Northeastern University
College *of* Computer and Information Science

Managing Data in Relational Databases

DATA, DATABASES, AND QUERIES

What is this About

- Storing, accessing, searching, and viewing data are important in any business.
- While spreadsheets work well for small amounts of data, databases are used for larger data collections.
- Learning how to access data is an important skill when working with databases.
- We will learn how to formulate queries in the Microsoft Access database system.

Reasons to Move to a Database

- Too much data in individual files
  - Difficult to manage data
- Have multiple uses for data
  - Need multiple “views” of the data
- Need to share the data
  - Numerous people are entering, deleting, viewing data
- Need to control the data
  - Control data values and consistency

This data for a business belongs in a database…

A	B	C	D	E	F	G	H	I	J	K	L	M	N	
Contacts.ContactID	FirstName	LastName	Address	Contacts.ZipCod	PhoneNumber	LineItemID	Quantity	UnitPrice	OrderID	Order Date	ProductID	Product Name	urrent Unit Pric	Units
4	Nicholas	Colon	9020 N.W. 75 Street	33065	3057539887	1	1	$23.00	O0001	4/15/1999	P0013	DVD Disks	$23.00	
4	Nicholas	Colon	9020 N.W. 75 Street	33065	3057539887	2	4	$9.99	O0001	4/15/1999	P0014	HD Floppy Disks	$9.99	
4	Nicholas	Colon	9020 N.W. 75 Street	33065	3057539887	3	1	$115.95	O0001	4/15/1999	P0027	Norton Anti-Virus	$115.95	
3	Neil	Goodman	4215 South 81 Street	33065	3054445555	4	1	$1,899.00	O0002	4/18/1999	P0001	Pentium II/300 MHz	$1,899.00	
3	Neil	Goodman	4215 South 81 Street	33065	3054445555	5	1	$499.00	O0002	4/18/1999	P0006	15" SVGA Monitor	$499.00	
3	Neil	Goodman	4215 South 81 Street	33065	3054445555	6	1	$189.95	O0002	4/18/1999	P0020	Fax/Modem 56 Kbps	$189.95	
3	Neil	Goodman	4215 South 81 Street	33065	3054445555	7	1	$1,395.00	O0002	4/18/1999	P0022	Laser Printer (network)	$1,395.00	
6	Jeffrey	Muddell	9522 S.W. 142 Street	33340	3052533909	8	1	$2,599.00	O0003	4/18/1999	P0005	Pentium II laptop/266MHz	$2,599.00	
6	Jeffrey	Muddell	9522 S.W. 142 Street	33340	3052533909	9	1	$189.95	O0003	4/18/1999	P0020	Fax/Modem 56 Kbps	$189.95	
6	Jeffrey	Muddell	9522 S.W. 142 Street	33340	3052533909	10	1	$1,395.00	O0003	4/18/1999	P0022	Laser Printer (network)	$1,395.00	
7	Ashley	Geoghegan	7500 Center Lane	33070	3057537830	11	1	$2,099.00	O0004	4/18/1999	P0003	Pentium II/400 MHz	$2,099.00	
7	Ashley	Geoghegan	7500 Center Lane	33070	3057537830	12	1	$799.00	O0004	4/18/1999	P0010	2 GB SCSI Hard Drive	$799.00	
7	Ashley	Geoghegan	7500 Center Lane	33070	3057537830	13	2	$1,395.00	O0004	4/18/1999	P0022	Laser Printer (network)	$1,395.00	
1	Benjamin	Lee	1000 Call Street	45501	9043274124	14	2	$2,099.00	O0005	4/20/1999	P0003	Pentium II/400 MHz	$2,099.00	
1	Benjamin	Lee	1000 Call Street	45501	9043274124	15	2	$249.00	O0005	4/20/1999	P0012	CD-ROM: 32X	$249.00	
1	Benjamin	Lee	1000 Call Street	45501	9043274124	16	2	$179.95	O0005	4/20/1999	P0016	Internal Zip Drive	$179.95	
1	Benjamin	Lee	1000 Call Street	45501	9043274124	17	1	$899.00	O0006	4/21/1999	P0007	17" SVGA Monitor	$899.00	
1	Benjamin	Lee	1000 Call Street	45501	9043274124	18	10	$9.99	O0006	4/21/1999	P0014	HD Floppy Disks	$9.99	
2	Eleanor	Milgrom	7245 NW 8 Street	33063	3059741234	19	1	$29.95	O0007	4/21/1999	P0028	Microsoft Scenes Screen	$29.95	
2	Eleanor	Milgrom	7245 NW 8 Street	33063	3059741234	20	3	$59.95	O0007	4/21/1999	P0030	Microsoft Cinemania	$59.95	
2	Eleanor	Milgrom	7245 NW 8 Street	33063	3059741234	21	1	$1,599.00	O0008	4/22/1999	P0001	Pentium II/300 MHz	$1,899.00	
2	Eleanor	Milgrom	7245 NW 8 Street	33063	3059741234	22	3	$2,299.00	O0008	4/22/1999	P0004	Pentium II/450 MHz	$2,299.00	
2	Eleanor	Milgrom	7245 NW 8 Street	33063	3059741234	23	4	$1,599.00	O0008	4/22/1999	P0008	20" Multisync Monitor	$1,599.00	
2	Eleanor	Milgrom	7245 NW 8 Street	33063	3059741234	24	2	$1,245.00	O0008	4/22/1999	P0011	4 GB SCSI Hard Drive	$1,245.00	
2	Eleanor	Milgrom	7245 NW 8 Street	33063	3059741234	25	1	$249.00	O0008	4/22/1999	P0012	CD-ROM: 32X	$249.00	
1	Benjamin	Lee	1000 Call Street	45501	9043274124	26	1	$499.00	O0009	4/22/1999	P0006	15" SVGA Monitor	$499.00	
2	Eleanor	Milgrom	7245 NW 8 Street	33063	3059741234	27	2	$1,999.00	O0010	4/22/1999	P0002	Pentium II/350 MHz	$1,999.00	
2	Eleanor	Milgrom	7245 NW 8 Street	33063	3059741234	28	1	$1,395.00	O0010	4/22/1999	P0022	Laser Printer (network)	$1,395.00	
2	Eleanor	Milgrom	7245 NW 8 Street	33063	3059741234	29	1	$249.95	O0010	4/22/1999	P0023	Ink Jet Printer	$249.95	
1	Benjamin	Lee	1000 Call Street	45501	9043274124	30	2	$179.95	O0011	4/24/1999	P0016	Internal Zip Drive	$179.95	
1	Benjamin	Lee	1000 Call Street	45501	9043274124	31	2	$189.95	O0011	4/24/1999	P0020	Fax/Modem 56 Kbps	$189.95	
7	Ashley	Geoghegan	7500 Center Lane	33070	3057537830	32	10	$65.95	O0012	4/24/1999	P0021	Fax/Modem 33.6 Kbps	$65.95	
7	Ashley	Geoghegan	7500 Center Lane	33070	3057537830	33	10	$129.95	O0012	4/24/1999	P0029	Microsoft Bookshelf	$129.95	
7	Ashley	Geoghegan	7500 Center Lane	33070	3057537830	34	10	$59.95	O0012	4/24/1999	P0030	Microsoft Cinemania	$59.95	
4	Nicholas	Colon	9020 N.W. 75 Street	33065	3057539887	35	4	$399.00	O0013	4/24/1999	P0009	2.5 GB IDE Hard Drive	$399.00	
4	Nicholas	Colon	9020 N.W. 75 Street	33065	3057539887	36	10	$179.95	O0013	4/24/1999	P0016	Internal Zip Drive	$179.95	
4	Nicholas	Colon	9020 N.W. 75 Street	33065	3057539887	37	2	$569.95	O0013	4/24/1999	P0024	Laser Printer (personal)	$569.95	
6	Jeffrey	Muddell	9522 S.W. 142 Street	33340	3052533909	38	2	$39.95	O0014	4/25/1999	P0019	Joystick	$39.95	
6	Jeffrey	Muddell	9522 S.W. 142 Street	33340	3052533909	39	1	$29.95	O0014	4/25/1999	P0028	Microsoft Scenes Screen	$29.95	
9	Luis	Couto	455 Bargello Avenue	33146	3056664801	40	1	$59.95	O0015	4/25/1999	P0018	Trackball	$59.95	
9	Luis	Couto	455 Bargello Avenue	33146	3056664801	41	1	$189.95	O0015	4/25/1999	P0020	Fax/Modem 56 Kbps	$189.95	
6	Jeffrey	Muddell	9522 S.W. 142 Street	33340	3052533909	42	2	$129.95	O0016	4/26/1999	P0029	Microsoft Bookshelf	$129.95	
11	Lauren	Center	12380 S.W. 137 Avenue	33186	3053854432	43	2	$39.95	O0017	4/26/1999	P0019	Joystick	$39.95	
11	Lauren	Center	12380 S.W. 137 Avenue	33186	3053854432	44	1	$399.00	O0018	4/26/1999	P0009	2.5 GB IDE Hard Drive	$399.00	

Value of Knowledge

- What we learn here is applicable to many other database that are used by businesses:
  - Oracle
  - Sybase
  - Microsoft SQL Server
  - JavaDB
  - …
- We will also learn how to decompose problems and think logically.

About Microsoft Access

- Not available with Mac OS
- You can use myApps (remotely login to a virtual Northeastern session). (see the course website under Resources -> Software)
- **DOWNLOAD AND SAVE!**
  - You must download and save Access files BEFORE starting to work on them or you will lose your work
- .laccdb files: file locking is controlled by a locking file with the file name extension .laccdb.
  - Do not submit this file! Close your file first and the .laccdb file goes away.

Relational Databases

- Microsoft Access is a *relational database* which means that it stores data in tables
  - Each table stores information about a single subject
- Each table contains rows; one row for each record, *i.e.*, a contact, order, product, etc.
- Each column (or field) contains different kinds of information about the subject
- Each row in a table has a unique identifier (or key), *e.g.*, OrderID, ProductID, ContactID, etc.

Relational Databases

- Each table in the database contains information related to a single subject and only that subject.
- You can manipulate data about two classes of information (such as customers and orders) based on related data values
- Example: it would be redundant to store all customer information with every order.
  - In a relational DB, the table for orders contains one field that stores data such as a customer ID which can be used to connect each order with the appropriate customer information.

Relational Databases

- Microsoft Access is a *relational database* which means that it stores data in **tables**.
- Tables contains **records**; one row for each record, *e.g.*, a contact, order, product, etc.
- Tables have **attributes**; each record has a value for every attribute, *e.g.,* name, price, address…
- Each row in a table has a unique identifier attribute called a **key**, *e.g.*, OrderID, ProductID, ContactID, etc.

Microsoft Access Tutorial: Data, Databases, and Queries

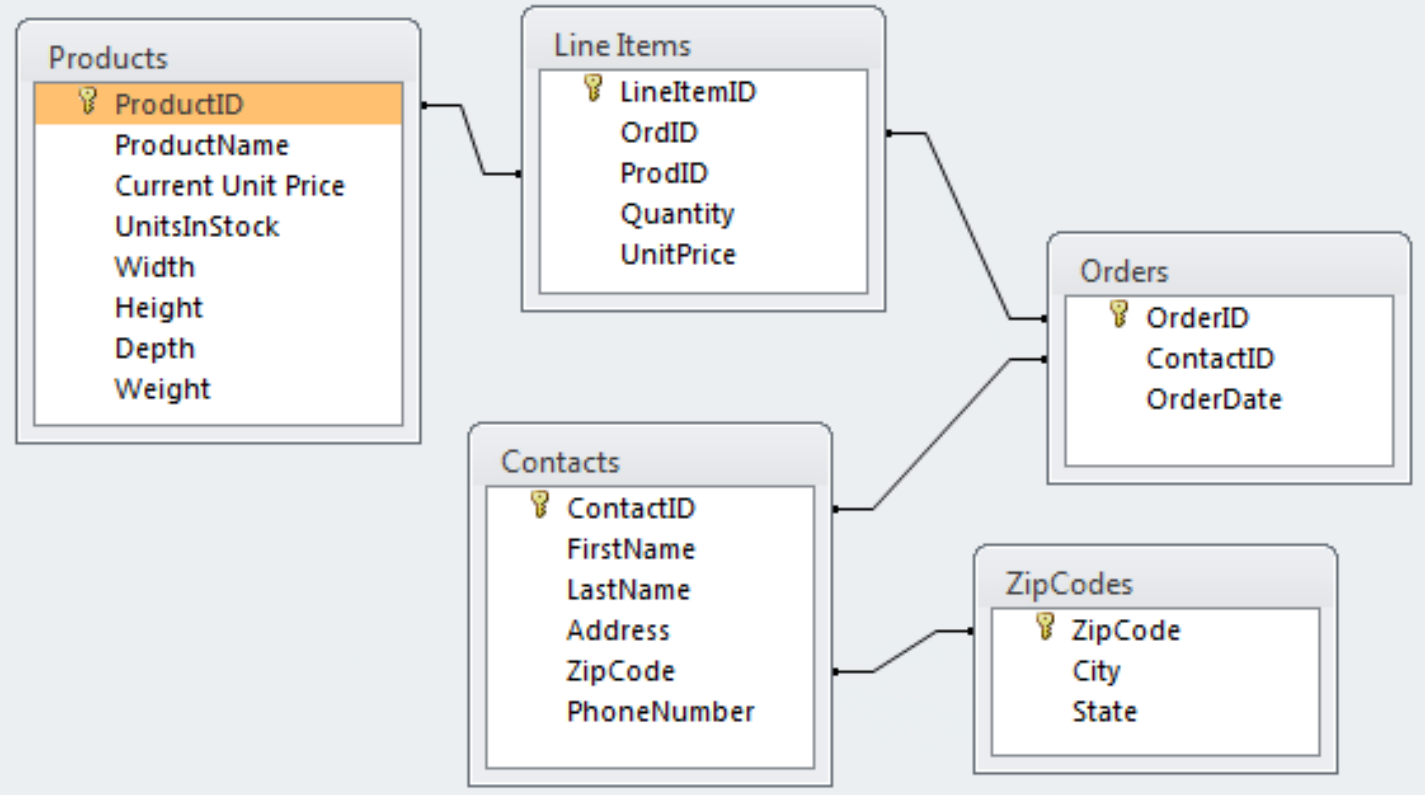
LAYOUT OF THE *ORDERS* DATABASE

The *Orders* Database

- We will be using a database that contains data for orders placed by customers for our examples.
- This database stores the following information:
  - For each order, we know what was ordered, how many of that item was ordered, and at what price.
  - For each order, we know who placed that order.
  - For each customer (called a contact), we store where he/she lives.
  - For each product, we track its description and price.

The Database Layout

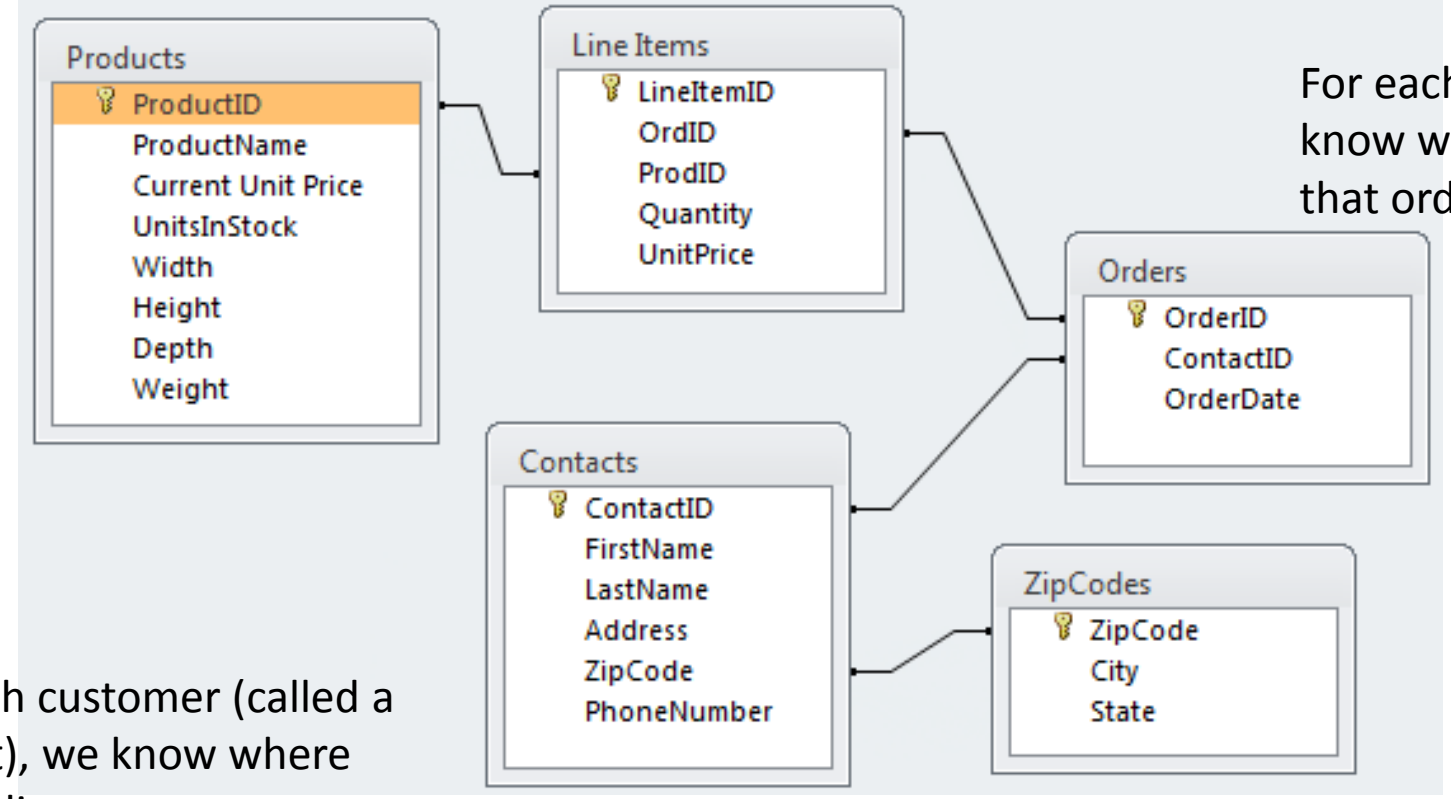
- These are all of the tables in the database:



The Database Layout

For each product, we know its description and price.

For each order, we know what was ordered, how many of that item were ordered, and at what price.



For each order, we know who placed that order.

For each customer (called a contact), we know where he/she lives.

A Sample Order

Order ***O0001***

Customer Contact

Contact ID: C0004
Name: Colon, Nicholas
Address: 9020 N.W. 75 Street
Coral Springs, FL 33065

Order Date: 4/15/1999

Product ID	*Product Name*	*Quantity*	*UnitPrice*	*ExtendedPrice*
P0013	DVD Disks	1	$ 23.00	$ 23.00
P0014	HD Floppy Disks	4	$ 9.99	$ 39.96
P0027	Norton Anti-Virus	1	$ 115.95	$ 115.95

Order Total: *$ 178.91*

Where Does The Data Come From?

Order ***O0001*** ← Orders.OrderID

Customer Contact — Contacts

Contact ID: C0004
Name: Colon, Nicholas
Address: 9020 N.W. 75 Street
Coral Springs, FL 33065 ← ZipCodes

Order Date: 4/15/1999 ← Orders.OrderDate

ExtendedPrice = Quantity * UnitPrice

Product ID	*Product Name*	*Quantity*	*UnitPrice*	*ExtendedPrice*
P0013	DVD Disks	1	$ 23.00	$ 23.00
P0014	HD Floppy Disks	4	$ 9.99	$ 39.96
P0027	Norton Anti-Virus	1	$ 115.95	$ 115.95

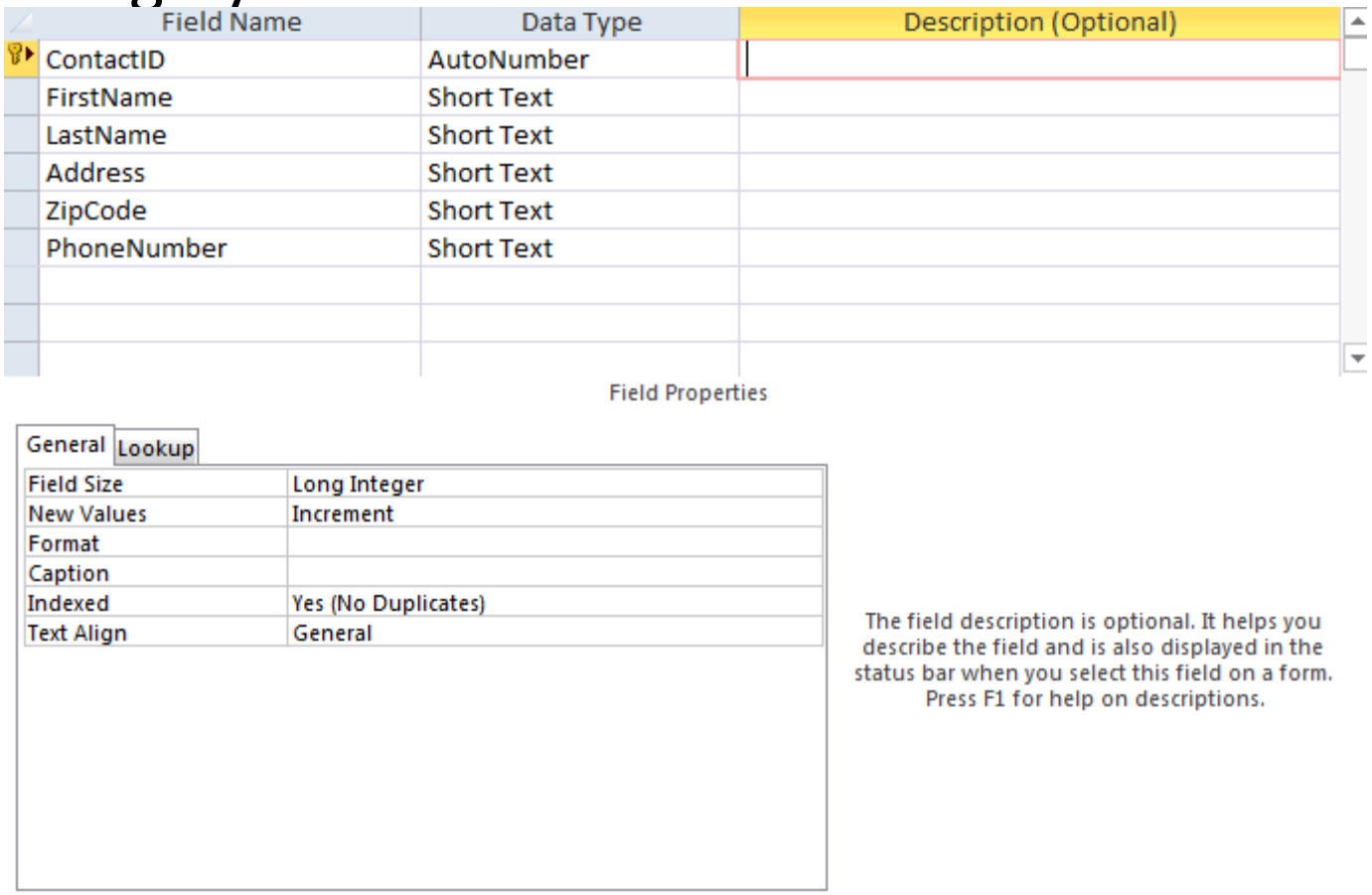
LineItems

Order Total: *$ 178.91*

Total Order Amount

A closer look at the Contacts table

- The Design view
  - Design your table in this view:



Field Name	Data Type	Description (Optional)
ContactID	AutoNumber	
FirstName	Short Text	
LastName	Short Text	
Address	Short Text	
ZipCode	Short Text	
PhoneNumber	Short Text	

Field Properties

General | Lookup

Field Size	Long Integer
New Values	Increment
Format	
Caption	
Indexed	Yes (No Duplicates)
Text Align	General

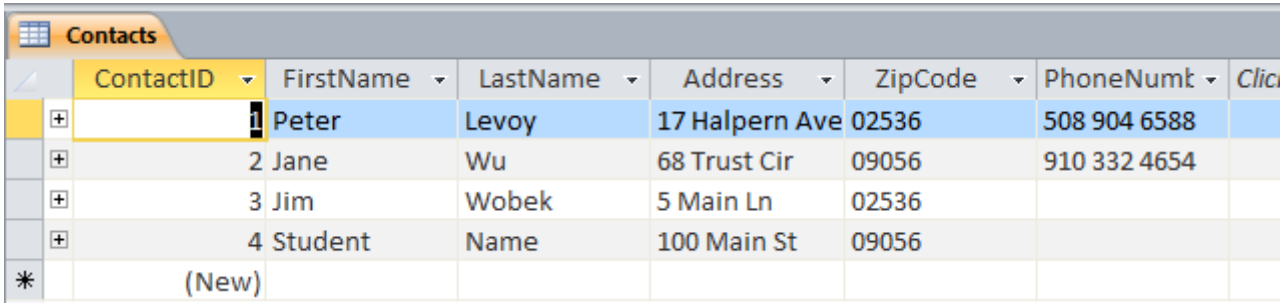
The field description is optional. It helps you describe the field and is also displayed in the status bar when you select this field on a form. Press F1 for help on descriptions.

Field Data Types

- Short Text – alphanumeric data up to 255 characters
- Long Text– alphanumeric data up to 1 gigabyte
- Number – numeric data
- Date/Time – dates and times
- Currency – monetary data
- AutoNumber – unique value generated by Access for each new record (not editable)

A closer look at the Contacts table

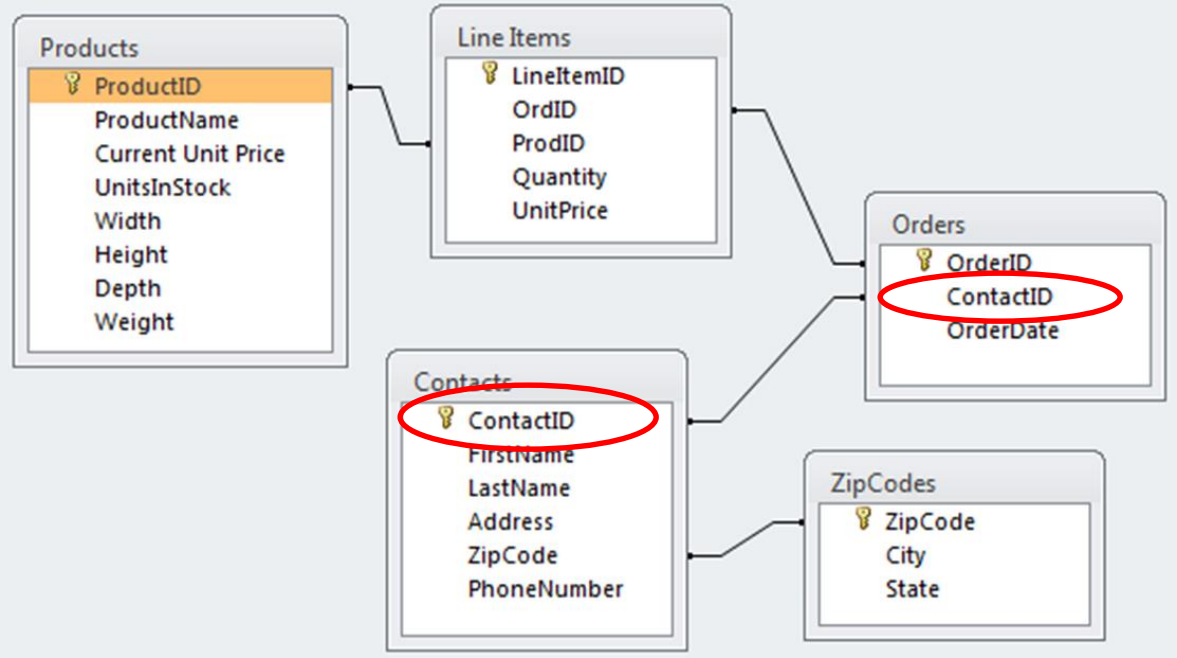
- The Datasheet view
  - Enter new data in this view


Contacts

ContactID	FirstName	LastName	Address	ZipCode	PhoneNumb	Clic
1	Peter	Levoy	17 Halpern Ave	02536	508 904 6588	
2	Jane	Wu	68 Trust Cir	09056	910 332 4654	
3	Jim	Wobek	5 Main Ln	02536		
4	Student	Name	100 Main St	09056		
(New)						

Relationships

- From the **Database Tools** tab, define how the data in tables is related, such as ID fields in tables that should match.
  - Example: ContactID in the Contact table is related to ContactID in the Orders table – a one-to-many relationship.



Microsoft Access Tutorial: Data, Databases, and Queries

RETRIEVING DATA WITH QUERIES

Queries

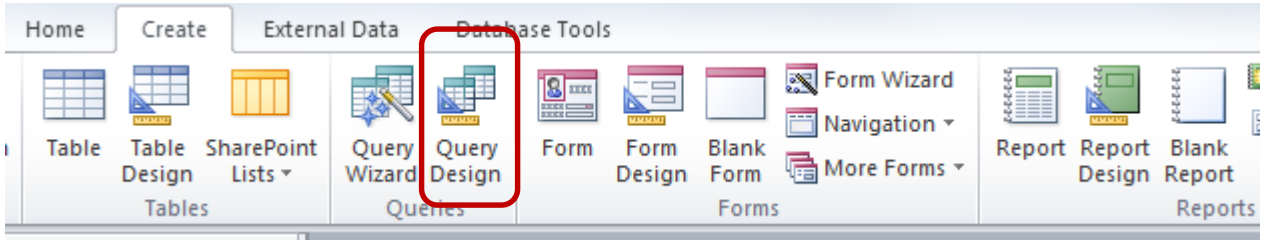
- Data is retrieved through queries.
- Queries are formulated in a specialized language called SQL (pronounced *SEQUEL*).
- Microsoft Access makes it easy to create SQL queries through a simple drag-and-drop interface called the *Query Builder*.
- Queries are eventually integrated into reports, forms, programs, or executed by themselves.

Queries on Tables

- Queries retrieve data from one or more tables.
- You can specify which
  - rows to include in the result through filters (WHERE clause in SQL terminology)
  - columns to include in the results
- The result of a query is a table that can be used in other queries (as subqueries).

Creating Queries in Access

- To create a query:
  - Select the **Create** tab
  - Pick **Query Design**

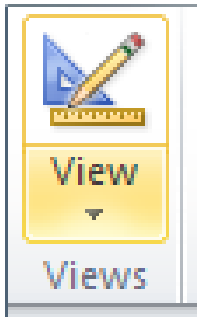


  - Select the tables to include in the query or simply close the dialog and drag the needed tables into the query designer

Running a Query

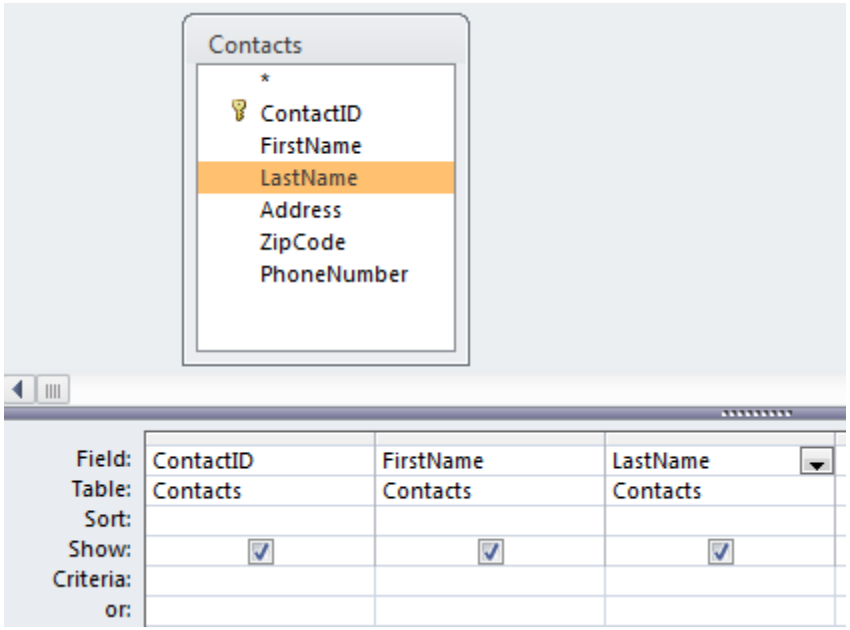
- To run a query, click on:

- To return to the query design, click on:



Example: Simple Query

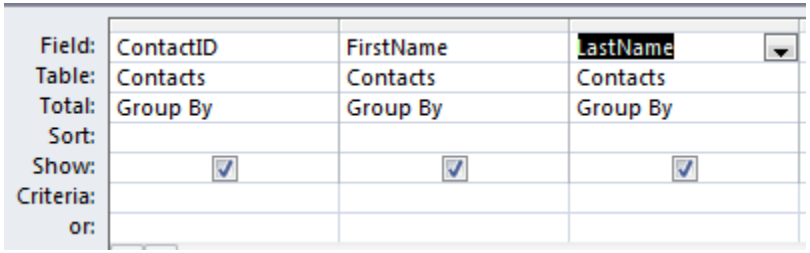
- Find the contact id, first name, and last name for each contact.



ContactID	FirstName	LastName
1	Benjamin	Lee
2	Eleanor	Milgrom
3	Neil	Goodman
4	Nicholas	Colon
5	Michael	Ware
6	Jeffrey	Muddell
7	Ashley	Geoghegan
8	Serena	Sherard
9	Luis	Couto
10	Derek	Anderson

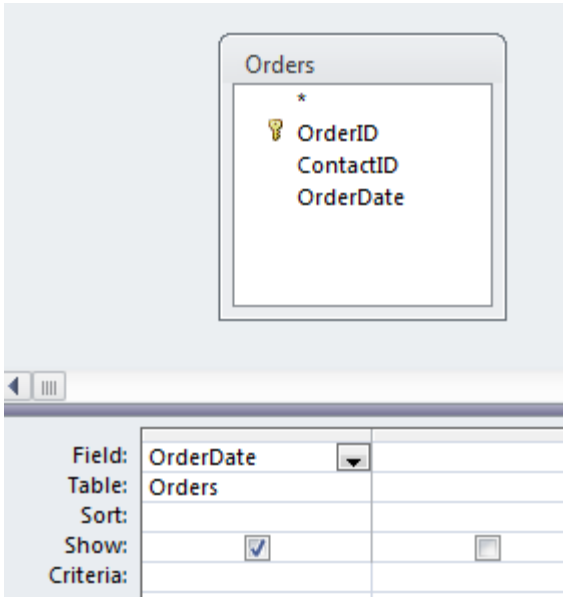
Removing Duplicates

- Queries often result in duplicate rows.
- These are removed by “grouping rows” with the same value as a single row.
- To do a Group By, follow these steps:
  - Select the function button Σ Totals in the ribbon
  - Select “Group By” for each field



Example: Group By

- Find the dates on which orders were placed.
- Here's the result ***without*** a Group By:

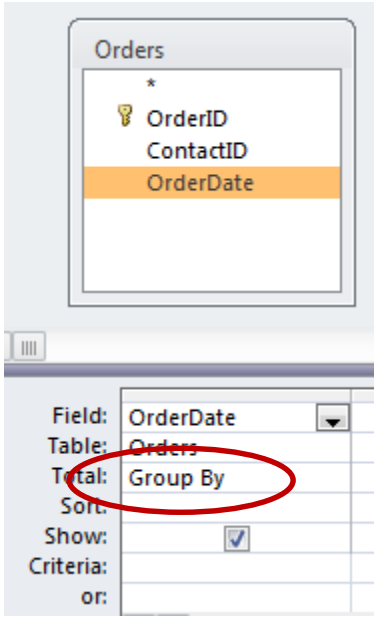


Order Date
4/15/1999
4/18/1999
4/18/1999
4/18/1999
4/20/1999
4/21/1999
4/21/1999
4/22/1999
4/22/1999
4/22/1999
4/24/1999
4/24/1999
4/24/1999

Note the duplicate rows

Example: Group By

- Here's the same query ***with*** a Group By:



Order Date
2/4/1998
3/15/1999
4/15/1999
4/18/1999
4/20/1999
4/21/1999
4/22/1999
4/24/1999
4/25/1999

Note that the duplicate rows have been "collapsed" into groups and only the group is displayed

Duplicates with Group By

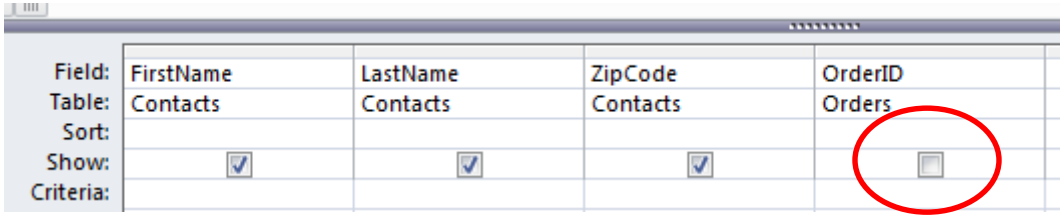
- Group By collapses all rows that contain the same data across **all** columns.

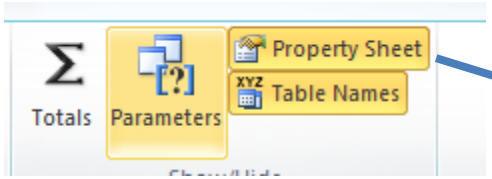
FirstName	LastName	ZipCode	OrderID
Benjamin	Lee	45501	O0005
Benjamin	Lee	45501	O0006
Benjamin	Lee	45501	O0009
Benjamin	Lee	45501	O0011
Eleanor	Milgrom	33063	O0007
Eleanor	Milgrom	33063	O0008
Eleanor	Milgrom	33063	O0010
Eleanor	Milgrom	33063	O0036
Neil	Goodman	33065	O0002
Nicholas	Colon	33065	O0001
Nicholas	Colon	33065	O0013

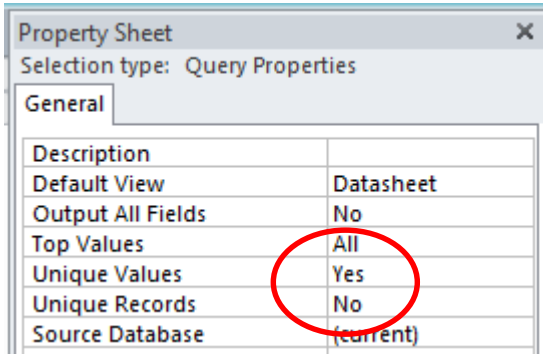
- OrderIDs are not the same in this example so names will show up more than once even if using Group By.

Eliminating Duplicates

- Duplicates can be eliminated by specifying that the query should only return unique records.







[Watch Demo]

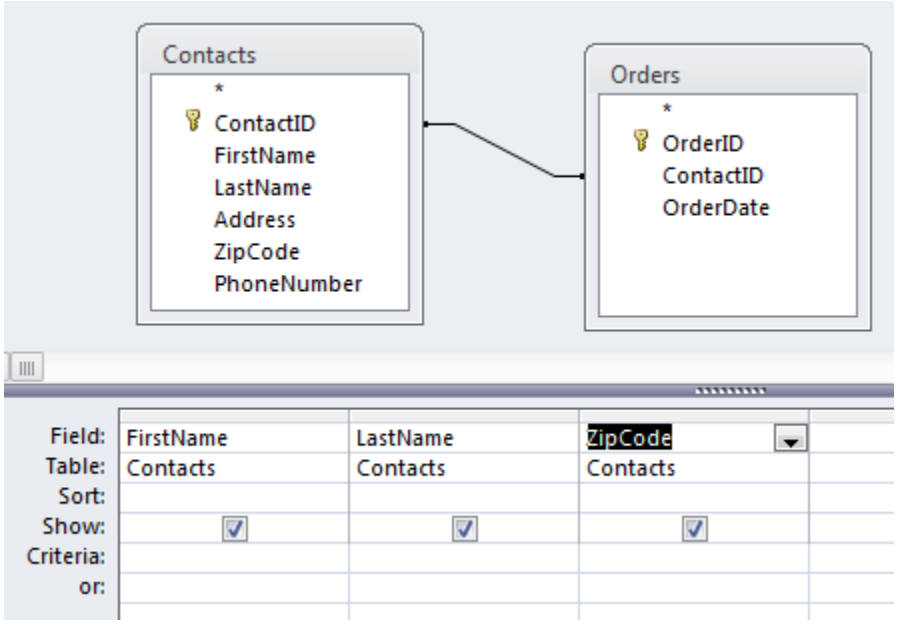
Joining Tables

- A “join” is a query operation in which rows are selected that have a common value for some row.
- To find contacts that actually placed an order[1], the *ContactID* column value must be the same in the *Contacts* and the *Orders* table.
- This essentially finds all contacts who placed at least one order.

[1] There may be contacts in the Contacts table that are not linked to any order, *i.e.*, they never placed an order.

Example: Group By and Join

- Find the first name, last name, and zip code of all contacts that placed an order.
- Here's the result ***without*** a Group By:

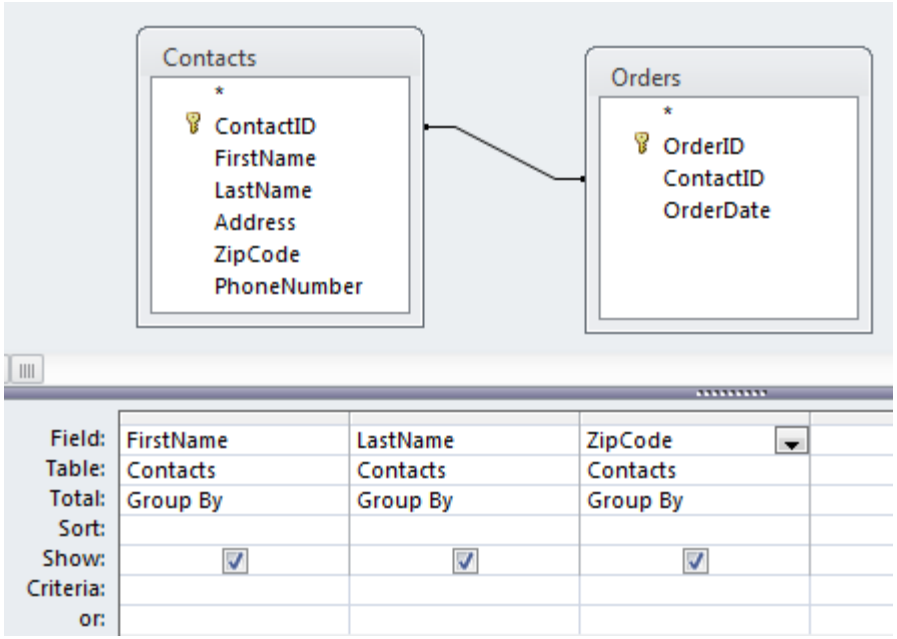


FirstName	LastName	ZipCode
Benjamin	Lee	45501
Benjamin	Lee	45501
Benjamin	Lee	45501
Benjamin	Lee	45501
Eleanor	Milgrom	33063
Eleanor	Milgrom	33063
Eleanor	Milgrom	33063
Eleanor	Milgrom	33063
Neil	Goodman	33065

Note the duplicate rows

Example: Group By and Join

- Find the first name, last name, and zip code of all contacts that placed an order.
- Here's the result ***with*** a Group By:

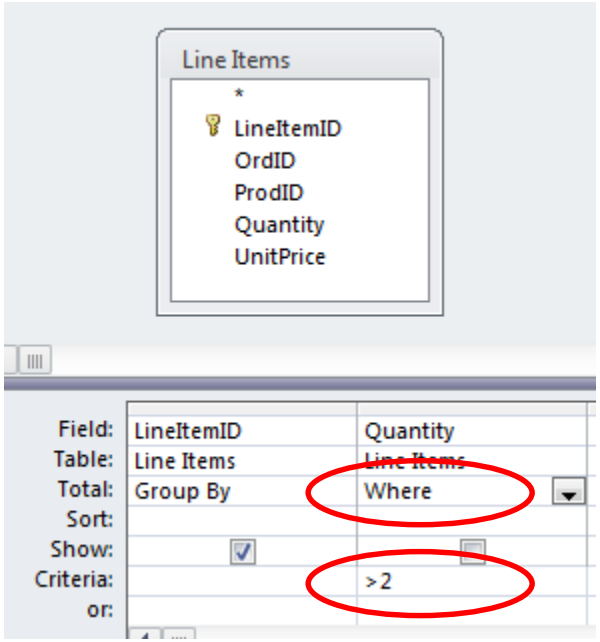


FirstName	LastName	ZipCode
Alan	Turing	33065
Ashley	Geoghegan	33070
Benjamin	Lee	45501
Derek	Anderson	33120
Eleanor	Milgrom	33063

All rows with the same first name, last name, and zip code have been collapsed into a single "group"

Filtering

- Selecting rows that meet certain criteria is done through a WHERE clause.



LineItemID
2
18
20
22
23
32
33
34

Lists all of the line items (ID only) that have a Quantity > 2.

Selection Criteria

- Selection criteria are specified as an algebraic relationship, but queries are generally stated as a narrative, so we need to "translate".

Narrative	Algebraic Term
At least X	>= X
No more than X	< X
More than X	> X
No less than X	>= X
Less than X	< X
Up to X	< X
At most X	<= X

RegistrarExampleDatabase

- Relationships
- Data
- Queries
  - Student names, address, city, state, zip
  - Course with 4 or more credits
  - Students in CS2500
  - Students in CS1100