Database Management

MIS 471

Instructor Contact Information

- Email
  - dbrandon@cbu.edu
- Phone
  - 321-3615 (email is better)
- Office
  - BU 302
    - Check office door for current physical office hours
    - Online courses may have all office hours online

Canvas

- Canvas is now used for this course
- Whether this class is in-person, online, or hybrid:
    - All submissions of assignments are to be submitted via Canvas
    - Gradebook is in Canvas
- Canvas contains the syllabus page and the course policies page

Canvas (con't)

Canvas (con't)

Canvas: Getting Started

The Basics

- What are the basic computer specifications for Canvas?
- Which browsers does Canvas support?
- How can I use Canvas on my mobile device?
- How do I get Help?

Canvas Overview
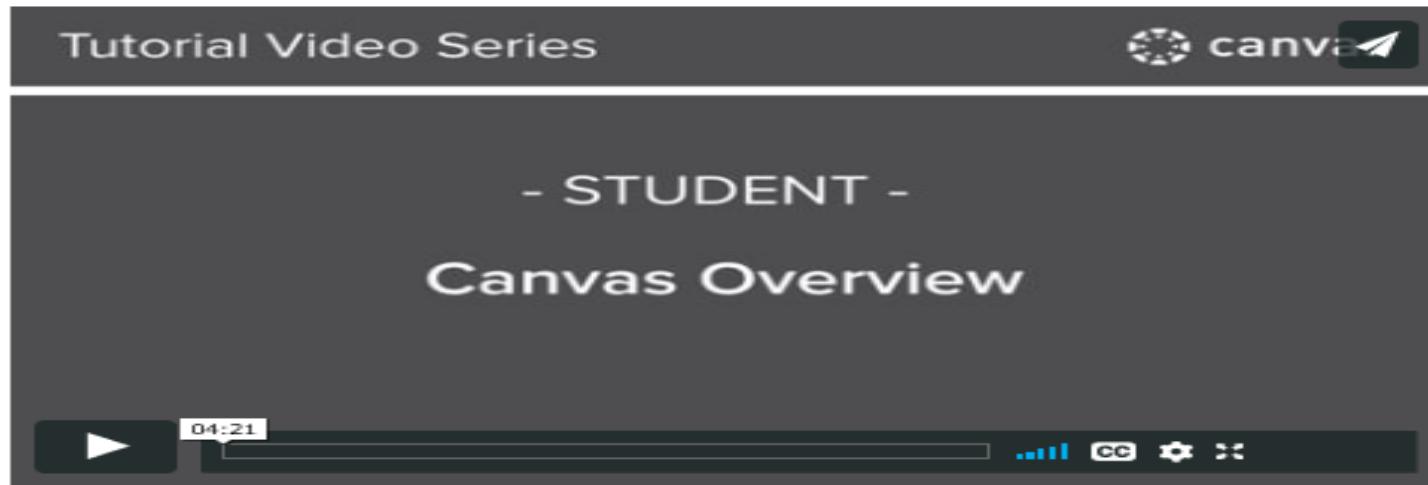
Tutorial Video Series · canva

- STUDENT -

Canvas Overview

04:21

Syllabus in Canvas

Textbook

Database Systems: Design, Implementation, & Management, 13th Edition
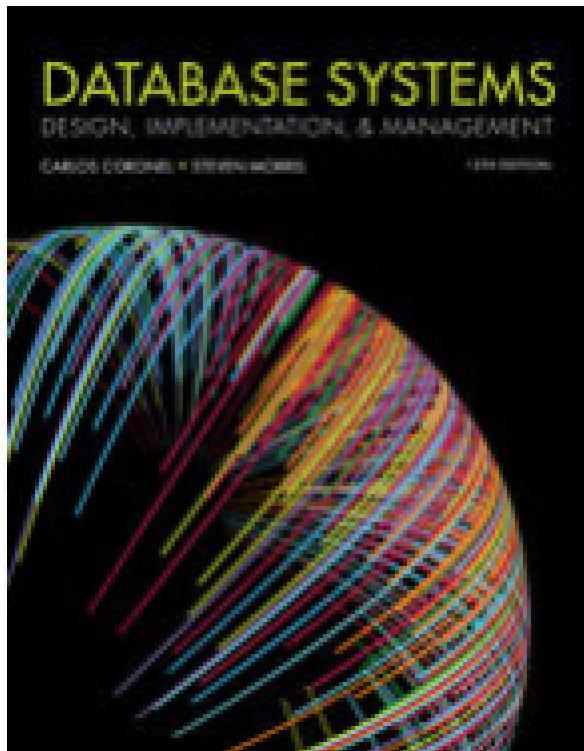
Carlos Coronel, Steven Morris
ISBN-10: 1337627909
ISBN-13: 9781337627900
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CBU Follet Access Program

[https://www.cbu.edu/bookstore/follett-access-book-program/]

- Now all CBU class textbook rental and required supplies costs will now be included in a flat-rate "book fee" on your CBU bill so that you know in advance what your costs will be

- The **Follett ACCESS Program** delivers required materials for the courses for which you're registered, making sure you're prepared for the first day of class

- Students will be charged $23 per credit hour (Spring 2022 rate) to cover all required course materials

- To make paying for the fee convenient, it can be included in any payment plan you choose

- Typically, students save money with the flat fee based on total credit hours!

CBU Follet Access Program

Follett ACCESS Program

STEP 1
Start of Class
Select courses for the upcoming term

STEP 2
Course List
Your course list will be sent to your campus store.

STEP 3
Your Order is Prepared
Your campus store pulls ALL required course materials. (They work with your professors and know everything you need!)
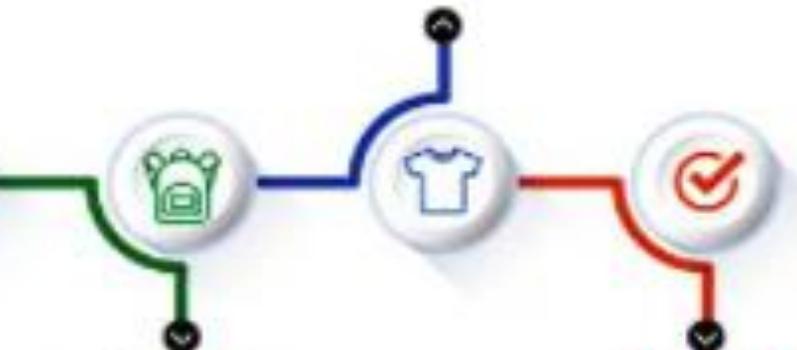
STEP 4
Pick up Your Physical Course Materials
at the CBU Bookstore

STEP 5
Gear Up!

STEP 6
That's it!
You are prepared for day one!

Is Follett ACCESS required for all students?

No, students may choose to opt out of the Follett ACCESS program by [clicking here](). Please note that you will be prompted to create an account to allow you to opt out. Students wishing to opt out must do so by the last day to add/drop a course to avoid having the "book fee" assessed on their account. When students opt out of Follett ACCESS, they do so for all courses in a given term. Students may not opt out of individual courses.

Follett ACCESS Opt Out

All students are by default enrolled in the Follett ACCESS program and must take action to opt out of the program.

Students who opt out of Follett ACCESS will be responsible for finding their required course materials on their own. You are not under an obligation to purchase your required course materials from the CBU Campus Bookstore or through the Follett ACCESS program, but all materials will be available at the CBU Campus Bookstore.

Cengage Unlimited

Cengage Unlimited (con't)

Cengage Unlimited (con't)

- All that is required of the student for a Cengage Unlimited subscription is to come by the CBU bookstore and choose whether they would like a 4 month (119.99), a 12 month (179.99), or 24 month access (239.99)

- With this access, they will have every book Cengage has ever digitized, which is around 22,000 total titles and about 7800 that Follett currently uses across all US stores

- Even if they are not taking the course the book is being used for, they can still access that title

- All instructors need to do is adopt the book through the bookstore and on the Shelf Tag, it will print the prices for the New and Used Retail, New and Used Rental (If Applicable) the three tiers of Cengage Unlimited, and the eBook only price

Cengage Unlimited eTextbooks

ONLY WANT TEXTBOOKS?

Ask about **Cengage Unlimited eTextbooks**—the new option including all the benefits of Cengage Unlimited without our learning platforms. Leverage as many textbooks as you want for your class without asking students to pay by-the-book.

STUDENT PRICING OPTIONS

Cengage Unlimited options are available direct to students in campus bookstores and online.

	CENGAGE UNLIMITED eTEXTBOOKS	MINDTAP WEBASSIGN OPENNOW SAM CNOW^{V2} OWL^{V2} eTEXTBOOKS		
	$69.99 for 4 months	$119.99 for 4 months	$179.99 for 1 year	$239.99 for 2 years
Instant Access Code (IACs)	978-0-357-69333-9	978-0-357-70000-6	978-0-357-70001-3	978-0-357-70002-0
Printed Access Code (PACs)	978-0-357-69393-3	978-0-357-70003-7	978-0-357-70004-4	978-0-357-70005-1

Backups

- Students are responsible for backing up their files

- Losing a file (or an USB) is no excuse

- Office 365 OneDrive

- Cloud Providers
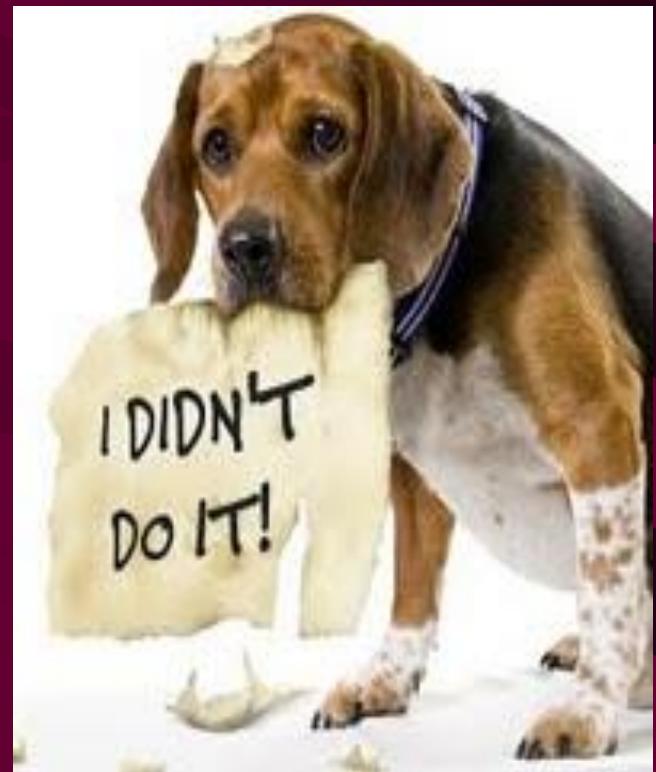
1. What OneDrive Is

OneDrive is a cloud-based storage drive for your CBU files. Your OneDrive is linked to your CBU Microsoft 365 account and password protected behind CBU's single sign-on (SSO). It's an ideal place to upload files you want to use in your course and to share.

2. Finding Your OneDrive

1. From the CBU website, access and log in to MyCBU.
2. From the Resources section, select Office 365.

MyCBU

Resources

Academic Account Links

Canvas	Outlook Email
BannerWeb	Office 365
Starfish	
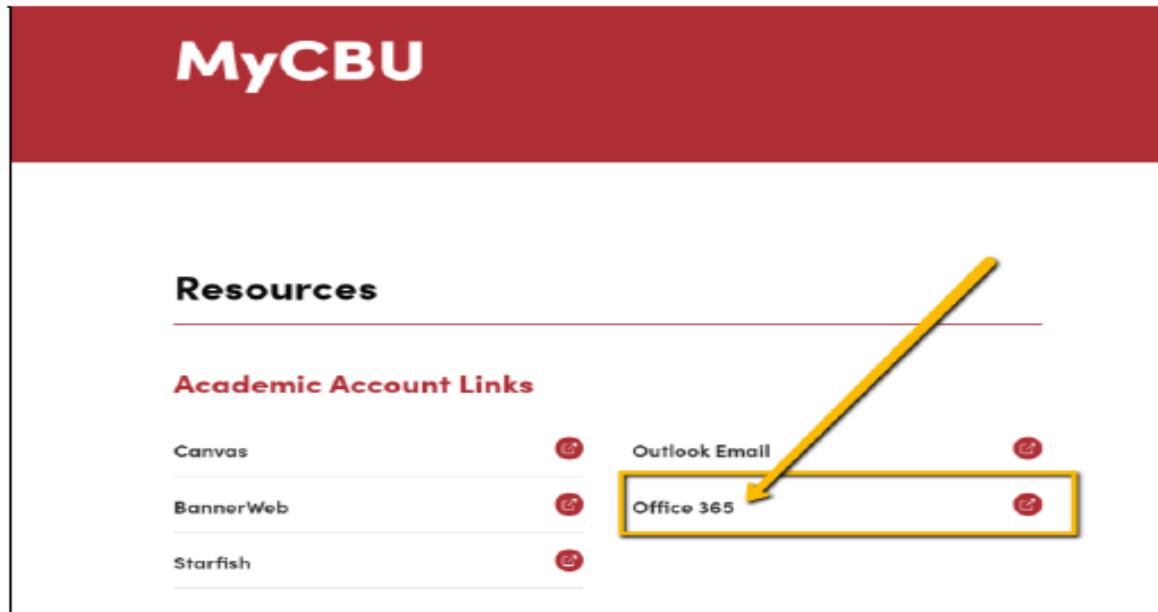
3. Your Office 365 Dashboard

1. You land in your Office 365 Dashboard, a place where you can quickly see and access the files you've recently been working on
2. From the left-hand toolbar, you can quickly create new files or access a number of commonly-used Office 365 tools.
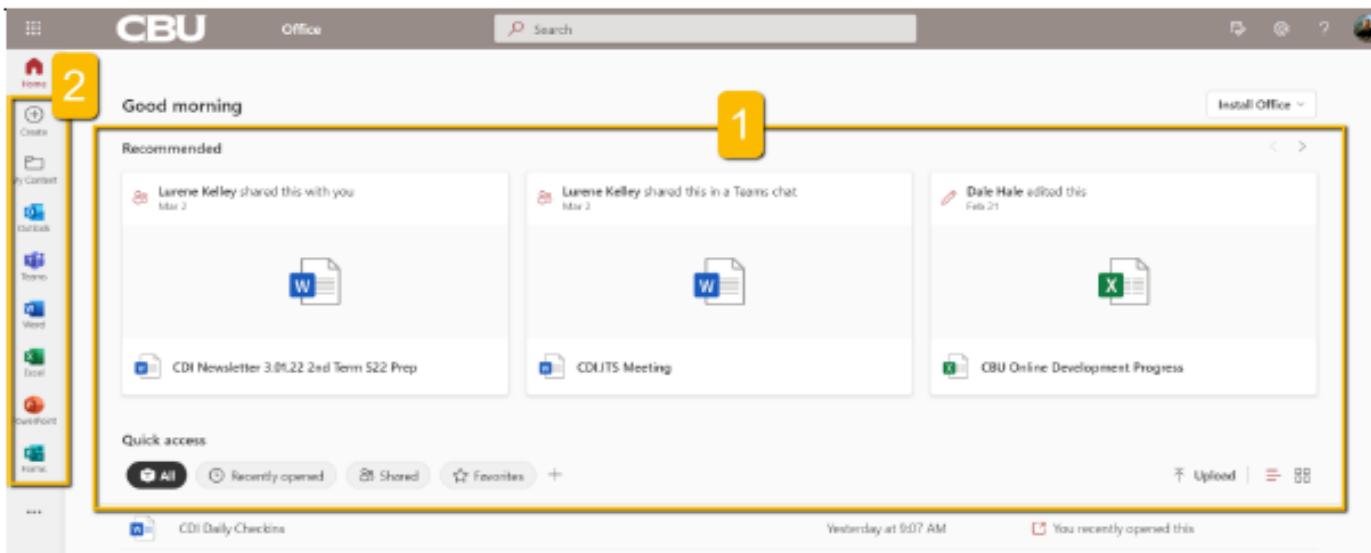
4. The App Launcher & OneDrive

1. To access the Office 365 App Launcher and OneDrive, click the domino icon in the upper right-hand corner of your Dashboard.

2. From the menu drawer that appears at the left of the screen, select OneDrive. Your OneDrive will open in a new tab.
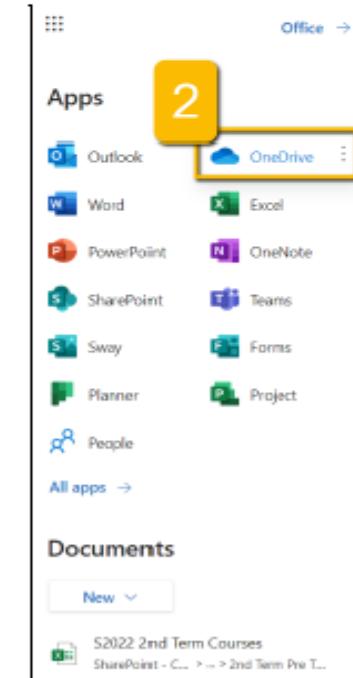
5. Your OneDrive Dashboard

From your OneDrive Dashboard, you can:

1. Quickly access all your files, your recent files, files that have been shared with you, or files that have been trashed;
2. Quickly access any groups to which you have been attached and any files or shared resources that are housed with these groups;
3. Search for a specific file or folder;
4. Quickly create new files/folders or upload existing files/folders from your desktop;
5. View your files and folders;
6. Sort your files and folders in a way that makes sense to you.

6. Create New Files & Folders

- Click the +New button to create new files (Word, Excel, PPT, OneNote, Forms, etc.) or folders in which to organize your files
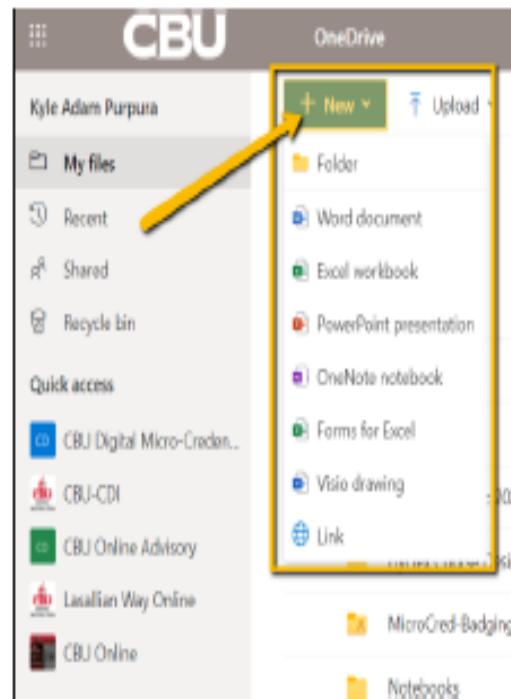
7. Upload Existing Content

- With just a couple of clicks, upload files and folders saved locally
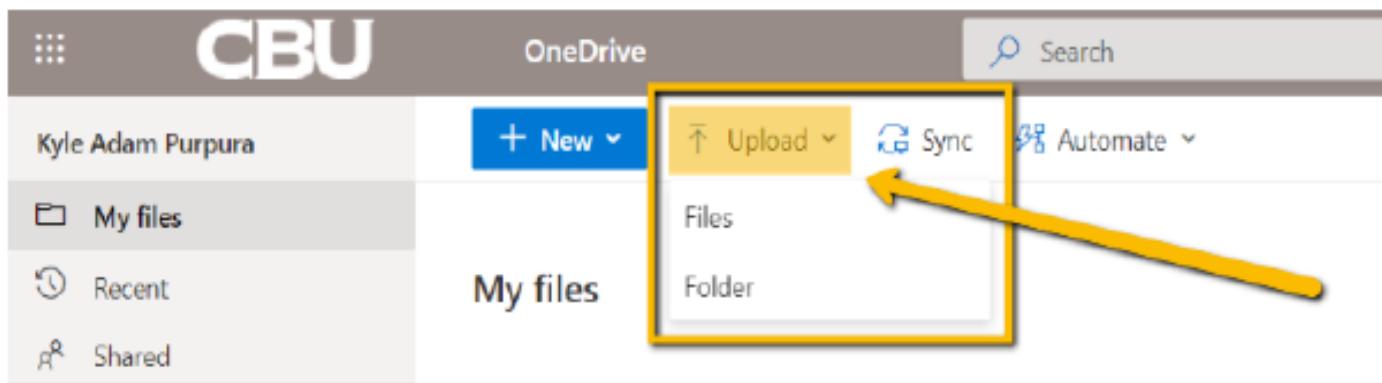
8. Manage Files & Folders

- Hover to the right of file/folder titles to reveal a sharing button and an options (ellipsis) menu
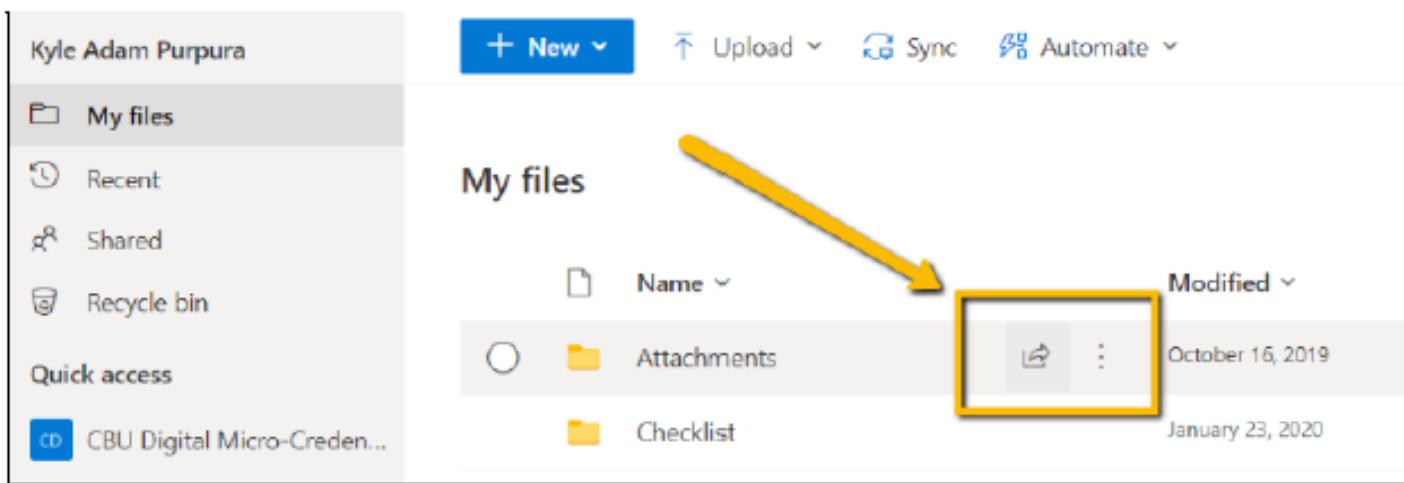
- You can manage the sharing permissions for any file or folder by clicking the sharing icon located to the right of the file/folder title.


1. Send links via email or copy a link to embed in a file;
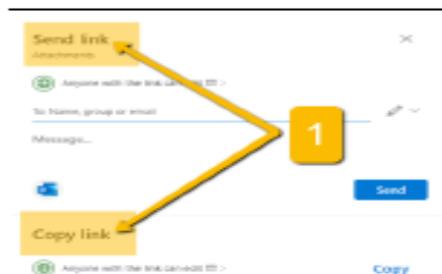
2. Decide who has access;
3. Manage editing rights;
4. Set added security measures;
5. Click Apply to save settings.

Link settings
7 Ideas for C...Content.pptx

Who would you like this link to work for? Learn more

- Anyone with the link
- People in Christian Br...rs University with the link
- People with existing access
- Specific people

Other settings
- ✔ Allow editing

- Expires Thursday Mar 10 2022
- Set password
- Block download

Apply   Cancel

*Notes
- "Anyone with the link" expires automatically in 24 hours
- If you are sharing for a professor in a course, it's best to select "Specific people" and then enter the professor's CBU email where indicated
- Sharing settings applied to a folder are automatically applied to any file within the folder, unless individually changed
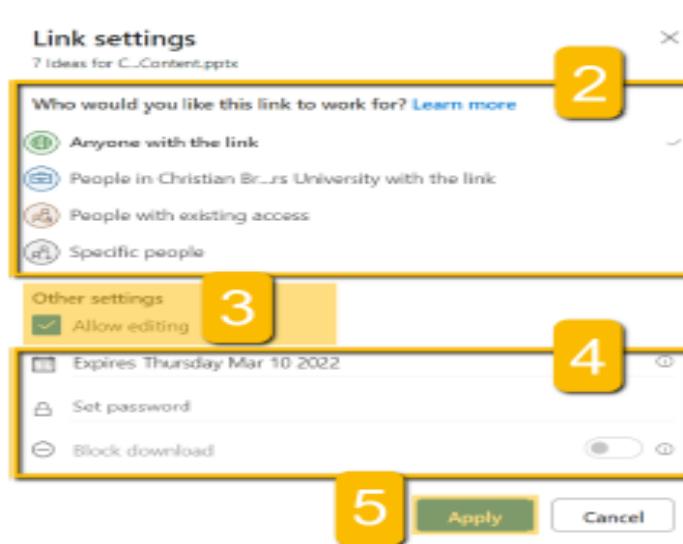
10. Ellipsis (Options) Menu

- The Ellipsis (Options) menu gives you more action options for your files/folders
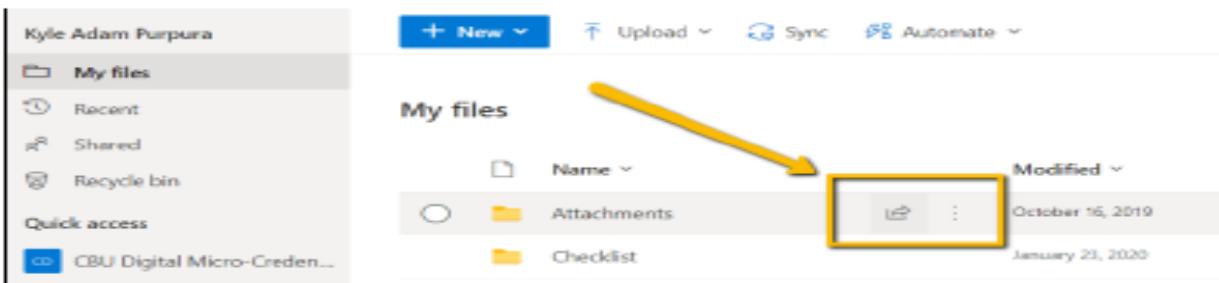
- Sharing, copying, requesting files via email from another person, managing access of existing people shared already, downloading, deleting, moving or copying to another location, renaming, automating (disabled at CBU), and accessing file information
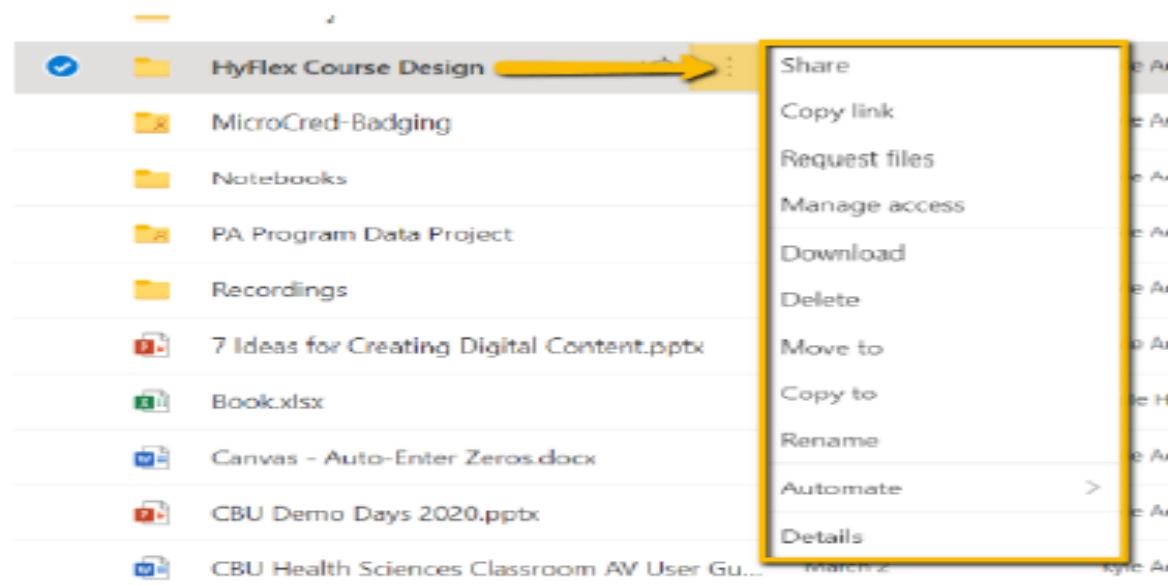
Cloud Backup & Sharing Sites

THE SITE	FREE SPACE	BEST FOR...
Google Drive drive.google.com	5GB	Documents, because the interface makes it easy to edit them
Amazon Cloud Drive amazon.com/clouddrive	5GB	Music, since you can play your stored tunes on any device with Amazon Cloud Player
Dropbox dropbox.com	2GB	Photos, because the site offers a viewer and makes it easy to share albums
Microsoft SkyDrive skydrive.live.com	7GB	Microsoft Office projects that you use from multiple computers, because the site syncs automatically
SugarSync sugarsync.com	5GB	Documents you're collaborating with others on, since you can password-protect public files

Project

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Project Schedule

- Project Progress Reports
  - Overview
  - Design Review (ER) - after coverage of database design
  - Physical Model
- Class Presentation & Files submittal- end of term

Project Topics

- Perhaps CBU Related, or elsewhere if you can get sample data

- Types of previous projects:
  - Student records
  - Parking tickets
  - Placement office
  - Equipment inventory
  - Library records
  - Internship records
  - Sports data (as long as different from example project)

Christian Brothers University

LABS & TOOLS

- <u>Access</u>
- PowerPoint
- Word
- Drawing tool(s)
  - MS Visio
  - ER Design Tool
  - Web Based Drawing

Project Overview

- Topic

- Problem Statement

- Major Entities

Design Review

- Requirements (info, queries/reports, …)
- Entity Attributes
  - Major attributes
  - Unique identifier(s)
- E-R Model
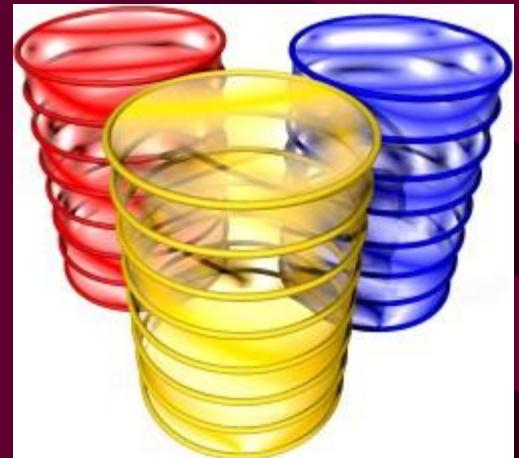
Course Project Deliverables

- Problem statement and requirements

- E-R Model (at least 3 entities)

- Database tables

- SQL Data Definition

- SQL queries (at least 5 queries)

- Prototype (Access, SQL Server, MySql)

  See example project - link from course web page !

Database Today

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Today's Data World

- <u>Ninety percent of all the data in the world was created within the last 2 years, according to IBM</u>

- 70 percent of all new Science, Technology, Engineering and Math (STEM) jobs are in IT

- Mobile computing, "big data", data analytics, and AI are prime growth areas

- "For now, the tech sector is where all the cool jobs are" – Bloomberg Business, 2019

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Career Opportunities

- **High demand and still low supply**
- Internet database application
- Business systems reengineering
- Large databases & distributed systems
- Applications analysis, design, development
- Database administration
- Multidimensional data analysis (OLAP)
- Business changes - globalization
- Mobile computing database applications
- Data Scientist

Top **50** Jobs

MONEY and PayScale.com developed this ranking based on growth prospects, pay for experienced workers, and overall job satisfaction.

CNN Money

		MEDIAN EXPERIENCED PAY	TOP PAY	10-YEAR GROWTH RATE	TOTAL JOBS	FLEXIBLE	SATISFYING	LOW STRESS	JOB PROSPECTS NEXT 12 MONTHS	LONG TERM
1	Software architect	$119,000	$162,000	34%	110,000	A	B	C	B	A
2	Physician assistant	92,000	124,000	39	100,000	B	A	D	B	A
3	Management consultant	117,000	209,000	24	50,000	B	B	D	B	A
4	Physical therapist	76,000	97,000	30	210,000	B	A	C	B	A
5	Environmental engineer	81,000	113,000	31	35,000	A	B	C	A	A
6	Civil engineer	80,000	120,000	24	170,000	B	B	C	B	A
7	Database administrator	93,000	129,000	20	110,000	B	A	C	B	A
8	Sales director	142,000	222,000	15	90,000	A	A	D	B	B
9	Certified public accountant	73,000	127,000	22	200,000	A	A	C	B	A
10	Biomedical engineer	76,000	111,000	72	20,000	A	A	B	B	A
11	Actuary	133,000	222,000	21	20,000	A	A	C	A	A
12	Dentist	142,000	237,000	15	110,000	B	A	C	B	A
13	Nurse anesthetist	156,000	206,000	13	20,000	B	A	D	A	A
14	Risk-management manager	107,000	175,000	24	20,000	B	A	C	C	A
15	Product management director	148,000	192,000	12	20,000	A	A	D	A	A
16	Health care consultant	96,000	174,000	24	30,000	A	B	D	B	A
17	Information systems security engineer	105,000	162,000	23	15,000	B	A	C	A	A
18	Software eng./development director	144,000	202,000	17	15,000	A	B	D	B	A
19	Occupational therapist	72,000	102,000	26	110,000	B	A	C	B	A
20	Information technology manager	102,000	169,000	17	150,000	A	B	D	B	A
21	Telecom network engineer	87,000	116,000	53	15,000	A	B	D	B	A
22	Environ. health and safety specialist	71,000	99,000	28	30,000	A	A	C	B	B
23	Construction project manager	90,000	140,000	17	390,000	A	A	D	B	B
24	Network operations project manager	103,000	155,000	23	10,000	A	A	D	A	B
25	Emergency room physician	250,000	368,000	22	25,000	B	A	D	B	A
26	Information tech. business analyst	82,000	115,000	20	140,000	B	B	C	B	A
27	Director of nursing	85,000	123,000	16	70,000	A	A	D	B	A
28	Information technology consultant	97,000	161,000	17	65,000	A	B	C	B	A
29	Psychiatrist	185,000	269,000	24	40,000	B	B	D	C	A
30	Test software development engineer	84,000	116,000	20	90,000	A	B	C	B	B
31	Information tech. network engineer	84,000	123,000	23	90,000	B	B	C	B	A
32	Senior sales executive	127,000	222,000	15	20,000	A	B	D	B	A
33	Information tech. program manager	103,000	149,000	17	20,000	A	B	D	B	A
34	Primary care physician	174,000	256,000	22	35,000	B	A	D	B	A
35	Computer and information scientist	115,000	167,000	24	25,000	A	A	B	B	B
36	Hospital administrator	98,000	180,000	16	15,000	B	A	D	A	A
37	Programmer analyst	77,000	109,000	20	130,000	B	B	C	B	B
38	Applications engineer	81,000	114,000	34	15,000	A	B	C	B	A
39	Research-and-development manager	116,000	156,000	15	10,000	A	A	D	A	A
40	Regional sales manager	107,000	167,000	15	125,000	A	A	D	B	A
41	Project engineer	100,000	148,000	24	50,000	B	B	C	B	A
42	Training development director	95,000	158,000	23	20,000	A	A	D	B	A
43	Human resources consultant	92,000	159,000	21	20,000	A	A	D	B	A
44	Speech-language pathologist	71,000	111,000	19	130,000	B	A	C	B	A
45	Business development analyst	75,000	109,000	24	20,000	B	B	C	B	B
46	Physical therapy director	84,000	111,000	16	20,000	B	A	C	B	A
47	Structural engineer	83,000	114,000	24	70,000	B	B	C	C	A
48	Nursing home director	88,000	125,000	16	25,000	A	A	D	B	A
49	Systems engineer	88,000	130,000	13	100,000	A	B	C	B	A
50	Health care svcs. program director	85,000	147,000	16	15,000	A	A	C	B	A

CNNMoney.com — For an expanded list of the 100 top jobs, a look at the best-paying jobs, survey results, exclusive video, and more, go to **cnnmoney.com/bestjobs.**

91

Median Hourly Wages - US Bureau of Labor Statistics

Home Care Aid	9.70
Retail Sales	10.33
Vet Assistant	12.34
Pharmacy Technician	14.02
Customer Service Rep	14.32
Auto Mechanic	14.69
Admin Assistant	16.74
Truck driver (heavy)	17.81
Accountant	19.42
Physical therapist assistant	19.82
Public school teacher	23.29
MRI technician	28.65
Account executive	28.82
Staff nurse (RN)	28.85
Dental Hygienist	30.26
Database Administrator	41.10

Database Administrators

[Projected job growth rates from the U.S. Department of Labor's Occupational Outlook Handbook, 2012-13 edition. All salary information from the U.S. Department of Labor Occupational Employment and Wages data, May 2012]

- **Projected Growth from 2010-2020:**
  - **31 percent, or 33,900 new jobs**

- **Salary:**
  - **Median Annual Salary: $77,080**
  - **Bottom 10% of Earners: $42,930**
  - **Top 10% of Earners: $118,720***

IT Jobs Most in Demand

1. Wireless network engineer
2015 salary range: $99,000-$137,500
2016 salary range: $108,750-$150,750
9.7% increase

2. Big data engineer
2015 salary range: $119,250-$168,250
2016 salary range: $129,500-$183,500
8.9% increase

3. Data scientist
2015 salary range: $103,000-$138,250
2016 salary range: $109,000-$153,750
8.9% increase

4. Mobile applications developer
2015 salary range: $107,500-$161,500
2016 salary range: $115,250-$175,750
8.2% increase

5. Data security analyst
2015 salary range: $106,250-$149,000
2016 salary range: $113,500-$160,000
7.1% increase

6. Chief security officer
2015 salary range: $134,250-$204,750
2016 salary range: $140,250-$222,500
7.0% increase

7. Developer/programmer analyst
2015 salary range: $74,250-$129,000
2016 salary range: $80,000-$137,000
6.8% increase

8. Lead applications developer
2015 salary range: $106,250-$148,250
2016 salary range: $110,750-$160,750
6.7% increase

9. Network security engineer
2015 salary range: $105,000-$141,500
2016 salary range: $110,250-$152,750
6.7% increase

10. Senior web developer
2015 salary range: $104,500-$144,250
2016 salary range: $111,250-$154,000
6.6% increase

11. Software engineer
2015 salary range: $96,000-$147,250
2016 salary range: $103,000-$156,250
6.6% increase

12. Software developer
2015 salary range: $85,500-$136,250
2016 salary range: $91,000-$145,250
6.5% increase

13. Data architect
2015 salary range: $119,750-$164,750
2016 salary range: $127,250-$175,500
6.4% increase

14. Applications architect
2015 salary range: $115,750-$159,500
2016 salary range: $121,250-$171,750
6.4% increase

15. Web developer
2015 salary range: $73,500-$122,000
2016 salary range: $78,500-$129,500
6.4% increase

16. Network administrator
2015 salary range: $71,250-$105,750
2016 salary range: $76,250-$112,000
6.4% increase

17. Information systems security manager
2015 salary range: $122,250-$171,250
2016 salary range: $129,750-$182,000
6.2% increase

18. Business intelligence analyst
2015 salary range: $108,500-$153,000
2016 salary range: $113,750-$164,000
6.2% increase

19. Data modeler
2015 salary range: $101,750-$145,250
2015 salary range: $106,750-$155,500
6.2% increase

20. Help desk tier 3
2015 salary range: $55,250-$74,000
2015 salary range: $59,500-$77,750
6.2% increase

Database | Any Skills or Keywords | in | Memphis, TN

Sign in with facebook

Find your inside connections

Find jobs in your network

38 Database jobs in Memphis, TN matched your search   200 miles

Advanced Search | Sort by relevance ▾

Development Database Analyst
Conservation Services Group
Today

Nashville, TN

See who you know

Database Administrator
Yusen Logistics (Americas) Inc.
4 days ago

Cordova, TN

See who you know

Database Developer
EPL, INC • $70,158 - $70,158
5 days ago

Birmingham, AL

See who you know

Oracle Database Administrator
NGP • $70,000 - $80,000
5 days ago

Nashville, TN

See who you know

SQL DBA Database Developer
Crye-Leike Realtors
6 days ago

Memphis, TN

See who you know

Sr. SQL Server Database Administrator
Vaco - Memphis
11 days ago

Memphis, TN

See who you know

SQL Database Administrator

Memphis, TN

See who you

Send Me Jobs
We'll keep looking and send you new jobs that match this search. It's that simple!

Email me Jobs

Grow Your BeKnown Network

monster BeKnown

Make more connections at the jobs you want

Career Services

⬈ **Resume Distribution**

Get your resume in the hands of hiring recruiters - fast!

💲 **Research Salaries**

More Use of Data Today

- Easier, faster, more accurate data input
- <u>Customer centric</u> data entry
  - EDI, Internet, Kiosk, Touch Tone, GPS
- Easier and more flexible data output (multimedia web pages)
- <u>Integration with Internet & E-Commerce</u>
- <u>Integration with personal smartphone apps</u>
- Business Intelligence (Data Analytics) from organized, cross references, filtered, and summarized data (OLAP, Data Warehousing and Data Mining)

Data versus Information

- <u>Data</u> consists of raw facts
  - Not yet processed to reveal meaning to the end user
  - Building blocks of information
  - Example: a grade
- <u>Information</u> results from processing raw data to reveal meaning
  - Requires context
  - Bedrock of knowledge
  - Should be accurate, relevant, and timely
  - Example: the grades for a particular student and course
- Knowledge
  - "Actionable"
  - Example: students with higher grades get better job offers

Data Hierarchy and Definitions

TERM	DEFINITION
Data	Raw facts, such as a telephone number, a birth date, a customer name, and a year-to-date (YTD) sales value. Data has little meaning unless it has been organized in some logical manner.
Field	A character or group of characters (alphabetic or numeric) that has a specific meaning. A field is used to define and store data.
Record	A logically connected set of one or more fields that describes a person, place, or thing. For example, the fields that constitute a record for a customer might consist of the customer's name, address, phone number, date of birth, credit limit, and unpaid balance.
File	A collection of related records. For example, a file might contain data about the students currently enrolled at Gigantic University.

Database Components
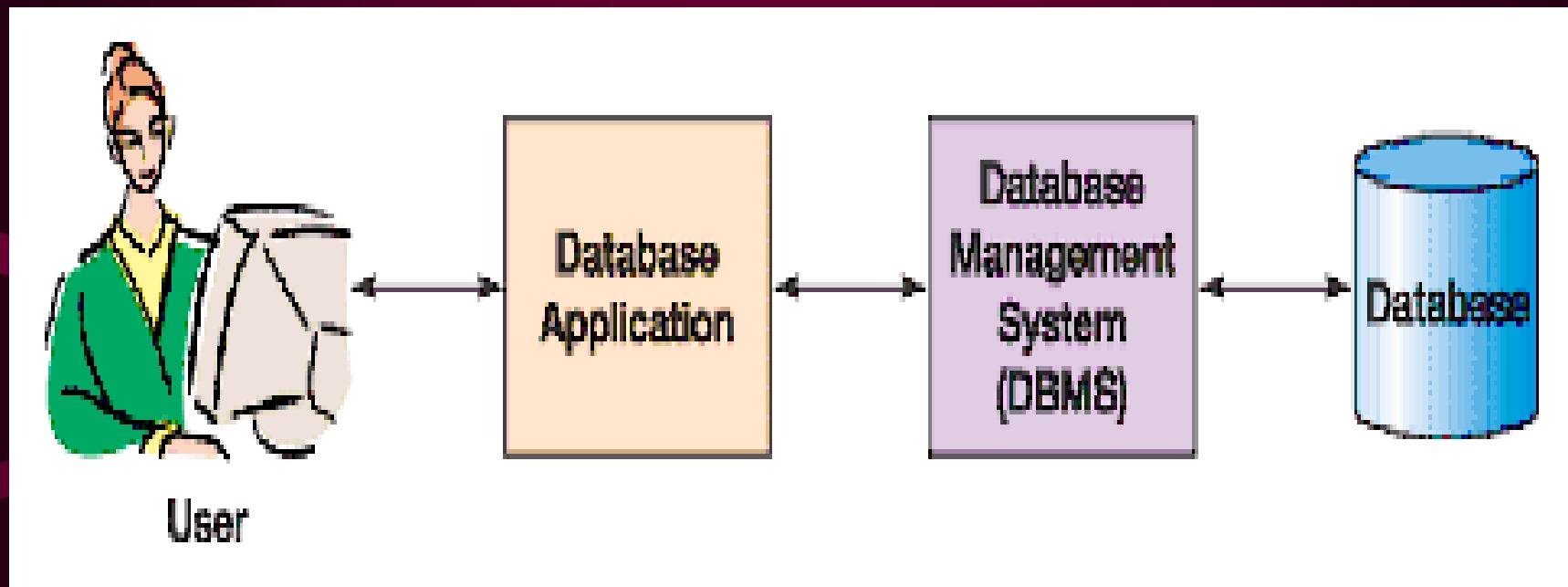
A Database "System" is made up of these three components.

Database Components (con't)

- Distinguish between:
  - <u>Database</u>
    - data
    - data about data (meta data)
  - <u>Database Management System (DBMS)</u>
    - manipulates data and meta data
  - <u>Database Applications</u>
    - uses data management system in communication with user (mainframe, PC, client-server, Internet type Ap's)
- DBMS and Applications may be part of same product (or from same vendor)

Components of a Database System: Microsoft Access
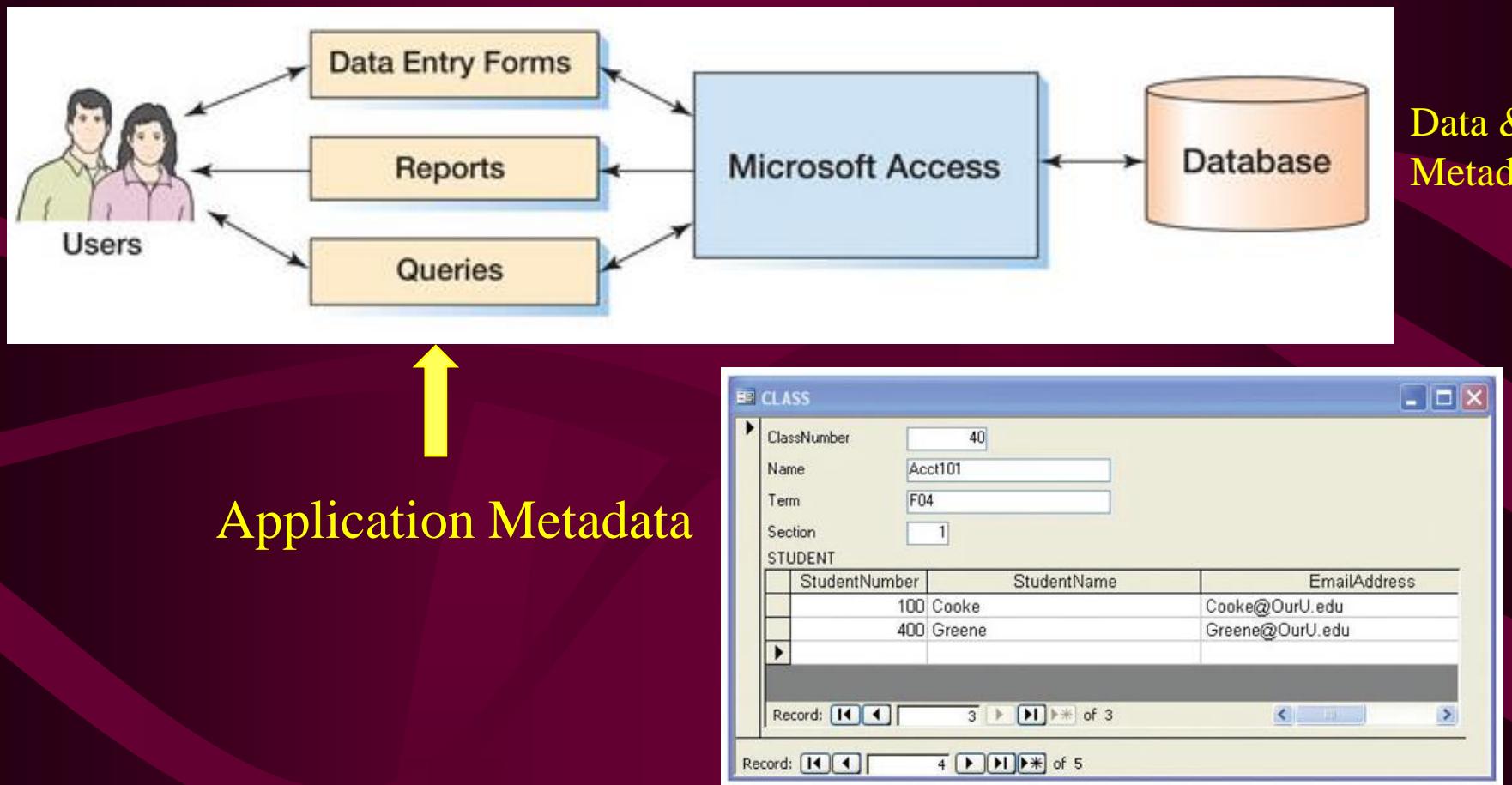
Database Application Components

- Tables – data arranged into tables
- Datasheets – a "view" of the data
- Application Metadata
  - Forms - Input/edit data
  - Reports - Standard output from database
  - Queries - "Ad Hoc" output from database
- Programs and Procedures – process "transactions" and other procedural tasks generally without user intervention

Data in Tables (Access)

Database Types (by Size)

Type	Typical # of Users	Typical Size	Example
Personal	1	< 10 MB	Small Business
Work Group	< 25	< 100 MB	Functional Department
Enterprise	Hundreds	> 10 GB	Corporate Database

What don't you have to be concerned with on personal databases ?

Database Environments
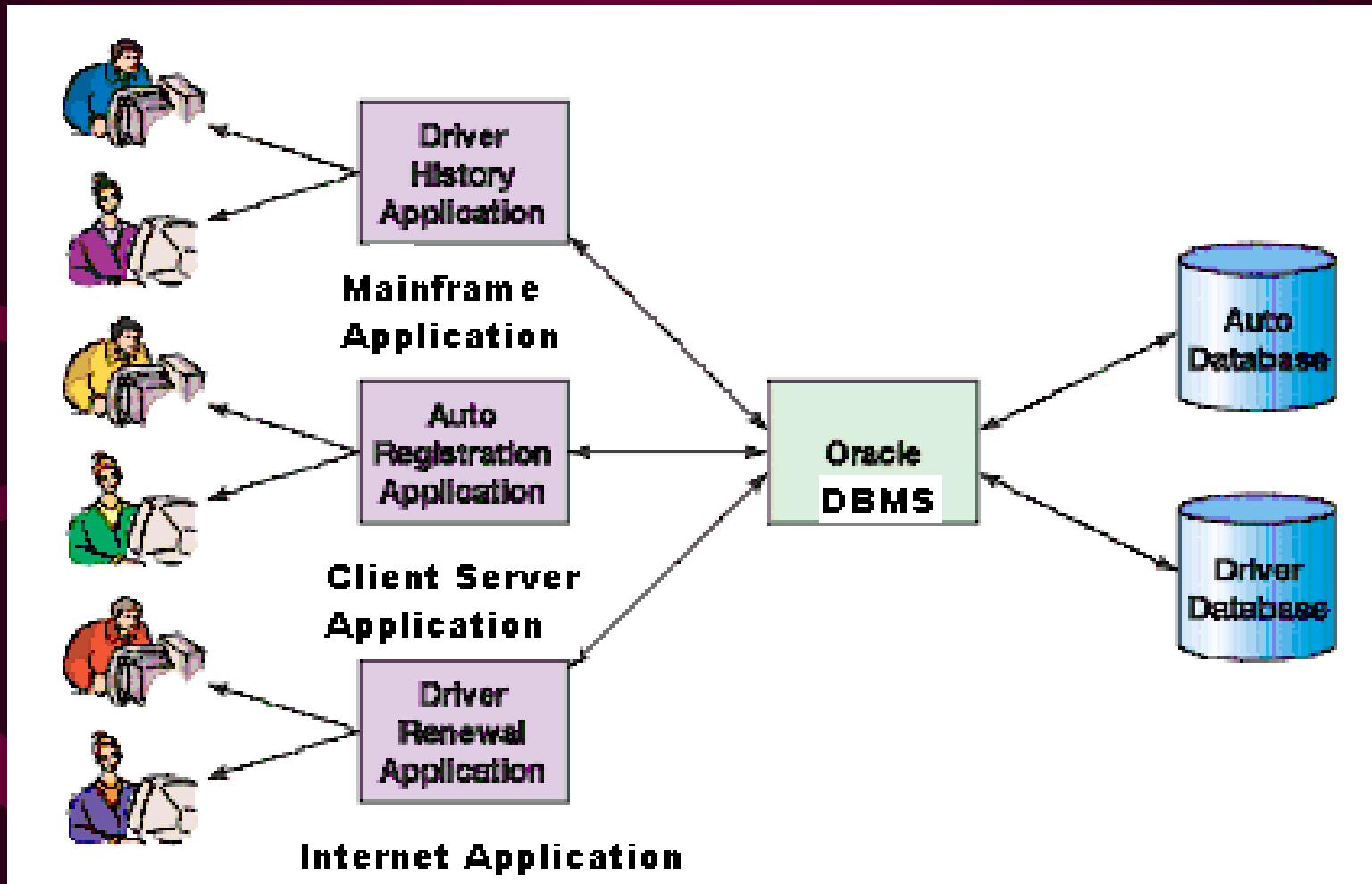
Database Definition

- <u>Self describing</u> collection of <u>integrated</u> information !

Self Describing

- Meta data - <u>data about data</u> - "schema"

- Data Dictionary & Domains

- Rules
  - Constraints
  - Triggers

- Procedures

Integrated Information

- Database contents
  - Data (file(s), records,fields,bytes,bits)
  - Metadata (schema)
  - Indexes, constraints, triggers
  - Application metadata (forms, reports, queries)

History of "Data"

- 4000 – 1200 BC Sumerians put records on stone
- 296 BC – Ptolemy collects data for Alexandrian library
- 200-0 BC – Paper invented in China
- 1450 – Guttenberg invents printing press
- 1879 – Frege founds discipline of modern math logic
- 1884 – Hollerith invents "punched-cards"
- 1937 – Turing presents concept of Turing Machine
- 1941 – Tarski formulates binary relations for computing
- 1951 – Univac invents magnetic tape
- 1956 – IBM invents first computer disk storage
- 1963 - American Airlines introduces SABRE system
- 2004 – SABRE goes "open source" (MySQL)

What is the advantage of writing on stone ?

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American Stonehenge

- The **Georgia Guidestones** is a large granite monument in Georgia, USA

- In June 1979, an unknown person or persons under the pseudonym R. C. Christian hired Elberton Granite Finishing Company to build the structure

- A message clearly conveying a set of ten guidelines is inscribed on the structure in eight modern languages

- The purpose is to provide information about our civilization to those that follow us after the apocalypse

- The structure is sometimes referred to as an "American Stonehenge"

- The monument is 19 feet 3 inches (5.87 m) tall, made from six granite slabs weighing 237,746 pounds (107,840 kg) in all

- **It was denounced as "Satanic" by a right-wing organization, and was blown up in July 2022**
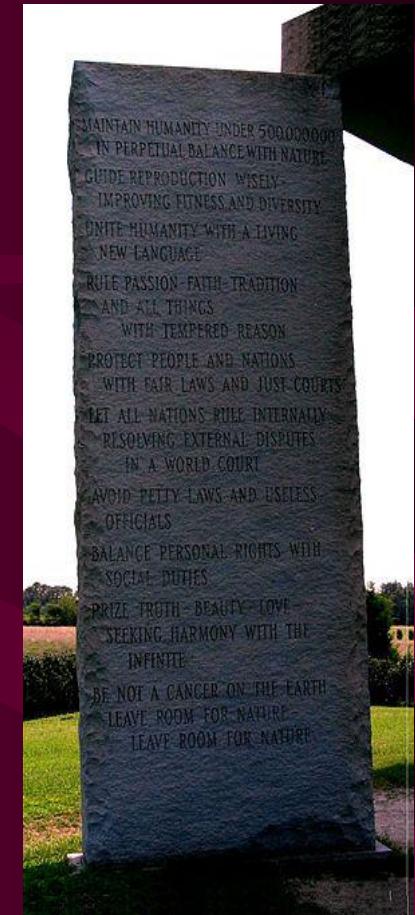
History of "Databases"

- Data embedded in programs
- Flat (sequential) files – 1950 - 1965
- Early databases of 1960's:
  - 1966 – IBM develops ISAM method
  - 1968 - IBM develops IMS
    - applications difficult to develop
    - database were slow
    - reliability was poor
    - vulnerability to failure, and extent of failure

History of "Databases" (con't)

- Mid 1970's <u>databases were competitive to file systems</u>
  - 1970 - Codd introduces relational model
  - 1971 – CODASYL started
  - 1971 – Bayer & McCreight develop B-Trees
  - 1972 - Boyce-Codd Normal Form
- Mid 1980's <u>database were superior to files</u>
- Relational Extensions (OLAP, "Universal")
- Object Oriented Data Bases
- Business Intelligence & Data Analytics
- Big Data (NoSQL), Blockchain, etc.

The Relational Model

- E.F. Codd in 1970

- Model of <u>logical</u> database (API) not physical database

- Data is stored in an easy to understand manner - <u>tables</u>

- Relationships implemented in an easy to see manner via <u>values</u> (early databases stored relationships directly via "pointers")

- Queries could be written directly by users <u>without regard for physical data structure</u>

1951: The Univac uses **magnetic tape** as well as punched cards for data storage.

1961: Charles Bachman at GE develops the first **database management system**, IDS.

1968: IBM offers the **IMS** hierarchical database for System/360 mainframes.

1976: Honeywell ships **Multics Relational Data Store**, the first commercial relational database.

1983: IBM introduces **DB2**.

```
1950        1960        1970        1980        1990
```

1956: IBM introduces first **magnetic hard disk drive** in its Model 305 RAMAC.

**1969:** Edgar ▶ F. "Ted" Codd invents the relational database.
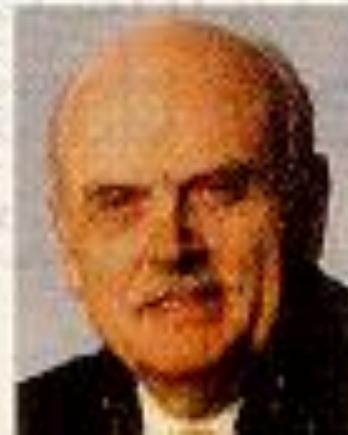
1973: Cullinane, led by **John J. Cullinane**, ships IDMS, a network-model database for IBM mainframes.

1979: Oracle introduces the first commercial **SQL relational database** management system.

Microsoft Access

- **Microsoft Access** is a low-end product intended for individual users and small workgroups
- MS Access tries to hide much of the underlying database technology from the user
- A good teaching tool
- A good strategy for beginners or for small organizations, but generally not for database professionals or large multi-user databases

MS Access in More Detail
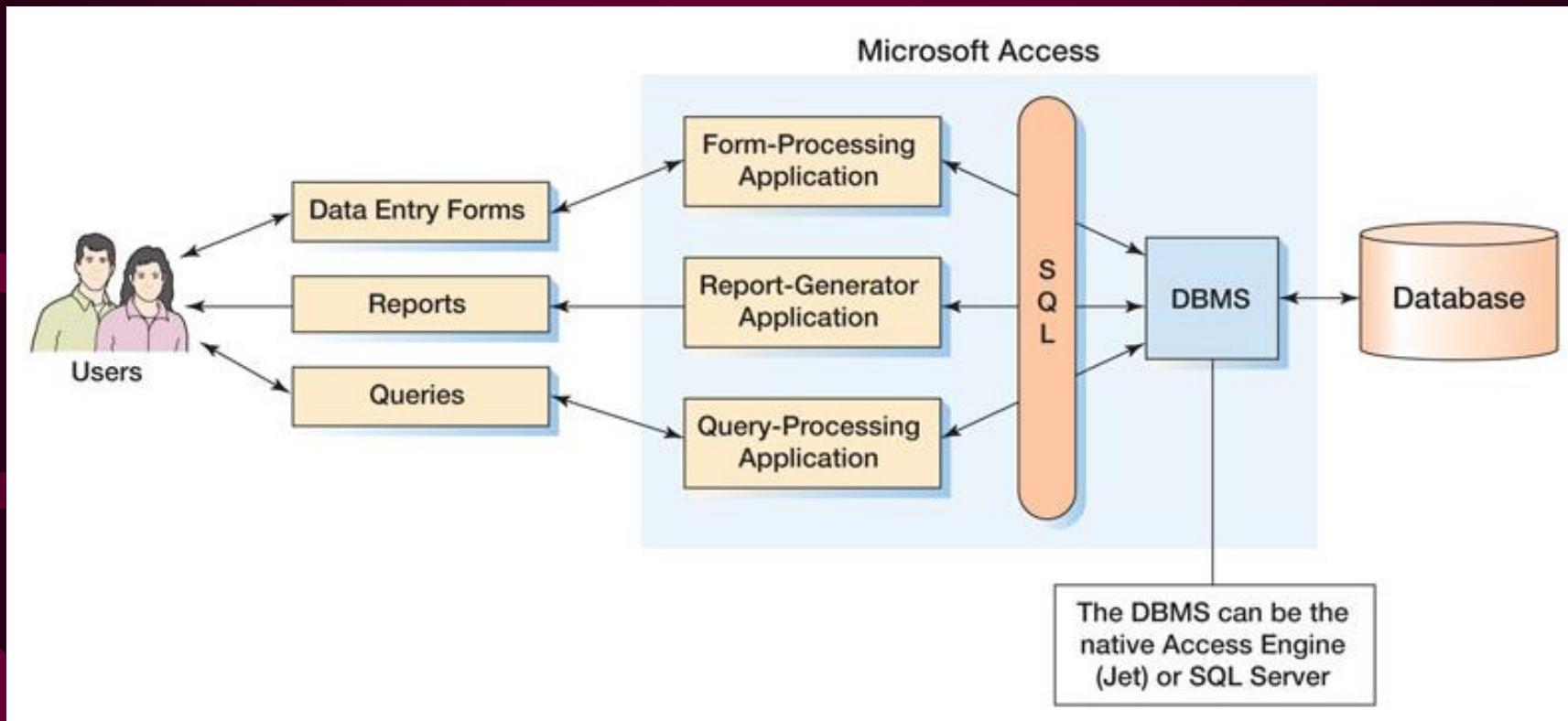
Access ACE Engine (accdb)

- Access 2007 introduced an architectural change

- Prior to Access 2007, Access used the Microsoft Joint Engine Technology (JET) engine for its data storage and query processing (.mdb)

- Even though JET was generally accepted as part of Access, since Microsoft Windows 2000 it was included as part of the Windows operating system

- However, the JET engine is no longer distributed with the latest Microsoft Data Access Components (MDAC)

- As a result, Access 2007+ versions provide a new engine based on JET, which is known as the Microsoft Access Engine (ACE Engine)

- The ACE engine is fully backward-compatible with previous versions of the JET engines so that it reads and writes (.mdb) files from earlier Access versions

- Access 2007 also introduced a new default file format (.accdb) that supported many product improvements

- Because the ACE engine is not part of the Windows operating system, application users must have new Access versions (2007 or higher)

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LAN Database Access

- Through PC LAN <u>file redirection ("mapped drives")</u>, PC database products can be used on a LAN by many users (also for updates as long as the product supported some form of concurrence control such as record locking)

- The PC database file(s) are simply placed on a network drive

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Client Server Database Applications

- Application on a client PC talks to DBMS via "requests" for service

- Requests can be to update or retrieve data

- Requests are typically expressed in SQL, and sent over the network (LAN or WAN)

- Distinguish this from host (or mini computer DBMS) where the requests are handled on the same computer in "shared memory"

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LAN Database Access vs Client/Server

- LAN Database access - database file(s) is on server machine, but data control (retrieve, filter, sort, lock,etc.) is still performed by each user on his PC

- Client/Server - database file(s) is on server and control is handled by DBMS on server; client simply makes request (typically via SQL) of his data needs - much more efficient

- Some systems like Microsoft Access can work both ways: the native Access database (Jet/ACE) can be placed on the LAN server, or Access can "front end" a client/server database such as SQL Server

Distributed Database Processing

- In distributed database processing, there are multiple servers as well as multiple clients

- A request for service (group of SQL statements forming a "transaction") can involve one or many of the servers

- The spreading of an organization's data over multiple servers can involve various ways of splitting the data and also multiple copies of some data

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- When is a database more appropriate than a spreadsheet for a problem ?

Don't look ahead !

Copyright Dan Brandon, PhD, PMP

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Spreadsheets vs Databases

- Spreadsheet
  - smaller amounts of data
  - little relationships among data
- Data
  - a lot of data
  - <u>relationships</u> between tables

The Key Characteristic of Databases: Related Tables

Layered Database Concept

- External Schema/Model (User View)
  - User oriented description of part of the database
  - The way in which a user or a program needs to view the data

- Conceptual Schema/Model (Logical View)
  - Machine, software and DBMS independent description of the total database
  - Entities and their relationships

- Internal Schema/Model (DBMS View)
  - Description of the database (tables, record formats, keys, indexes, …)

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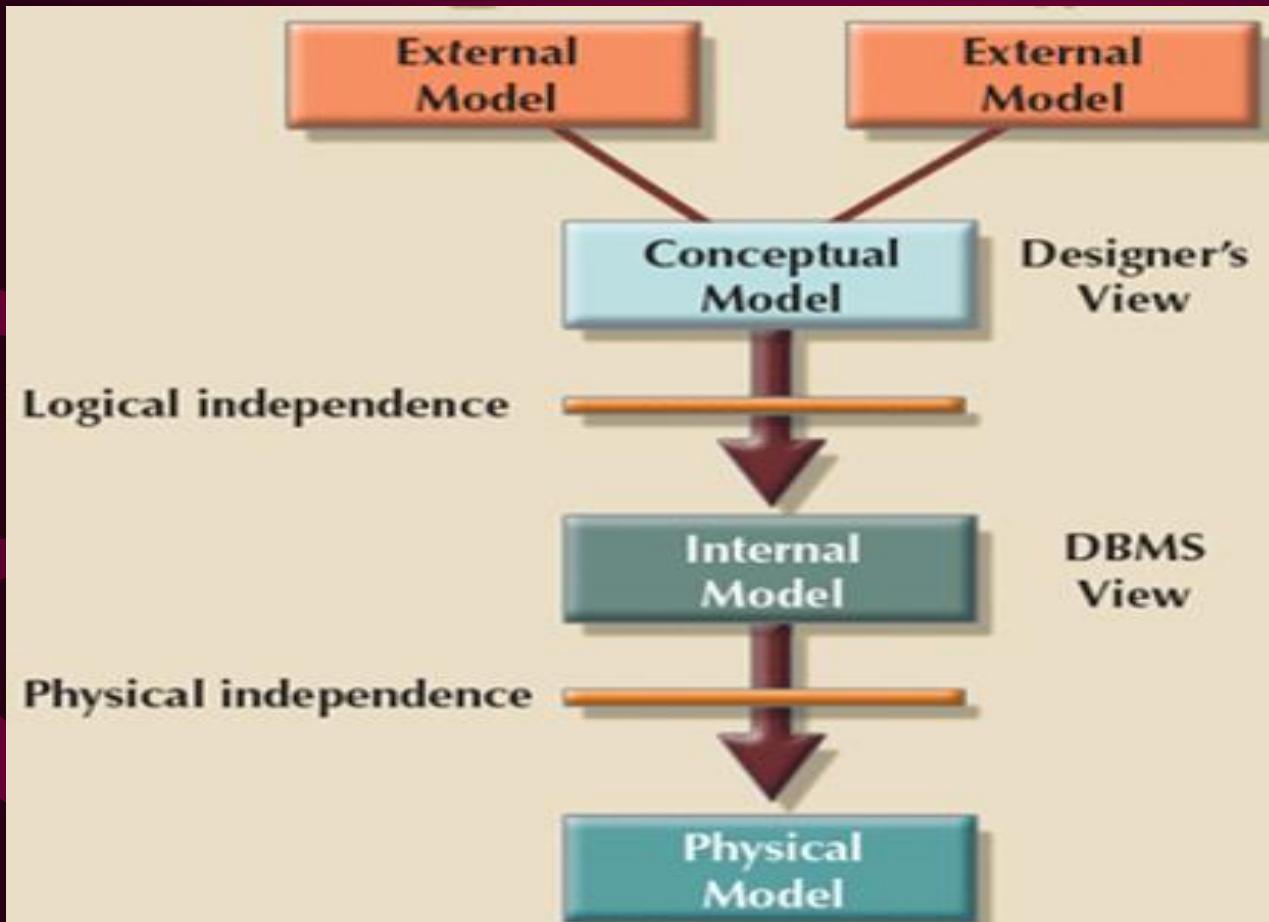
Database Layers

Can be multiple external models representing needs of various user groups.

IT Focus at Each Layer

- External Schema (User View)
  - User oriented description of part of the database
  - The way in which a user or a program needs to view the data
  - IT focus here is on requirements gathering and application design
- Conceptual Schema (Logical View)
  - Machine, software and DBMS independent description of the total database
  - IT focus here is on database design
- Internal Schema (DBMS View)
  - Description of the physical database (tables, keys, indexes, …)
  - IT focus here is on design of tables, keys, indices, etc.

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External Schema

- Domains

- Data Dictionary

- User Views

Domains (kinds of attributes)

- Individual Names &Company Names
- FID's & SS #'s
- Dates
- Money
- Phone Numbers
- Towns
- States
- Zip Codes
- Addresses
- Company Codes

Display & Input/Validity

Some DBMS, like Access do not have domains

Should be Enterprise Wide and administered by Organization or Committee !

- How would you store a phone number in a database ???

Don't look ahead !

Phone Number Definition

- How to store (data type)
  - characters (10 bytes)
  - decimal (4 bits per number, 5 bytes)
  - long integer [binary] (4 bytes, unsigned)
- How to display
  - (xxx) xxx-xxxx
  - xxx.xxx.xxxx

What happens when the domain is not enterprise wide ?
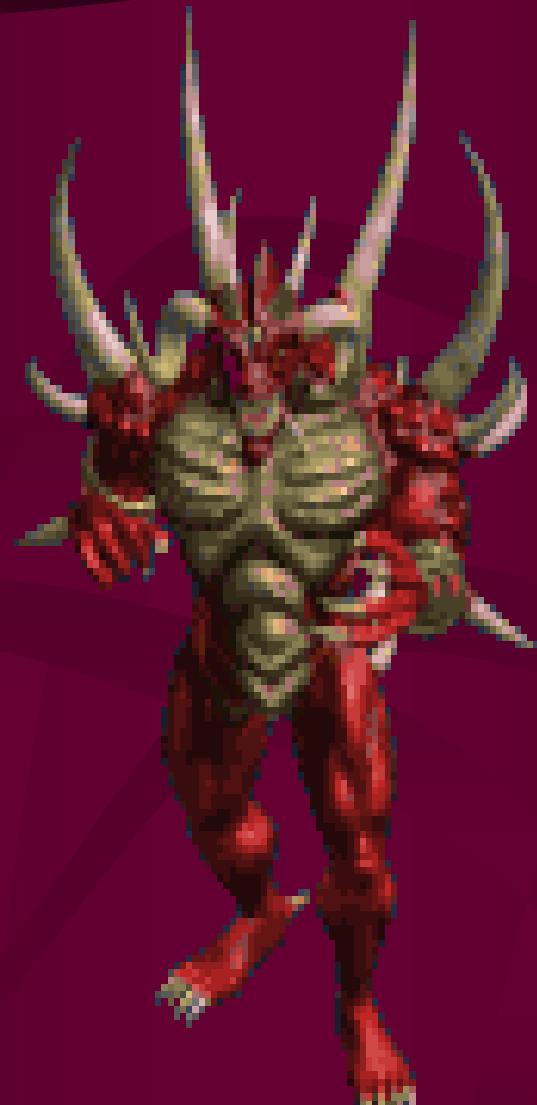
Don't look ahead !

- Data format and display may be different for each different computer system
- This makes data transfer or data consolidation very difficult

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Data Dictionary

[each item in each file/table]

- Data Item name & aliases
- Domain membership
  - Data type: integer, decimal, real, character, time, date, timestamp, BLOB
  - Format (display as, print as, prompt as)
  - Maximum and Minimum lengths
- Allowable values , ranges, constraints
- Allow Nulls
- Default value

Why User/Application <u>Views</u>?

- Application Program Requirements
  - Application level independence

- End User Query Requirements
  - Table "joins"
  - Interpretation of "codes"

- Security Requirements
  - Table "joins"
  - Subset of data
  - Restricted operations

Conceptual Schema

- Entities

- Relationships
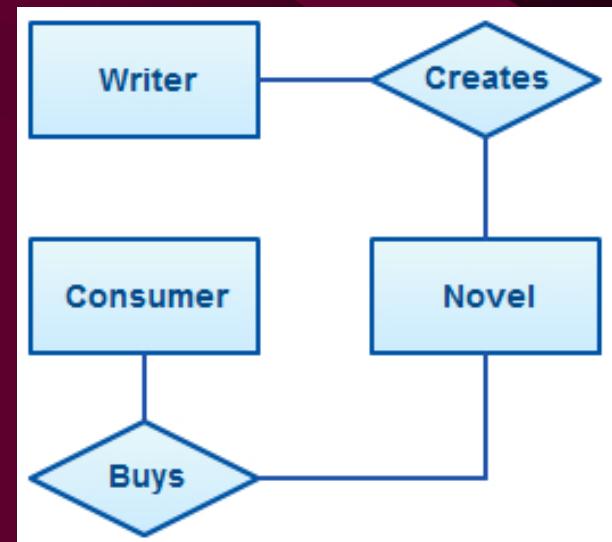
Entities

- An "entity' is an item (typically in the real world) about which we want to record data:
  - person
  - product
  - department
- The data associated with an entity is called its 'attributes"
- Attributes may be:
  - Mandatory or optional
  - single valued or multi-valued (age vs children)
  - aggregate or simple (i.e.. telephone number)
  - attribute may be part of defined domain

Relationships

- A Connection between Entities (of the same or different types)
- Bi-directional
- Given a unique name
- May Have Attributes
- Branching Factors (Cardinality)
  - Maximum Branching Factor
  - Minimum Branching Factor

Branching Factors

Parents

[2,2]

[0,N]

Children
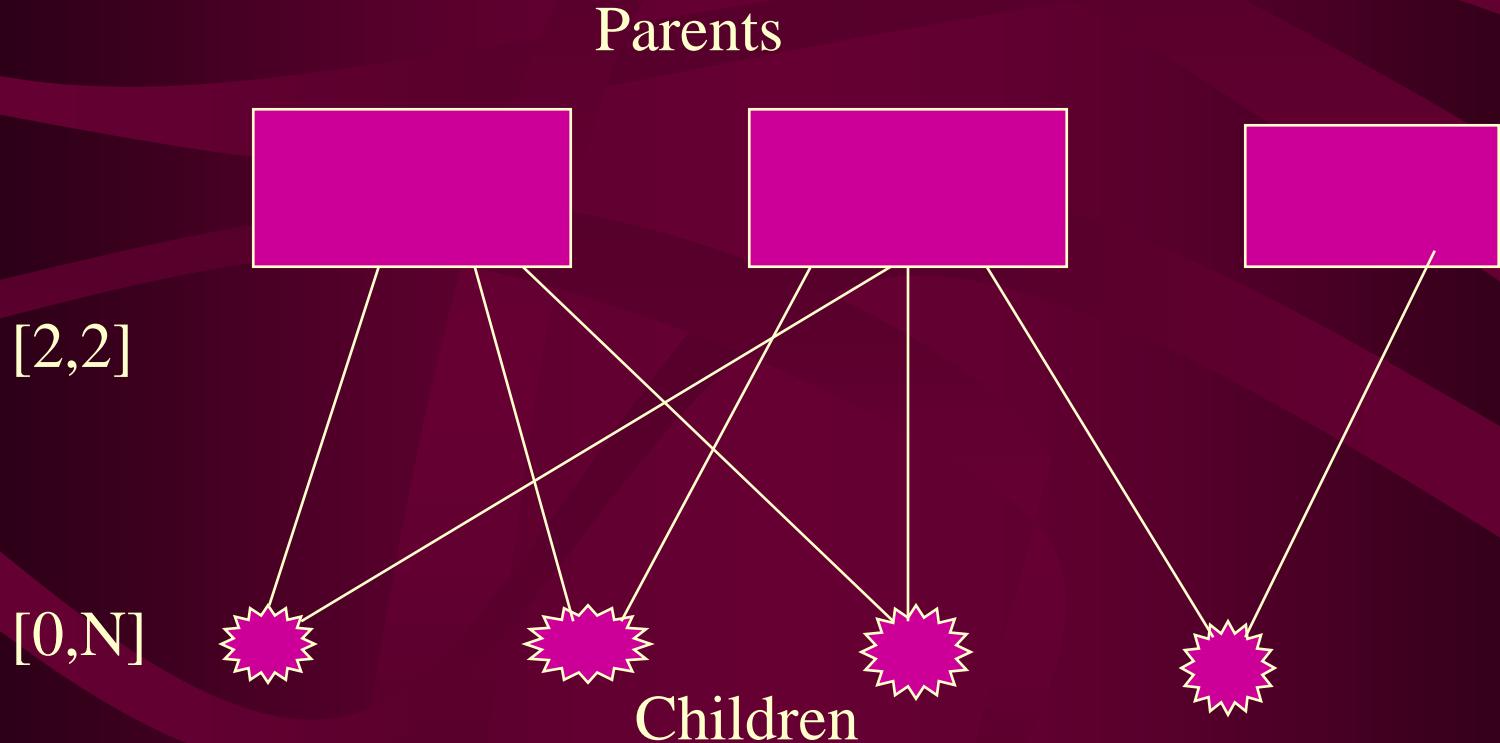
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The Database

- Table Arrangement of User Data

- Schema

- Application Metadata

User Data

- Today usually represented in two dimensional arrays

- These 2D arrays are usually called tables, tuples, or relations

- Not all arrangements of data into tables are equally suited to the task of data management

What's Wrong With This Arrangement ?

Student Name	Student Phone	Advisor Name	Advisor Phone
Baker,Rex	232-8897	Parks	236-0098
Charles,Mary	232-0099	Parks	236-0098
Johnson,Beth	232-4498	Jones	236-0110
Scott,Glenn	232-4444	Parks	236-0098
Zylog,Frita	232-5588	Jones	236-0110

Don't look ahead !

- Multiple "themes" in one table
- Duplicate info
- Have to make changes more than one place to change an advisor's phone number
- Loose advisor data, if delete last student with that advisor

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"Normalized" Arrangement

Student Name	Student Number	Advisor
Baker, Rex	232-8897	Parks
Charles, Mary	232-0099	Parks
Johnson, Beth	232-4487	Jones
Scott, Glenn	232-4444	Parks
zylog, Frita	232-5588	Jones

"Normalized" Arrangement (con't)

Advisor Name	Advisor Phone
Parks	236-0098
Jones	236-0110

- Easier to maintain (i.e. change advisor phone)

- Less susceptible to "anomalies"
  - Loosing advisor data
  - Adding advisor without students yet

- However, need to *join* tables to produce some reports

Database Schema

- Metadata

- Keys & Indexes

- Triggers/Procedures

Metadata

- A modern database is *self describing*

- Data about data

- Most DBMS now store metadata in the same format as user data (i.e. tables)

- Metadata used by the DBMS for maintenance and integrity

- Users can typically access metadata just like user table (via built in tools)

SysTables Table

Table Name	Number of Columns	Primary Key
Student	4	Student Number
Advisor	3	Advisor Name
Course	3	Catalog Number

SysColumns Table

Column Name	Table Name	Data Type	Length
Student Number	Student	Integer	4
First Name	Student	Text	20
Last Name	Student	Text	20
Major	Student	Text	15
Name	Advisor	Text	20
Phone	Advisor	Text	12

Indexes

- Improve performance
  - quick access to specified records
  - sorting for queries and reports
- Primary organization - hashing with linked list ("Clustered Index")
- Secondary indexes - B trees
- Additional space
- Additional time for update operations

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User Data Table

Student Number	First Name	Last Name	Major
100	James	Baker	Accounting
200	Mary	Abernathy	IT
300	Beth	Jackson	Accounting
400	Eldridge	Johnson	Finance
500	Chris	Tufte	Accounting
600	John	Smathers	IT
700	Michael	Johnson	Accounting

LastName Index

Last Name	Student Number
Abernathy	200
Baker	100
Jackson	300
Johnson	400, 700
Smathers	600
Tufte	500

Major Index

| Major	Student Number
Accounting	100, 300, 500, 700
IT	200, 600
Marketing	500

Triggers/Procedures

- Data manipulation functions stored in database

- Usually combination of multiple updates

- "Transactions"

Application Metadata

- Definition of application components:
  - views (queries)
  - forms
  - reports
  - menus
  - functions
- Not all DBMS have application metadata
- Not all store application metadata with database

The Data Base Management System (DBMS)

- Tools

- Run - Time Subsystem

- DBMS Engine

- Communications and Middleware Components
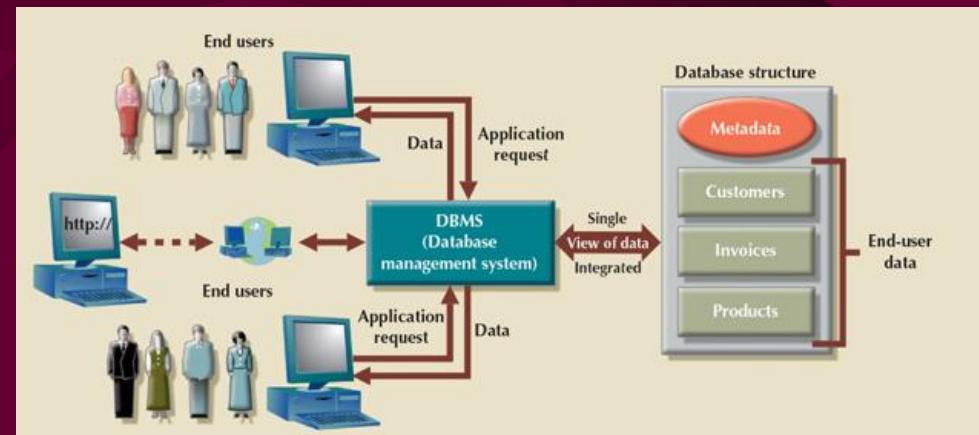
Tools

- Design tools
  - forms
  - reports
  - menus
- Languages (database script)
  - Data Definition/Data Manipulation
  - macros
  - procedures/programs/modules
  - language interfaces (C, COBOL, ...)
- DBA
  - schema manipulation
  - security
  - performance
  - physical aspects

Run-time Subsystem

- Processes the application components that have been built with the tools
  - Forms
  - Reports
  - Menus
- Combined with the DBMS for some products

- What is the disadvantage to a product (such as Access) that combines the run time system with the DBMS (as opposed to creating separate .exe files) ?
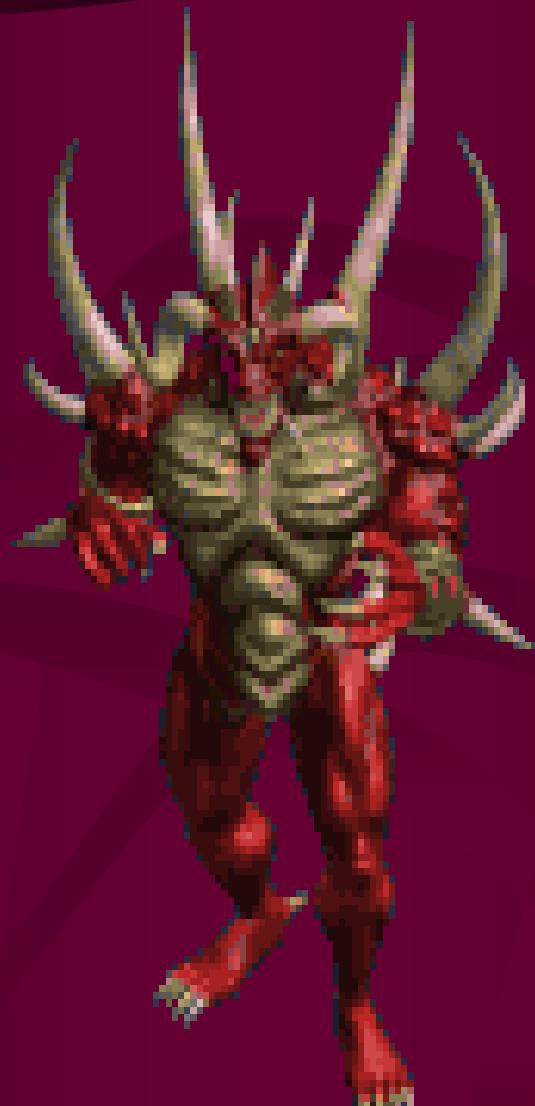
Don't look ahead !

- Have to purchase the full database product on each client to run the applications (forms, tables, queries, etc.) !

Database Personnel
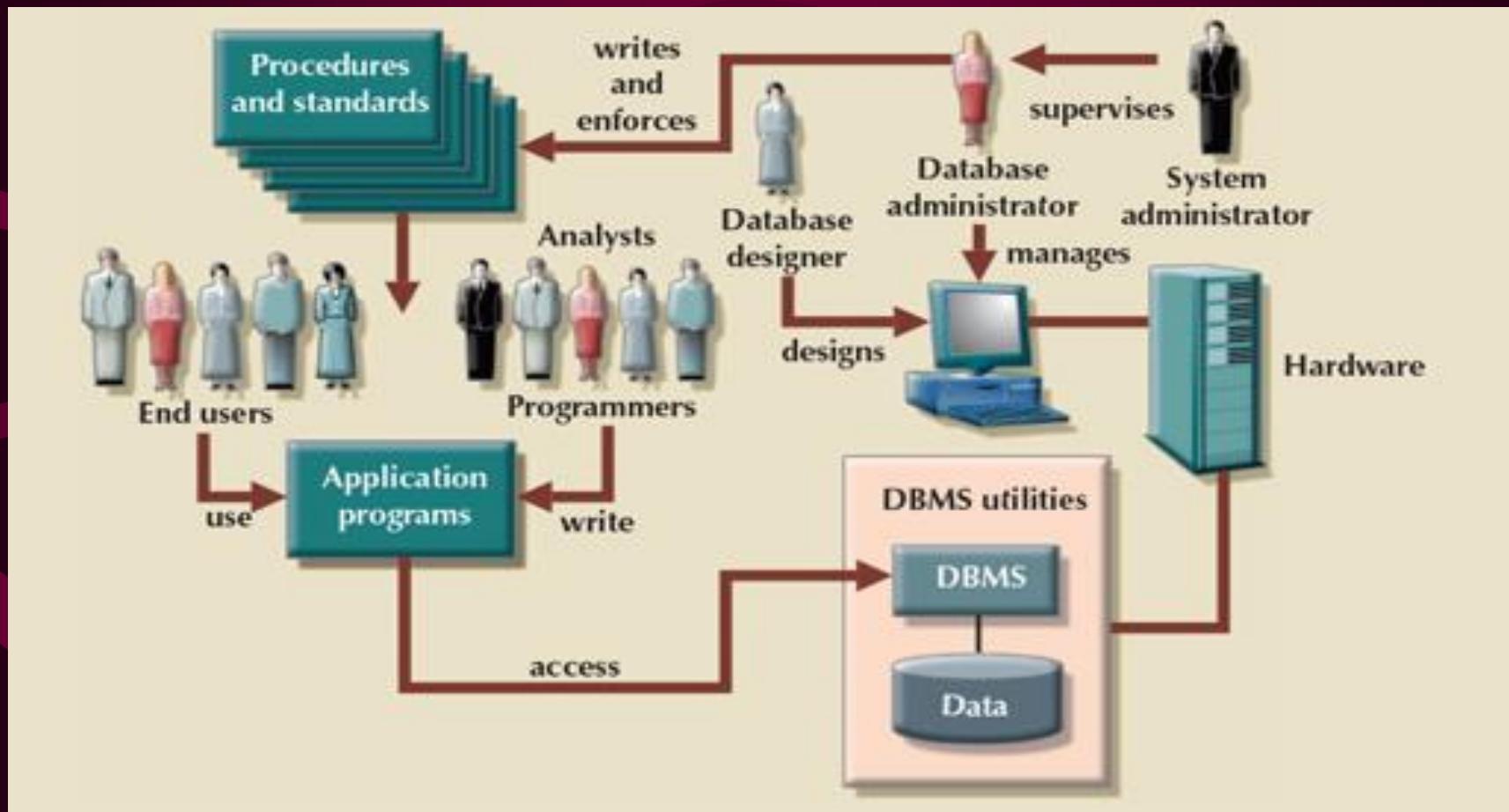
Database Jobs

JOB TITLE	DESCRIPTION	SAMPLE SKILLS REQUIRED
Database Developer	Create and maintain database-based applications	Programming, database fundamentals, SQL
Database Designer	Design and maintain databases	Systems design, database design, SQL
Database Administrator	Manage and maintain DBMS and databases	Database fundamentals, SQL, vendor courses
Database Analyst	Develop databases for decision support reporting	QL, query optimization, data warehouses
Database Architect	Design and implementation of database environments (conceptual, logical, and physical)	DBMS fundamentals, data modeling, SQL, hardware knowledge, etc.
Database Consultant	Help companies leverage database technologies to improve business processes and achieve specific goals	Database fundamentals, data modeling, database design, SQL, DBMS, hardware, vendor-specific technologies, etc.
Database Security Officer	Implement security policies for data administration	DBMS fundamentals, database administration, SQL, data security technologies, etc.
Cloud Computing Data Architect	Design and implement the infrastructure for next-generation cloud database systems	Internet technologies, cloud storage technologies, data security, performance tuning, large databases, etc.
Data Scientist	Analyze large amounts of varied data to generate insights, relationships, and predictable behaviors	Data analysis, statistics, advanced mathematics, SQL, programming, data mining, machine learning, data visualization

References

- Fundamentals Of Database System, 7Th Edn by Elmasri Ramez And Navathe Shamkant

- Fundamentals of Database Systems, Global Edition by Ramez Elmasri and Shamkant B. Navathe

- Database Design for Mere Mortals: A Hands-On Guide to Relational Database Design by Michael J. Hernandez

Homework

- Read Textbook Chapter 1
- Textbook Review Questions 1 thru 10
  - Submit answers via Canvas
- Textbook problems # 5 & 6
  - Submit answers via Canvas
- Consider Project Topic