

Data Bases and ADO.NET

Relational Databases

- Most data handling today done with relational databases
 - Logical representations of data that allow relationships among data to be considered without concern for the physical structure of the data
 - Composed of tables (like spreadsheets)
 - Lots of proprietary formats
 - Some database sources:
 - Microsoft SQL Server
 - Access
 - Oracle
 - Sybase
 - Microsoft ADO.NET can handle data from multiple locations (servers) stored in different formats

ADO.NET

- Based on Microsoft's ActiveX Data Objects
 - Data stored and transferred in Extensible Markup Language (XML)
 - Allows simple access to database data in many formats
 - Easy-to-use classes represent tables, columns, rows inside relational databases
 - Introduces DataSet class representing a set of data from related tables encapsulated as a single unit preserving the integrity of the relationships between them
 - Basic types of database connections:
 - SQLClient for SQL Server
 - OleDb for all other database formats
 - Can be used to obtain/update data from sources such as Access, Oracle, Sybase, DB2, etc.
 - Many others supported

Database Terminology

- Each database file can hold multiple tables
- A table:
 - Each row represents data for one item
 - Called a record
 - Each column used to store a different data element
 - Elements represented in columns are called fields

	Last Name	First Name	Phone
Records	Smith	John	777-1111
	Jones	Mary	777-2222

Records → Smith
Records → Jones
Fields ↑ Mary
Fields → 777-2222

Database Terminology, continued

- Primary Key Field
 - Used to identify a record in a table
 - A field that contains unique data not duplicated in other records in the table
 - e.g., social security number for employees
- Current Record
 - Anytime a table is open, one record is considered to be the current record
 - As we move from record to record in a table the current record changes

Queries

- A query retrieves information from a database
- SQL (Structured Query Language) is the standard for expressing queries
 - We won't need to be experts in using it since Visual Studio .NET provides a “Query Builder” tool to construct SQL queries

XML Data

- Industry standard for storing and transferring data
 - Specs at: www.w3.org/XML
- Most database formats store data in binary
 - Cannot be accessed by other systems or pass through firewalls
- Data stored in XML is text
 - Identified by tags similar to HTML tags
 - Not predefined as in HTML
 - We can define our own XML tags to indicate their content
 - So very flexible for describing any kind of data
- Use of XML allows programs to communicate even though they are written in different languages and run on different hardware

Overview of XML

- Machine-Readable and Human-Readable Data
- Defines the Data Content and Structure
- Allows Developer to Define his/her Own Tags and Attributes

```
<employee>
  <name>Jake</name>
  <salary>25000</salary>
  <region>Ohio</region>
</employee>
```

XML Schemas

- A schema describes fields, data types, and any constraints on the data
- Defines the structure of an XML document
- A schema is expressed in XML as well
- Use of schemas permits strong typing and data validation

Using ADO.NET

- Data from a database can be displayed on a Windows Form or a Web Form
- Add controls to the form and bind the data to the controls
 - Controls can be what we've already seen:
 - label, text box, list box, combo box, etc.
 - Or special controls designed just for data:
 - DataGridView
- ADO.NET classes are in the System.Data namespace

Reading Database Data with a DataReader

- A simple way to go – like network & file I/O
- Connected model
- Create and open a DataConnection
 - Establishes a link to the data source, which is a specific database file and server
- Then create a Database Command associated with the connection that specifies the data to be accessed
 - This is an SQL query
- Execute the command
- Use a DataReader to read the data
- Display the data

Creating a Connection

- ADO.NET provides several types of Connection objects
- Two important ones:
 - SqlConnection
 - Only for connecting to a Microsoft SQLServer database
 - OleDbConnection
 - For connecting to other database systems such as Access
- Can set up a data connection by constructing a Connection object
 - Connection string specifies details
- Or use Visual Studio’s “Server Explorer” to set one up
 - Start it with “View” | “Server Explorer”

An Example: Manual Coding to Read the contents of a Database Table

- Windows Form Example: DataReadingForm
 - Reads and displays data from a small Access database: rnrbooks.mdb
 - Contains two tables:
 - “Books” with the following fields:
 - » ISBN, Title, Author, Publisher, and other fields
 - “Subjects” with the following fields:
 - » SubjectCode, Subject

DataReadingForm Example

- The important code:

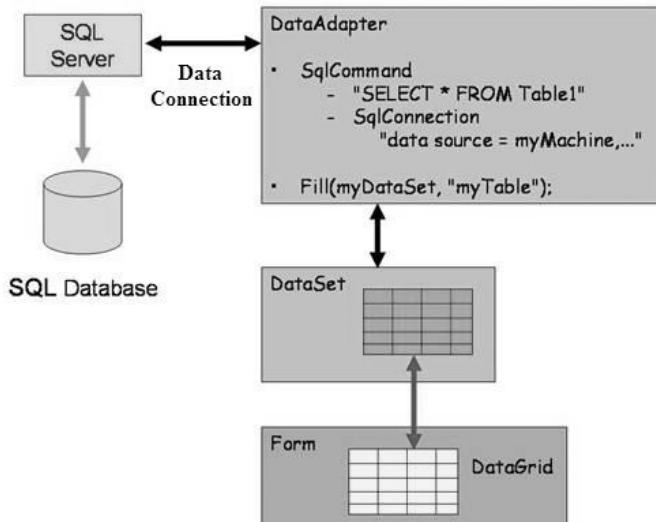
```
 OleDbConnection thisConnection = new
    OleDbConnection(@"Provider=Microsoft.Jet.OLEDB.4.0;Data
        Source=C:\360\Programs_managedVCSharp\rnrbooks.mdb");
thisConnection.Open();
OleDbCommand thisCommand = thisConnection.CreateCommand();
thisCommand.CommandText = "SELECT Title, Author FROM Books"; //SQL
OleDbDataReader thisReader = thisCommand.ExecuteReader(); //create reader
while (thisReader.Read()) //returns true if more rows to read
{
    //display DataReader's data rows in a text box called displayTextBox
    displayTextBox.Text += "\r\n" + thisReader["Title"] + thisReader["Author"];
}
thisReader.Close();
thisConnection.Close();
```

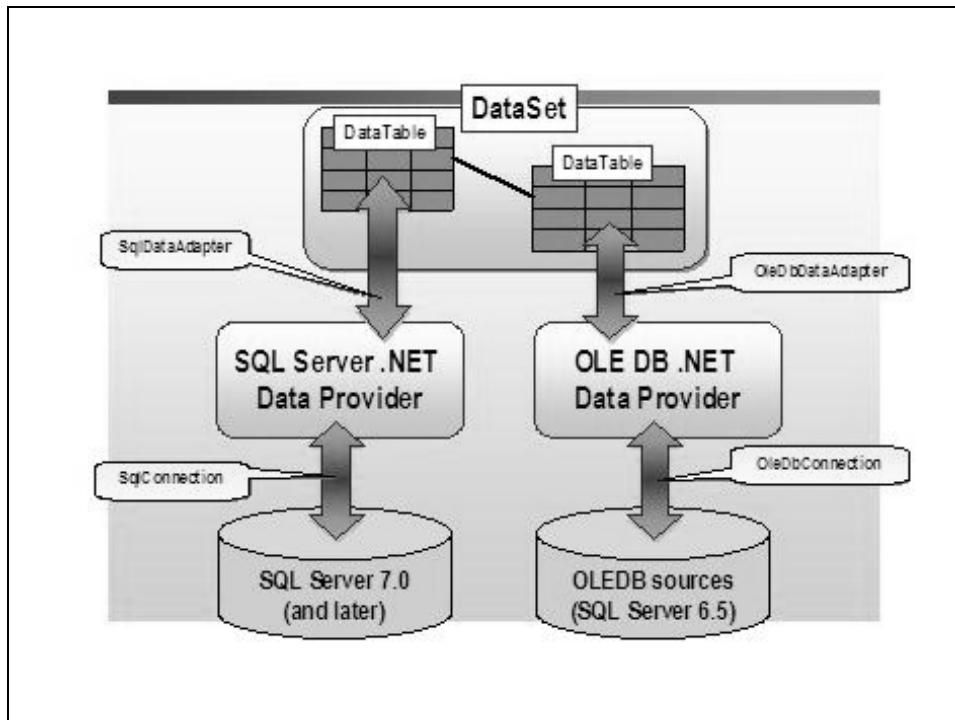
- @ - a string literal to avoid escape chars: @"c:\x\aa.txt" is equivalent to "c:\\x\\aa.txt"

Disconnected ADO.NET Data Access

- 1. Set up a Data Connection
 - Establishes a link to the data source
- 2. Set up a DataAdapter
 - Handles retrieving and updating the data
 - Data adapter uses “Command” objects to retrieve/store records from/to the database and can be used to create a DataSet
- 3. Create a DataSet:
 - A temporary set of data tables stored in the computer’s memory
 - ADO.NET datasets are disconnected
 - So data in memory does not keep an active connection to data source
 - Much better: Many more clients can connect and use the data server
 - DataAdapters’s Fill(–,–) method gets a data table into the DataSet
 - Uses SQL in a “Command” object to specify data to retrieve/update
- 4.. Add controls on the Windows Form or Web Form
 - Display the data from the DataSet and allow user interaction
- 5. Write C# code to put the data into the controls

Connections, Data Adapters, Datasets





Example using a DataAdapter and a DataSet

- DataReadingWithDataSet
 - Also reads data from the rnrbooks.mdb database
- Also coded manually

Steps to Follow in Code

- Instantiate and Open an OleDbConnection to the DB

```
OleDbConnection thisConnection=new OleDbConnection (@"Provider=Microsoft.Jet.OLEDB.4.0; Data Source=C:\360\Programs_managedVCSharp\rnrbooks.mdb");
thisConnection.Open();
```

- @-string literal to avoid escape chars: @"c:\x\l\a.txt" is equivalent to "c:\\x\\l\\a.txt"

- Create an `OleDbDataAdapter` specifying an SQL SELECT command using the `Connection`

```
OleDbDataAdapter thisAdapter =new OleDbDataAdapter("SELECT ISBN, Title, Author  
    FROM Books", thisConnection);
```

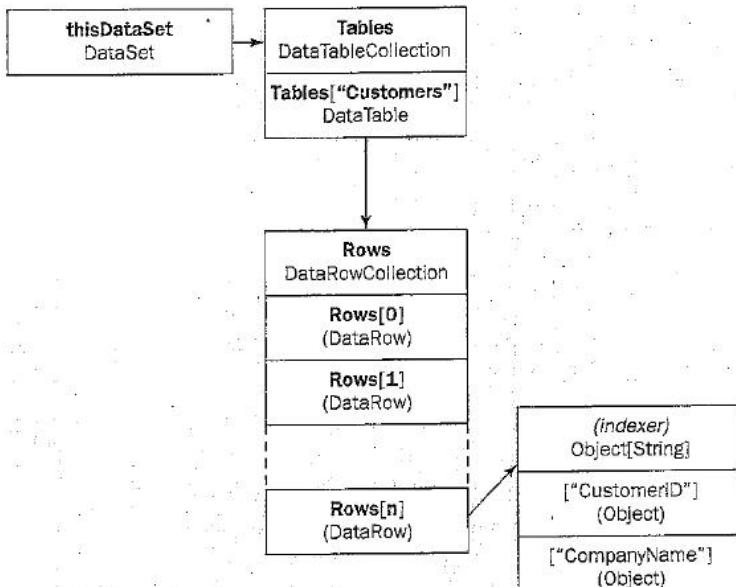
- Instantiate and Fill a DataSet with data from one of the DB tables using the OleDbDataAdapter

```
DataSet thisDataSet = new DataSet();
thisAdapter.Fill(thisDataSet, "Books");
```

- Index through the rows of the Table to get and display the values of their fields in a multiline text box

```
foreach (DataRow r in thisDataSet.Tables["Books"].Rows) //each row in "Books" Table  
    tBox.Text += r["ISBN"] + "\t" + r["Title"] + "\t" + r["Author"] + "\r\n";
```

DataSet Structure



Finding Items in a Database Table

- Extract a DataTable from the DataSet

```
DataTable table = thisDataSet.Tables("Books");
```
- Set up an array of DataRows to hold the rows in which there's a field matching a search criterion

```
DataRows[ ] foundRows;
```
- Use DataTable's Select(...) method with an appropriate selection criterion filter
 - Selects one or more records in a DataSet

```
foundRows = table.Select(s_query);
```
 - Here s_query is a string giving a selection criterion
 - e.g., "title = 'Megatrends'"
- Index through DataRows array and display results
- See DataSelectRow example

Using ADO.NET in Web Forms

- Just use Visual Studio to create a new ASP.NET Web Form
 - "File" | "New" | "Web Site" | "ASP.NET WebSite"
- As usual the .aspx and .aspx.cs files will be in the default Server directory
 - C:\inetpub\wwwroot\project-name for an IIS Server
- Can then run the app from a browser on any machine
 - URL:
 - `http://machine-domain-name-or-IP-address/directory/app.aspx`
- DatabaseWeb.aspx example has same functionality as DataSelectRow example, but it's now a Web Form
 - Run it from a browser

Updating a Database

- Some actions:
 - update, add, insert, delete records
- All done in same way
 1. Fill a DataSet with the data from the database you wish to work with
 2. Modify the data contained in the database (update, add, insert, or delete records)
 3. After changes are made, persist the DataSet changes back to the database

Changing the Contents of a Database

- SELECT query strings retrieve data
- Other actions to change data in a database:
 - Updating, Adding, Inserting, Deleting records
- All done in the same way:
 - Fill a DataSet with data retrieved from a DataAdapter
 - As in previous examples
 - Modify (change, add, delete) the data in the DataSet
 - Use a CommandBuilder object associated with the DataAdapter
 - After modifications, persist the DataSet changes back to the database by calling `da.Update(....)`
 - This won't work without the CommandBuilder object
- See [DataUpdate06](#) for an updating example

Adding a Row

- Again set up a Connection and a DataAdapter
- Create a CommandBuilder object
- Create and Fill a DataSet
- Create a new row with DataSet Table's NewRow() method

```
DataRow dr = thisDataSet.Tables["Books"].NewRow();
```
- Give values to all its fields

```
dr["ISBN"] = "New ISBN";
dr["Title"] = "New Title";
dr["Author"] = "New Author";
```
- Add the row with the Table's Rows.Add() method

```
thisDataSet.Tables["Books"].Rows.Add(dr);
– Row will be added and Rows.Length property will be incremented
```
- Update DataAdapter to make change permanent

```
thisAdapter.Update(thisDataSet, "Books");
– Only the changed fields are updated
– Again, this will fail if there is no CommandBuilder object
```

Deleting a Row

- After setting up the Connection, DataAdapter, CommandBuilder, and DataSet:
 - Retrieve the rows to be deleted and use each row's Delete() method, for example:

```
DataRow[] rows = ds.Tables["Books"].Select(criterion);
foreach (DataRow r in rows) r.Delete();
```
 - Finally make change permanent with an Update(...):

```
thisAdapter.Update(thisDataSet, "Books");
```

Data Binding

- Connecting GUI controls to data sources
 - Any changes made to the underlying data source will be reflected in what is displayed in a data-bound control
 - Saving any changes made in data presented in a data-bound control will update the underlying data source
- Example:
- Set a DataAdapter's CommandText property to the SQL to be executed in a query:

```
thisAdapter.SelectCommand.CommandText = "SELECT ISBN, Title, Author FROM Books WHERE Title = 'Best Book';"
```
- The DataAdapters's Fill() member then causes its SelectCommand to execute and fill the DataSet with result of the query
- Then bind the result to a control such as a textbox
 - `textBox1.DataBindings.Add(new Binding("Text", thisDataSet, "Books.ISBN"));`
- Data will automatically be displayed in the textbox
- Example: [DataSQLSelect2007](#)

Using Visual Studio Designer to Set Up Access to the Data Base

- The tasks of setting up the DataConnection, the DataAdapter/DataTable, and the DataSet are automated
- In addition VS facilitates simple navigation through database tables with a BindingNavigator object
- Result is a database application with a LOT of functionality without writing any code

Creating a Data Base Project with Visual Studio 2005

- Start a new VS Windows Application
 - Change Name and Text properties
- Add a Data Source
 - Menu: “Data” | “Show Data Sources”
 - Brings up “Data Sources” Window
 - Click on “Add New Data Source”
 - Select “Database” and click “Next”
 - Click on “New Connection” button
 - In “Add Connection” dialog box:
 - Choose Microsoft Access Database File
 - Browse to directory containing the dbase file and Open it
 - Click “Test Connection” and then “OK”
 - Click “Next” and respond “yes” to question about copying files to your project folder
 - Click “Next” and the database objects in the DB will appear

- From Configuration Page called “Choose Your Database Objects”:
 - Expand the “Tables” node to view its tables and the fields in the tables
 - Expand the node and check the fields you want to access
 - (e.g., ISBN, Titles, Author)
 - Click on “Finish”

Using the Data Source in the App

- Menu: “Data” | “Show Data Sources”
 - Brings up a “Data Sources” Window
- Add Data-Bound Controls to the form
 - Expand the Books node in Data Sources
 - Drag each field node over to the form
 - Visual Studio will create data-bound text boxes with appropriate labels on the form
 - Other data-bound controls could be chosen
 - » Click down-arrow next to the data field in Data Sources window
 - Also creates a Binding Navigator tool bar underneath the form’s title bar
 - Permits adding, deleting, saving, and navigation through database
 - Also in area below the form a DataSet, a BindingSource, and a TableAdapter objects are created
 - TableAdapter is a single-table version of a DataAdapter
- Run the application
 - Lots of new toolbar functionality without writing any code!!

Adding a DataGridView Control to Form

- Displays all the records in the Database table in a spreadsheet-like format
- Very easy to use VS Designer to add the control:
 - Just drag the desired table from the Data Sources window
 - Resize resulting DataGridView control on the form
 - Run the program
 - DataGridView control is already connected to the database
 - If you click on any row in the grid the data in the other controls change to match the selected row
 - No code needs to be added – Visual Studio generated all the needed code

Using ADO.NET with Web Forms

- Because of client/server/client round trips and stateless nature of web pages, all controls must be explicitly bound
- Set DataBindings in form's properties window or in code
- Simple Data Binding
 - Connects one control to one data element
 - Use to display a field value in controls that display one item (e.g., listbox)
 - Do at design time using control's property window, or in code:
 textBox1.DataBindings.Add("Text", dsBooks1, "Books.Author");
 - Also, in a web app with a listbox, each time user makes a selection from the list, a postback occurs
 - After postback, the Web page redisplays and the Page_Load event occurs
 - Logic in Page_Load event handler must be modified or the dataset for the list elements will be re-created
 - Use the fact that a page's IsPostBack property is set to false the first time a page displays and true every time after that
- For list controls AutoPostBack property must be set to true for SelectedIndexChanged event handler to execute on the server

Some Code for Web Forms

```
private void Page_Load(object sender, System.EventArgs e)
{
    if (!IsPostBack)
    {
        daTitles.Fill(dsTitles1);
        titlesDropDownList.DataBind();
    }
}
```

Making ADO.NET Projects Portable

- When moving DB projects from one computer to another, connection information must be changed
- Database must be available on new computer
 - Or ConnectionString must specify where it is
- Easiest to put database file in the project's bin directory and change the DataSource in the ConnectionString in the Form_Load event handler:

```
Private void Form1_LOAD(object sender, System.EventArgs e)
{
    conRnR.ConnectionString =
        "Provider=Microsoft.Jet.OLEDB.4.0;DataSource=rnrBookd.mdb";
    daTitles.Fill(dsTitles1);
}
```

- DataSource can be another machine/file

LINQ – Language Integrated Query

- C# General purpose query language
 - New in .Net Framework 3.5 & VS 2008
 - Can query any data defined as an object, database, or XML
- See Deitel, et. al., “Visual C# 2008: How to Program,” Chapters 9, 20, 21

LINQ Queries

- General form:

- *var varName = from itemName in obectName where condition select fieldName|listOfFields|items* e.g.

```
var ltMinQuery = from anItem in amtDecimal where  
anItem < 100m select anItem;
```

Operator	Purpose	Example
from	name of a single element	from anItem
in	Specifies source of data (all elements to query)	in amtDecimal
where	Boolean expression that specifies query condition	where anItem<100m
select	Execute query, identifier determines type of data elements to be returned	select anItem