MOVES Training

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Expected Preparation

- Software installed (Java, MySQL & MOVES).
- Basic familiarity with the Windows operating system.
    - How to start a command prompt.
    - How to use Window Explorer.
- How to use Notepad or another text editor.
- Some familiarity with mobile source modeling techniques (such as MOBILE6).

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Course Objectives

- In this course, you will learn how to
  - Install MOVES (Done—Congratulations!).
  - Run MOVES from the GUI.
  - View and post-process output.
  - Edit, save, and modify Run Specifications (runspecs).
  - Use the summary reporter to generate output reports.
  - Provide detailed user input data to MOVES.
  - Access the additional features of MOVES.

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Course Objectives (cont.)

- Along the way, you will learn a little about how MOVES works

- Because MOVES is a little complicated and not idiot proof, you need to understand a little of how it works in order to troubleshoot your runs and look at its output critically.

- This training is <u>not</u> a substitute for reading the MOVES User Guide.

- For more on the schedule for MOVES, planned enhancements, guidance, and training, attend the <u>Mobile Source session Thursday morning</u>.

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Other potential topics, time permitting

- Whatever you would like!
- Configure MOVES.
- Look at distributed processing.
- Run MOVES from a command line.

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Logistics

- Hours: 1:00 PM - 5:00 PM
- One break
- Please turn off or set pagers and cell phones on vibrate
- If you need to talk on your cell phone, please leave the room.

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Logistics (cont.)

- For the hands-on exercises, I'll explain how to do it, then you do it, then I'll do it.
  - So pay attention rather than typing along.
  - <u>Work together</u> – you'll learn more.
  - If you finish an exercise, please help others who are having trouble.
  - Ask questions if you get stuck.
  - I'll be here after the session and all week.

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Questions

- Feel free to ask at any time--*if you are confused, so are other people!*
- The answer may be
    - I'll cover that later.
    - I don't know.
    - Out of the scope.
    - My brother knows the answer to that one.

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Miscellaneous

- Download the latest software and database: http://www.epa.gov/otaq/ngm.htm

- Important: subscribe to the mobile source listserver to learn about updates, bugs, fixes for MOVES.

- We won't be able to cover everything.

- You can ask questions later by phone or email.

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Resources

- Handouts—These Slides.

- The MOVES User Guide is in the Help menu of the MOVES GUI or can be printed from the Acrobat PDF provided with the software.

- MOVES Documentation at: http://www.epa.gov/otaq/ngm.htm, including the Software Design & Reference Manual.

- Sign up for the Mobile Source listserver.

- Email mobile@epa.gov with questions.

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What is MOVES?

- The **MO**tor **V**ehicle **E**missions **S**imulator
  - a consolidated emissions modeling system for onroad and nonroad emission inventories.
- Main use case:
  - Currently: MOVES estimates only energy usage.
  - Ultimately will replace MOBILE6 and NONROAD models.
- Combines a Java^{TM} framework with a MySQL database of input values.
- Capable of stand-alone or distributed processing.

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What is MOVES Demo?

- Highway vehicles only
- This demonstration version of the MOVES model contains only <u>placeholder</u> data values.
- The MOVES model GUI and these values will be changed in the final release.
- MOVES Demo (and MOVES2004) are <u>not</u> approved for official purposes.
- MOBILE6.2 is still the <u>official</u> EPA model.

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Will **I** need further training?

- This training only addresses the MOVES Demonstration version.

- This training will <u>not</u> cover any issues with the MOVES2004 version.

- Many changes are planned and additional training may be needed when later versions of MOVES are released.

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Changes Since MOVES2004

- Upgrade to Java 1.4.2_03
- Upgrade to MySQL 5
- New Features
  - Additional pollutants and processes (but no data).
  - Output summary reporting options.
  - Emission rate output option.
  - Pre-processor for I/M inputs.
  - Trip information input processing.
  - Performance features.
- Many more changes will occur!

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State of the software

- The most reliable functions are those already available using MOVES2004.
- MOVES Demo is still primarily a macroscale model.
  - Adding features in next draft to simplify county and project-level analysis.
  - User input features have not been fully implemented.
- The emission rates are still being changed and developed.
- Not idiot-proof—it helps to understand how it works.

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What's next?

- **Changing the way MOVES handles domains**
  - County and project-level domains

- **Adding data importers**
  - Allow simple direct input of local data, with some error checking and/or conversion from MOBILE format

- **There will be further discussion of the planned updates in the Mobile Source session Thursday morning.**

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How MOVES Works
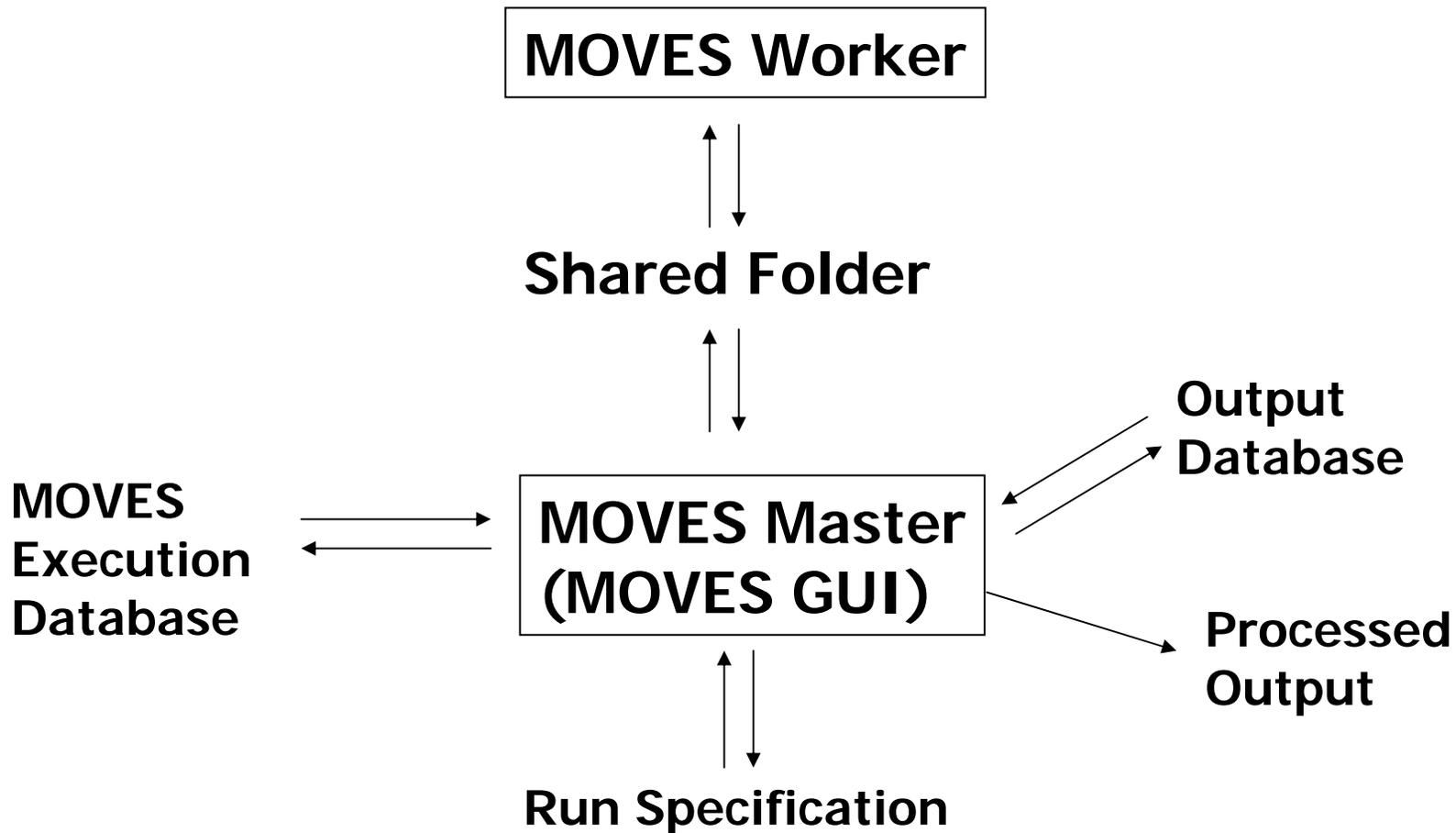
MOVES Default Database

- Similar to NMIM County Database.

- Includes county specific data:

  - Temperatures, relative humidity.
  - Fuel properties (gasoline and diesel).
  - Vehicle activity.

- Also, includes all national default values:

  - Emission rates and age deterioration.
  - Growth rates.
  - Vehicle technologies.
  - Adjustments for temperatures, humidity, fuels, etc.

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Exercise 1: Start Master Using Desktop Icon

- **Start the Master using the desktop icon.**
  - Notice the console window associated with the MOVES window.
- **Stop the Master.**
  - Note that console window closed.
- **If no Worker is present, one will automatically be started.**

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Help Menu

- "About MOVES" will tell you your version of the software.

- MOVES User's Guide
  - Also stored as an Adobe Acrobat PDF.
  - PDF is located in the Help subdirectory of the MOVES installation.

- MOVES Software Design/Reference Manual
  - Detailed description of how MOVES is works.
  - Also available as a PDF document.

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Exercise 2:
Create a RunSpec

- Start Master

- The Navigation List is in blue in the right hand side.

  - Green check means input is ready.

  - Red exclamation indicates more information is needed.

  - Wavy lines means no input is necessary.

- All Navigation List inputs must be green checked or wavy lines before MOVES will run.

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Exercise 2: RunSpec Description

- Description - Enter a brief description (optional)

  - This description will appear only in the runspec.

  - Do not use the five XML reserved characters: ' " < > &

  - <u>Enter a description</u> for your runspec.

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Domain

- Domain refers to the area to which "area wide" parameters apply.
- Some parameters are only allowed at a domain wide level.
- It may be necessary to have separate MOVES run specifications for areas using parameters that vary, but are only allowed at a domain wide level.
- Multiple MOVES run specifications can be run at once by running MOVES from a command line.

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Exercise 2: RunSpec Scale

- Scale relates to geographic detail:
    - "Macro" scale looks at counties with roadways aggregated – primarily for national analysis
    - "Meso" scale looks at counties or sub-county zones, with individual link specific results.
    - "Micro" scale looks at individual intersections or small portions of zones or roadways.
- MOVES Demo is primarily a macroscale model.
- <u>Choose Macroscale</u> for this trial runspec.
- Terminology is changing – future versions may describe these as national, county, and project-level
    - County and project levels will include look-up table option.

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Pre-Aggregation

- MOVES calculations can take a long time.
- Aggregation of inputs is one way to reduce the number of calculations and speed up a run.
- Aggregation of inputs will affect results; while aggregation of outputs does not affect results.
- Proper aggregation is a policy issue and will be addressed in guidance.

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Exercise 2:
RunSpec Geography

- Geographic Bounds – experiment with different options:
  - Region aggregates the inputs. <u>Choose County</u> for this runspec.
  - You can select multiple counties from multiple states.
  - <u>Select Cook County, Illinois</u> for this runspec.

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Exercise 2:
RunSpec Time

- **Time Spans – experiment with this screen:**
  - Time Aggregation Level pre-aggregates inputs.
  - Hours must be chosen in a range.
- **For this run specification:**
  - For Time Aggregation Level <u>choose Hour</u>.
  - <u>Select 1999</u>, click Add.
  - <u>Check July</u>.
  - <u>Check Weekdays</u>.
  - Choose a single hour: <u>Select 12:00 – 12:59 for both Start and End Hour</u>.

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Exercise 2: RunSpec Vehicles

- **Vehicles/Equipment**
  - Only onroad vehicles are available in MOVES Demo.
  - Experiment with this screen.
  - Choose a single vehicle class: <u>Select Gasoline/Passenger Car</u>
  - Click Add Fuel/Type Combinations

Exercise 2:
RunSpec Road Type

- Currently defined road types:
  - Rural Restricted Access (freeway)
  - Rural Unrestricted Access
  - Urban Restricted Access (freeway)
  - Urban Unrestricted Access
  - Off-Network
- <u>Select urban unrestricted access</u>.
- Click Add.

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Exercise 2:
Pollutant & Processes

- Multiple processes can produce the same pollutant.

  - E.g., gasoline evaporation and engine exhaust both produce HC emissions

- Each process will have different emission rates and results.

- Processes are always computed separately, but the results can be aggregated in the results.

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Exercise 2:
Pollutant & Processes

- Some pollutants are "chained" to others.
  - Check CO2 Equivalent/Running Exhaust.
  - This pollutant requires Atmospheric CO2.
- If you need VMT results, you must check the Distance Traveled here.
- <u>Select Oxides of Nitrogen (NOx), Running Exhaust</u>.

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Exercise 2:
RunSpec Manage Input

- **Manage Input Data Sets – <u>None</u>.**
  - All data inputs are located in MySQL tables.
  - Multiple input databases can be used simultaneously.
  - Database Server: localhost
  - Enter nothing. We'll talk about inputs later.

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Exercise 2: RunSpec Strategies

- **Strategies – <u>None</u>.**
  - Now: Alternative Vehicle Fuels & Technologies.
  - Other strategy use cases will be added here (e.g., retrofits).
  - We can talk about this later.

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Exercise 2:
RunSpec Output - General

- **General Output**
  - Create output database: <u>Enter Test1.</u>
    - Server can be left blank or localhost.
    - Push the Create Database button.
  - Select Output Units: <u>Grams, Kilojoules, Miles</u>.
    - You cannot select distance units if you did not select Distance Traveled in the Pollutants screen.
  - You can use the same output database for multiple runs. Each will be assigned a run ID number.

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Exercise 2:
RunSpec Output - Emissions

- **Output Emissions Detail**
  - Determines the amount of output aggregation.
  - Select <u>Hour and County</u>.
  - Select <u>SCC, Model Year and Emission Process</u>.
  - Estimate Uncertainty – Monte Carlo simulation. <u>Not now</u>.

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Exercise 2:
RunSpec Advanced Features

- **Advanced Performance Features**
  - This is an advanced feature primarily to reduce run time.
  - Save Data prevents MOVES from destroying intermediate result values from the MOVES execution database.
  - Don't Execute assumes that the results are already available in your input database.
  - <u>Don't use this feature until you understand it.</u>

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Exercise 2:
Saving Your RunSpec

- Save RunSpec -
  - Suggestion: Make a directory: RunSpecs
  - Suggested RunSpec name: test1.mrs
- Close RunSpec (File,Close)
- Reload RunSpec (File, Open)—are your saved choices still there?
- Are there only green check marks?

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Exercise 3: Waiting

- MOVES calculates both activity estimates and emission rates. <u>This will take time.</u>

- The more time periods, geographic locations, source types and pollutants you choose, the longer the run will be.

- You can monitor the activity:
    - MOVES GUI.
    - MOVES DOS window.
    - Shared Work folder.

- <u>Open the Shared Work folder</u> so that you can watch what happens.

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Exercise 3: Execute

- Select "Action" from top-level menu
- <u>Click Execute</u>. (Always save the RunSpec.)
- A Worker application will appear, unless one has already been started.
- Run is complete when navigation list returns (mine took only 2 minutes).
- Select Action, MOVES Run Error Log—any errors?

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MySQL Query Browser

- A handy utility for examining MySQL Databases and tables.

- Can modify individual entries in tables.

- Using MySQL scripts is superior because:
  - You can quickly modify many entries.
  - Scripts provide a record of what you did.

- See installation ReadMe.doc for installation and startup.

- Supported by MySQL.

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Exercise 4:
Where is the output?
(Introduction to MOVES's MySQL databases.)

- Open MySQL Query Browser.

- Find your output database: test1

- What are the six output database tables?

  - How many records are in each table?

  - What are the fields of each table?

- You may need to right-click to refresh the list of databases and tables.

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Exercise 4:
Output tables

- Look at <u>MOVESOutput</u>. Note all the cryptic (numeric) ID fields.

- Look at <u>MOVESActivityoutput</u>. Similar to MOVESOutput, but with distance values.

- <u>MOVESRun</u> contains information about the run (like run duration).

- <u>MOVESError</u>, <u>MOVESWorkersUsed</u> and <u>MOVESEventLog</u> tables are for run diagnostics.

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Exercise 5: Post Processing - MySQL scripts

- Select "Post Processing" from top-level menu.
- Choose Run MySQL Script on Output Database.
  - DecodeMOVESOutput will add fields which describe the meaning for many of the numeric ID fields.
  - MPGCalculator will convert energy units and distance to miles per gallon.
  - TabbedOutput will export the contents of the output tables to ASCII tab delimited files.

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Exercise 6: Post processing - Summary Report

- Select "Post Processing" from top-level menu.

- Choose Produce Summary Report.

- Choose the Process to report (or all).
  - Only the current output database is available.
  - Pollutants are reported separately.
  - "All processes" sums results by pollutant.

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Exercise 6:
Summary Report (cont.)

- Previous content of the report file is overwritten.
- Any run can be reported separately or in combination with other runs.
- Categories can be aggregated or reported separately and the order of sorting can be chosen.
- Results will be stored in a MySQL table.
  - Also display results on the screen.
  - Also write the results to ASCII text files.
- Three tables:
  - Header – description of the data sources for the report.
  - Body – results for fields chosen by the user.
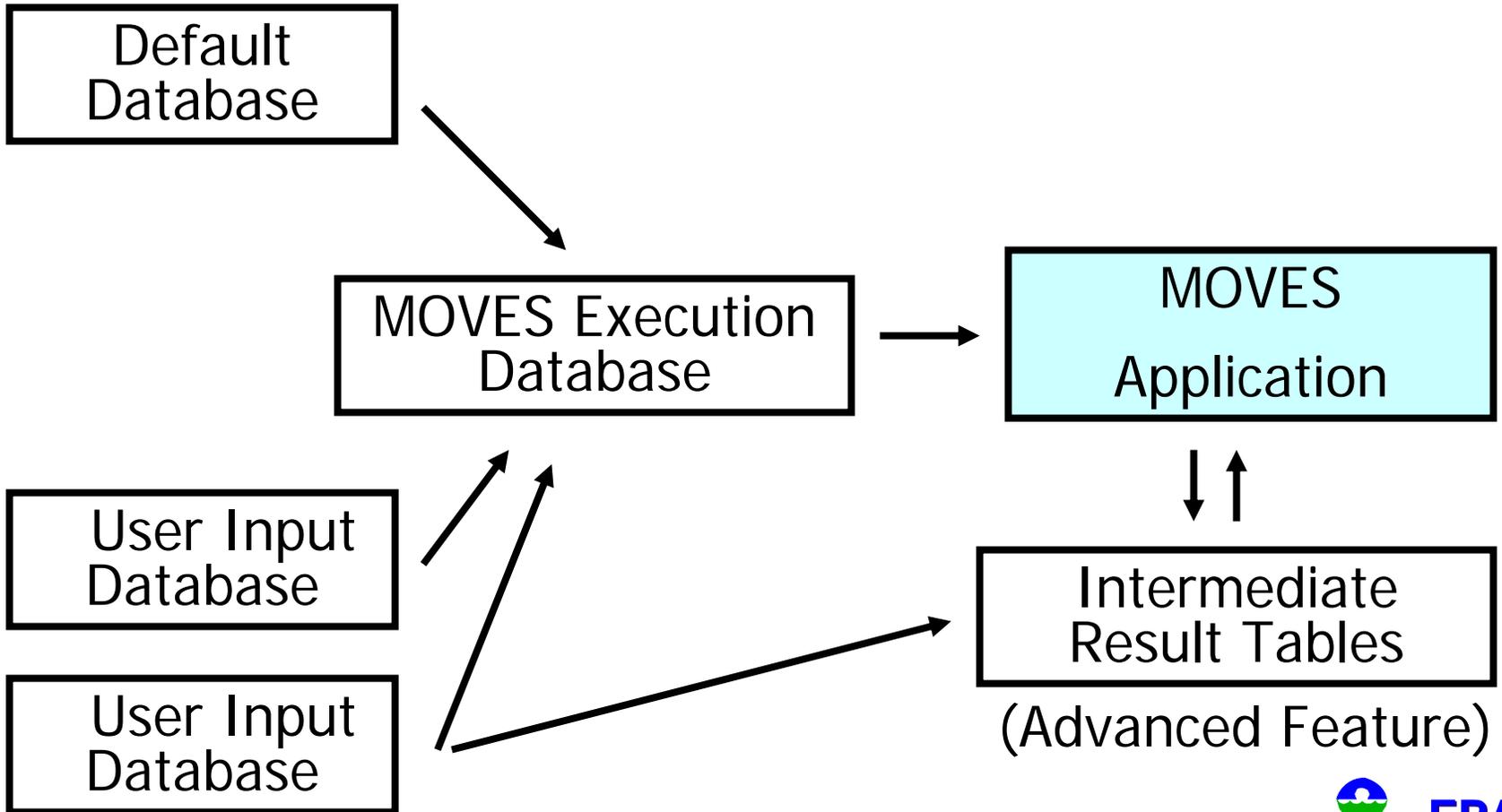 - Decode – description of categorical fields.

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Exercise 7: Post processing – Drawing Maps.

- Select "Post Processing" from top-level menu.
- Choose Produce State/County Map
- Choose database table that contains result values.
- Identify field with State or County FIPS.
- Identify field with results to display. All results will be aggregated regardless of type.
- Refine display options.
- Map can be saved as standard JPEG.

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User Input

- No additional input information is required if you use defaults.

- *All* default values can be altered using either GUI pre-processors or by providing alternate tables of data.

- Users may also substitute values for intermediate results that MOVES calculates.

- Guidance will describe what circumstances default values can be used for official submissions.

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User Input - Databases

Default
Database

MOVES Execution
Database

MOVES

Application

User Input
Database

User Input
Database

Intermediate
Result Tables

(Advanced Feature)

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Exercise 8:
Create an input database

- Created using the MOVES GUI.
- Select - Manage Input Data Sets
  - Enter a database name – use MyInputs.
  - Use the Create Database… button.
  - All database tables will be empty.
- Input databases and tables can also be created manually using MySQL commands.

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User Input – Pre-Processors

- Accessed from the pull-down menu.

- Allows users to create an input database with alternate input values directly from the MOVES GUI.

- Intended to be the primary way to include user supplied information.

- <u>Has not been fully implemented</u>.

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Input Pre-Processer: Update Future Emission Rates

- Allows the user to create energy, CH4 and N2O emission rates for alternative fuel and advanced technology vehicles.

- Creates an EmissionRate table within the input database.

- Developed for use by EPA. Not likely of value to most non-EPA users.

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Input Preprocesser: Edit I/M Coverage Records

- Displays the default descriptions of the I/M programs included in the run specification.

- Allows the user to change the description and save the results.

- Only needed to update default information.

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Exercise 9:
Edit I/M Coverage Records

- Select Display/Edit I/M Program Coverage Records from the Pre-Processor menu.

- Select Generate New and Replacement Records, without selecting any records.

- Select an existing database or enter an input database name and select Create Database.

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Exercise 9:
I/M Coverage (cont.)

- The I/M Coverage Categories screen can be used to add categories to the I/M program.

- Once categories are added they cannot be removed.

- Select at least one category from every section and choose OK.

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Exercise 9:
I/M Coverage (cont.)

- The I/M Coverage Details screen allows you to select the coverage for any of the combination of categories you selected in the previous screen.

- The Adjustment Fraction reduces or increases the full benefits estimated for the base I/M program.

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User Input Data Options

- Data can be organized using any application.
- Data must be imported into MySQL tables before it can be used by MOVES.
- Alternate methods:
  - Use GUI Pre-processors & Importers (preferred).
  - Importing using MySQL commands.
  - Adding or editing data using the MySQL Query Browser (QB).
  - Using other database applications to access MOVES MySQL tables.

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MOVES Input Database

- All input tables mimic default or execution tables.

- Tables are generally named in a way that suggests their primary key.

- Multiple input databases can be used simultaneously.

- Let's look.

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Exercise 10:
Update age distributions

- a. Create an input database. (Done!)
- b. Create a text file with registration (age) information.
- c. Write a MySQL script to import the text file into the input database table.
- d. Run the MySQL script.

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Exercise 10:
Create a text file to import

- Create a folder: C:\MOVES\Change
- Create an Excel spreadsheet (call it NewAgeDist.xls) in this folder.
- Put in the correct headings:
  - Use MySQL Query Browser to display the SourceTypeAgeDistribution table.
  - Put a field name at the top of each column.
- Find valid values for sourceTypeId.
  - Use MySQL Query Browser to display the SourceUseType table.
  - Choose the source type ID – select 21 (passenger car).
- Determine ranges for yearId and ageId.
  - Use MySQL Query Browser to display the AgeCategory table.
  - Use MySQL Query Browser to display the Year table. (Note that 1999 is a base year.) – use 1999.
- Enter 30 values which are each less than one and sum to one for each ageId.
- Save as comma-delimited (CSV) text.
- You could have created this text file with FoxPro, Access, Oracle, SAS, etc., etc.

Exercise 10:
Write a MySQL script

- **In the Change directory, create a new text file, and name it LoadAge.sql**

- **This script will**
  - add records if the primary key does not exist.
  - change records if the primary key does exist.

- **This kind of script can work for every single table.**

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Exercise 10:
Write a MySQL script (cont.)

- **In the script below, notice that**
  - We use a complete path for the input file.
  - <u>Forward</u> slashes separate directories
  - The order of variables must exactly match the order in the text file. The heading line in the text file is ignored.
  - "#" indicates a comment

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Exercise 10:
Final MySQL Script (cont.)

```
# MySQL Script to alter SourceTypeAgeDistribution table.

# Choose the input database to alter.
use myinputs;

load data
infile 'c:/MOVES/Change/NewAgeDist.csv'
replace
into table SourceTypeAgeDistribution
fields terminated by ','
ignore 1 lines
(sourceTypeId,yearId,ageId,ageFraction)
;
```

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Exercise 10:
Run the script

- Open a command window
- Type

`C:\mysql\bin\MySQL –vvv < c:\MOVES\loadage.sql`

- The –vvv means verbose
- Note that you can now run any MySQL script!

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Exercise 11:
Query the database

- We already did this sort of thing in Exercise 4

- Verify that our data got added:

  - Use the MySQL Query Browser
    or

  - MySQL>select * from SourceTypeAgeDistribution where sourceTypeId=21 and yearId=1999;

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Exercise 12:
Export a table

- Use the MySQL Query Browser.
  - Use File/Export Resultset.
  - CSV, HTML, XML, Excel and PLIST options.
- MySQL commands can also be used to export tables into text files.

```
select * into outfile
'c:/MOVES/roadtype.txt' from
roadtype;
```

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Running MOVES from the Command line

- Allows multiple existing run specifications to be run consecutively unattended.

- Allows other computer programs to run MOVES.

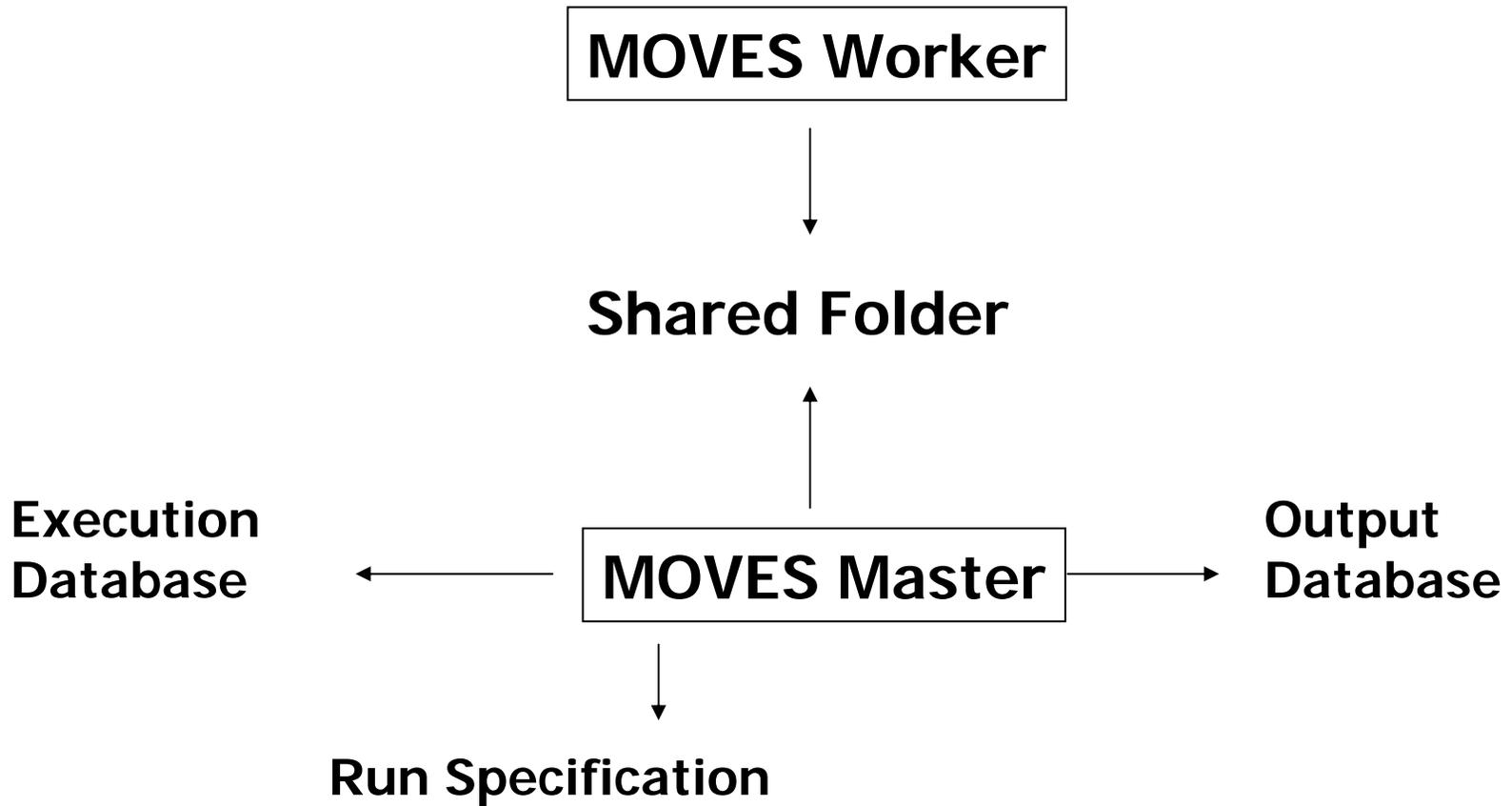- Described in the MOVES User Guide Appendix D.

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Run Specification Files: RunSpecs

- XML code that can be text-edited.

- Most codes are obvious or easy to figure out.

- Runspecs are best edited using the MOVES GUI to avoid problems.
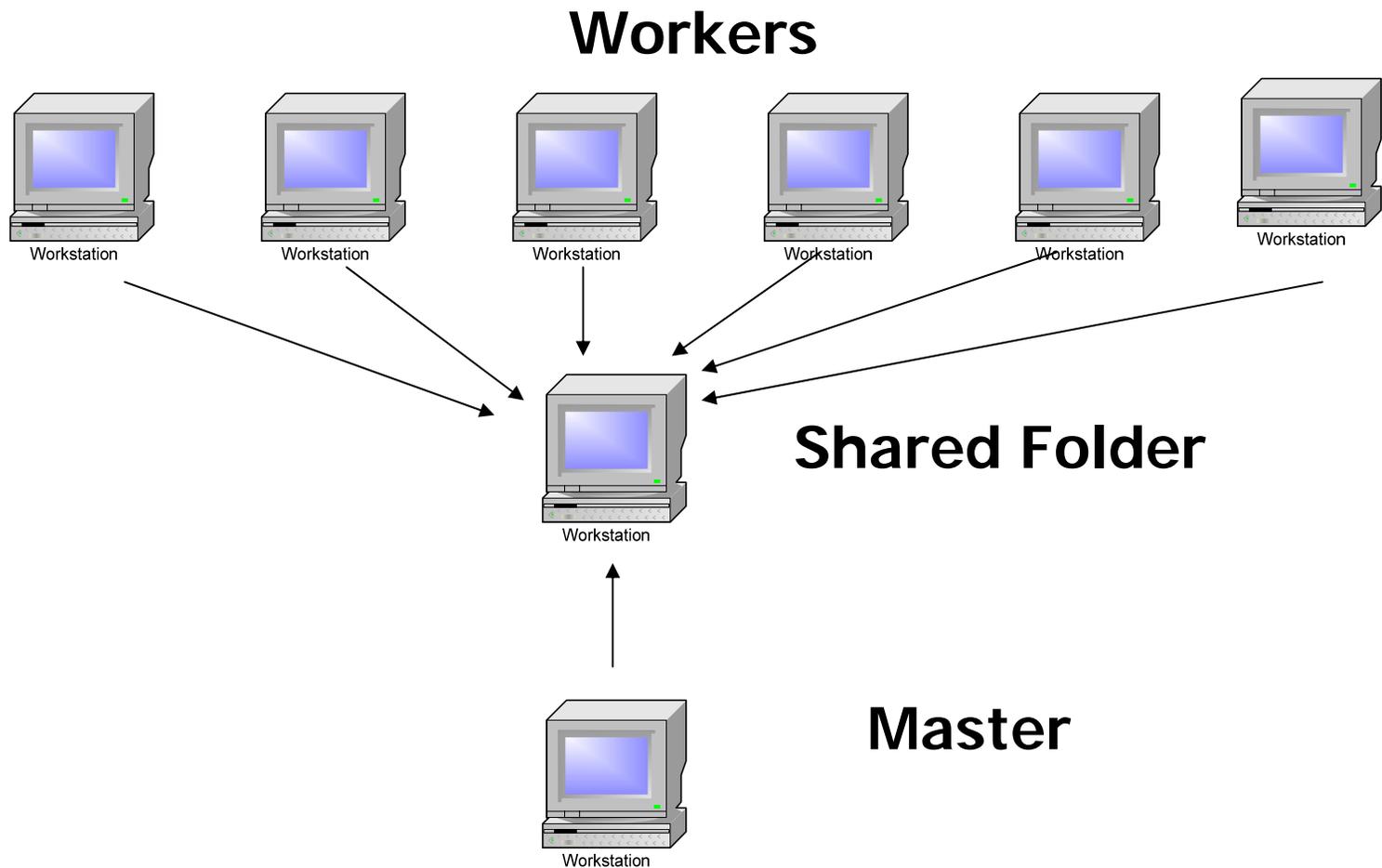
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Exercise 13: XML RunSpec

- Look at test1.mrs using a text editor
- Look at it using the MOVES GUI
- Extra
  - Change it using the text editor.
  - Look at the change in the MOVES GUI.
  - Change it using the GUI.
  - Look at the change using the text editor.

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Standalone Processing

MOVES Worker

Shared Folder

Execution Database ← **MOVES Master** → **Output Database**

Run Specification

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Distributed Processing

Workers

Shared Folder

Master

Distributed Processing

- Workers and Master must point to the same shared folder

- Run only one worker per machine (their temporary database tables will interfere with each other)

- If you have distributed workers, there is no point in running a worker on the Master machine.

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Gotchas

- Limit your run specification to just what you need.

- Organize your inputs and outputs so you don't get confused.

- Use naming conventions to help you identify files.

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Concepts

- **Don't mix up databases and tables.**
  - Databases are collections of tables.
  - The tables contain the information.
- **Don't alter the EPA default database.**
  - All new information you want to use can be included in an input database.
  - Changing the defaults, without changing the database name, will cause confusion.
  - You can create your own default database.

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Concepts (cont.)

- Aggregation of input reduces run time, but is not the same as aggregation of output.

- Many inputs are "domain wide", limit each RunSpec to a single domain.

- Not all calendar years are base years. Non-base years are projected.

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Concepts (cont.)

- Time is generic. You need to enter data to get a specific time.

- The "off network" road type is a catch-all for any highway vehicle emissions that are not directly associated with specific roads on the network roadways.

- Your own data may be able to be used in intermediate tables directly.

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MySQL

- The MOVES input database is in MySQL
- MOVES output is stored in MySQL.
- Documentation on your hard drive: c:\MySQL\Docs
- Web URL: www.mysql.com
- Worth understanding at least a little about it
- Putting C:\mysql\bin in your path will allow you to run from DOS from any directory.

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Structure of MySQL Databases

- C:\MySQL\data
- Each folder is a separate database.
- Each table consists of three files:
  - .MYD - the data
  - .MYI - the index
  - .frm - the format
- To copy a table you must copy all three files.

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Microsoft Access Database Program Can Be Used as As a Front End for MySQL

- Get ODBC Driver - free download from MySQL.com
  - MyODBC-standard-3.51.07-win.exe
  - Install by clicking on it
- Set up ODBC connection for your MySQL DB
  - Start, settings, control panel, administrative tools,
  - data sources, System DSN tab
  - Add
  - Choose Driver (MySQL ODBC 3.51 Driver), Finish
  - Data Source Name and Database Name: County20040508
  - OK

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Microsoft Access (cont.)

- Open Access
- File, new, blank database
- Create where you want it
- File, get external data, link tables
- Files of type: "ODBC databases"
- Machine databases tab
- Select database name, OK
- Link Tables, Select all, OK

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There are Three MOVES Configuration Files

- Initial configuration is done during installation.

- MOVESConfiguration.txt
  - Default MOVES database.
  - Path to SharedWork folder.

- WorkerConfiguration.txt
  - Path to SharedWork folder.

- Setenv.bat
  - Paths to Java & its libraries.

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MOVESConfiguration.txt

- Must point to a valid MOVES default database.
- Shared folder must already exist.
- Identifies location of GREET application.
- Use "localhost" for the server names.
- ComputerID helps identify results.

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WorkerConfiguration.txt

- Shared folder must already exist.

- Worker will only do work that is placed in the shared folder, so this folder <u>must</u> match the shared folder used by a Master.

- ComputerID helps identify results and locate problems when there are multiple workers.

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Exercise 14:
Examine MOVE Configuration

- Open the MOVESConfiguration.txt file.
  - What is the default database?
  - Where is the shared folder?
  - What is the master name?
- Open the WorkerConfiguration.txt file.
  - Where is the shared folder?
  - Is it the same as the MOVES master?
  - What is the worker name?

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Appendix A: Uninstalling MySQL

- When you update MySQL it is sometimes safer to uninstall your current version.

- Step 1: Back up your data.

  - Copy the contents of the MySQL\Data folder to a backup location.

  - Copy any runspecs or other user created files to a backup location.

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Appendix A:
Uninstalling MySQL (cont.)

- Step 2: Stop MySQL.
  - Open a DOS command line prompt window. Use the following commands:
    - C:\
    - CD \
    - Net stop MySQL
    - C:\mysql\bin\mysqld-max-nt.exe –remove MySQL

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Appendix A: Uninstalling MySQL (cont.)

- Step 3: Uninstall MySQL from Windows.
  - Under Windows Start go to Settings/Control panel.
  - Run the Add or Remove Programs.
  - Find and Select MySQL Servers and Clients.
  - Click the Change/Remove button.
  - Remove MySQL.

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