centric.
Patient appointment (doctor, dentist)	Medical office	15 to 50	100,000 rows	Vertical market software vendors incorporate databases into their software products.
Customer relationship management (CRM)	Sales, marketing, or customer service departments	500	10 million rows	Major vendors such as Microsoft and Oracle PeopleSoft Enterprise build applications around the database.
Enterprise resource planning (ERP)	An entire organization	5,000	10 million+ rows	SAP uses a database as a central repository for ERP data.
E-commerce site	Internet users	Possibly millions	1 billion+ rows	Drugstore.com has a database that grows at the rate of 20 million rows per day!

# More Examples from...

- QuickPlot CLI
- C But Thai
- ระบบจัดการหนังสือรุ่นอัจฉริยะ  
ย้อนยุคดึกดำบรรพ์อัตโนมัติ  
โดยอัตโนมัติ
- Student Grading System
- Lung(Bin)go Store
- Prison Management System
- Risk Management Master
- Life Balance"
- Mood Diary
- Minor Cineplex
- Clonetaker
- 8-bit Arcard Game
- Word Scramble
- Hangman Game



SCOREBOARD

Name	Peak	Total	Words	W/HP	W/Min
Fin	1530	2905	48	1.00	6.34
Tae	225	435	12	0.00	2.40
Nammy	75	150	5	0.00	0.00
Ping	60	190	11	0.00	0.00
Dog	45	45	2	0.00	6.00
Food	45	45	2	0.00	0.00
Bob	30	30	2	0.00	12.00
Jerry	20	80	4	0.00	0.00

Type a name to look up the rank, or (1) to exit: |

Summary Your Week

Sun	Mon	Tue	Wed	Thu	Fri	Sat
13/10	14/10	15/10	16/10	17/10	18/10	19/10
-	-	9	-	-	7	-
		0v0			I_I	

# Storage



## Dedicated Server

One physical machine runs a single app of a business

Expensive & high maintenance



## Virtual Private Server

One physical machine runs multiple apps of a business on virtualized machines



## Shared Hosting

One physical machine shared by several businesses

Cheap & limited

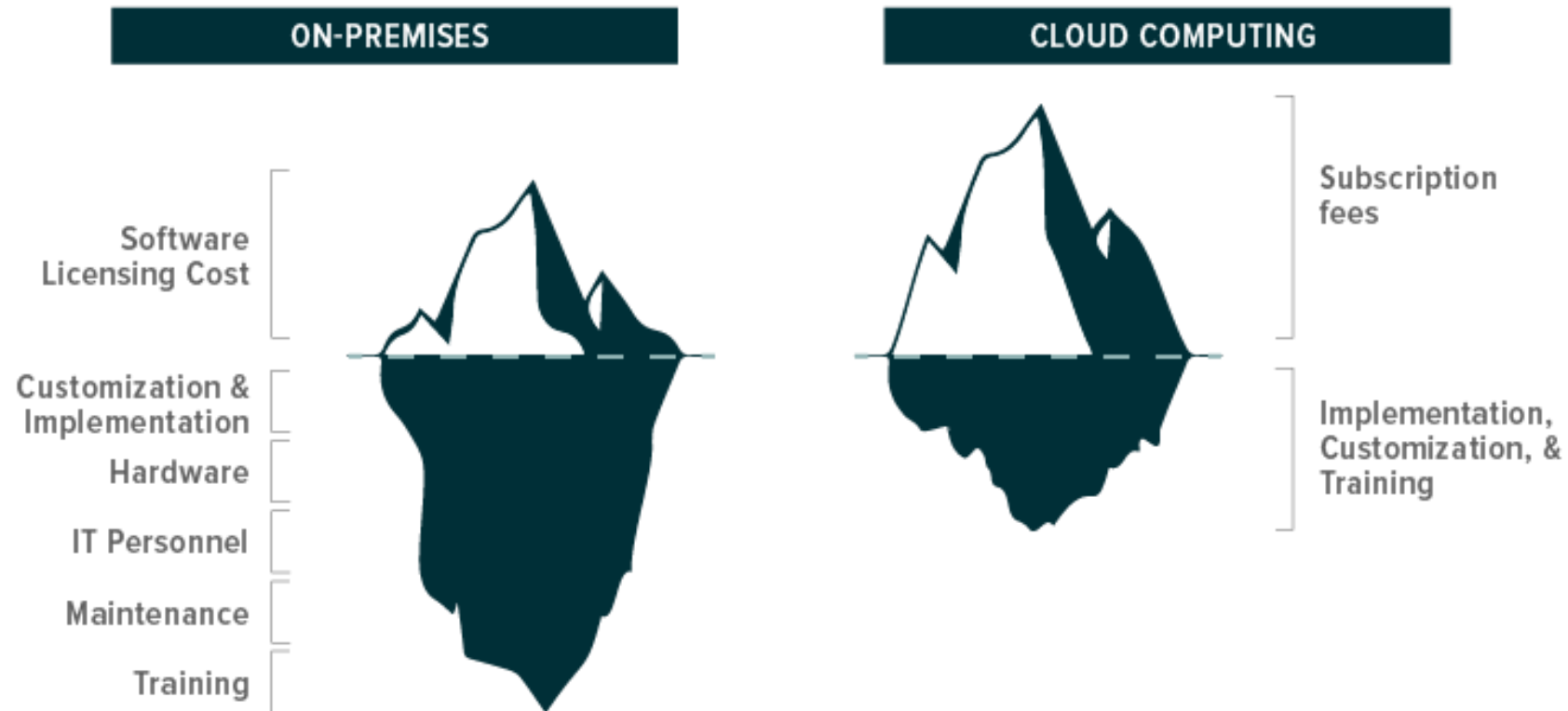


## Cloud Hosting

Multiple physical machines (as one system) provide multiple cloud services

Flexible, scalable, secure, cost-effective

# On-premise vs Cloud Computing



ONGOING COSTS	
- Apply patches, upgrades	- Upgrade dependent applications
- Downtime	- Ongoing burden on IT (hardware)
- Performance tuning	- Maintain/upgrade network
- Rewrite customizations	- Maintain/upgrade security
- Rewrite Integrations	- Maintain/upgrade database

ONGOING COSTS	
- Subscription fees	- Configuration
- Training	- System Administration

Source: <https://www.globalxetfs.com/cloud-computing-digital-infrastructure/>

# Database Types

1. Hierarchical databases
2. Network databases
3. Relational databases
4. Object oriented databases

3

Roll no.	Student Name	Marks Awarded
1	Raman Tripathi	86
2	Rajan Govindan	94
3	Mahesh Nandalal	94

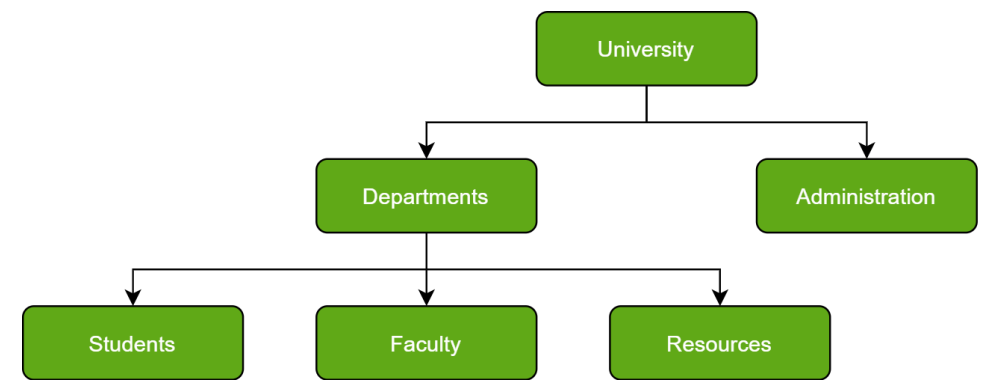
Key = 94

Marks Awarded	Student Name	Rank	Scholarship
94	Rajan Govindan	17	Yes
94	Mahesh Nandalal	16	Yes

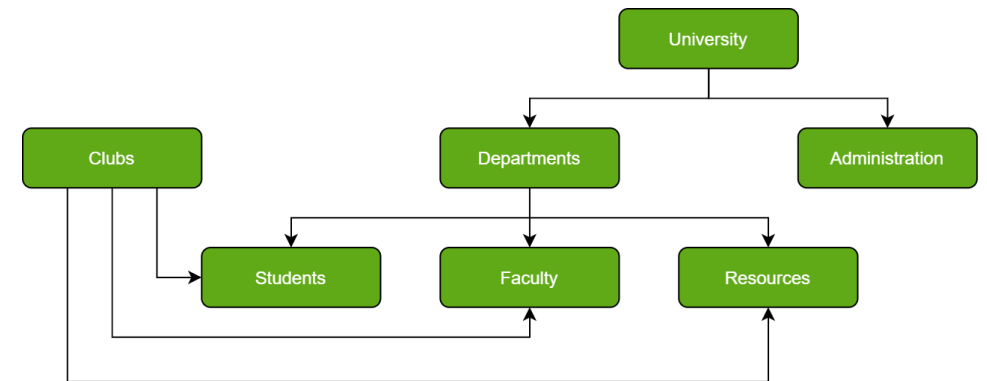
Source: <https://www.geeksforgeeks.org/types-of-databases/>

Section	Student Name	Marks Awarded	Rank
A	Raman Tripathi	86	43
B	Rajan Govindan	94	17
C	Mahesh Nandalal	94	16

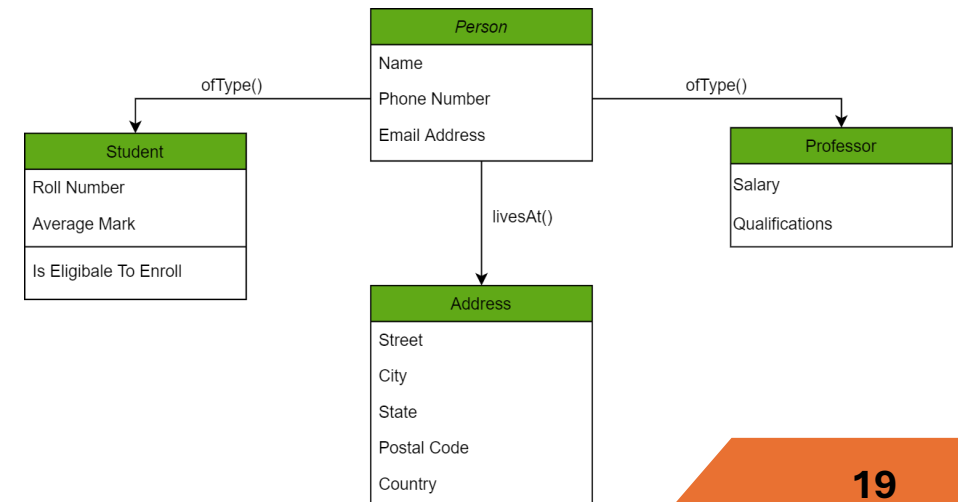
1



2



4

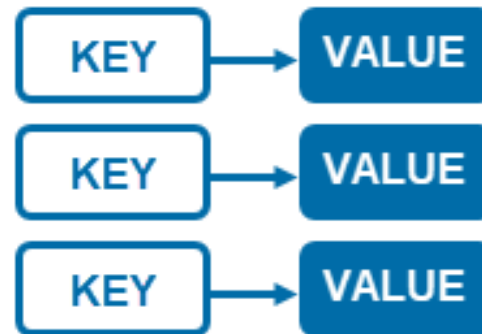


# Database Types

- NoSQL
  - Column-oriented
  - Key-value stores
  - Graph database
  - Document-oriented: JSON, BSON, XML documents
- Etc.



**Column based**



**Key-value**



**Graph**



**Document**

# Relational Databases

- What does relational database look like?
- Data organized systematically

**Entity, Relation / Table / File**

**Attribute / Column / Field**

**Tuple / Row / Record**

	A	B	C	D	E	F
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

# Relational Databases

- A relation is a two-dimensional table that has the following characteristics:
  - Rows contain data about an entity.
  - Each record must be uniquely identifiable (normally by a *primary key*).
  - Columns contain data about attributes of the entity.
  - All entries in a column are of the same kind.
  - Each column has a unique name.
  - Cells of the table hold a single value.
  - The order of the columns/rows is unimportant.

# Relational Databases

- An example of a relation

EmployeeNumber	FirstName	LastName	Department	Email	Phone
100	Jerry	Johnson	Accounting	JJ@somewhere.com	834-1101
200	Mary	Abernathy	Finance	MA@somewhere.com	834-2101
300	Liz	Smathers	Finance	LS@somewhere.com	834-2102
400	Tom	Caruthers	Accounting	TC@somewhere.com	834-1102
500	Tom	Jackson	Production	TJ@somewhere.com	834-4101
600	Eleanore	Caldera	Legal	EC@somewhere.com	834-3101
700	Richard	Bandalone	Legal	RB@somewhere.com	834-3102

# Relational Databases

- An example that is not a relation

EmployeeNumber	FirstName	LastName	Department	Email	Phone
100	Jerry	Johnson	Accounting	JJ@somewhere.com	834-1101
200	Mary	Abernathy	Finance	MA@somewhere.com	834-2101
300	Liz	Smathers	Finance	LS@somewhere.com	834-2102
400	Tom	Caruthers	Accounting	TC@somewhere.com	834-1102
				Fax:	834-9911
				Home:	723-8795
500	Tom	Jackson	Production	TJ@somewhere.com	834-4101
600	Eleanore	Caldera	Legal	EC@somewhere.com	834-3101
				Fax:	834-9912
				Home:	723-7654
700	Richard	Bandalone	Legal	RB@somewhere.com	834-3102

# Relational Databases

- Data stored in a database have relationship with other data.
- Describe how data is related.
- A link between the data in the tables.

**Student**

Student ID	Name	Email
100001	Alice	Alice@kmutt.ac.th
100002	Bob	Bob@kmutt.ac.th
100003	Carol	Carol@kmutt.ac.th

**StudentCourse**

Student ID	Course ID
100001	CPE100
100001	CPE112
100001	CPE241
100002	CPE100
100002	CPE112
100003	CPE100

**Course**

Course ID	Name
CPE100	Computer Programming for Engineers
CPE112	Programming with Data Structures
CPE241	Database Systems

# Relational Databases

- Each record must be uniquely identifiable (normally by a **primary key**).

**Student**

<u>Student ID</u>	Name	Email
100001	Alice	Alice@kmutt.ac.th
100002	Bob	Bob@kmutt.ac.th
100003	Carol	Carol@kmutt.ac.th

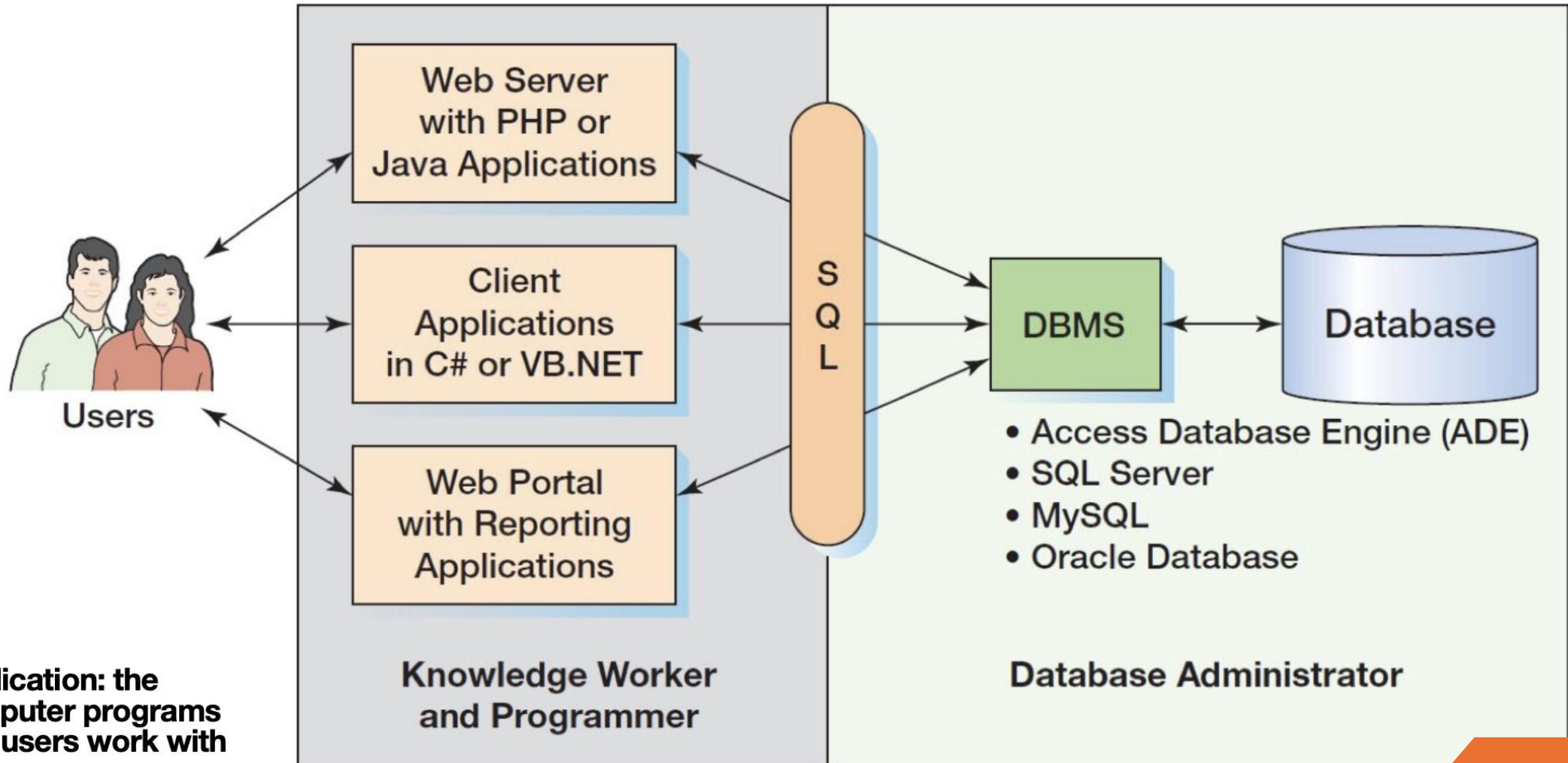
**StudentCourse**

<u>Student ID</u>	<u>Course ID</u>
100001	CPE100
100001	CPE112
100001	CPE241
100002	CPE100
100002	CPE112
100003	CPE100

**Course**

<u>Course ID</u>	Name
CPE100	Computer Programming for Engineers
CPE112	Programming with Data Structures
CPE241	Database Systems

# Enterprise-class DBMS



# Structured Query Language

- SQL – standard language that can be interact with structured data on databases
- Advantages
  - User-friendly – requires little coding skill
  - Standard language – compatible with available relational databases
  - Portable language – can be used in any hardware running any OS
  - Data processing – process large amount of data quickly and efficiently

# Wrap up

- Evolution of ways to store data
  - Database history
- What are database and DBMS?
  - Tasks
  - Storage
  - Database types
- A short introduction
  - Relational databases
  - SQL