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 2-dimensional 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

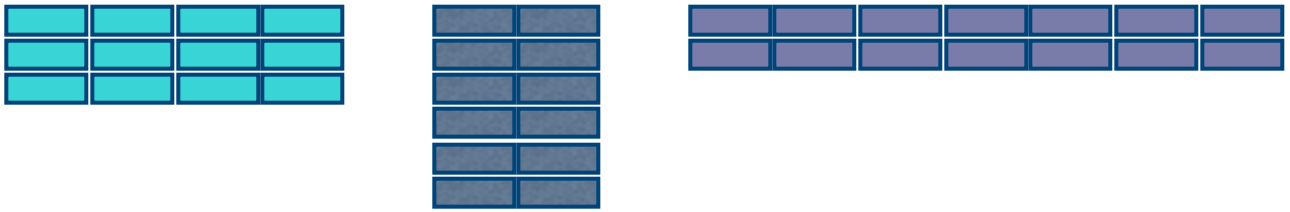
Basic Elements of Relational Database

Table:

columns

rows

Database: collection of tables



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

Date	Parameter	Conc
2/1/96	Pb	2.4
2/2/96	tol	1.7
2/3/96	tol	0.3
2/14/96	Cu	0.5

Name	Parameter	Conc
copper	Cu	mg/L
toluene	tol	ug/L
lead	Pb	mg/L

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

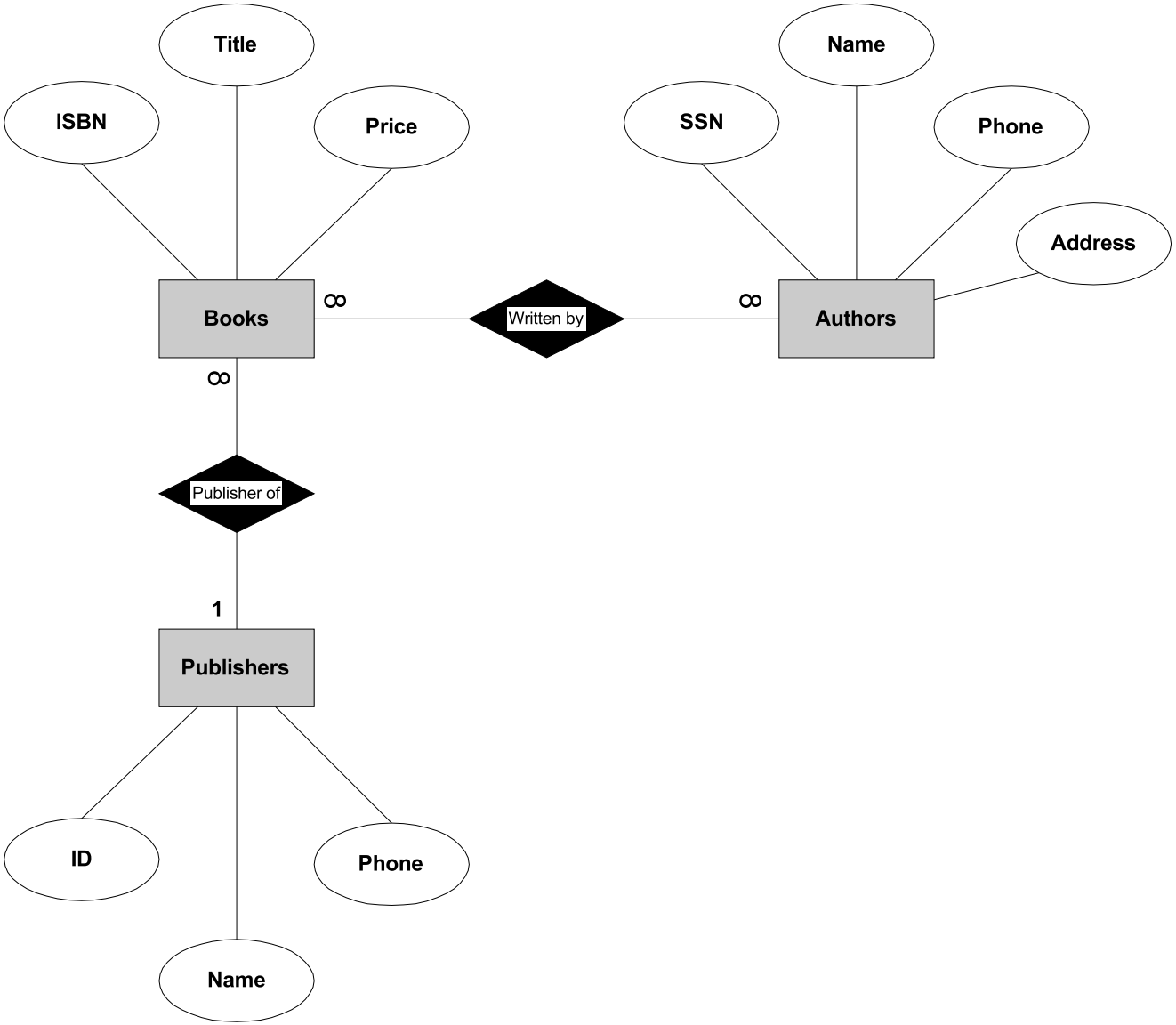
Keys

- 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

Example Entity-Relationship Diagram



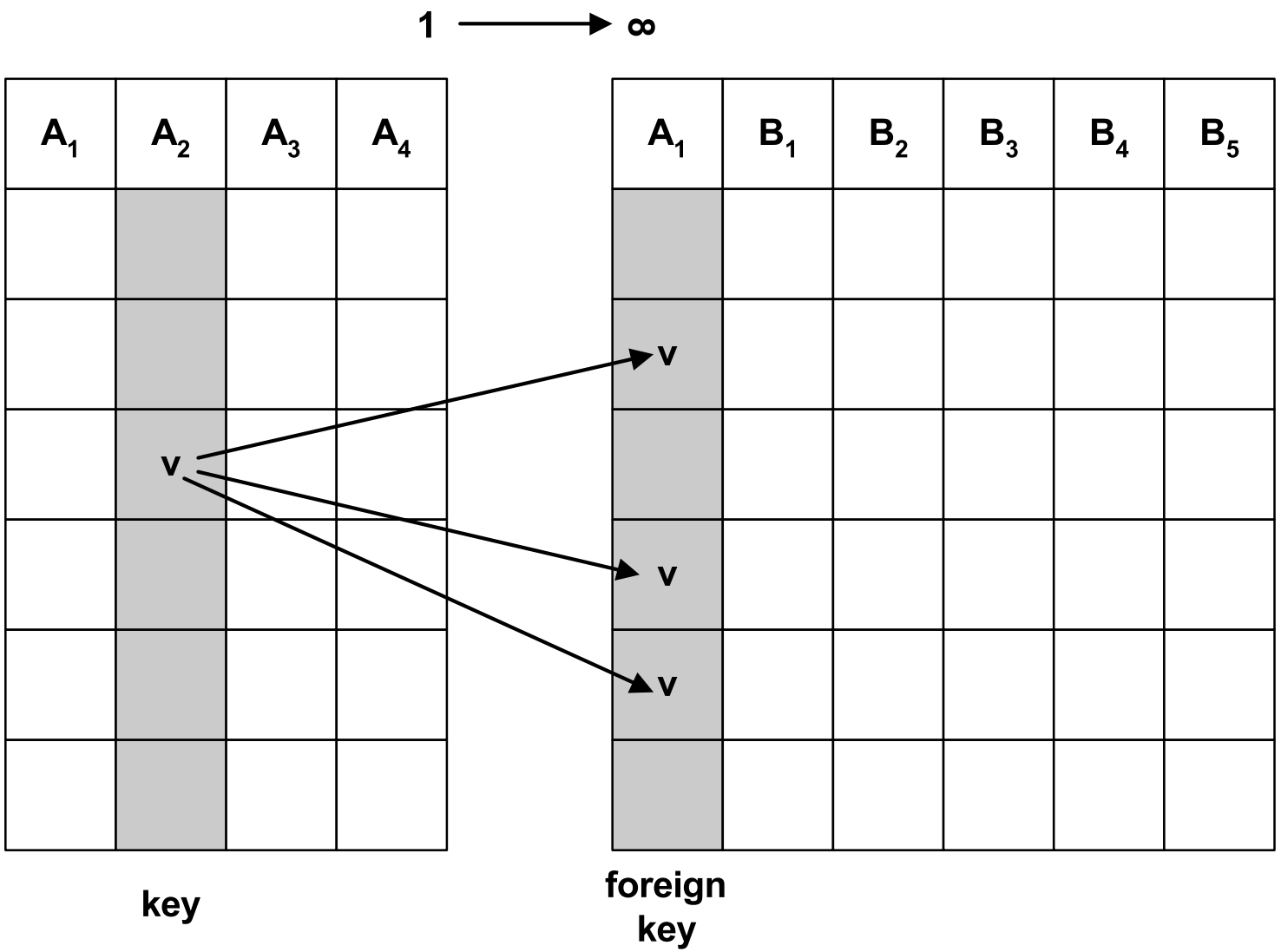
Relationship Types

- 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

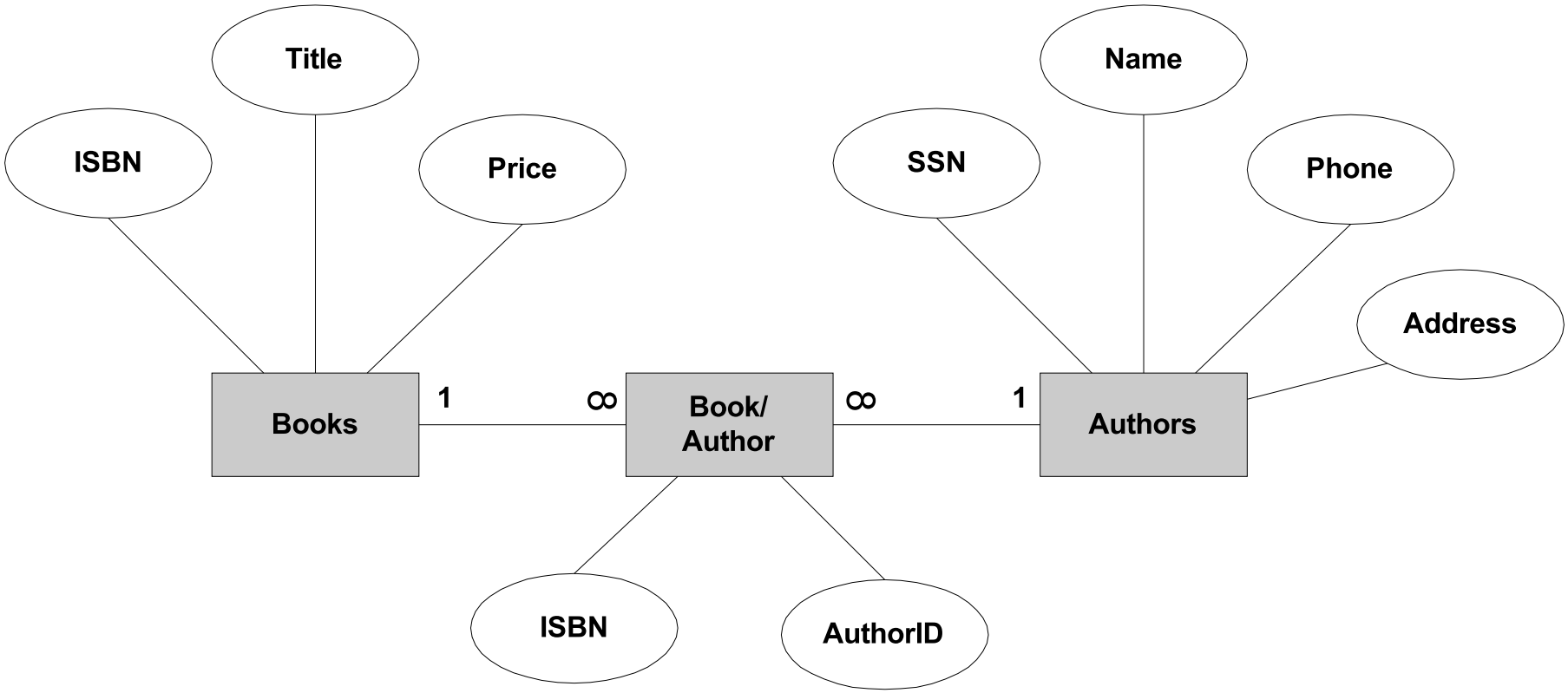
One-to-Many Relationship



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-to-many relationships
  - BOOK/AUTHOR(ISDN,SSN)
- Usually not shown on initial ERD

Example Many-to-Many Relationship



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

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**

Conversion to 2nd Normal Form

Table 1

Date	Station No.	Parameter	Conc
2/12/96	107062	Benzene	0.8
2/12/96	107062	Chloroform	1.2
2/13/97	LA66	Toluene	2.7
2/13/97	LA66	Benzene	1.1

key **key** **key** **non key**

Table 2

Station No.	Agency	River Mile
107062	USGS	111.2
LA66	USEPA	137.7

key **no key** **no key**

- 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**

Conversion to 3rd Normal Form

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

Table 1

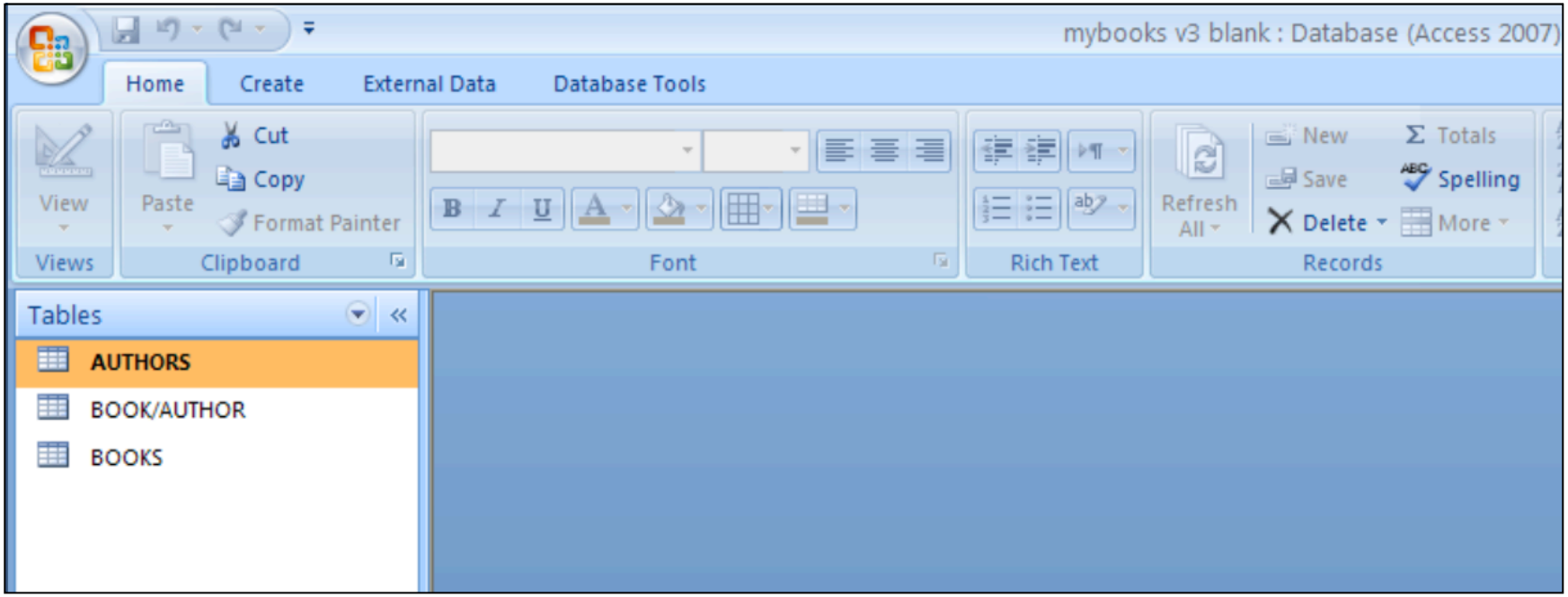
Sample ID	Station No.	Sample Date	Parameter	Conc
101	107062	1/14/96	Benzene	0.8
102	107062	1/15/96	Chloroform	1.2
103	108935	1/17/96	Toluene	2.7
key	**non key**	**non key**	**non key**	**non key**

Table 2

Station No.	Date Station Establ.
107062	1964
108935	1979
key	**non key**

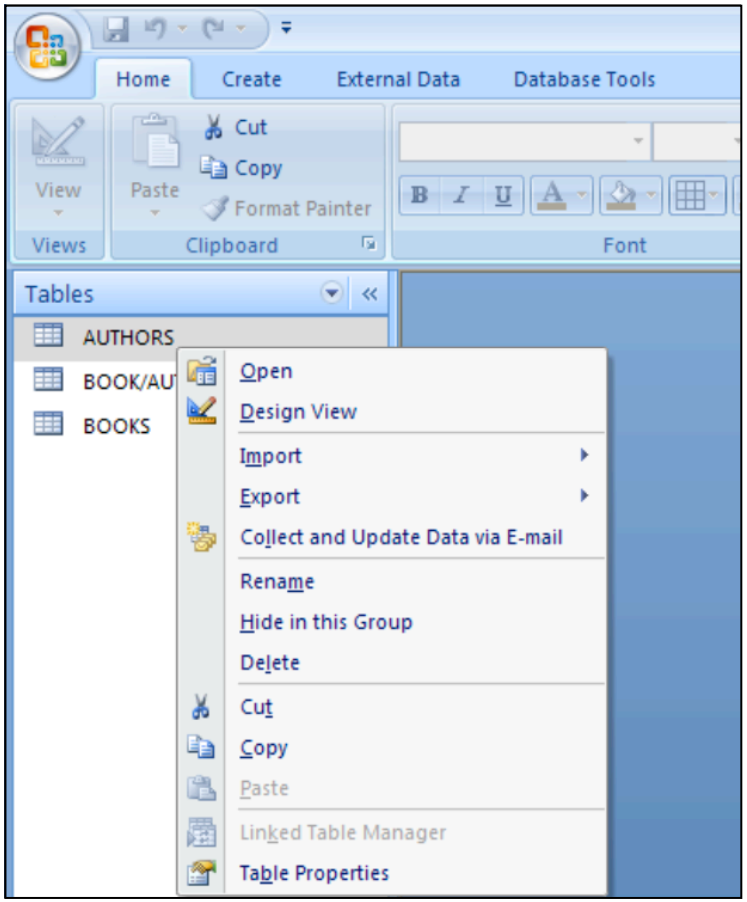
Example Database (mybooks v3 blank) (Download the data from the web site)

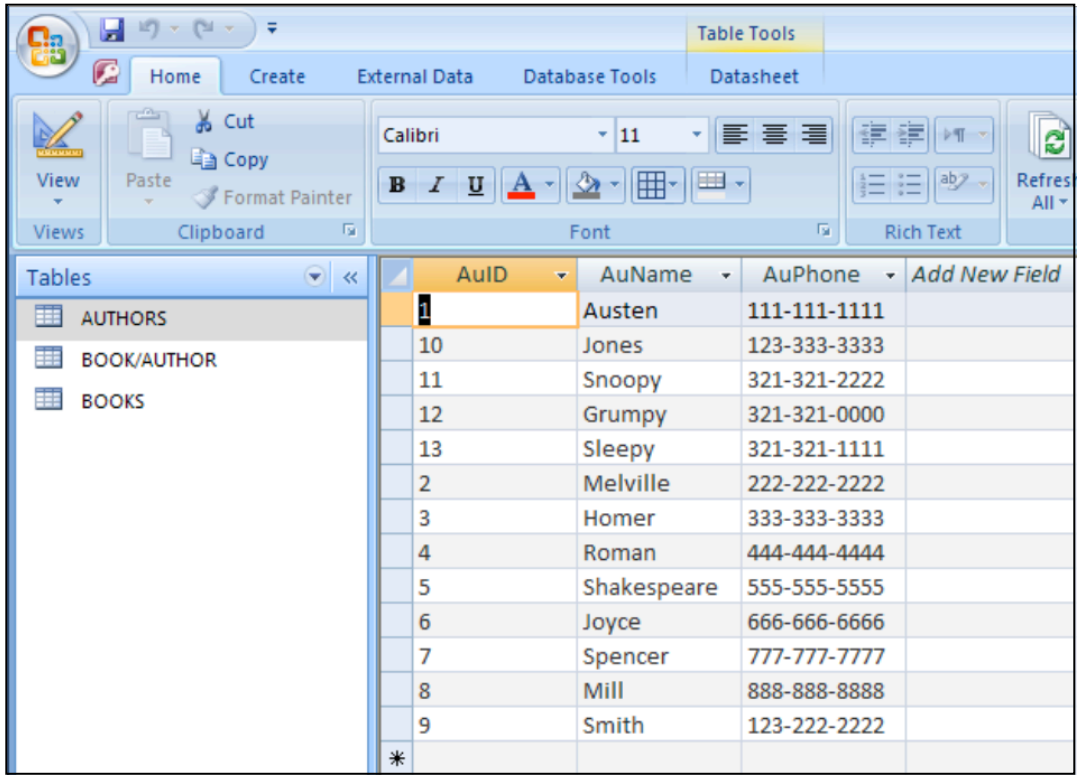
- Authors Table
- Book/Author Table
- Books Table



View Content of Data (mybooks v3 blank)

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

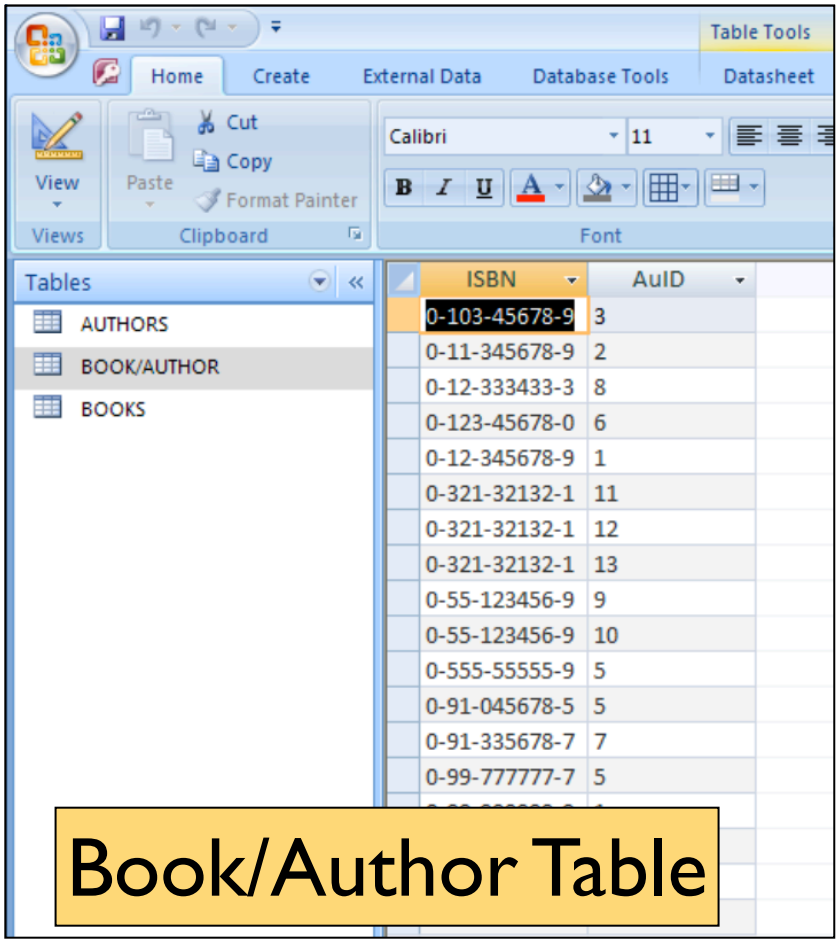


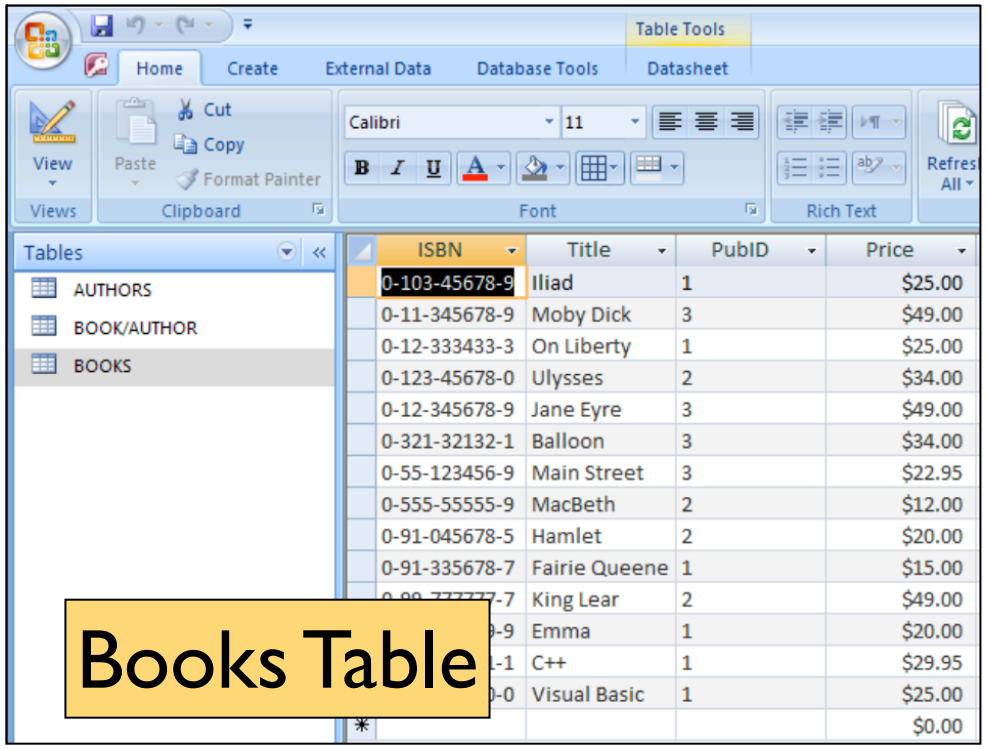


Content of Authors Table

View Content of Data (Other Tables)

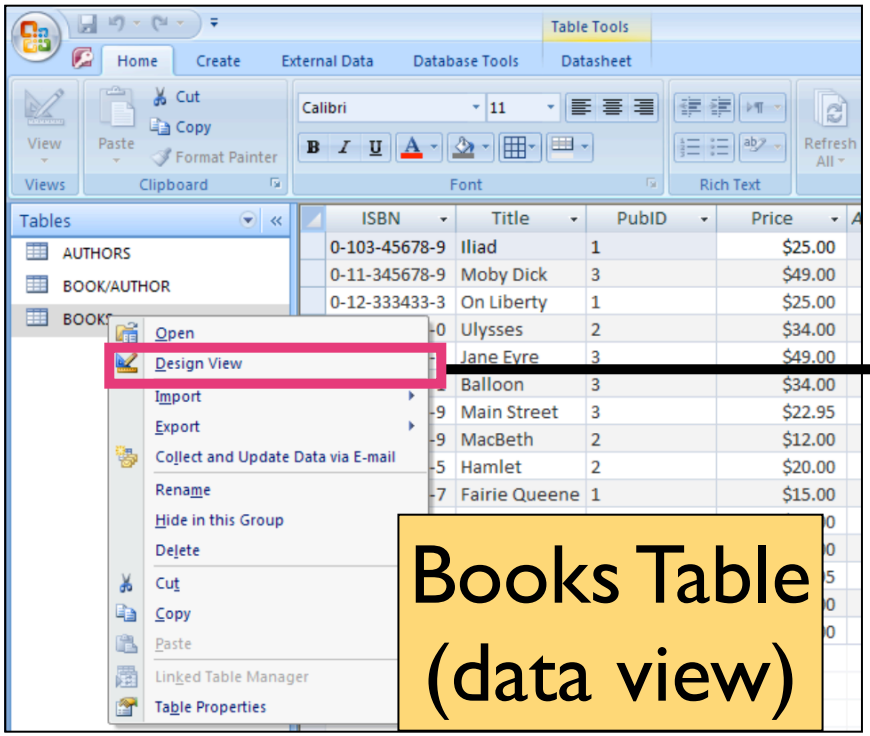
- Select the Book/Author Table (right click to select the context menu). Repeat for the Book Table.

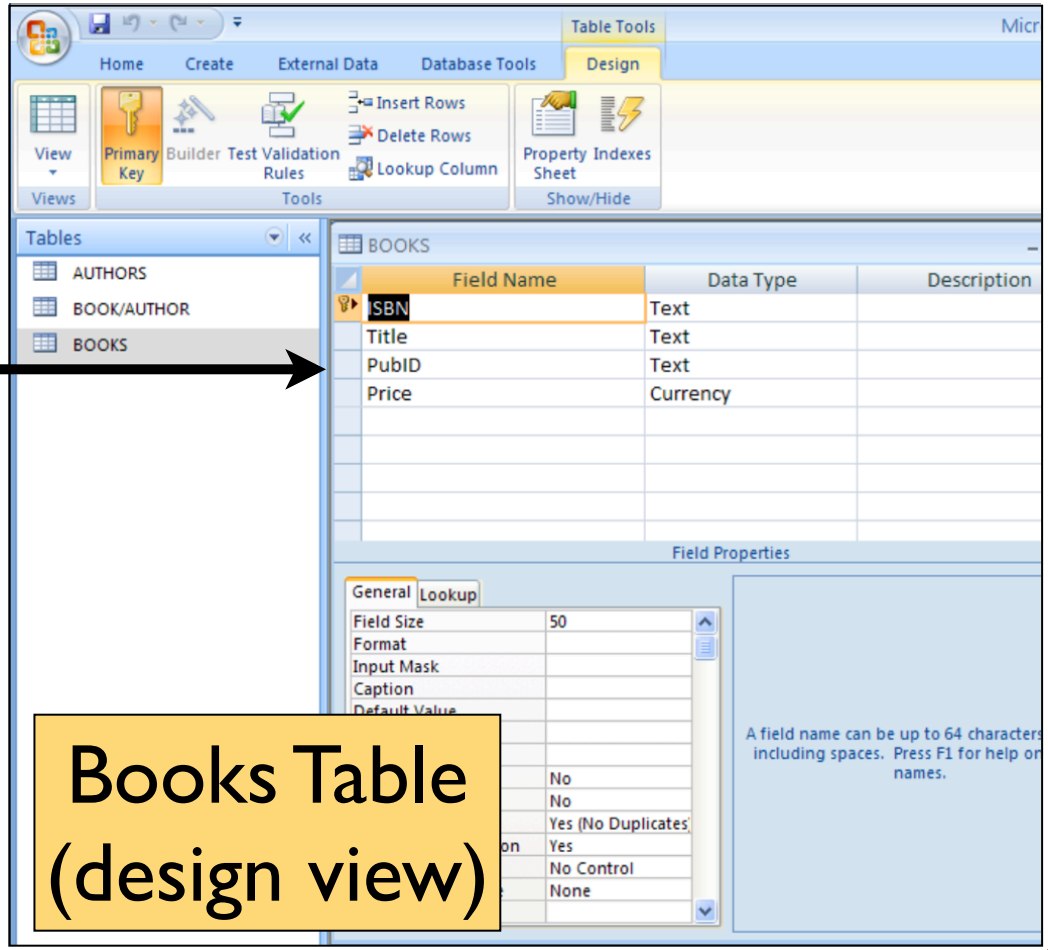




Inspecting the Database Field Types

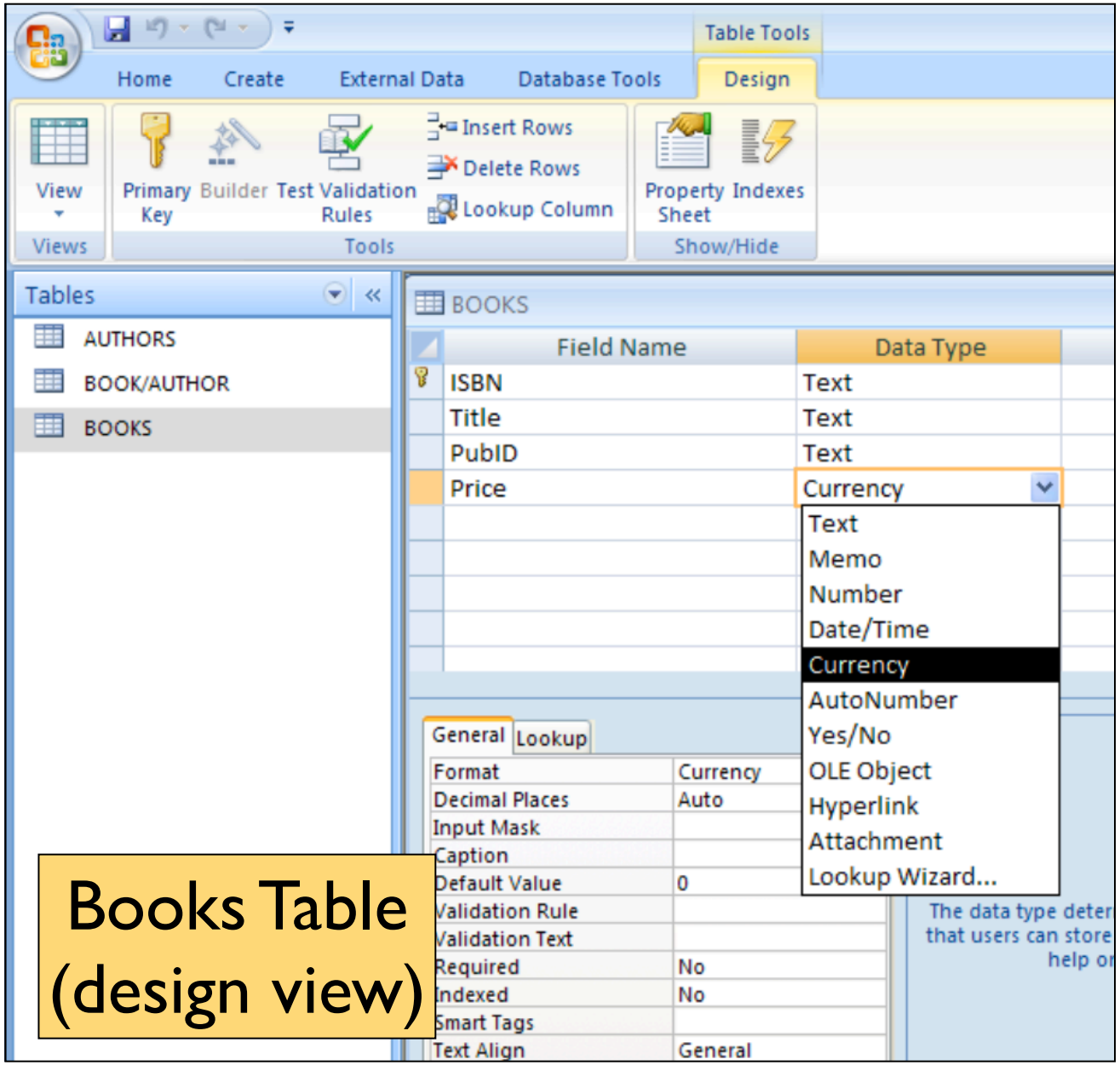
- When a table is created you need to specify the field type for each record
- Use the **Design View** to accomplish this





Database Field Data Types

- Access provides 11 data types for your records
- Common types:
  - Text
  - Number
  - Date/time
  - Currency



Books Table (design view)

Adding the Publishers Table

- The current database is pretty useless unless we relate the fields of some of the 2-dimensional 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

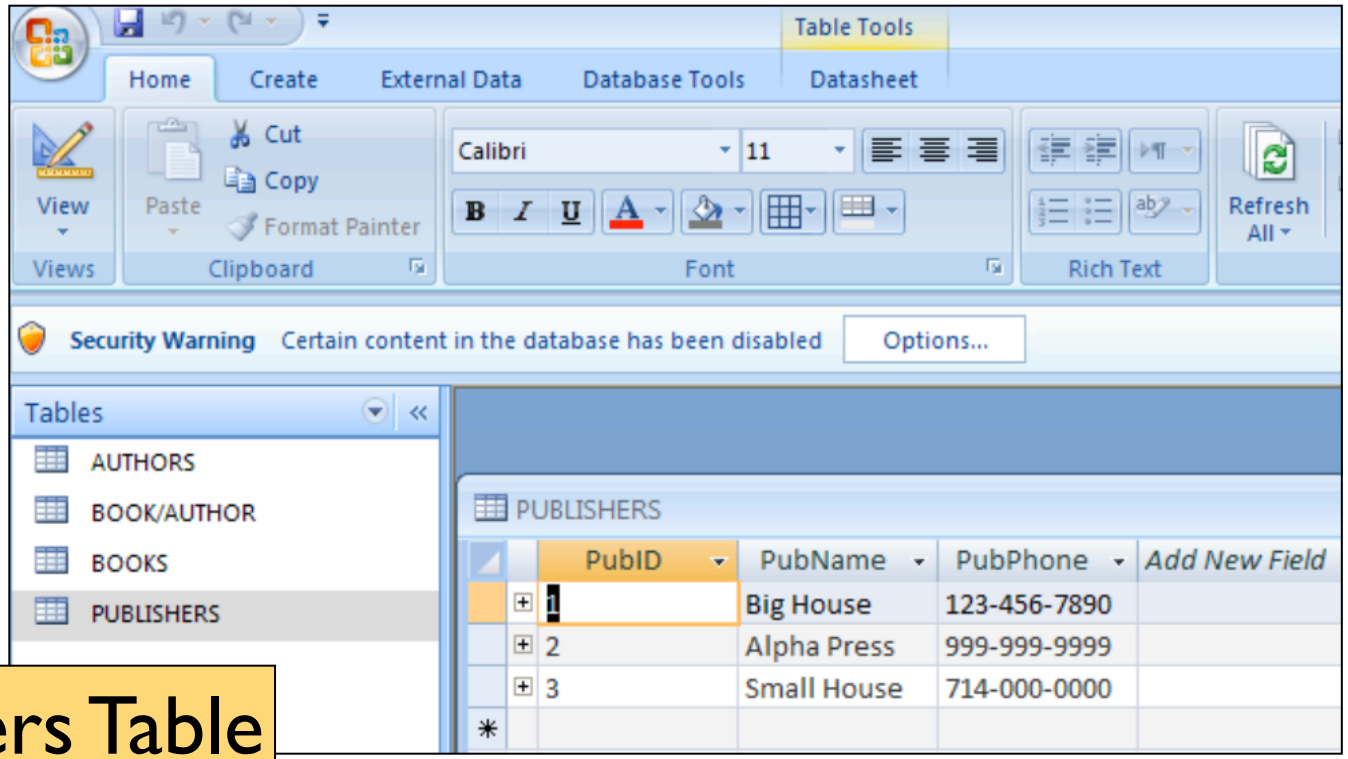
BOOKS

ISBN	Title	PubID	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

Books Table

Adding the Publishers Table

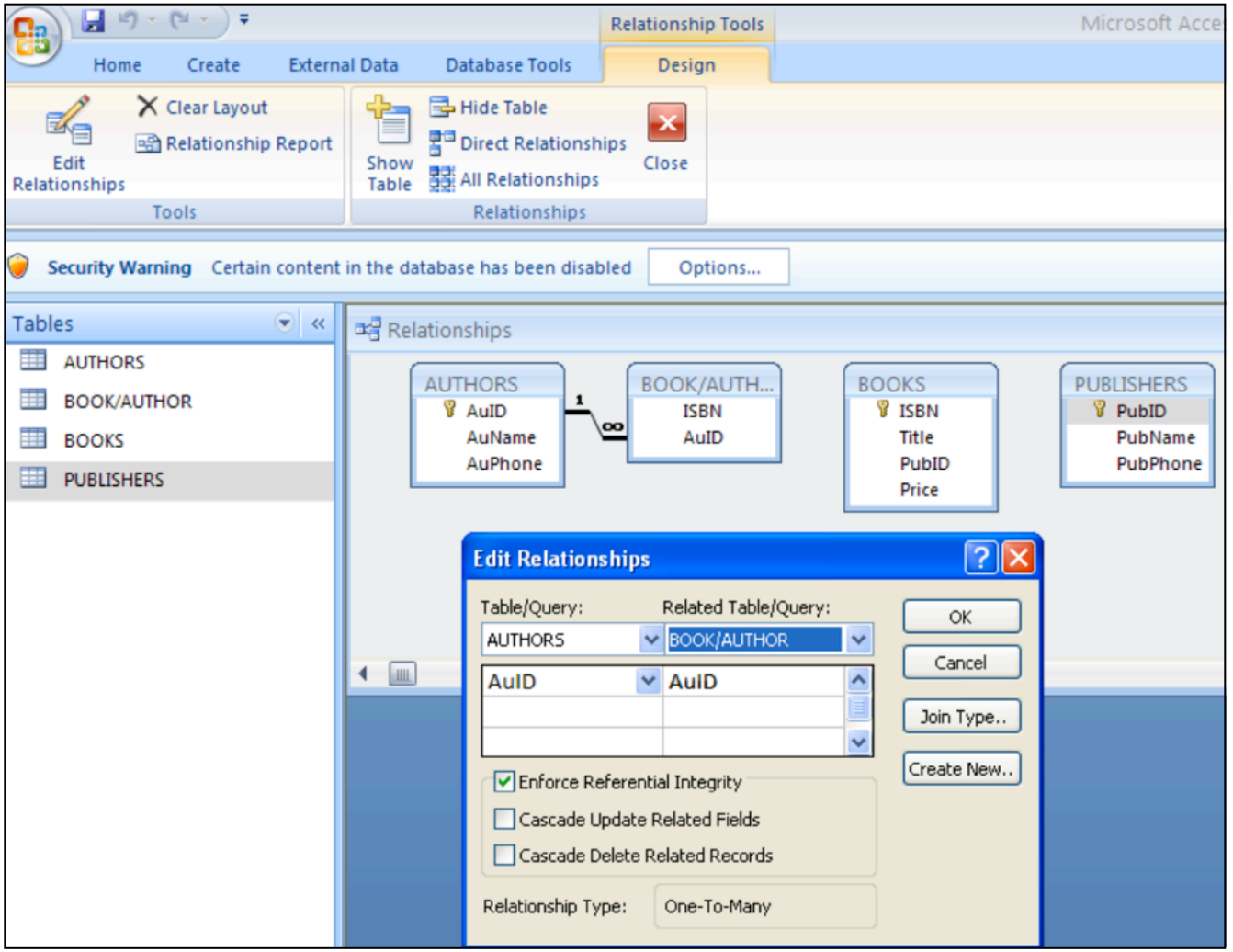
- Select the “Create” panel and define a new table
- Later rename the table as PUBLISHERS
- Add three fields to the table:
  - PubID
  - PubName
  - PubPhone



Publishers Table

Establishing Relationships Between Tables

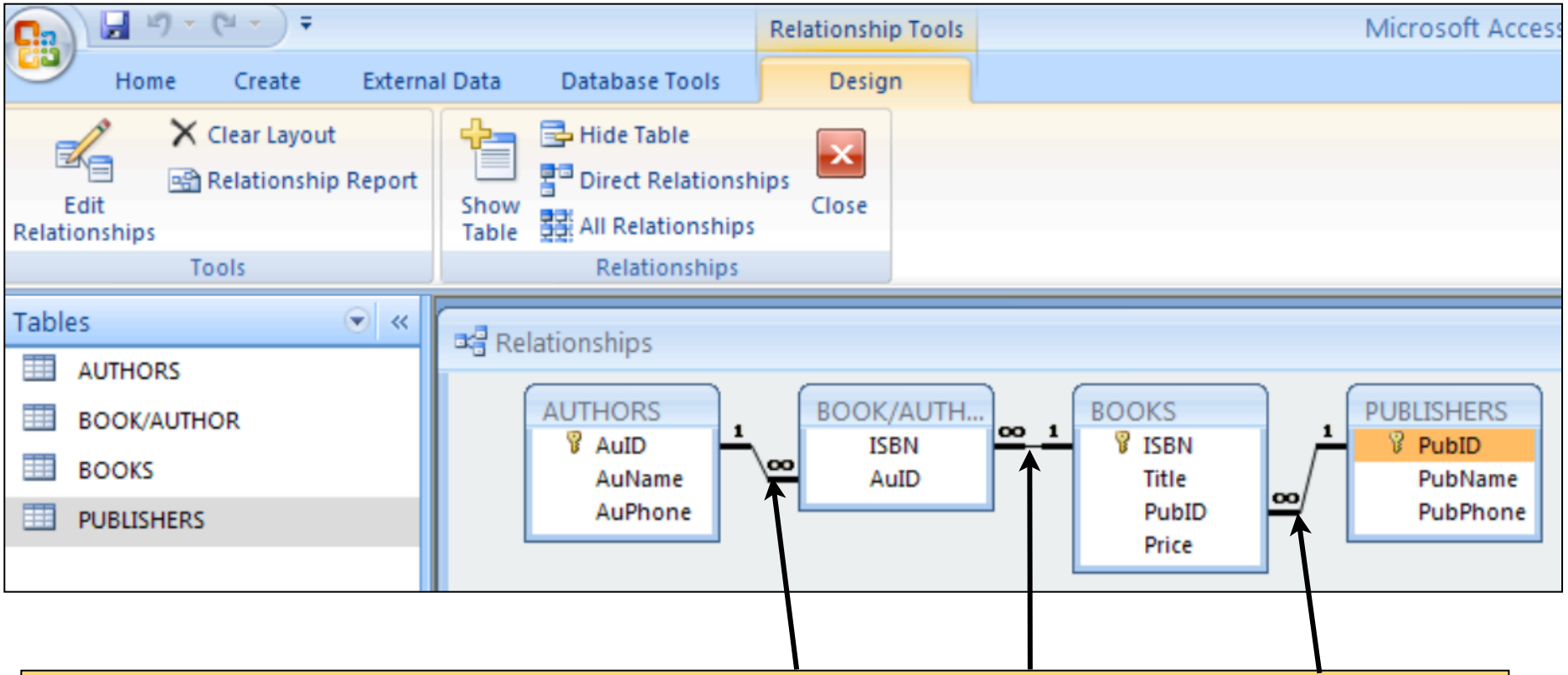
- Select the "Database Tools" panel and define relationships
- First add the tables that you want to relate
- Select "Edit Relationships"



Can create a table relationship using the table format

Final Relationships

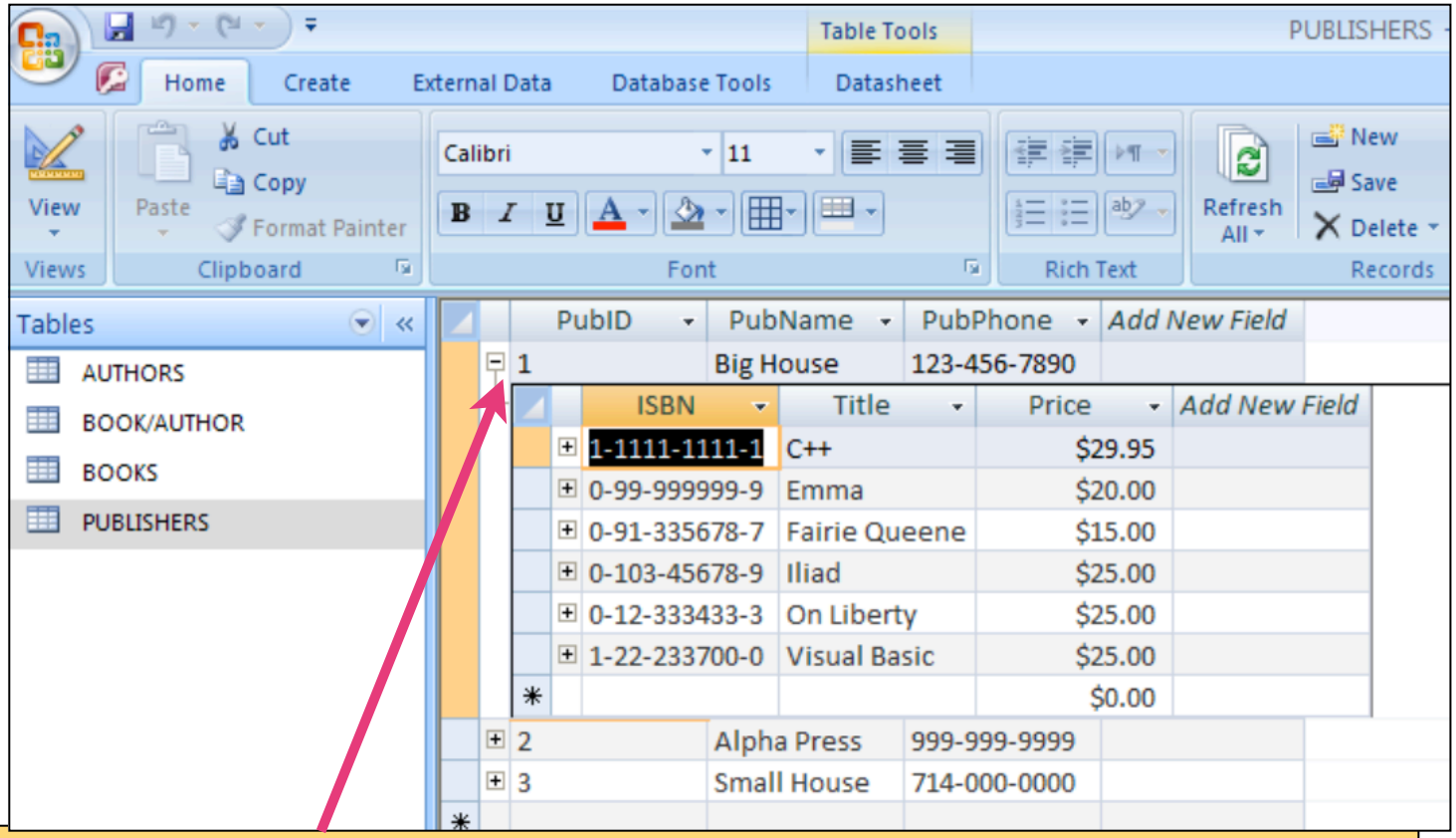
- Edit the relationships and join variables with same names among the tables



All relationships between tables are one-to-many

What Happened After Relationships are Established?

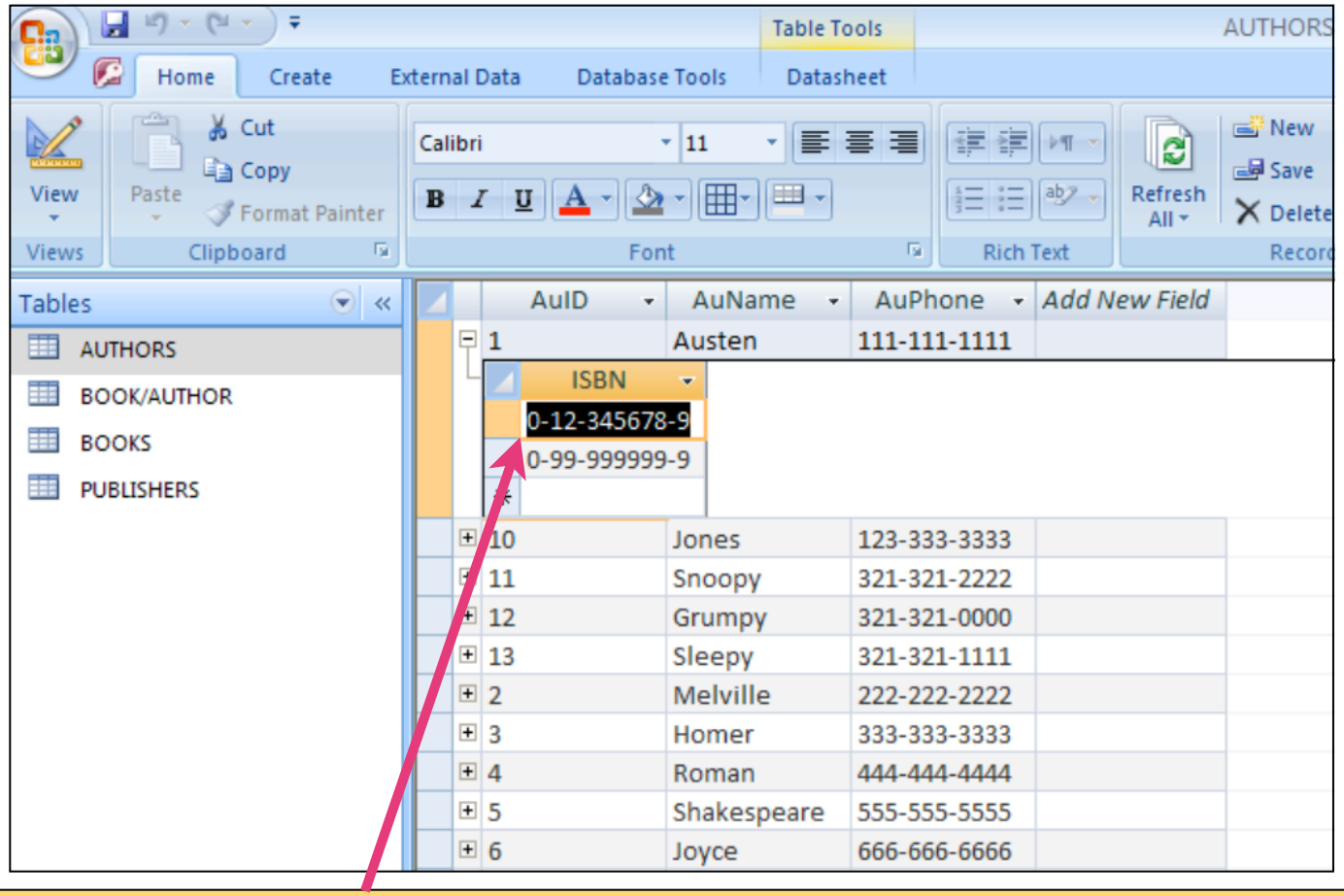
- You can easily inspect the data sets that are related



Each Publisher Instance (or record) has several associated Books

After Relationships are Established

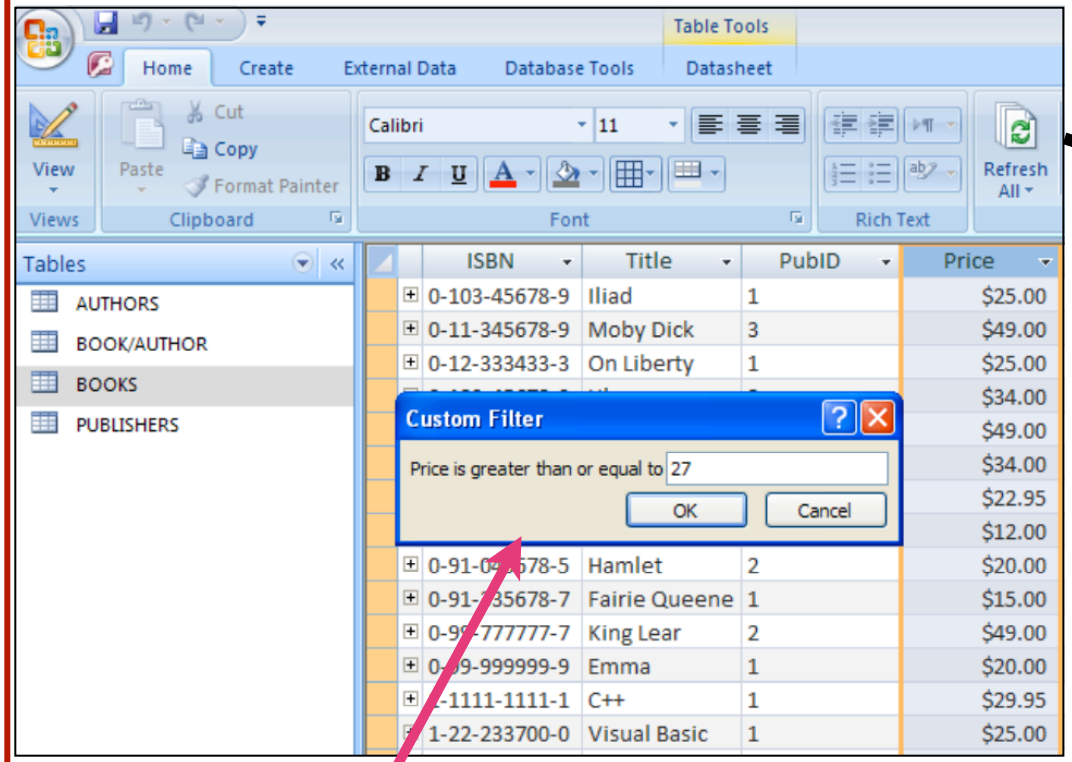
- You can easily inspect the data sets that are related

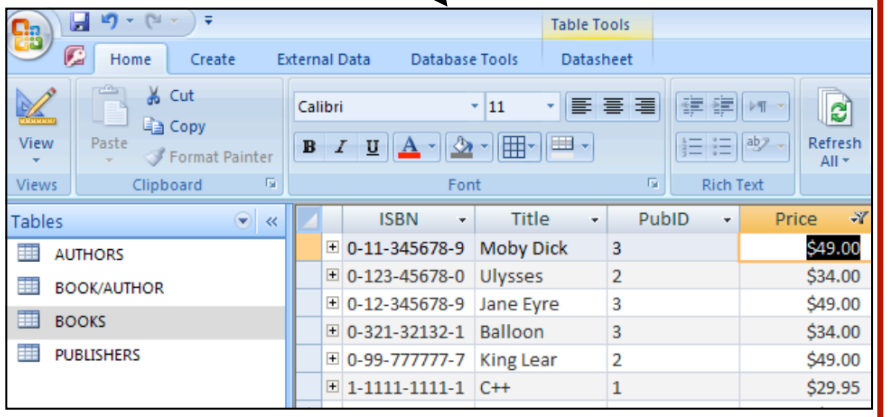


Each Author Instance (or record) has several associated ISBN numbers

Basic Filtering in the Database

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





Books with a price of >= $27.00

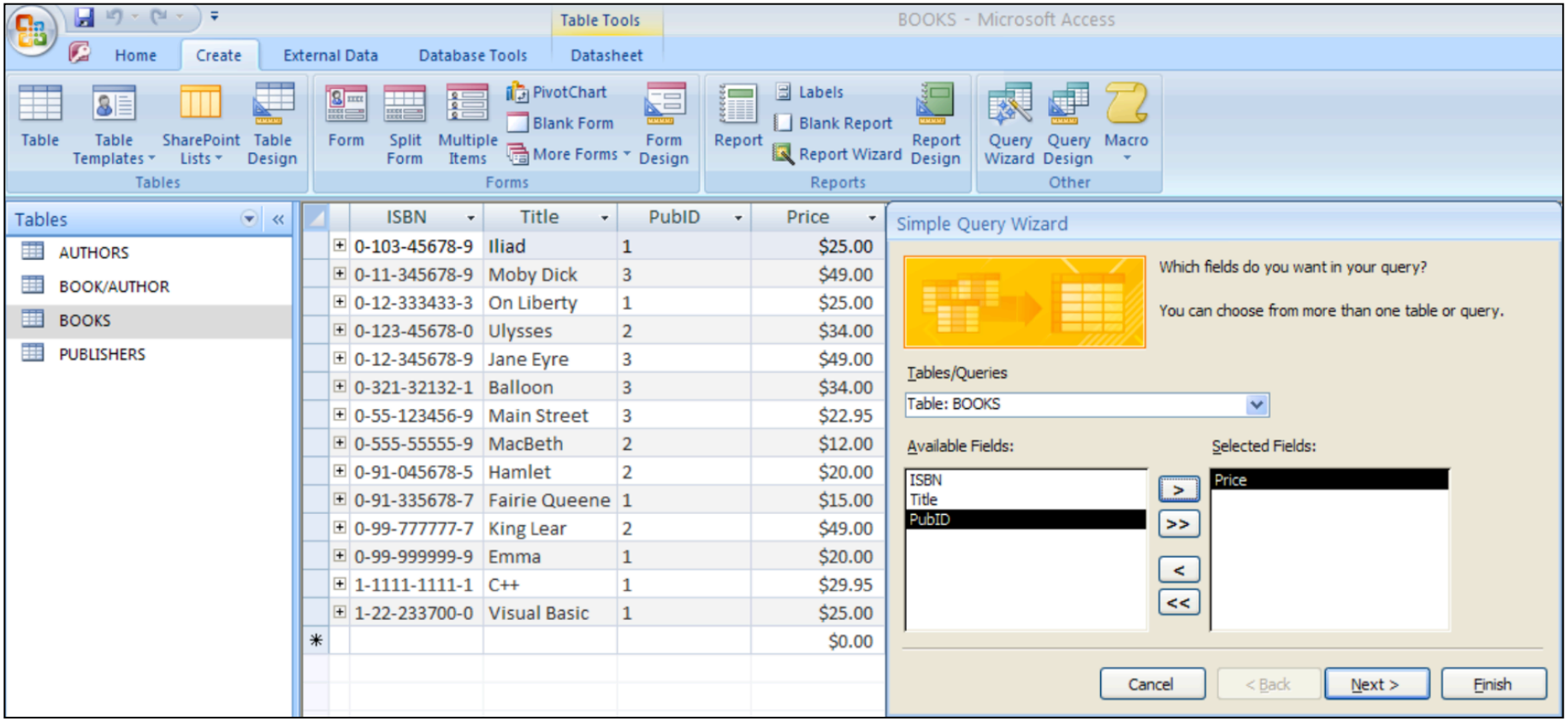
Result

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)

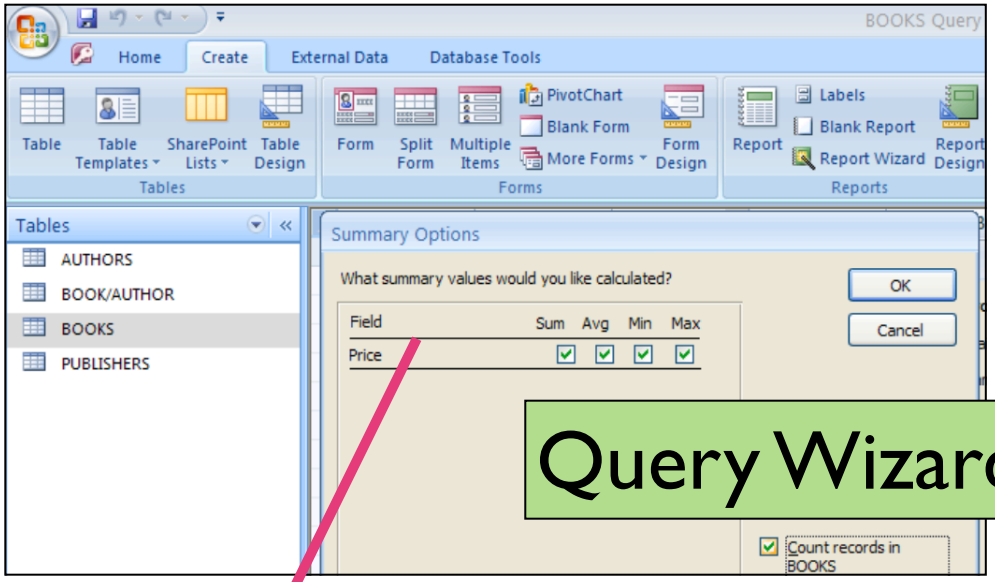
Basic Queries in the Database (The Query Wizard)

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

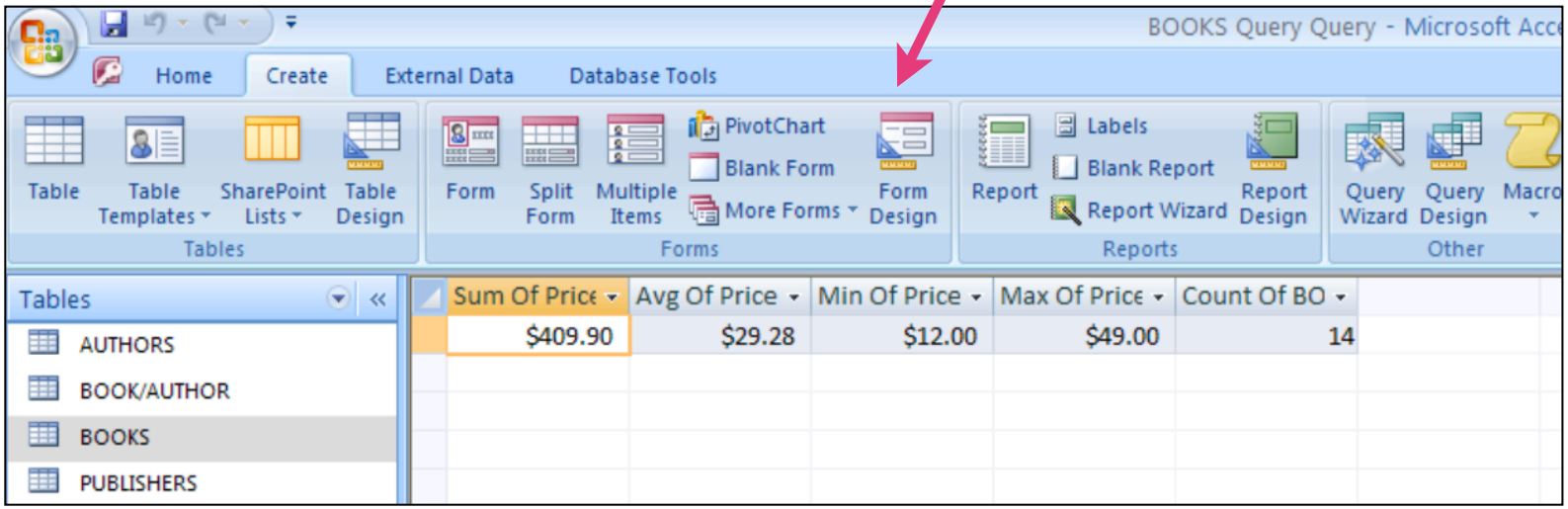


Basic Queries in the Database (The Query Wizard)

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

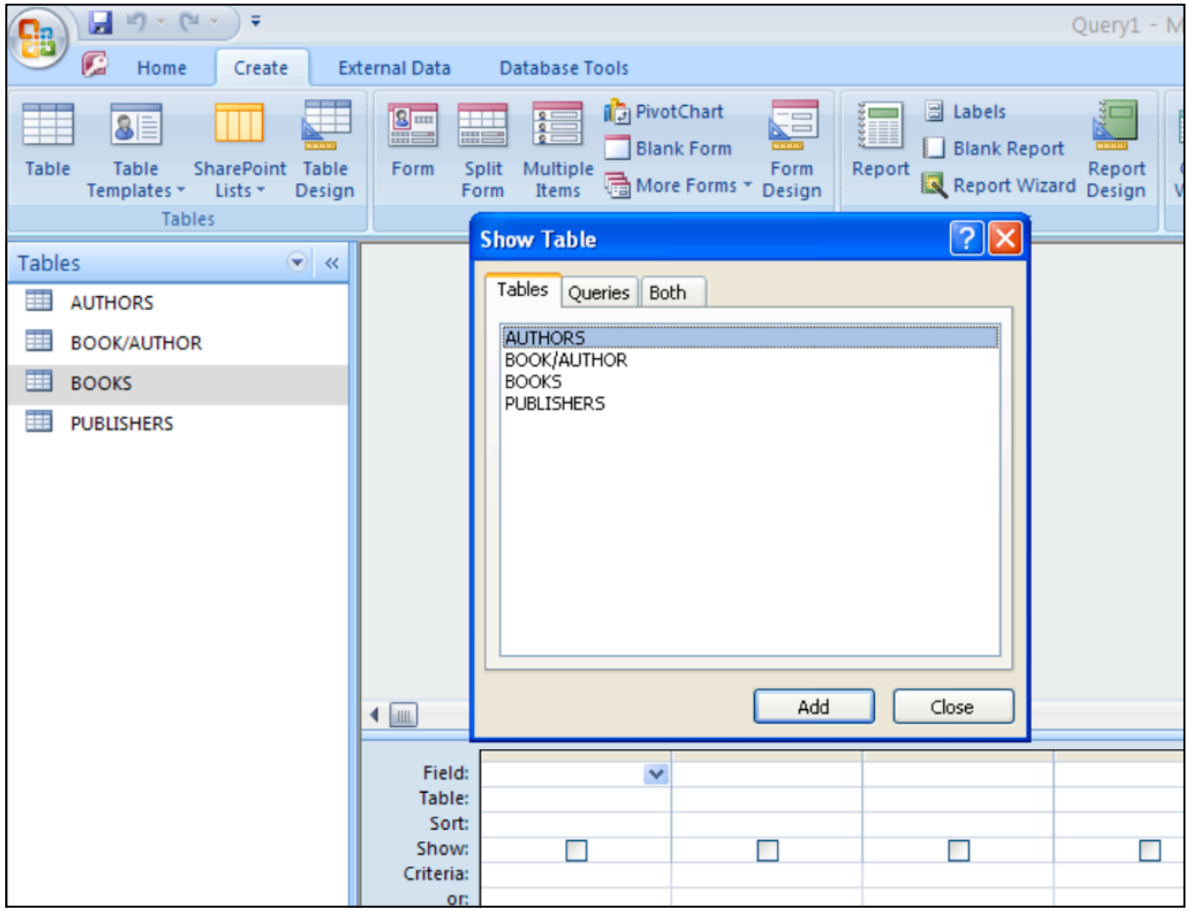


Query Wizard



Basic Queries in the Database (The Query Design)

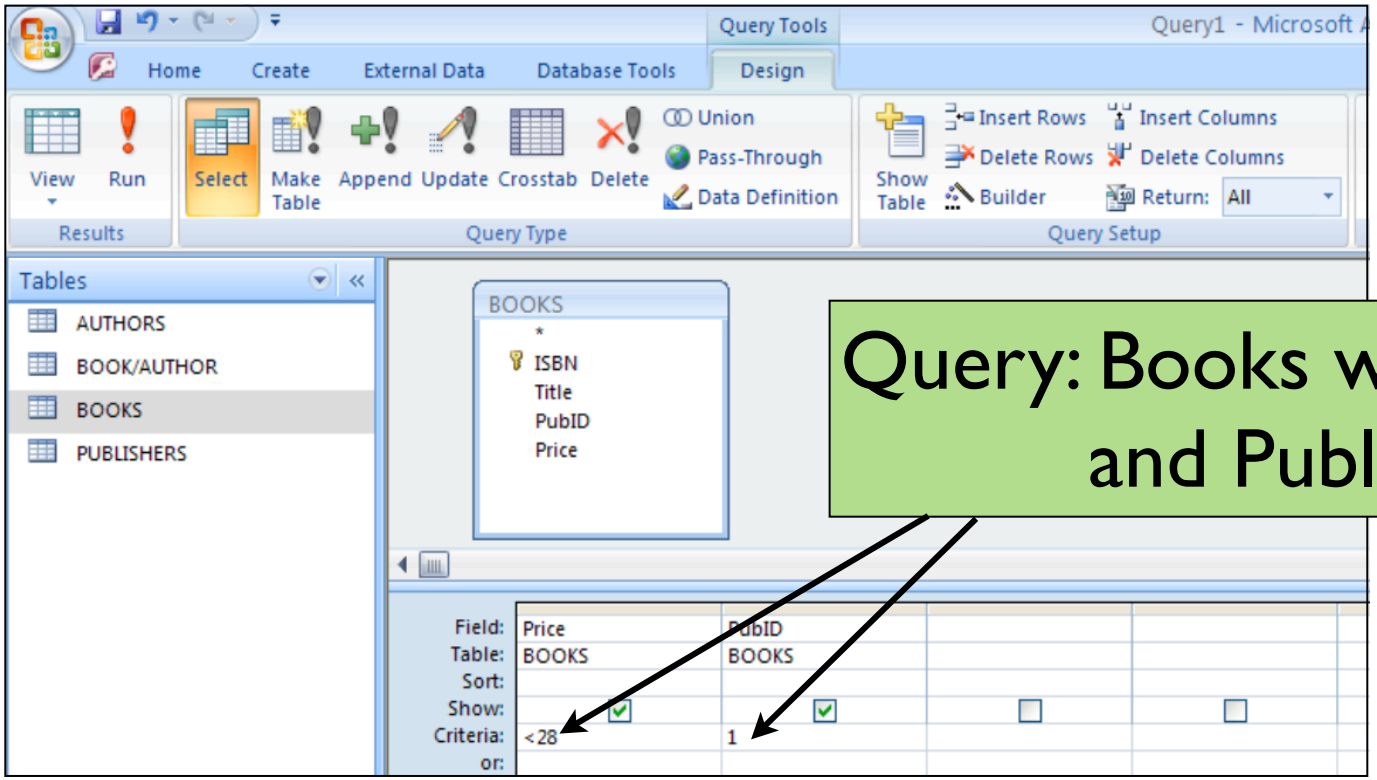
- A better way to make queries is to use the “Query Design” interface
- Look under “Create” tab in Access 2007



Query Design Interface

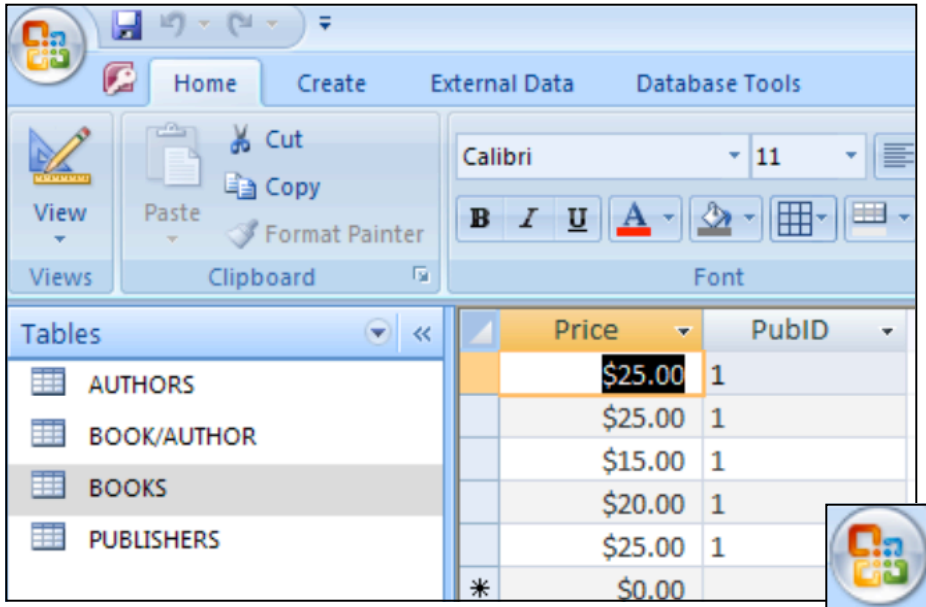
Basic Queries in the Database (The Query Design)

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



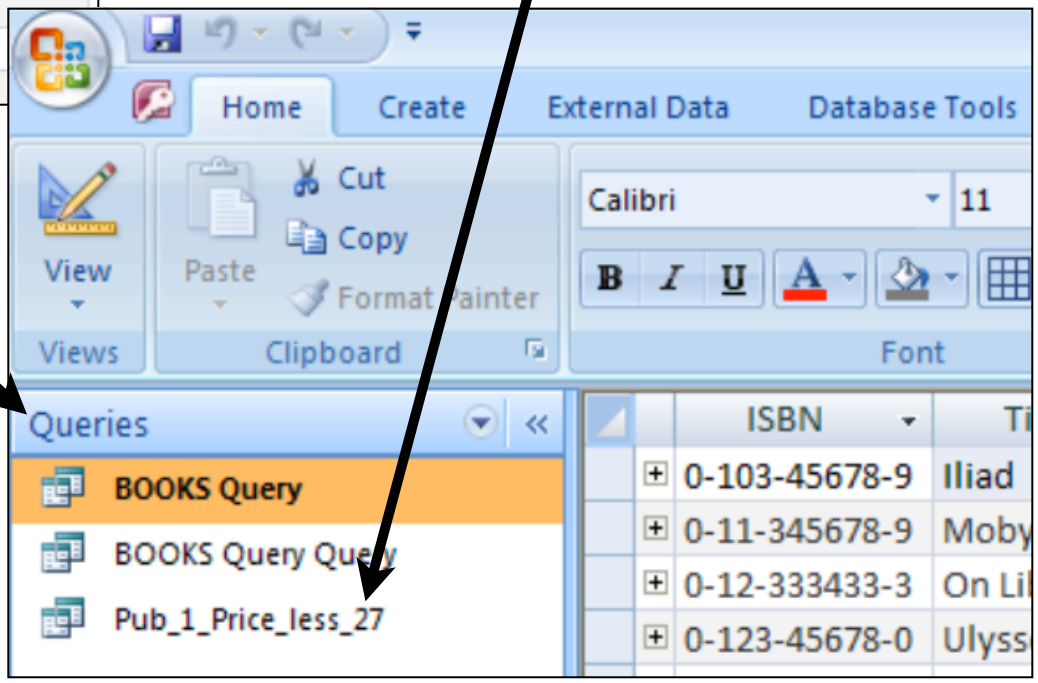
Query: Books with price < 28 and Publisher 1

Output of the Query



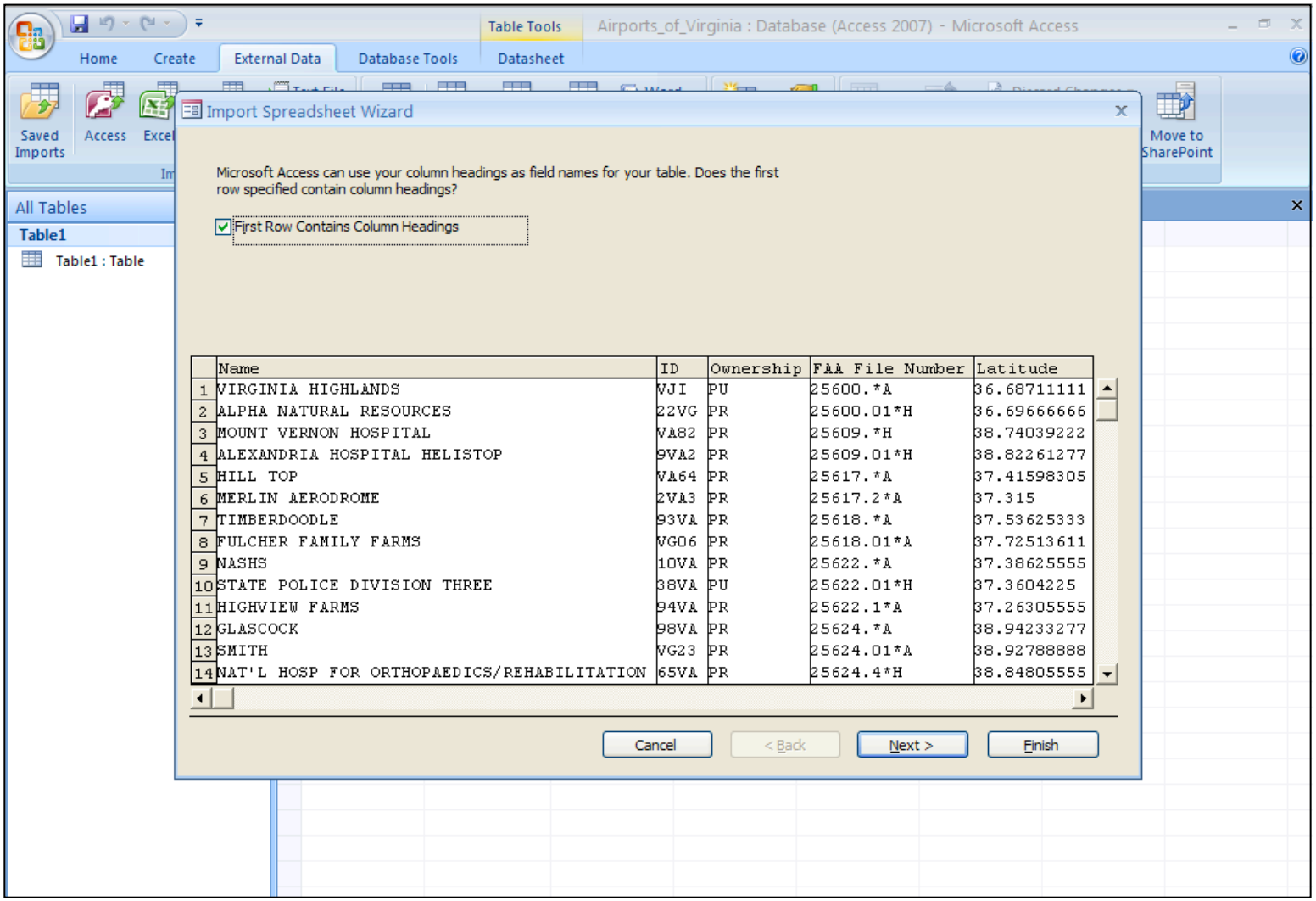
- Saves your queries for reuse in the Navigation panel

- Select "Queries" in the navigation panel



Importing Data into Access

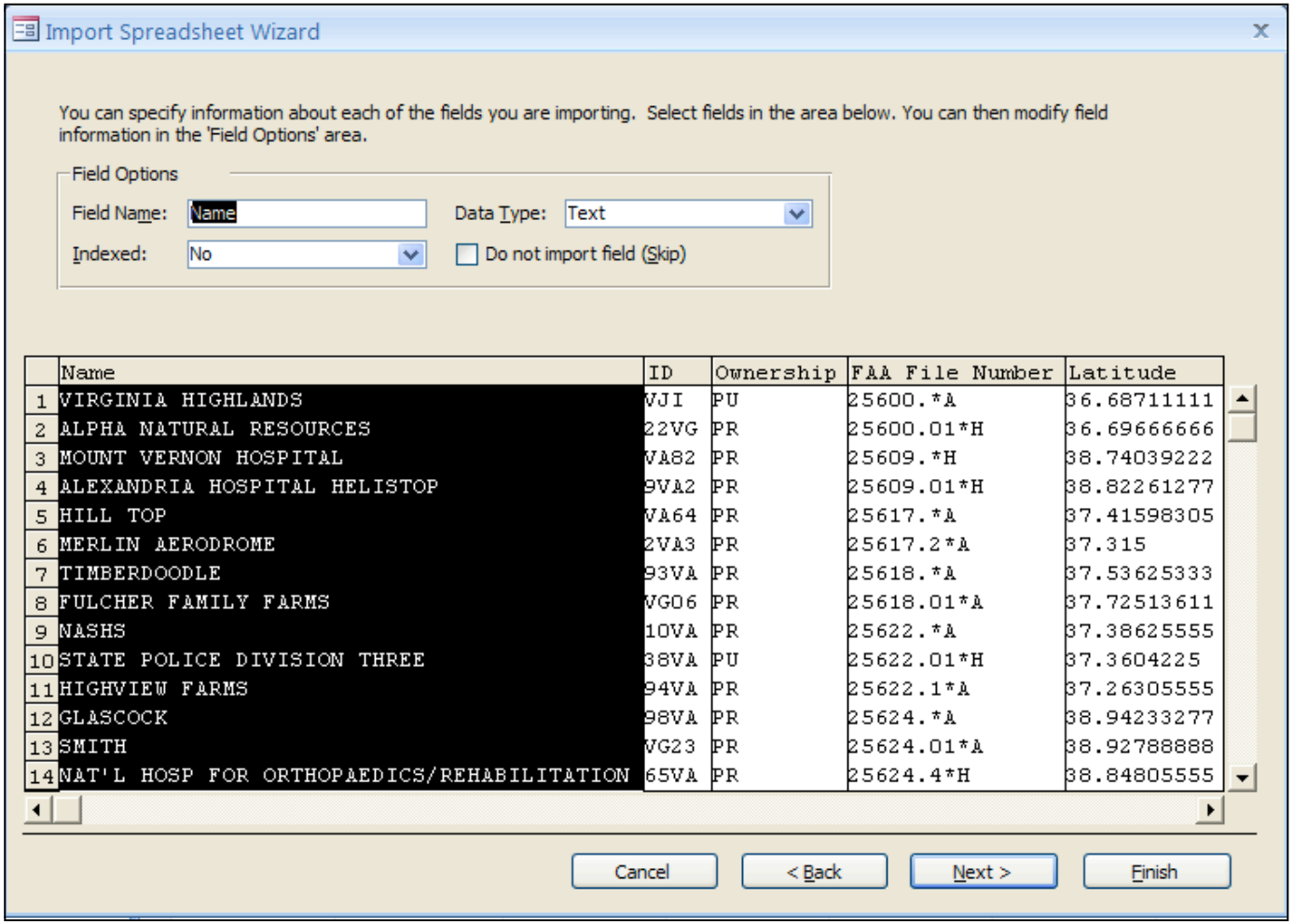
- Can import data from many sources (like Excel or text files)



	Name	ID	Ownership	FAA File Number	Latitude
1	VIRGINIA HIGHLANDS	VJI	PU	25600.*A	36.68711111
2	ALPHA NATURAL RESOURCES	22VG	PR	25600.01*H	36.69666666
3	MOUNT VERNON HOSPITAL	VA82	PR	25609.*H	38.74039222
4	ALEXANDRIA HOSPITAL HELISTOP	9VA2	PR	25609.01*H	38.82261277
5	HILL TOP	VA64	PR	25617.*A	37.41598305
6	MERLIN AERODROME	2VA3	PR	25617.2*A	37.315
7	TIMBERDOODLE	93VA	PR	25618.*A	37.53625333
8	FULCHER FAMILY FARMS	VG06	PR	25618.01*A	37.72513611
9	NASHS	10VA	PR	25622.*A	37.38625555
10	STATE POLICE DIVISION THREE	38VA	PU	25622.01*H	37.3604225
11	HIGHVIEW FARMS	94VA	PR	25622.1*A	37.26305555
12	GLASCOCK	98VA	PR	25624.*A	38.94233277
13	SMITH	VG23	PR	25624.01*A	38.92788888
14	NAT'L HOSP FOR ORTHOPAEDICS/REHABILITATION	65VA	PR	25624.4*H	38.84805555

Importing Data into Access

- As you import data, you can specify the data types for each field of the data to import



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6	MERLIN AERODROME	2VA3	PR	25617.2*A	37.315
7	TIMBERDOODLE	93VA	PR	25618.*A	37.53625333
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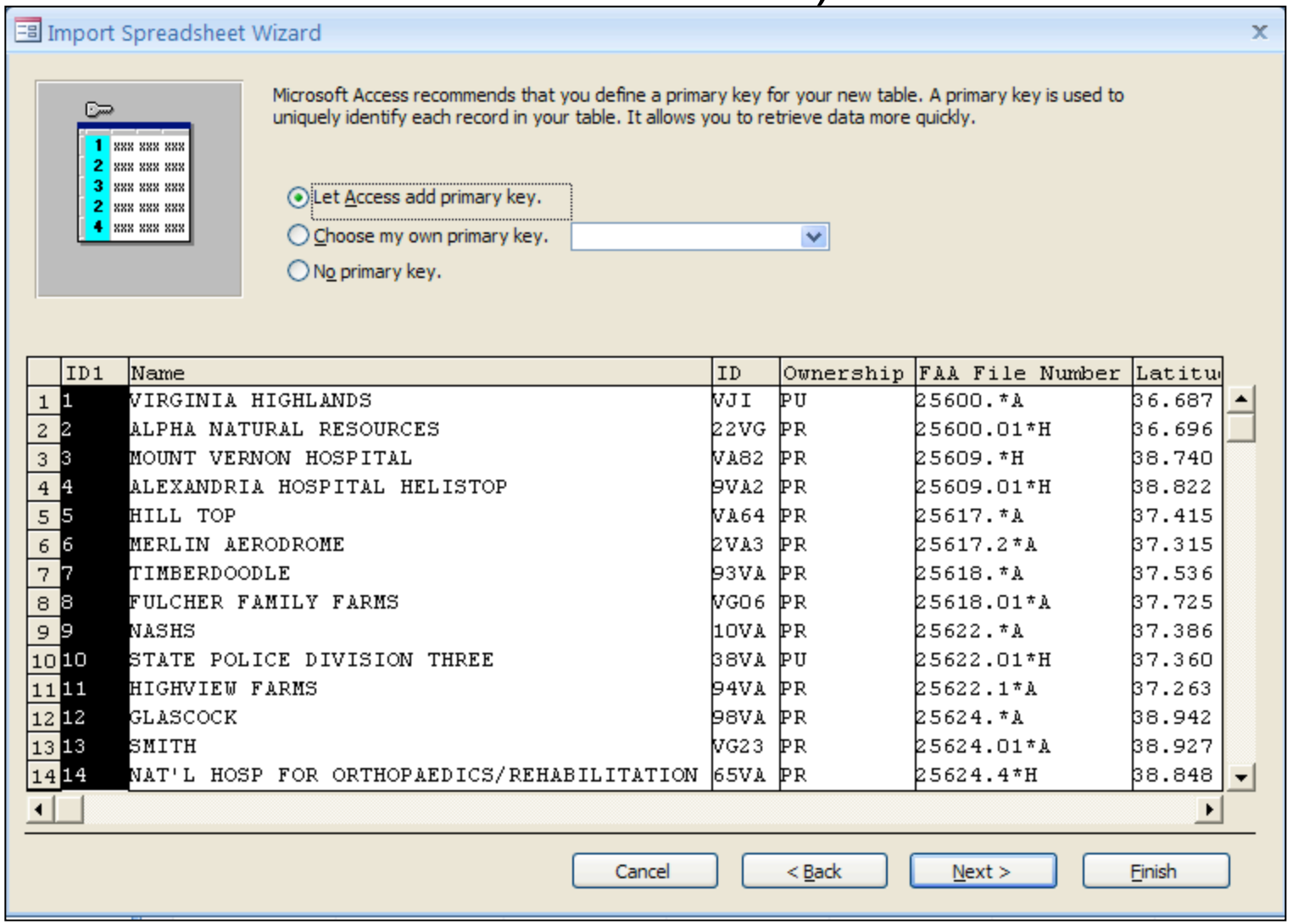
13	SMITH	VG23	PR	25624.01*A	38.92788888
14	NAT'L HOSP FOR ORTHOPAEDICS/REHABILITATION	65VA	PR	25624.4*H	38.84805555

Importing Data into Access

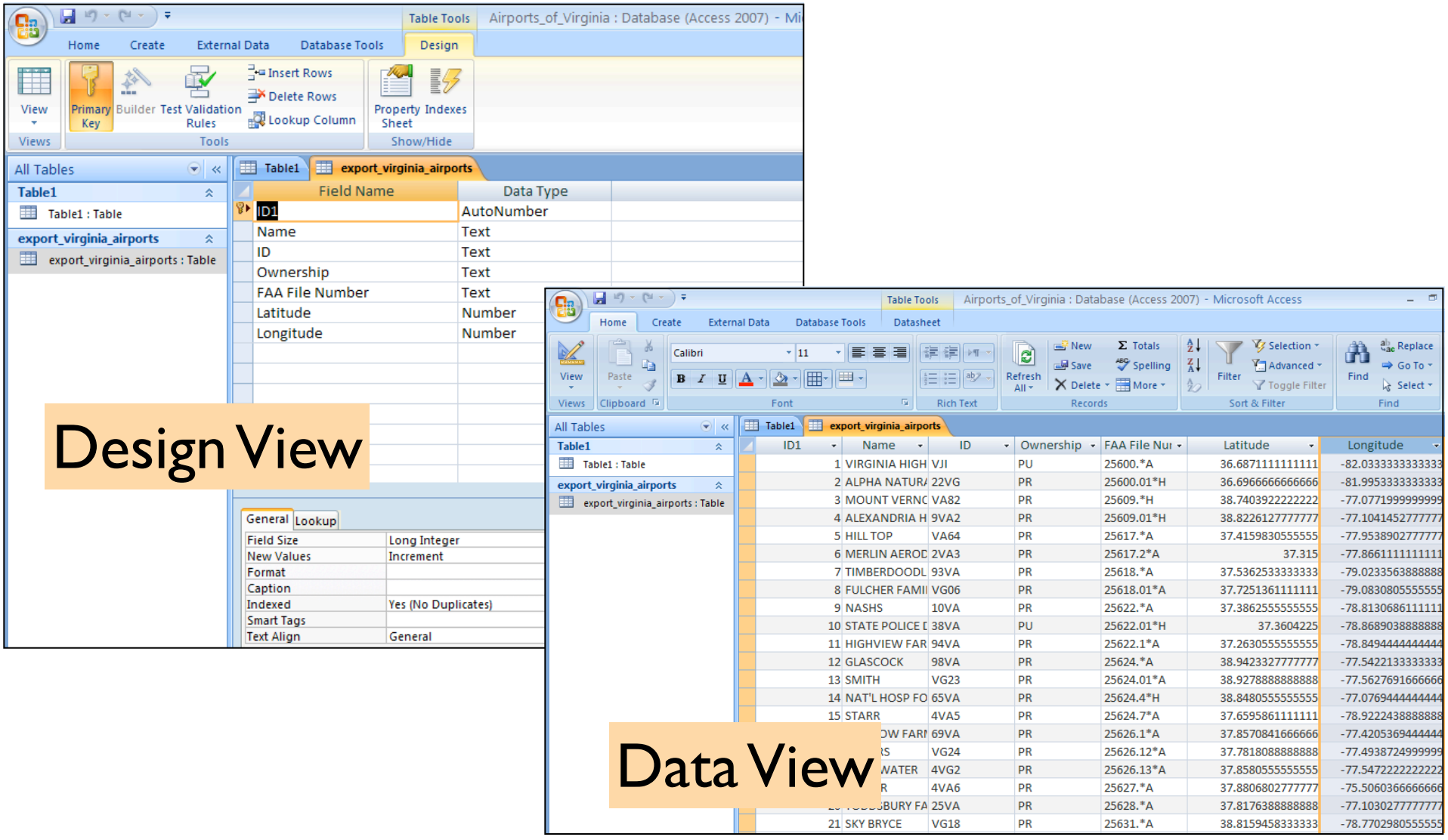
- Selecting the Primary Key of the data (I am letting Access define a new column for me)



	ID1	Name	ID	Ownership	FAA File Number	Latitu
1	1	VIRGINIA HIGHLANDS	VJI	PU	25600.*A	36.687
2	2	ALPHA NATURAL RESOURCES	22VG	PR	25600.01*H	36.696
3	3	MOUNT VERNON HOSPITAL	VA82	PR	25609.*H	38.740
4	4	ALEXANDRIA HOSPITAL HELISTOP	9VA2	PR	25609.01*H	38.822
5	5	HILL TOP	VA64	PR	25617.*A	37.415
6	6	MERLIN AERODROME	2VA3	PR	25617.2*A	37.315
7	7	TIMBERDOODLE	93VA	PR	25618.*A	37.536
8	8	FULCHER FAMILY FARMS	VG06	PR	25618.01*A	37.725
9	9	NASHS	10VA	PR	25622.*A	37.386
10	10	STATE POLICE DIVISION THREE	38VA	PU	25622.01*H	37.360
11	11	HIGHVIEW FARMS	94VA	PR	25622.1*A	37.263
12	12	GLASCOCK	98VA	PR	25624.*A	38.942
13	13	SMITH	VG23	PR	25624.01*A	38.927
14	14	NAT'L HOSP FOR ORTHOPAEDICS/REHABILITATION	65VA	PR	25624.4*H	38.848

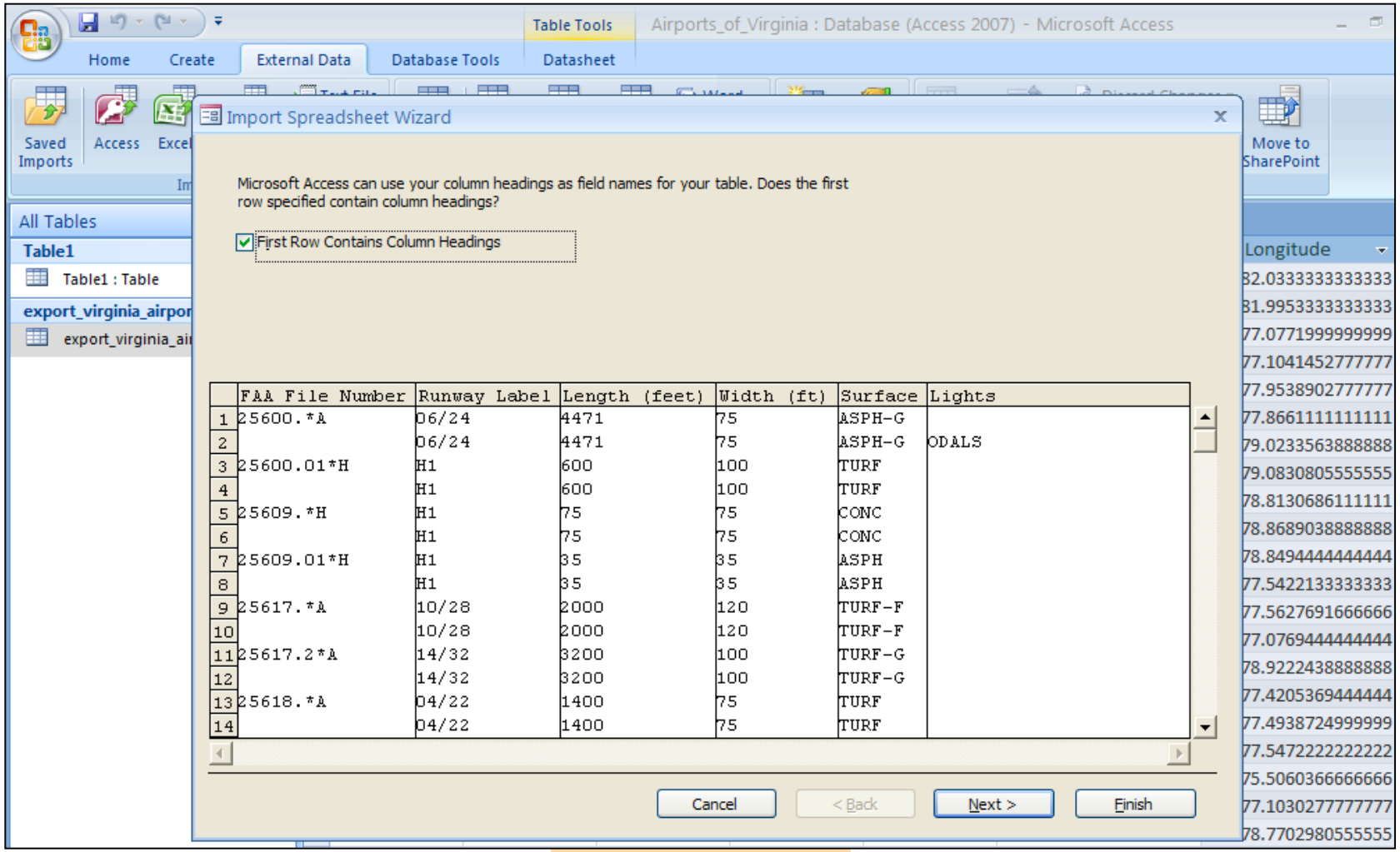
Importing Data into Access

- Imported Virginia Airports Excel file



Importing the Runways Excel File

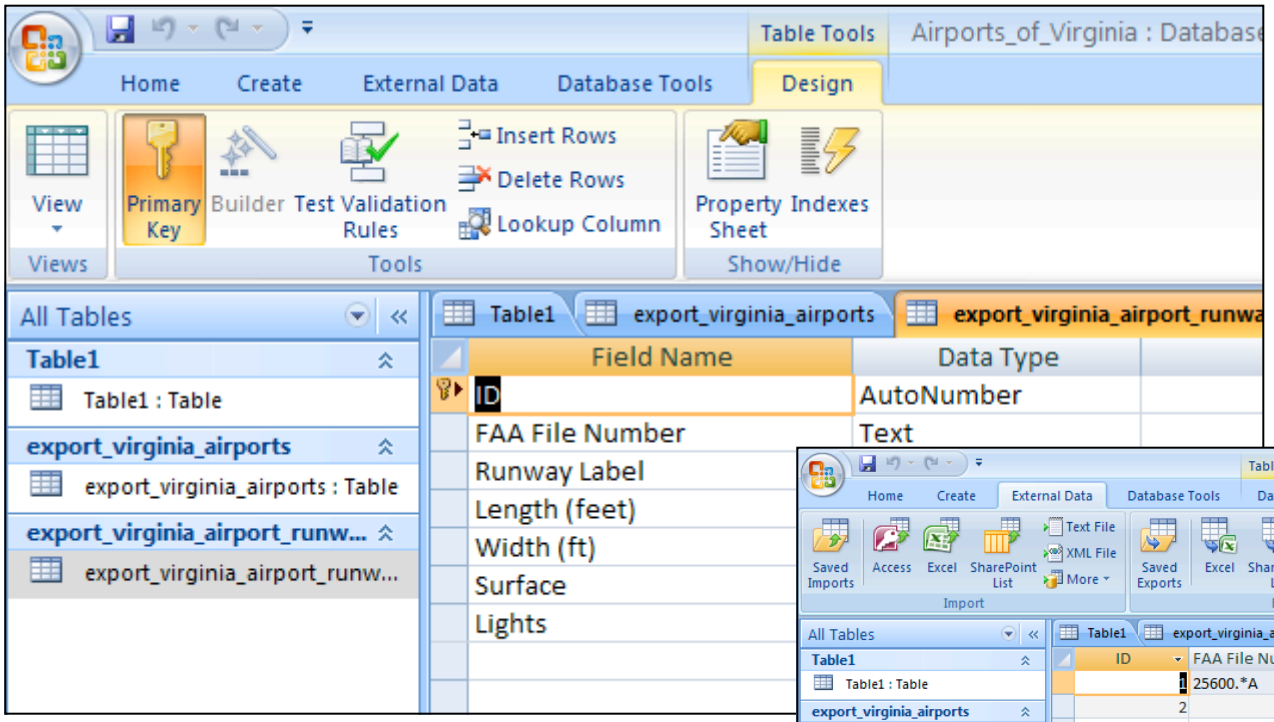
- Import a second file containing runways at the Virginia Airports



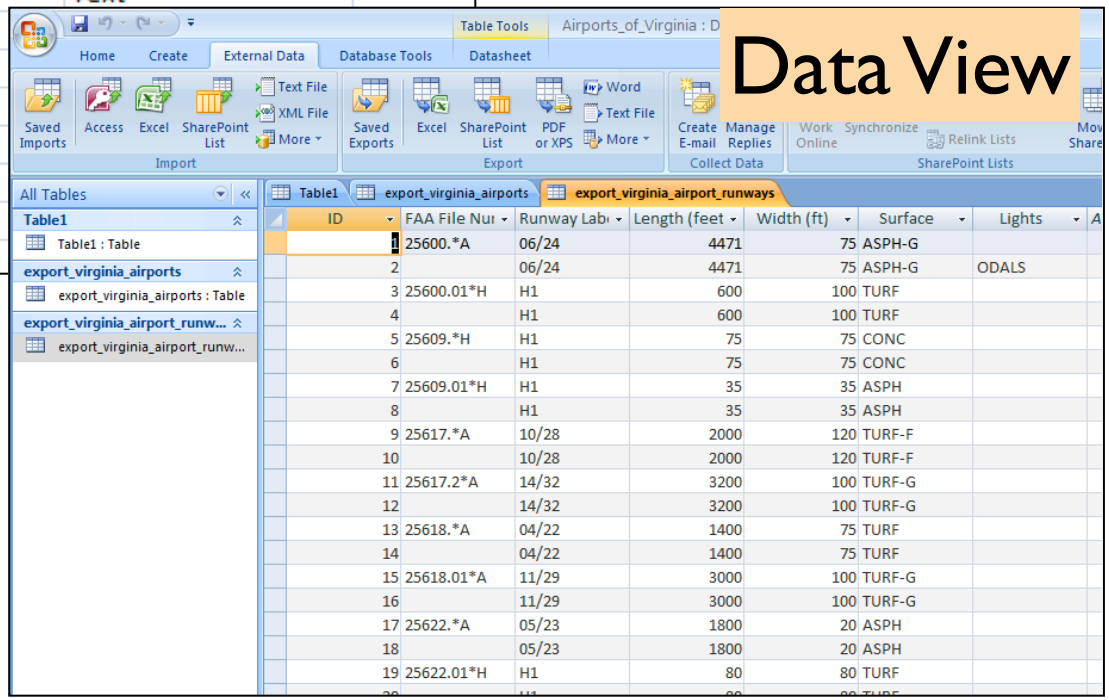
	FAA File Number	Runway Label	Length (feet)	Width (ft)	Surface	Lights
1	25600.*A	06/24	4471	75	ASPH-G	
2		06/24	4471	75	ASPH-G	ODALS
3	25600.01*H	H1	600	100	TURF	
4		H1	600	100	TURF	
5	25609.*H	H1	75	75	CONC	
6		H1	75	75	CONC	
7	25609.01*H	H1	35	35	ASPH	
8		H1	35	35	ASPH	
9	25617.*A	10/28	2000	120	TURF-F	
10		10/28	2000	120	TURF-F	
11	25617.2*A	14/32	3200	100	TURF-G	
12		14/32	3200	100	TURF-G	
13	25618.*A	04/22	1400	75	TURF	
14		04/22	1400	75	TURF	

Imported Runway File

- Imported Virginia Airports Runway Excel file



Design View



Data View