

## Databases

❖ **Database** – A collection of related data stored in a manner so it can be retrieved as needed

❖ **Database Management System**

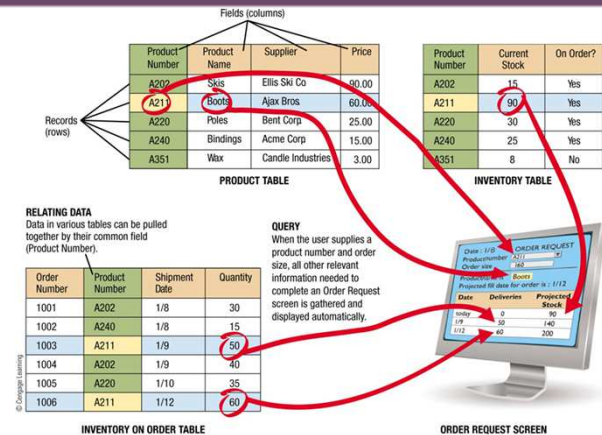
◆ Software that organizes data for fast and easy access (**DBMS**)

◆ Used to create, maintain, and access databases

❖ Phone books, file cabinets, and index cards are non-computer versions of a database

Copyright © 2017 R.M. Laurie 1

## What is a Database?



Copyright © 2017 R.M. Laurie 2

## Evolution of Databases

MODEL	FLAT FILES	HIERARCHICAL	NETWORK	RELATIONAL	OBJECT-ORIENTED	MULTI-DIMENSIONAL
YEAR BEGAN	1940s	1960s	1960s	1970s	1980s	1990s
DATA ORGANIZATION	Flat files	Trees	Trees	Tables and relations	Objects	Data cubes, tables and relations, or a combination
DATA ACCESS	Low-level access	Low-level access with a standard navigational language	Low-level access with a standard navigational language	High-level, nonprocedural languages	High-level, nonprocedural, object-oriented languages	OLAP tools or programming languages
SKILL LEVEL REQUIRED TO ACCESS DATA	Programmer	Programmer	Programmer	User	User	User
ENTITY RELATIONSHIPS SUPPORTED	One-to-one	One-to-one, one-to-many	One-to-one, one-to-many, many-to-many	One-to-one, one-to-many, many-to-many	One-to-one, one-to-many, many-to-many	One-to-one, one-to-many, many-to-many
DATA AND PROGRAM INDEPENDENCE	No	No	No	Yes	Yes	Yes

Copyright © 2017 R.M. Laurie 3

## Database Provides Information

❖ Information created from data

- ◆ Timely relevant information key to decision making
- ◆ Good decision making key to organization survival

❖ Database Management System (DBMS)

- ◆ Manages database structure -- tables and relationships
- ◆ Controls access to data – Security
- ◆ Contains query language -- SQL

❖ Relational DBMS advantages

- ◆ Integrated data (All items accessible)
- ◆ Integrity (Accurate, up to date, no duplication)
- ◆ Reduced redundancy (Enter data once)
- ◆ User Security Level Access
- ◆ Easy Data Archive

Copyright © 2017 R.M. Laurie 4

## A Database Table

- ❖ Columns are the **fields**
- ❖ Rows are the **records**

Table

Field

Record

EMP_NUM	EMP_LNAME	EMP_FNAME	EMP_INITIAL	JOB_CODE
101	News	John	G	502
102	Senior	David	H	501
103	Abough	June	E	503
104	Ramoras	Anne	K	501
105	Johnson	Alice	K	502
106	Smithfield	William		504
125	Laurie	Robert	M	504

Data Items

Copyright © 2017 R.M. Laurie 5

## Relational DB Model Data Structure

- ❖ **Data Value** (Cell), Characters in textbook
  - ◆ Contents of a field contained in a record
  - ◆ “Raw Facts” that can be recognized
- ❖ **Field** or Attribute (Column)
  - ◆ Group of characters representing something with same data format
- ❖ **Record** or Entity or Tuple (Row)
  - ◆ Collection of related fields
- ❖ **Table** or Entity Set (File)
  - ◆ Collection of related records and fields
  - ◆ Ordering of Columns and Rows is immaterial

Copyright © 2017 R.M. Laurie 6

## Field Name and Data Type

- ❖ Each Field must have a unique name.
 

<b>LastName</b>	<b>FirstName</b>	<b>HomeAddress</b>
<b>PhoneNum</b>	<b>CustID</b>	<b>AgentCode</b>
- ❖ Fields may contain one of four data types:
  - ◆ **Character** = descriptive data (text).
  - ◆ **Numeric** = numbers used for calculation
  - ◆ **Date** = Month Day Year and/or time
  - ◆ **Logic** = T/F, Y/N, Checked/Unchecked
- ❖ Field width determines the maximum number of characters or digits to be contained in the field



Copyright © 2017 R.M. Laurie 7

## Creating a Database

- ❖ Design Database Table Field Structure
  - ◆ Field Names
  - ◆ Field Types (Character, Numbers, Logical)
  - ◆ Field Widths (Max Characters for Entry)
  - ◆ Unique Primary Key Field (For Query Use)
- ❖ Link Tables using **Relationships**
  - ◆ Primary Key fields must be unique
  - ◆ Foreign Key fields must join with primary key field data in another table
- ❖ Entering Data
  - ◆ Using Tables
  - ◆ Using Forms

Copyright © 2017 R.M. Laurie 8

## Designing Database Tables

First create a paper sketch of the tables and the kind of data that will be put into each field

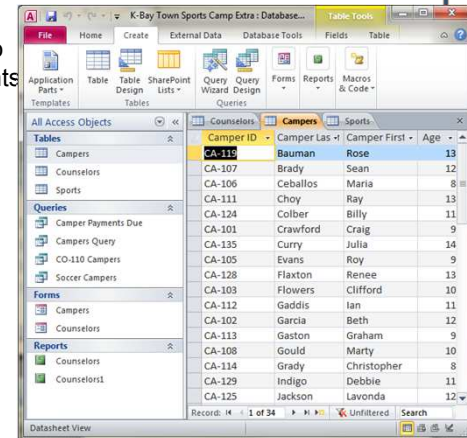
<u>Tour-id</u>	<u>Description</u>	<u>Cost</u>	<u>Hours</u>	<u>Food</u>	<u>Walk</u>	<u>Stairs</u>
14	San Juan Islands	25	3.5	Y	N	N

Copyright © 2017 R.M. Laurie 9

## MS Access Navigation

❖ **Access Objects**  
Provides interface to database components

- ◆ **Tables**  
Containers for data
- ◆ **Forms**  
Input one record
- ◆ **Reports**  
Information output
- ◆ **Queries**  
Ask?

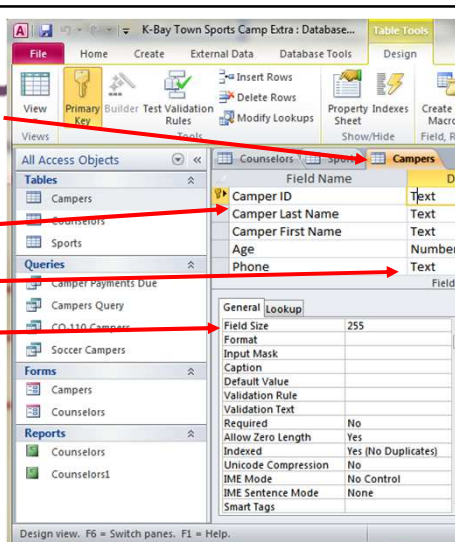


## Table Design View

**Design Field Structure**

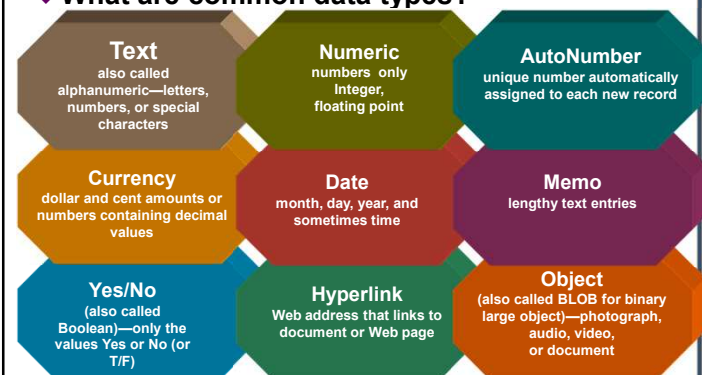
- Table Name
- Field Name
- Data Types
- Field Width

**Data Dictionary:**  
Contains data about each file in database and each field within those files



## The Hierarchy of Data

❖ **What are common data types?**



Copyright © 2017 R.M. Laurie 12

## Key Fields

### ❖ A **key field** is determines table relationships

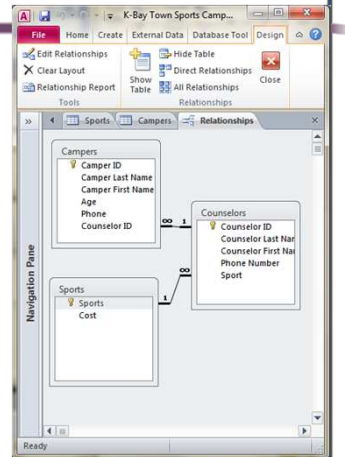
- ◆ A Key field determines all other fields in a record

### ❖ **Primary Key Field**

- ◆ Uniquely identifies all other fields in a record
- ◆ The One side of a 1 to Many Relationship

### ❖ **Foreign key**

- ◆ Field that links records in table to records in another table
- ◆ The Many side of a 1 to Many Relationship



Copyright © 2017 R.M. Laurie 13

## Enter Data into Tables or Forms

Camper ID	Camper Last Name	Camper First Name	Age	Phone	Counselor ID
CA-110	Bauman	Rose	13	555-3627	CO-110
CA-107	Brady	Sean	12	555-2654	CO-111
CA-106	Ceballos	Maria	8	555-9835	CO-110
CA-111	Choy	Ray	13	555-2876	CO-112
CA-124	Colber	Billy	11	555-2654	CO-111
CA-101	Crawford	Craig	9	555-9857	CO-110
CA-135	Curry	Julia	14	555-2980	CO-113
CA-105	Evans	Roy	9	555-4637	CO-111

Counselor ID	Counselor Last Name	Counselor First Name	Phone Number	Sport
CO-110	Laurie	Robert	555-4567	Soccer
CO-111	Young	Lynn	555-9876	Volleyball
CO-112	Chan	Kim	555-7865	Baseball
CO-113	Weeks	Hanna	555-8902	Gymnastics
CO-114	Mather	Joe	555-8348	Tennis

Copyright © 2017 R.M. Laurie 14

## Data and Information

### ❖ What is data integrity?

- ◆ Degree to which data is correct
- ◆ Garbage in, garbage out (GIGO)
  - ◆ Computer phrase that means you cannot create correct information from incorrect data



Copyright © 2017 R.M. Laurie 15

## Data Anomalies: Restaurant Owner Database

### Enter Record data items into each Field of the Table

Microsoft Access - [OwnersRestaurants : Select Query]								
File Edit View Insert Format Records Tools Window Help								
Type a question for help								
RestaurantID	Address	City	Phone	TypeofService	VisaCard	OwnerFstName	OwnerLstName	OwnerPhone
R0001	2345 SW Miami	(305) 44	Table Service	<input checked="" type="checkbox"/>	Jim	Antonucci	(305) 777-8888	
R0002	3487 Mai Pens	(850) 88	Table & Take-out	<input type="checkbox"/>	Dottie	Balchunas	(850) 222-1111	
R0003	89 Turnt Orlan	(407) 55	Table Service	<input checked="" type="checkbox"/>	Benjamin	Grauer	(407) 444-8888	
R0004	4598 SW Miami	(305) 44	Take-out	<input checked="" type="checkbox"/>	Jim	Antonucci	(305) 777-8888	
R0005	9000 Bis Tallal	(904) 22	Table & Take-out	<input checked="" type="checkbox"/>	Steve	Spann	(561) 999-1199	
R0006	2 State S Boca	(561) 44	Take-out	<input type="checkbox"/>	Steve	Spann	(561) 999-1199	
R0007	8990 SE Miami	(305) 78	Table Service	<input checked="" type="checkbox"/>	Jim	Antonucci	(305) 777-8888	
R0008	298 W 76 Vero	(407) 22	Table & Take-out	<input checked="" type="checkbox"/>	Megan	Miller	(407) 333-0033	
R0009	1000 Grs Gain	(352) 66	Take-out	<input type="checkbox"/>	Jessica	Kinzer	(352) 999-0044	
R0010	6767 NW Miami	(305) 88	Table Service	<input checked="" type="checkbox"/>	Megan	Miller	(407) 333-0033	
Records: 14 of 10								
Datasheet View								

### ❖ Do you see any potential problems with this table?

- ◆ **Data Redundancy leads to Data Inconsistencies**
- ◆ **Update Data Anomaly**
- ◆ **Deletion Data Anomaly**

Copyright © 2017 R.M. Laurie 16



## Removing Data Redundancy

RestaurantID	Address	City	Phone	TypeofService	VisaCard	OwnerFstName	OwnerLstName	OwnerPhone
R0001	2345 SW Miam	(305) 44	Table Service	<input checked="" type="checkbox"/>	Jim	Antonucci	(305) 777-8888	
R0002	3487 Mai Pens	(850) 88	Table & Taki	<input type="checkbox"/>	Dottie	Balchunas	(850) 222-1111	
R0003	89 Turnt Orlan	(407) 55	Table Service	<input checked="" type="checkbox"/>	Benjamin	Grauer	(407) 444-8888	
R0004	4598 SW Miam	(305) 44	Take-out	<input checked="" type="checkbox"/>	Jim	Antonucci	(305) 777-8888	
R0005	9000 Bis Tallal	(904) 22	Table & Taki	<input checked="" type="checkbox"/>	Steve	Spann	(561) 999-1199	
R0006	2 State S Boca	(561) 44	Take-out	<input type="checkbox"/>	Steve	Spann	(561) 999-1199	
R0007	8990 SE Miam	(305) 78	Table Service	<input checked="" type="checkbox"/>	Jim	Antonucci	(305) 777-8888	
R0008	298 W 75 Vero	(407) 22	Table & Taki	<input checked="" type="checkbox"/>	Megan	Miller	(407) 333-0033	
R0009	1000 Grz Gaine	(352) 66	Take-out	<input type="checkbox"/>	Jessica	Kinzer	(352) 999-0044	
R0010	6767 NW Miam	(305) 88	Table Service	<input checked="" type="checkbox"/>	Megan	Miller	(407) 333-0033	

1. Remove any duplicate records
2. Determine Primary Key Fields: RestaurantID
3. Normalize to remove non key data dependencies

RestaurantID	Address	City	Phone	TypeofService	VisaCard	OwnerFstName	OwnerLstName	OwnerPhone
RestaurantID	Address	City	Phone	TypeofService	VisaCard	FranchiseeID		
OwnerID	OwnerFstName	OwnerLstName	OwnerPhone					

## Making a Better Database

RestaurantID	Address	City	Phone	TypeofService	VisaCard	FranchiseeID
R0001	2345 SW 98 St	Miami	(305) 444-8787	Table Service	<input checked="" type="checkbox"/>	F001
R0002	3487 Main High	Pensacola	(850) 886-5555	Table & Take	<input type="checkbox"/>	F002
R0003	89 Turnberry Dri	Orlando	(407) 555-9999	Table Service	<input checked="" type="checkbox"/>	F004
R0004	4598 SW 136 S	Miami	(305) 444-4444	Take-out	<input checked="" type="checkbox"/>	F001
R0005	9000 Biscayne	Tallahassee	(904) 222-1111	Table & Take	<input checked="" type="checkbox"/>	F003
R0006	2 State Street	Boca Raton	(561) 444-1100	Take-out	<input type="checkbox"/>	F003
R0007	8990 SE 2 Ave	Miami	(305) 787-7889	Table Service	<input checked="" type="checkbox"/>	F001
R0008	298 W 75 Terrai	Vero Beach	(407) 222-9999	Table & Take	<input checked="" type="checkbox"/>	F005
R0009	1000 Grand Ave	Gainesville	(352) 666-7788	Take-out	<input type="checkbox"/>	F006
R0010	6767 NW 75 St	Miami	(305) 887-8877	Table Service	<input checked="" type="checkbox"/>	F005

OwnerID	OwnerFstName	OwnerLstName	OwnerPhone
+ F001	Jim	Antonucci	(305) 777-8888
+ F002	Dottie	Balchunas	(850) 222-1111
+ F003	Steve	Spann	(561) 999-1199
+ F004	Benjamin	Grauer	(407) 444-8888
+ F005	Megan	Miller	(407) 333-0033
+ F006	Jessica	Kinzer	(352) 999-0044
+ F007	Carlos	Portu	(305) 787-8778

Data Redundancy Eliminated

## Enforcing Referential Integrity

- ❖ Foreign key must match primary key values or be null value
- ❖ Impossible to delete row whose primary key has matching foreign key values in other table

Primary Key

Foreign Key

Edit Relationships

Table/Query: Job  
Related Table/Query: Employee

Enforce Referential Integrity

Cascade Update Related Fields

Cascade Delete Related Records

Relationship Type: One-To-Many

## Database Form

- ❖ Forms allow the user to enter or view fields for one record at a time
- ❖ Forms can be attractively Formatted

Employee Form

Employee

Fields

Record Select

Go to First Record

Go to Next Record

Create New Record

Go to Last Record

## REPORTS: Information Output

Reports are for information output only

You cannot enter data or edit data using reports

EMP_NUM	EMP_LNAME	EMP_FNAME	EMP_INITIAL	JOB_CODE
101	News	John	G	502
102	Senior	David	H	501
103	Arbough	June	E	503
104	Ramoras	Anne	K	501
105	Johnson	Alice	K	502
106	Smithfield	William		504

Copyright © 2017 R.M. Laurie 21

## QUERY: What If?

- ❖ Queries can be used to answer “What If?” type questions by selecting and displaying records and fields that match a relational expression
- ❖ Structured Query Language = SQL
- ❖ SQL became an ANSI Standard 1992
- ❖ Relational Functions:
  - ◆ SELECT, PROJECT, JOIN, INTERSECT, UNION, DIFFERENCE, PRODUCT, and DIVIDE.
- ❖ Relational Operators are described below:
  - ◆ < Less Than
  - ◆ > Greater Than
  - ◆ = Equal To
  - ◆ <= Less Than or Equal To
  - ◆ >= Greater Than or Equal To
  - ◆ <> Not Equal To

Copyright © 2017 R.M. Laurie 22

## QUERY By Example and SQL: Single Table

EMP_NUM	EMP_LNAME	EMP_FNAME	EMP_INITIAL	JOB_CODE
101	News	John	G	502
102	Senior	David	H	501
103	Arbough	June	E	503
104	Ramoras	Anne	K	501
105	Johnson	Alice	K	502
106	Smithfield	William		504
113	Joenbrood	Delbert	K	508
125	Laurie	Robert	M	504

**SQL Code**

```
SELECT *
FROM Employees
WHERE EMP_LName <="M"
ORDER BY EMP_LName;
```

## QUERY By Example and SQL: Multi Table

EMP_NUM	EMP_LNAME	EMP_FNAME	EMP_INITIAL	JOB_CODE	JOB_DESCRIPTION	JOB_CHG_HOUR
101	News	John	G	502	Programmer	\$85.00
102	Senior	David	H	501	Systems Analyst	\$96.75
103	Arbough	June	E	503	Database Designer	\$105.00
104	Ramoras	Anne	K	501	Electrical Engineer	\$110.00
105	Johnson	Alice	K	502	Mechanical Engineer	\$90.00
106	Smithfield	William		504	Civil Engineer	\$70.00
113	Joenbrood	Delbert	K	508	Clerical Support	\$26.87
125	Laurie	Robert	M	504	DSS Analyst	\$45.95

**SQL Code**

```
SELECT Employee.EMP_FNAME, Employee.EMP_LNAME,
Job.JOB_DESCRIPTION, Job.JOB_CHG_HOUR
FROM Job INNER JOIN Employee ON Job.JOB_CODE =
Employee.JOB_CODE
WHERE Employee.EMP_LNAME <="M";
```

Copyright © 2017 R.M. Laurie 24

## What is data security?

- ❖ DBMS provides means to ensure only authorized users can access data
- ❖ Access privileges define activities that specific user or group of users can perform
  - ◆ Read-only privileges - user can view data, but cannot change it
  - ◆ Full-update privileges -user can view and change data

Copyright © 2017 R.M. Laurie 25

## Single-User vs. Multiuser DBMS

- ❖ Single-User Database System
  - ◆ Located on a single computer
  - ◆ Designed to be accessed by one user
  - ◆ Widely used for personal applications
- ❖ Multiuser Database System
  - ◆ Designed to be accessed by multiple users
  - ◆ Most business databases today
  - ◆ Client-Server Database Systems
    - ◆ Has both clients (front end) and at least one database server (back end)

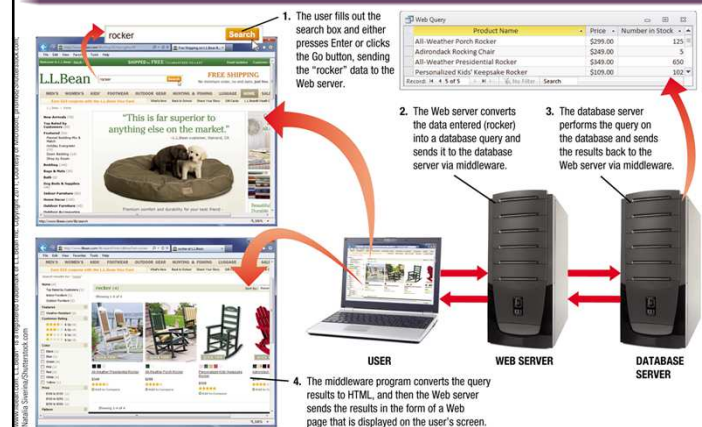
Copyright © 2017 R.M. Laurie 26

## Centralized vs. Distributed DBMS



Copyright © 2017 R.M. Laurie 27

## Databases and the Web



Copyright © 2017 R.M. Laurie 28