Databases Using MS Access

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Why Learn M.S. Access?

- Learn to manipulate large datasets
- Lear the basics of relational databases
- Engineers need to manipulate large amounts of data
- Data sometimes comes in a variety of formats
- Data is both numeric and character or "string" data
- MS Access is part of the Office suite that you already have in your computer

Relational Structure

- Data is organized into independent 2dimensional arrays (or a table)
- No formal linkages required between arrays
- Easy to modify the structure of a 2-D table
- Theoretically least complex and most intuitive structure for user
- However: 2-dimensional tables can be very large and cumbersome to manipulate
- Moreover, real world data comes from different sources and thus creating relationships between data sets



Database: collection of tables

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Alternative Relational Terms Used in Textbooks or in the Database Literature

table = relation = array

row = record = tuple

column = field = attribute

Table Concepts

- Table may have a name intended to convey the meaning of the table as a whole
 - Size of table refers to the number of rows
 - **Degree** of table refers to the number of **columns**
- The order of the rows or columns is not important (as long as we keep headings with columns). i.e. a sorted table is considered the same table
- Often denoted by table name with attributes BOOK (ISBN,Title,Price)

Relationship Between Multiple Tables in Relational DBMS

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Design Principles for Relational Database

- Required key fields
- Normalization
 - first normal form
 - second normal form
 - third normal form

Key Field

- A key is a field or combination of fields that uniquely identify each record
- Duplicate entries in key fields are not allowed within a table
- It is good practice, and often required, for each table to have key field(s)
- examples
 - single key field: unique ID sample number
 - multiple key field: date + time + location + pollutant

Keys

- Set of attributes that uniquely defines any entity from among all possible entities in the entity class that may appear in the database is called a superkey. Ex: ISBN
- Superkeys can contain more attributes than absolutely necessary, e.g. SSN and LastName for USCitizen class
- Key is minimal superkey, e.g SSN

Entity-Relationship Diagram

- Used to display the entity classes in a database model with their attributes and relationships
- entity class rectangles
- attributes ellipses
- relations diamonds



Relationship Types

One-to-one

- each entity in one table related to at most one entry in related table (i.e. fairly rare)
- One-to-many
 - each entity in one table related to many entities in related table
- Many-to-many

Implementing One-to-Many Relationships

- Add key attribute from related table. Thus, to implement *Publisher Of* relationship
 - -BOOK(ISBN, Title, Price) becomes
 - -BOOK(ISBN, Title, Price, PublisherID)
 - Publisher ID in Book entity class is referred to as *foreign key*, since is key for foreign entity class



Implementing Many-to-Many Relationships

- More involved than one-to-many
- Cannot simply treat as 2 one-to-many, would result in redundancy
- Need to add new table then treat as 2 one-tomany relationships
 - BOOK/AUTHOR(ISDN,SSN)
- Usually not shown on initial ERD



Referential Integrity

- When using foreign keys to implement relationships, each value of foreign key must have matching value in related table, otherwise dangling reference
- This restriction termed referential constraint
- Ensuring referential restraint is termed ensuring referential integrity.

Referential Integrity, continued

- Referential integrity can be lost by adding new records with foreign key that does not exist in related table
- Referential integrity can also be lost if value of key is changed or deleted, e.g. delete a publisher in Publisher database
- Many records in the Book database now have dangling references

Cascading Updates and Deletions

- Options in many database programs.
- Cascading update:
 - If value in referenced key is changed, then all matching entries in the foreign key are automatically changed.
- Cascading delete:
 - If value in referenced key is deleted, then all matching records with same value in foreign key are deleted.
 - Maintains referential integrity, but should be used with extreme caution.

First Normal Form

- No more than one value may be contained in each field
- The following table is not in first normal form because
- There are multiple values in the Parameter and Concentration fields

Date	Station No.	Agency	River Mile	Parameter	Conc
2/12/96	107062	USGS	111.2	Benzene Chloro- form	0.8 1.2
2/13/97	LA66	USEPA	137.7	Toluene Benzene	2.7 1.1

Conversion to First Normal Form

- Split records containing multiple entries in a field into multiple records instead.
- The follow table shows the results of converting previous table to 1st normal form

Date	Station No.	Agency	River Mile	Parameter	Conc
2/12/96	107062	USGS	111.2	Benzene	0.8
2/12/96	107062	USGS	111.2	Chloroform	1.2
2/13/97	LA66	USEPA	137.7	Toluene	2.7
2/13/97	LA66	USEPA	137.7	Benzene	1.1
			I	I	1

Second Normal Form

• All non-key fields must be a fact about the entire key

 Following table is not in 2nd normal form because 2 of the fields (agency, river mile) relate only to station number, not to the rest of the key (date, parameter)

Date	Station No.	Agency	River Mile	Parameter	Conc
2/12/96	107062	USGS	111.2	Benzene	0.8
2/12/96	107062	USGS	111.2	Chloroform	1.2
2/13/97	LA66	USEPA	137.7	Toluene	2.7
2/13/97	LA66	USEPA	137.7	Benzene	1.1
key	key	non key	non key	key	non key
		Virginia Tech	(copyright A A Trani)		

Conve	ersion to	2nd	Ν	lormal	Form	
Table	e 1				Table 2	
Station No.	Parameter	Conc		Station No.	Agency	River Mile
107062	Benzene	0.8		107062	USGS	111.2
107062	Chloroform	1.2		LA66	USEPA	137.7
LA66	Toluene	2.7				
LA66	Benzene	1.1		key	no	no
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 To convert table to 2nd normal form, non-key fields should be moved to a new table

Third Normal Form

A non-key field may not contain a fact about another non key field

Sample ID	Station No.	Date Station Establ.	Sample Date	Parameter	Conc
101	107062	1964	1/14/96	Benzene	0.8
102	107062	1964	1/15/96	Chloroform	1.2
103	108935	1979	1/17/96	Toluene	2.7
key	non key	non key	non key	non key	non key
	L				

Table 2

Station

Establ.

non

key

Conversion to 3rd Normal Form

 Non-key fields that refer to other non-key fields should be moved to new table

Table 1

key	non key	non key	non key	non key	key	no ke
103	108935	1/17/96	Toluene	2.7	108935	1979
102	107062	1/15/96	Chloroform	1.2	107062	1964
101	107062	1/14/96	Benzene	0.8		Estat
ID	No.	Date	ratailletei	Conc	No.	Statio
Sample	Station	Sample	Parameter	Conc	Station	Data

Example Database (mybooks v3 blank) (Download the data from the web site)

- Authors Table
- Book/Author Table
- Books Table

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View Content of Data (mybooks v3 blank)

Select the Authors Table (right click to select the context menu)

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			5		Shakespeare	555-555-	5555			
			6		Joyce	666-666-	6666			
			7		Spencer	777-777-	7777			
			8		Mill	888-888-	8888			
			9		Smith	123-222-2	2222			
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Content of Authors Table

View Content of Data (Other Tables)

 Select the Book/Author Table (right click to select the context menu). Repeat for the Book Table.

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Inspecting the Database Field Types

 When a table is created you need to specify the field type for each record

• Use the **Design View** to accomplish this





Adding the Publishers Table

- The current database is pretty useless unless we relate the fields of some of the 2dimensional tables in a useful way
- Lets add a table that contains the Publisher of each book
- Note that in the Books
 Table we have a
 Publisher ID field

BOOKS					
ISBN 👻	Title 🔹		PubID	Ŧ	Price 👻
0-103-45678-9	Iliad	1			\$25.00
0-11-345678-9	Moby Dick	3			\$49.00
0-12-333433-3	On Liberty	1			\$25.00
0-123-45678-0	Ulysses	2			\$34.00
0-12-345678-9	Jane Eyre	3			\$49.00
0-321-32132-1	Balloon	3			\$34.00
0-55-123456-9	Main Street	3			\$22.95
0-555-55555-9	MacBeth	2			\$12.00
0-91-045678-5	Hamlet	2			\$20.00
0-91-335678-7	Fairie Queene	1			\$15.00
0-99-777777-7	King Lear	2			\$49.00
0-99-999999-9	Emma	1			\$20.00

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Books Table

Adding the Publishers Table

- Select the "Create" panel and define a new table
- Later rename the table as PUBLISHERS
- Add three fields to the table:
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Establishing Relationships Between Tables

- Select the "Database Tools" panel and define relationships
- First add the tables that you want to relate
- Select "Edit Relationships"

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Can create a table relationship using the table format

Final Relationships

 Edit the relationships and join variables with same names among the tables



What Happened After Relationships are Established?

You can easily inspect the data sets that are related



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associated Books

After Relationships are Established

• You can easily inspect the data sets that are related

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Each Author Instance (or record) has several associated ISBN numbers

Basic Filtering in the Database

 Quick filters are included in Access to perform basic selections (just like in Excel)



Basic Queries in the Database

- The power of the database manager resides in making queries
- Query: from the Latin word "quaerere" (to ask)
- Queries are instructions provided to the database that meet a certain criteria
- Queries can contain complex logical statements
- Queries can be saved so that they can be reused (filters are temporary search mechanisms)

Basic Queries in the Database (The Query Wizard)

- Simple to use (2-3 step process)
- Less control ("canned approach" to construct queries)

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Basic Queries in the Database (The Query Wizard)

 Want to get a summary with the average, sum and min/max cost of the books in the Books Table

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AUTHORS

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Lists -



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Basic Queries in the Database (The Query Design)

- A better way to make queries is to use the "Query Design" interface
- Look under "Create" tab in Access 2007

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Query Design Interface

Basic Queries in the Database (The Query Design)

- A better way to make queries is to use the "Query Design" interface
- Look under "Create" tab in Access 2007

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Can import data from many sources (like Excel or text)

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7 TIMBERDOODLE	93VA	PR	25618.*A	37.53625333	
8 FULCHER FAMILY FARMS	VGO6	PR	25618.01*A	37.72513611	
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 As you import data, you can specify the data types for each field of the data to import

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Selecting the Primary Key of the data (I am letting Access define a new column for me)

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1 1 VIRGINIA	HIGHLANDS	VJI	PU	25600.*A	36.687
2 2 ALPHA NAT	URAL RESOURCES	22VG	PR	25600.01*H	36.696
3 3 MOUNT VER	NON HOSPITAL	VA82	PR	25609.*H	38.740
4 4 ALEXANDRI	A HOSPITAL HELISTOP	9VA2	PR	25609.01*H	38.822
5 <mark>5</mark> HILL TOP		VA64	PR	25617.*A	37.415
6 <mark>6 Merlin Ae</mark>	RODROME	2VA3	PR	25617.2*A	37.315
7 7 TIMBERDOO	DLE	93VA	PR	25618.*A	37.536
8 B FULCHER F	AMILY FARMS	VGO6	PR	25618.01*A	37.725
9 <mark>9</mark> NASHS		10VA	PR	25622.*A	37.386
0 10 STATE POL	ICE DIVISION THREE	38VA	ΡU	25622.01*H	37.360
11 HIGHVIEW	FARMS	94VA	PR	25622.1*A	37.263
2 12 GLASCOCK		98VA	PR	25624.*A	38.942
.3 13 SMITH		VG23	PR	25624.01*A	38.927
.4 14 NAT'L HOS	P FOR ORTHOPAEDICS/REHABILITATION	65VA	PR	25624.4*H	38.848
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Imported Virginia Airports Excel file

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Importing the Runways Excel File

 Import a second file containing runways at the Virginia Airports

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Imported Runway File

UrginiaTech

Imported Virginia Airports Runway Excel file

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